

Intelligent Cargo Systems study (ICSS)  
Impact assessment study on the introduction of  
intelligent cargo systems in transport logistics industry

PTV Planung Transport Verkehr AG

and

ECORYS Nederland B.V.

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# Contents

<b>1</b>	<b>Introduction .....</b>	<b>9</b>
1.1	Background .....	9
1.2	Aims of the study .....	9
1.3	Definitions and terminology .....	10
<b>2</b>	<b>Framework for Intelligent Cargo systems .....</b>	<b>14</b>
2.1	Scope of framework .....	15
2.2	Development directions of IC applications (categorization) .....	16
2.3	The criteria for Intelligent Cargo Systems .....	27
<b>3</b>	<b>Interviews .....</b>	<b>29</b>
3.1	Overview of conducted interviews .....	29
3.2	Feedback on criteria and applications .....	30
3.2.1	Autonomous systems on cargo level	30
3.2.2	Paperless documentation	31
3.2.3	Self and context awareness	32
3.2.4	Secure information access	33
3.2.5	Ubiquitous data availability	33
3.2.6	Bi-directional communication	34
3.2.7	Standard data formats	34
3.2.8	SME Inclusion	35
3.3	Major changes as expected by experts .....	35
3.4	Impacts expected by the experts .....	36
3.5	R&D focus and development path .....	38
3.6	Interim conclusions - summary .....	40
<b>4</b>	<b>Scenarios .....</b>	<b>41</b>

4.1	Scenario building approach .....	41
4.2	Description of scenarios .....	44
4.2.1	Reference scenario .....	44
4.2.2	Realistic future .....	47
4.2.3	Visionary future .....	49
<b>5</b>	<b>Impact assessment regarding the scenarios.....</b>	<b>52</b>
5.1	Approach .....	52
5.2	Impact chains .....	53
5.2.1	Use Case 1 .....	56
5.2.2	Use Case 2 .....	64
5.2.3	Use Case 3 .....	68
5.2.4	Use Case 4 .....	71
5.2.5	Use Case 5 .....	74
5.3	Impacts on efficiency and sustainability .....	78
5.3.1	Impacts overview .....	78
5.3.2	Impacts of the realistic scenario .....	81
5.3.3	Impacts of the visionary scenario .....	90
5.3.4	Analysis of results .....	94
5.4	Impacts on safety and security .....	96
5.5	Conclusion.....	100
<b>6</b>	<b>Migration path and recommendations .....</b>	<b>101</b>
6.1	Paradigm shift.....	101
6.2	Migration path to the visionary scenario .....	102
6.2.1	ICT requirements .....	107
6.2.1.1	SOA and Cloud computing.....	108
6.2.1.2	Intelligent tags, RFID and Identification .....	109
6.2.1.3	Data security and privacy.....	111
6.2.1.4	Communication, services and applications.....	112
6.2.2	Other requirements .....	115
6.2.2.1	Data standardisations and interoperability.....	115
6.2.2.2	SME involvement .....	117

6.3	Cost/benefit reflection .....	118
6.3.1	Realistic scenario	118
6.3.2	Visionary scenario	121
6.4	Conclusions and recommendations on migration paths .....	123
<b>7</b>	<b>Annex 1 – Input data and assumptions .....</b>	<b>126</b>
<b>8</b>	<b>Annex 2 – Descriptions of the applications .....</b>	<b>128</b>
<b>9</b>	<b>Annex 3 – Questionnaire for interviews .....</b>	<b>198</b>
<b>10</b>	<b>Annex 4 – Interview evaluation.....</b>	<b>202</b>
10.1	Evaluation Question 1 – realisation of Intelligent cargo systems...	202
10.2	Evaluation Question 2 – expected major changes in transport systems.....	206
10.3	Evaluation Question 5 – socio-economic impacts .....	206
10.4	Evaluation Question 6 – focus of future research activities .....	207

## Figures

Fig. 1: Area of analyses and allocated criteria	14
Fig. 2: Selection and description of intelligent cargo applications	15
Fig. 3: Evaluation of completeness of applications categories	36
Fig. 4: Impacts expected on logistics processes	37
Fig. 5: Legend to the impact chains within the Use cases	55
Fig. 6: Migration path	103
Fig. 7: The development phases of the migration path	104
Fig. 8: Concept of Cloud-Computing	108
Fig. 9: Standards and their adoption rate across different sectors	116

## Tables

Table 1: Categories of applications	16
Table 2: Allocation of criteria to projects – part I	27
Table 3: Allocation of criteria to projects – part II	27
Table 4: Number of allocated criteria with regard to applications	28
Table 5: Conducted interviews per group	30
Table 6: Scenarios regarding the categories	43
Table 7: Overview on efficiency and sustainability impacts	78
Table 8: Impacts overview for UC1 of the realistic scenario	83
Table 9: Main impacts for UC1 of the realistic scenario	84
Table 10: Overview impacts UC2 realistic scenario	85
Table 11: Main impacts of UC2 realistic scenario	86
Table 12: Overview impacts of UC 3 realistic scenario	86
Table 13: Main impacts of UC3 realistic scenario	88
Table 14: Summarized impacts of the realistic scenario	88
Table 15: Overview impacts for UC4 in visionary scenario	90
Table 16: Main impacts for UC4 in visionary scenario	91
Table 17: Overview impacts for UC5 in visionary scenario	92
Table 18: Main impacts for UC5 in visionary scenario	93
Table 19: Summarized impacts of the visionary scenario	93
Table 20: Main impacts of the two scenarios	95
Table 21: Overview of impacts of the use cases	97
Table 22: Structure and systematic of safety and security impacts	98
Table 23: Road safety data in EU 27 (2006)	99

Table 24: Reduction of km and fatalities, injuries – realistic scenario	99
Table 25: Reduction of km and fatalities, injuries – visionary scenario	100
Table 26: Overview EC related measures	106
Table 27: Industry specific standards (examples)	115
Table 28: Costs and benefits for the EU	123



# **1 Introduction**

## **1.1 Background**

Transport is a key enabler for the development of economies and societies by facilitating the movement of goods and people. The transport industry accounts for 7% of European GDP and for around 5% of its employment. The growth of goods transport within the EU, at a rate of 2.8% per year, was broadly in line with economic growth, which was 2.3% on average in the period 1995–2004. Overall, goods transport grew by 28% and passenger transport by 18% during the period 1995–2004.

The mid-term review of the 2001 White Paper stresses the key role of logistics in ensuring sustainable and competitive mobility in Europe and contributing to meeting other objectives, such as a cleaner environment, security of energy supply, transport safety and security. In 2007, the European Commission published a Freight Logistics Action Plan as one of a series of policy initiatives jointly launched by the European Commission to improve the efficiency and sustainability of freight transport in Europe. In this action plan, it is indicated that advanced information and communication technologies can contribute to a more efficient freight transport system. These technologies may even lead to a paradigm shift for the whole freight transport sector, to the concept of “intelligent cargo”.

## **1.2 Aims of the study**

The main objective of this study is to perform an analysis of information and communication technologies' (ICT) potential to increase efficiency of freight transport. The results of the study will support the decision processes on relevant European policies in the area of ICT for freight transport by providing independent assessment of direct and indirect impacts of intelligent cargo systems.

The Intelligent Cargo Systems Study (ICSS) will provide a description on the state of the art of intelligent cargo applications and the users and expert views on the development. The next step will be to develop one or more scenarios of future transport logistics applications based on intelligent cargo technologies. Further more an analysis of the impacts of intelligent cargo systems addressing efficiency, sustainability, safety and security issues will be carried out. This analysis will be focused on the socio-economic impacts.

Final output will be the description of a migration path from the current situation to the scenario with the highest potential. A specific care will be given to this part of the study.

This report builds up upon the inception report describing the general framework of the study as well as on the interim report, which contains the results from the expert interviews and the development of the reference scenario and the 2 future scenarios on Intelligent Cargo Systems. This final report is covering the overall results of the study integrating findings out of the Impacts Assessment and the Migration path.

### **1.3 Definitions and terminology**

In previous initiatives the terminology of Intelligent Cargo Systems has been addressed under different perspectives. In the following a short outline of related definitions developed by different EC units is given.

#### *ICT for mobility services for goods*

Mobility services subsume the services to physically move goods as well as the services to enable, to improve or to support freight transport. Information and communication technologies (ICT) play a dominant role in this latter group of services and a key objective is to improve logistic operations' performances. Optimisation in the management of the transport chains, exploitation of new technologies (such as RFID and Smart Tags, advanced ICT platforms and common application architectures), promotion of co-modality and exploration of the potential of advanced urban logistics solutions for sustainability remain on the top of the research agenda. Other areas have been identified, but not promoted with the necessary emphasis yet. In addition to security issues in general and hazardous goods transportation more specifically, international co-operation in global supply chains and advances in ICT services for freight collection and delivery need to be addressed in the near future.

#### *e-freight*

The e-Freight concept as outlined in the "Freight transport logistics action plan" denotes the vision of a paper-free, electronic flow of information associating the physical flow of goods with a paperless trail built by ICT. It includes the ability to track and trace freight along its journey across transport modes and to automate the exchange of content-related data for regulatory or commercial purposes

This will be made more practical and affordable by emerging technologies such as RFID and the use of the Galileo satellite positioning system. Freight should be identifiable and locatable regardless of the mode it is transported on. A necessary

condition for this is that standard interfaces within the various transport modes are put in place and their interoperability across modes is assured.

### *Intelligent Transport System*

Intelligent transport systems (ITS) are under development for many years. Their focus is traditionally on managing traffic as a whole and on developing intelligent vehicles to ideally suit their tasks and to optimally behave in traffic situations with others. The “Action Plan for the development of Intelligent Transport Systems in Europe” defines “Intelligent Transport Systems” by the application of Information and Communication Technologies (ICT) to transport. But there are also ICT developments and solutions which can be directly associated with intelligent cargo systems and which directly address the more logistics functions and the freight transport specific aspects which are not shared with passenger transportation. Several approaches can be identified which address many different aspects of intelligent cargo system that are presently being discussed in EU policy. These applications are being developed for different transport modes and for interaction between them (including interchange hubs).

Examples on “Intelligent Transport Systems” are:

- *SESAR* as air traffic management system
- *RIS* to manage waterway utilization
- *ERTMS* as rail traffic management system
- *TAF-TSI* as Telematics application
- *VTMIS* as vessel traffic monitoring and information system

### *Intelligent Cargo*

A further definition towards “Intelligent Cargo Systems is given in the ICSS project underlying tender specifications. The term “Intelligent cargo” means goods which are self aware, context aware and connected through communication networks delivering a wide range of information services. Information systems based on the Intelligent Cargo concept will allow secure access to cargo information and related services by a wide variety of industrial and public sectors (user, transport industry, customs). Intelligent Cargo systems will modify rather static, inflexible information exchange infrastructures into a dynamic and flexible environment with easy, on-the-spot access to the information needed. This cargo infrastructure will give even the smallest logistics providers the opportunity to create, discover, and use intelligent services tied to single cargo items or the complete supply chain.

### *Internet of Things*

The Internet of Things is first of all a very broad term which expresses a future where items in the real world can exchange information with each other. In transport and logistics the concept of Internet of Things refers to the electronic networking of cargo units with each other but also with infrastructure elements along their transport path and finally also with mobile devices. Main characteristic is that these items can be individually addressed and contain a certain level of intelligence allowing for an autonomous communication with other units.

The amount of information should go beyond the information on the identification, as provided by barcodes. Communication should take place without a human interface. Therefore, RFID is an enabling technology for the concept of Internet of Things. A definition on the Internet of Things was given by the Fraunhofer Institute IML stating that RFID in combination with logistics is the Internet of Things- RFID is organizing and controlling cargo units in movement. First applications on the Internet of Things are running in the intra logistics of manufacturing and retail companies using mainly passive RFID tags. Approaches and examples to extend the concept along the supply chain (extra logistics) are taking place on a container level with active RFID tags.

RFID provides key technological feature to enlarge the information basis of objects and gives each object a unique identification. Major objects that are linked to RFID are:

- Improvement of processes along the transport chain
- Enhancing the (delivery) reliability
- (real time) Tracking and tracing of objects

Overall RFID provides possibilities for a proactive organization of transport chains, since e.g. losses of objects/consignments are recognized when the shipment is broken up, but when the next scan is taking place.

In intra logistics approaches on data-on-tag characterized by an autonomous planning and organization of cargo movement are already realized. Similar examples for self autonomous systems in extra logistics do not exist, yet. Main technologies for realizing autonomous/intelligent systems are software agents that establish contact with other agents, react on the environment and have capabilities for own decision making. Routing is a further key functionality of intelligent units in the Internet of Things.

An extension of the intra logistics concept addresses the following aspects:

- The tracing of intra and extra company cargo flows
- Optimization of processes (warehousing, sequence of transport etc.)
- Autonomous identification of events and the generation of decisions
- Visualization and control of the transport chains

A main technical problem of such an extension is that especially on global process level an explosion of information and the number of possible decision and the related data volumes will take place. A target leading approach for realizing the Internet of Things in an extended environment is:

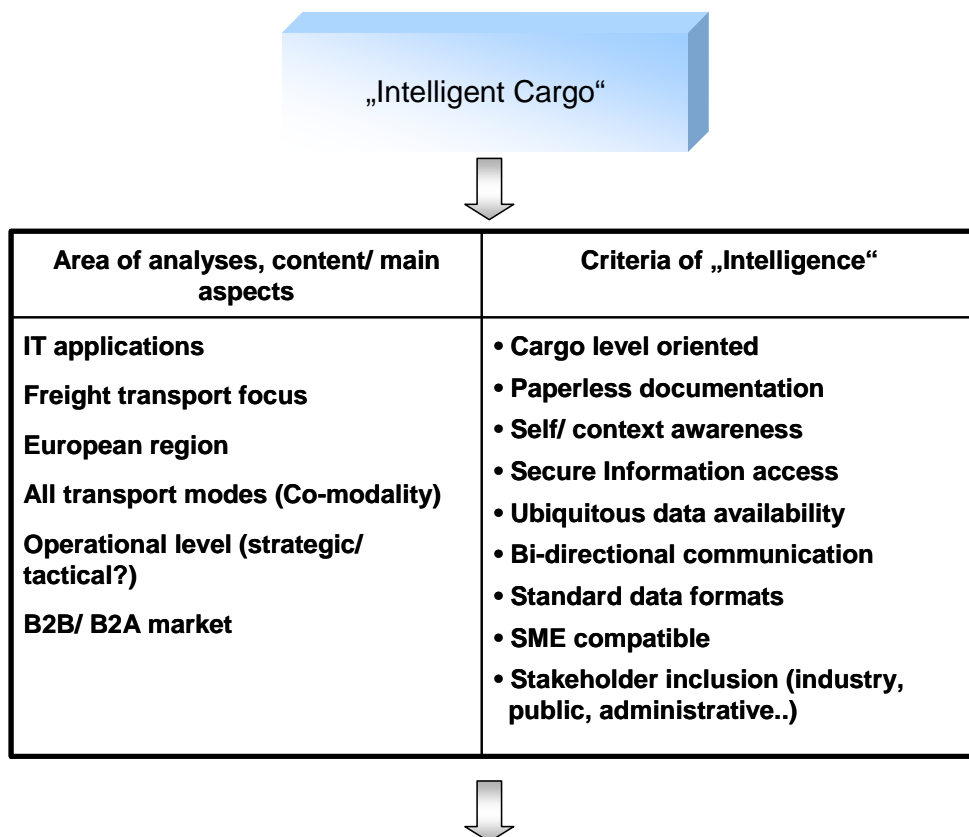
- To place all relevant information on the cargo
- All relevant information is at place to make decisions on site and in real time
- The information at cargo level is capable to negotiate interfaces successfully

## 2 Framework for Intelligent Cargo systems

The vision on the scope of the study is based on two pillars: the area of analyses and the criteria for intelligence. The area of analyses should be focused on IT applications which are being developed to support the processes in the freight transport sector. Additionally it is considered that in principle all transport modes are covered and that the study is limited to Europe.

Criteria have been used to identify appropriate intelligent cargo solutions which are of major importance for the impact assessment study. These criteria are the main basis to carry out a screening of relevant projects / applications and approaches in order to narrow down the “intelligent cargo world” and to focus on the most relevant innovation streams. The following figure presents in detail the area of analyses and the criteria that will be applied to decide whether applications are intelligent.

**Fig. 1: Area of analyses and allocated criteria**



Project/ innovation/ approaches overview			
Project title/ Acronym	Status	Innovation approach, Objective	Area of analysis, content/ main aspects
SMARTERIGHT	Execution		ICT applications

Overview, list of projects, approaches, applications  
(which are related in a way)

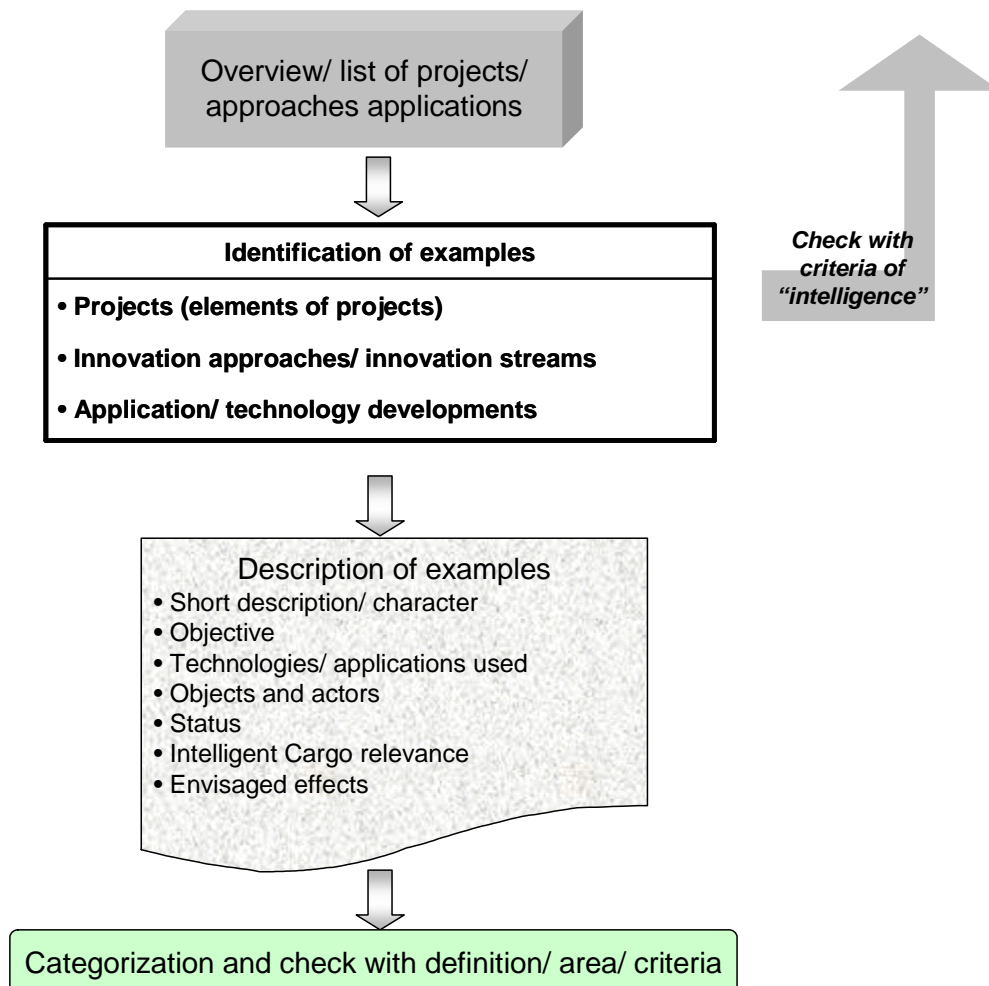
Based on the definitions and the main focus on “Intelligent cargo systems” of this study the framework, the scope and analyses of the projects can be derived.

## 2.1 Scope of framework

The framework of the analyses determines the first two working steps: (i) structured review of the state-of-the art of intelligent cargo applications and (ii) interviews.

The overview of state-of-the-art applications and technologies for intelligent cargo systems consists of different project approaches, innovations and technologies/ applications.

**Fig. 2: Selection and description of intelligent cargo applications**



## 2.2 Development directions of IC applications (categorization)

The state-of-the-art ICT applications/ projects identified regarding Intelligent Cargo Systems have been described in a common framework. All in all 35 applications/ projects have been collected. The descriptions can be found in the Annex 2.

In order to get a structured overview the applications can be categorized under the following headlines:

- 1) *Dangerous goods applications*
- 2) *Intelligent loading unit (e.g. track and trace)*
- 3) *Intelligent agent / mesh network applications*
- 4) *Freight/Cargo architecture/ frameworks*
- 5) *RFID applications*
- 6) *Sensor related applications*
- 7) *Web based applications/ platforms*
- 8) *Other applications/ projects which are connected to intelligent transport systems*

The allocation of projects/ applications to the different categories is depicted in the following table:

**Table 1: Categories of applications**

<b>Categories and projects/ applications</b>	<b>Short descriptions</b>
<b>1. Dangerous goods applications</b>	
Advanced Tracking System - ATS	Tracking in waste transport management
TRAMP	Monitoring of hazardous goods on road transport
CVIS/CF&F	Cooperative systems for dangerous goods guidance and monitoring, access control and parking management
GoodRoute	Routing/ monitoring system for dangerous goods
Hazardous Material Tracking	Vehicle tracking and location monitoring of hazardous material
CARIN	EDI on dangerous goods on inland WW vessels



<b>2. Intelligent loading unit (for example track and trace applications)</b>	
Integrity	Intermodal container supply chain visibility
Secure Trade Lane	Intelligent cargo tracking with open standards
SMART-CM	Smart container chain management
Cargobox	Intelligent cargo container for multi-modal use
INWEST	Intelligent container tracking and tracing
Intelligent container	Autonomous transport monitoring system (for perishable and sensitive goods)
Intelligent container seal	Security seal for tracking of container
<b>3. Intelligent agent/ mesh network applications</b>	
I-Scheduler for road transportation	Multi-agent architecture to handle large logistic networks
MECD	Mobile edge computing devices
<b>4. Freight/cargo architecture/ frameworks</b>	
FREIGHTWISE	Intelligent Intermodal Management Framework
KOMODA	eLogistics System supporting co-modality
EURIDICE	Intelligent cargo architecture Europe-wide
ARKTRANS	Multi-modal system architecture for freight and passenger transport
SMARTFREIGHT	Integration of traffic and freight management in urban areas
<b>5. RFID applications</b>	
SmartTruck (or webbased applications)	Integration of RFID, traffic information and transport planning for enhanced vehicle monitoring
LAENDmarkS	Tracking with enhanced RFID for supply chain in car industry
Mobile SLK	Real time track and trace with GSM
Smart packages	RFID use in logistics chain of military and defence
KO-RFID	RFID-network structure for different value chains
LogNetAssist	Assistance system for steering of intelligent logistics networks
RTLS	Location system for passenger cars based on RFID
<b>6. Sensor related applications</b>	
RAEWatch sensor module	Sensor for monitoring intermodal shipping container
Truck intelligence work attendance system	Vehicle weight and driver attendance monitoring
VitOL	Intelligent sensor nodes for cargo and infrastructure
Machine Talk	Real-time monitoring of particular values

<b>7. Web based applications/ platforms</b>	
Cargoreservation.com	Real-time cargo tracking system for air-freight
ELOGMAR-M	Web-based solution for collaborative logistics and maritime applications
<b>8. Other</b>	
IATA e-freight	e-freight business process for air cargo
E-train	GPS/GSM real time train monitoring

Within the categories the different applications focus on a wide range of technologies, services, management issues, concepts, frameworks and criteria which are related to Intelligent cargo/ transport system aspects. The categories chosen are not free from overlaps. Thus, it can be stated that the applications have been allocated according to their main focus.

**1. *Dangerous goods applications* → Focus on tracking, monitoring and paperless documentation of hazardous/ dangerous goods**

The applications on dangerous goods that have been identified generally aim to monitor the transport of dangerous goods. Another single application focuses on the paperless handling of dangerous goods transport. The general development direction is towards a stronger real time monitoring of the movements of dangerous goods, but with different ambition levels. These ambition levels vary from knowing where the dangerous goods are, to being informed that the transport of goods deviates from an agreed route to re-routing enforcement and driver support if such deviation is determined.

There are a number of technologies involved in these applications. Common technologies are:

- GPS for positioning information (in combination with EGNOS in one case)
- Mobile communication (e.g. GPRS)
- Sensors to monitor the status of the dangerous goods

The different applications then apply a set of different additional techniques for their own application purposes, such as ZigBee wireless solutions and RFID.

There are a number of impacts foreseen by these applications:

- Improved efficiency of monitoring: authorities responsible for monitoring have more and real time data available that improve the efficiency of their tasks.
- Improved efficiency of the transport of dangerous goods: reduction of trip length due to better optimising of routes.

- Improved safety: the applications enable a better risk management, and enable authorities to optimise emergency management if accidents occur.
- Improved security: part of the dangerous goods can be applied for unlawful event. The improved monitoring enables authorities to remotely disconnect the truck engine if the transport deviates from its route.

The applications identified generally involve all actors in the chain: shipper, forwarder, LSP, driver, consignee operator, public authority and recipient. Clearly, most impact is for the public authority (who can now better monitor the transport), the LSP and the driver who knows he is constantly monitored.

One project is about paperless documentation regarding dangerous transports, in which a platform has been developed for exchanging the information electronically. This implies that authorities receive the relevant information in advance, and are able to analyse that information. In return, transport operators are refrained from police control of shipments. This concerns inland waterway transport of dangerous goods.

## **2. *Intelligent loading unit (track and trace)* → Cargo loading unit related tracking and tracing applications enhancing loading unit chain management**

Intelligent loading units provide technologies for tracking and tracing of loading unit related information. Loading unit tracking devices and applications monitoring loading units along the transport chain are to be distinguished. Intelligent loading unit applications typically provide sensor systems to track the transport or cargo related parameter and indicators, a RFID system to identify and inform on the cargo and a CPU and communication system. With regard to autonomous decision making intelligent cargo need to be capable to react on changes and to communicate with planning systems, e.g. for rerouting or to change stop sequence.

The project screen within ICSS showed a number of applications providing examples on intelligent loading unit approaches:

- The intelligent container seal provides an example for a seal that combine a reusable hardened cargo security seal with an USB digital memory storage device. Electronic data such as manifest information, photographs, customs documentation, packing instructions, MSDS sheets, and biometric signatures can be securely stored within the container security seal. This data is accessible using most laptop, handheld or desktop computers.
- The FP7 projects SMART CM and INTEGRITY are examples for integrated applications for intelligent loading unit application integrating

different stakeholders sharing information to improve the security of global loading unit transport.

- To improve the supply chain planning INWEST is surveying the capabilities of intelligent loading unit solution in combination with planning systems.

One of the criteria of intelligence is the cargo level orientation. The focus regarding cargo level in this category is lying clearly on container units. Besides the container devices some projects are dealing with management issues of loading unit transport chains. The envisaged effects of these projects or applications can be summarized as follows:

- Improved data availability and access
- Improved security in loading unit logistics
- Improved supply chain planning

Technologies mainly used are sensors and RFID systems. Partly, communication links are provided for real time tracking and tracing applications. Main drivers for intelligent devices at loading units are electronic seals in order to meet requirements as set by the US customs. The connection of loading unit seal and real-time tracking applications is an approach to combine security related issues with the improvement in the supply chain management and is explicitly part of some loading unit related projects. Actors which are being addressed by those projects are mainly logistics service providers, ports (authorities) and shipping companies.

Key issues in this field are:

- Development of an affordable device for the collection, storing and transferring of cargo related data
- Attachment of this device in a secure and robust way to the loading unit for the prevention of losses, damages and data manipulation etc.
- Enabling communication processes with different systems and actors
- The enhanced information flow to/from loading units is a major step towards intelligent cargo systems.

### **3. *Intelligent agent / mesh network applications* → Network applications for logistic management**

Intelligent agent technology is based on using a system of software agents. Software agents are computer programs that are delegated some problem by their “owner”, and can decide for themselves what they need to do to solve this problem.

Solving a problem in a world of global Internet connections means interaction with other systems via network. A collection of agents, working together in this way, is called a multi-agent system. An agent based information system can be made by associating agents with end users and information sources. Intelligent agent technology can be used to handle the transportation network as a whole.

A mesh network is a network which provides each node with multiple data transmission paths, forming a mesh. Routing data through intermediate nodes is not only rapid, but also self-healing, because data packets automatically reroute through an alternate path if one link fails. A self-configuring container mesh network can be used to make the network more robust.

Intelligent agents are software components and therefore don't have specific hardware requirements. A container mesh network consists of several layers. These are for example an internal network which can contain sensors and RFID tags. And an external network which provides node-to-node communication between containers.

The main expected impacts of intelligent agents are efficiency gains. The software agents represent the main stakeholders and the cargo units of the supply chain. In case delays happen during the transport process, the agents will be able to negotiate with each other and reach a new planning which will reduce the overall delays in the supply chain. For mesh networks also efficiency gains are expected, like improving scalability, more flexibility and more cost-efficiency. In addition to that also improved security is expected. The mesh network will be able to reconfigure itself when certain nodes in the network are damaged and therefore the risk of losing messages is minimized. This also leads to an improved reliability of the overall network.

A number of the actors in the supply chain will probably be involved, like shipper, forwarder, LSP, driver, consignee operator and recipient. The actual actors which are involved will depend on the actual implementation of the intelligent agent technology or mesh network.

I-scheduler is a project, where intelligent agent technology is used to develop a scheduler for road transport. MECD (Mobile Edge Computing Devices) is a research project concerning the use of self-configuring container-based dynamic mesh networks.

#### **4. Freight/Cargo architecture/ frameworks → Conceptual frameworks and architectures for management of global multi-modal logistics networks**

These projects have their approach on an upper level of system development. Focus is mainly not on the cargo unit but on the whole system of logistic network. Mostly the projects try to cover several different areas of applications with regard to

intelligent transport systems. Networking aspects, standardization or integration of different systems are of major importance for these projects, which are being handled by a consortium of different technological, industry related and research partners on European level. The projects are answers to EC research initiatives and therefore try to integrate different interests and stakeholders.

The project overview generated in ICSS shows a number of European research projects with relation to intelligent transport systems:

- EURIDICE is the project with the closest relation to the intelligent cargo approach, it addresses most of the criteria/ elements of an Intelligent transport system: intelligent cargo architecture integrating different technologies (GPS, RFID, ZigBee, UMTS etc), enhancing capability of cargo items to identify and communicate with the environment, developing collaborative business models to promote intelligent cargo infrastructure.
- FREIGHTWISE and KOMODA are focusing on the different modes of transport, integrating different stakeholders sharing information on the choice of transport mode. The conceptual approaches aim at developing architectures/ frameworks which should support better efficiency in transport chains and efficient use of the different transport modes.
- Within ARKTRANS and SMARTFREIGHT the focus on freight transport is being enlarged to public transport and / or the use of traffic information. ARKTRANS' objective is multi-modal framework architecture for freight and public transport. SMARTFREIGHT is trying to integrate traffic management and freight management in urban areas.

The envisaged results of this kind of projects have more generic character:

- Safer and environmental transport chains
- More efficient freight transport in specific areas
- Better availability of information regarding multi-modal transport chains

A wide range of technologies are being used or considered within the approaches. It reaches from communication standards like UMTS, GPRS, and infrastructure related equipment to comprehensive architectures.

Stakeholder inclusion in these projects is very broad. Users, industry partners, authorities and other affected groups should be linked to each other.

### **5. *RFID applications → Enhanced RFID applications for track/ tracing and monitoring in different sectors***

A huge number of applications and projects with focus on the use and development of RFID can be found. In the ICSS screening some examples with regard to intelligent transport systems have been selected. The RFID technology is considered as enabling technology for Intelligent Cargo Systems. Core functionality of RFID is the automatic identification of remote transponders called tags. RFID has also the possibility to change the information stored on the cargo unit, does not require visual contact and is less susceptible to environmental conditions than other identification technologies. There is a wide range of RFID technologies from small inductive tags reaching a few centimetres up to active microwave or UHF active transponders with 100 meter reading range.

Enlarging the application field of RFID by including processing capabilities and sensor applications is one development path of present research activities. Furthermore, several initiatives are ongoing to reach a widely industrial standard and business models to enhance the deployment of RFID in supply chains. Within the screened applications the enhancement of cargo related data availability e.g. real time tracking and tracing is one of the major objectives. The cargo level which is being addressed in these applications is different; either cargo units/ shipments, containers or vehicles can be equipped with RFID.

Connected with different planning solutions and industry sectors the applications have different foci regarding type of cargo and provision of data:

- LAENDMARKS; Smart packages and RTLS are using the RFID technology to enhance the supply chain management through improved tracking and tracing for specific sectors like car industry or military.
- RFID is used for the data acquisition and tracking information and are being integrated within enhanced management systems for the improved traceability and steering of cargo flows; related projects are Log Net Assist and SmartTruck.
- A very customised solution is the Mobile SLK application which is RFID combined with GSM for event based tracking and tracing of shipments tailored to the needs of a Logistics service provider.
- RFID as a starting point for the enhanced collaboration of different stakeholders within the supply chain network is main part of the KO-RFID approach. This projects is very much network oriented where different sectors, ICT providers and research partners work together on an integrated approach.

Envisaged effects can be summarized as follows:

- Better information and data availability regarding cargo item
- Enhanced management and steering of cargo items/ cargo units
- Improvement of security and efficiency through the use of these information

The RFID technology in this field is the basis for all developments.

**6. *Sensor related applications* → Sensor technologies for better tracking and data transfer on cargo level**

Four applications have been identified in this category, with the common denominator that they work with sensors. Objectives of these projects are:

- Special purpose sensor nodes that can be configured according to the needs in the transport chain
- Sensor modules to monitor radiation, intrusion, temperature and shock
- Sensors that are used in a broader inter-machine communication
- Sensors to check the weight of the truck and to monitor the driver's attendance

Red line between the applications is that information is collected by the sensor, subsequently combined with information from other sensors and then sent to a monitoring centre.

Key technologies that are applied are:

- Bluetooth intelligence systems
- Temperature sensors in combination with RFID or mobile data communication
- Sensors in combination with mesh networks and mobile/satellite communication.
- RFID

A number of impacts are envisaged:

Increased security:

- 1) improved theft prevention thru permanent condition monitoring



- 2) reduction of the risk on tampering with certain goods
  - 3) improved control of truck access
  - 4) accident prevention
- Improved data redundancy: via the use of mesh networks the failure of particular sensors can be overcome by rerouting of data. This improves the certainty that data is available.
  - Efficiency improvements: one can respond faster to events (theft etc.) if the sensor information is observed.

The majority of actors involved are the shipper, forwarder and LSP. However, for some applications also the recipient is involved. One application underlines the involvement of the driver (truck access).

Part of the applications has not passed the prototype model.

## **7. *Web based applications/ platforms* → Platforms for data exchange and cooperation**

Key objective in these applications is the desire to exchange information. In many cases this information exchange is real time, and aims to steer towards collaborative partnering in different domains. The applications can be in many parts of the transport chain, such as in air cargo or maritime transport. There are many applications developed throughout Europe (and beyond), and by no means we intend to be complete in listing these applications. In this report we provide a flavour of the types of applications that one can get in this domain.

The technologies applied are web-based solutions and platforms, in the different variants that lie beneath this overarching technology. Obviously, this is combined with databases.

The main impact is to improve efficiency. This can result from improved planning, which can result in combining loads etc. Another route to efficiency improvement is the replacement of traditional approaches for outsourcing shipments / transport in a more cost-effective way. Finally, the impact on security is mentioned, following the fact that information is electronically available and can easier be combined with other information that allows authorities to better focus security controls.

Depending on the type of application, many actors from the transport chain can be involved. There is no general red line to draw in this respect.

## **8. *Other* → eLogistics applications with focus on specific areas/ modes**

The two projects within this category are specific approaches each one related to a specific transport mode; the air mode and the rail mode. Focus is lying on paperless documentation and train monitoring.

IATA eFreight uses message standards, interfaces and integration platforms (e.g. Cargo Community Systems Services CCS, Cargo Data Management Platform CDMP) in order to reduce the number of paper documents used in air cargo. Different users and stakeholders are involved in this initiative: carriers, freight forwarders, ground handlers, shippers and customs authorities.

E-train is developing a new satellite based positioning system for real time train monitoring. Each train will be equipped with hardware components for the GPS satellite tracking. The system is customized for a freight train operator.

The cargo relation is different. Paperless documentation in air freight is related to each air cargo shipment which requires documentation. Real time train monitoring is a concept for the tracking of whole train progressions with regard to the planned timetable. Main envisaged results are efficiency gains through improved processes and better information availability.

## 2.3 The criteria for Intelligent Cargo Systems

The criteria for Intelligent Cargo Systems as described in chapter 2 have been linked to the 35 different projects/ applications collected in ICSS. An overview about the projects and allocated criteria can be given as follows:

**Table 2: Allocation of criteria to projects – part I**

criteria/ applications and projects	Advanced Tracking System - ATS (alix)	ARKTRANS	Cargobox	Cargoreservation.com	CARIN	CVIS/CF&F	ELOGMAR-M	EURIDICE	E-Train	FREIGHTWISE	GoodRoute	Hazardous Material Tracking	IATA e-Freight	Integrity	Intelligent container	Intelligent container seal	INVEST	I-Scheduler for road transportation
More autonomous system on cargo level	truck	cargo unit	load unit	cargo item	container	vehicle	vehicle	load unit	train wagon	vehicle/ truck	vehicle/ truck	truck	cargo unit	container	container	container	container	truck
Paperless documentation			✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	
Self/ context awareness	✓							✓				✓			✓			
Secure Information access			✓					✓				✓		✓		✓		
Ubiquitous data availability		✓						✓			✓				✓			
Bi-directional communication						✓		✓	✓		✓	✓			✓			
Standard data formats		✓		✓	✓	✓	✓	✓		✓			✓	✓		✓	✓	
SME compatible	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stakeholder inclusion (industry, public, administrative...)		✓		✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	

**Table 3: Allocation of criteria to projects – part II**

criteria/ applications and projects	KOMODA	KO-RFID	LAENDmarks	LogNetAssist	Machine Talk	MECD	Mobile SLK	RAEWATCH sensor module	RTLS	Secure Trade Lane	Smart packages	SMART-OM	SMARTFREIGHT	SmartTruck	TRAMP	Truck intelligence work attendance system	VIOL
More autonomous system on cargo level	general/ truck	load unit	cargo item	load unit	truck/ container	container	shipment	container	cargo unit/ cars	container	container	container	vehicle/ truck	vehicle	vehicle	truck	cargo item
Paperless documentation	✓											✓		✓			✓
Self/ context awareness					✓	✓	✓	✓		✓					✓		✓
Secure Information access			✓			✓				✓	✓	✓					
Ubiquitous data availability		✓		✓				✓		✓		✓	✓				
Bi-directional communication					✓	✓	✓	✓		✓	✓		✓	✓	✓		✓
Standard data formats	✓									✓		✓	✓	✓			✓
SME compatible	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Stakeholder inclusion (industry, public, administrative...)	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓		✓		✓

The screening of the projects according to the criteria has been made on the basis of the main project objectives and (if applicable) the available results (the short project abstracts can be found in Annex 2). The criteria should be at least explicitly mentioned in the project approach or objectives. It is clear that some criteria, e.g. secure information access, are often part of projects in terms of needed requirements or condition for the feasibility of the approach, however many of those projects are not dealing with the issue in an explicit/ obvious way.

The focuses of the projects are different. Many of the projects are using RFID for further development in connection with mobile or other applications for enhanced

tracking and tracing. Some of the approaches focus on standardization and bi-directional communication. The SME compatibility is mentioned as objective in many projects/ approaches. The final assessment of this objective is more complex as some of the projects/ approaches are not market matured solutions and have thus not proved the SME compatibility.

Many of the projects and applications have the data availability in specific fields as part of their objective. Thus the overall approach of networked and ubiquitous information availability is covered more by generic projects with holistic approaches. The understanding for ubiquitous data availability in the context of intelligent cargo systems can be seen as the availability of needed data anywhere in the supply chain for any affected stakeholder.

The assessment of the 35 projects/ applications with regard to the criteria can be summarized:

**Table 4: Number of allocated criteria with regard to applications**

<i>Allocated criteria to projects</i>	
SME compatible	34
Stakeholder inclusion (industry, public, administrative..)	27
Standard data formats	17
Bi-directional communication	16
Paperless documentation	12
Self/ context awareness	11
Secure Information access	10
Ubiquitous data availability	10

## 3 Interviews

### 3.1 Overview of conducted interviews

In order to reflect the stakeholder's opinions and views towards intelligent cargo systems and how this concept will affect their business an extensive interview programme has been carried out. All in all 15 interviews could be carried out with different experts and stakeholders from transport, logistics and IT.

The interview structure (questionnaire) which has been used for the telephone interviews can be found in Annex 3. Initially the duration of the interviews was calculated by around 30 minutes. During the course of carrying out the interviews the following experiences can be summarized:

- Questionnaire was good to use
- High acceptance by the interview partners
- Due to the top level position of many of the interview partners there have been some difficulties of finding a common time slot
- Different views exist on determining intelligence
- Timeframe for carrying out the interviews has been longer than expected, actually (between 40 and 70 minutes)

Overall, the experts responded exhaustive and gave many interesting input to the different questions from their perspectives.

The following table gives an overview about the business fields of the experts:

**Table 5: Conducted interviews per group**

Group	Interviews per group
LSP*	2
Industry	1
IT-Expert/company	3
Branch organization	1
Consultancy	3
Researcher	2
Other (e.g. ports)	3

(\* LSP = Logistics Service provider)

It can be seen that a wide range of interview partners could be approached. The respondents are almost equally distributed among the different groups.

## 3.2 Feedback on criteria and applications

Within question 1 the criteria which have been defined for Intelligent Cargo Systems were discussed with the experts and assessed in terms of future realisation. Necessary requirements for the realisation of such a system and main barriers/bottlenecks have been discussed. Chapter 3.2 gives a summary on the statements given by the experts on the single categories of intelligent cargo systems and their expected impacts on the transport system.

### 3.2.1 Autonomous systems on cargo level

Experts consider autonomous systems as shipping units equipped with devices for identification, sensing and communication. The value of autonomous systems has been assessed comparing RFID with barcode based systems. Two main categories can be distinguished from the expert statements:

- On the one side a shipment unit has no computation power and is carrying the relevant information passive, e.g. as a barcode, or RFID. In addition

such shipments could be equipped with sensors and communicate on demand (in one direction)

- On the other side a shipment unit has computation power. Intelligence is attributed by the self/context awareness using bidirectional communication based on a common data and communication standard

Key question for experts is to describe business cases for the employment of these autonomous units. For autonomous systems they see single applications on dedicated corridors or for specific customers or branches; however an implementation on large scale is seen by most of the expert as a long term vision.

Main barriers for the implementation are:

- Securing a data protection
- Define common standards across the different stakeholders in the supply chain
- Define business models to off set the costs

Expert statements suggest to classify autonomous systems in two development paths:

- Intelligence is on the shipment unit, however planning and data hosting takes place centrally
- All intelligence is on the cargo level, planning and data hosting is accompanying the movement of the shipment (decentrally)

### **3.2.2 Paperless documentation**

Examples for paperless documentation are given on administrative as well as on industry level:

- eWaybills of the German Railways
- eDelivery notes as implemented by large forwarding companies
- single examples for eCustoms for the TIR scheme by Turkish operators
- the eGovernment initiative by the EC
- The electronic customs declaration system ATLAS
- The eFreight initiative of the IATA

Main barriers and limitations of the paperless documentation are:

- Not all paper documents could be replaced by electronic (perishable goods, specific transport documents and permissions etc.)
- A European approach might be possible, however an introduction on global level needs strong cooperation among the different governments

Most experts see the development of paperless documentation as prerequisite for Intelligent Cargo Systems that should be realised in the short term at least on European level. Common agreements and standards on European and global level need to be developed for its implementation. Technical feasibility is considered as the minor issue that can be solved using existing technologies, or technology that will become available in the near future. The main barriers are legal and administrative issues. Public authorities need to agree on common standards that certain obliged paper documents can be replaced by digital versions.

### **3.2.3 Self and context awareness**

Experts consider self and context awareness as an important, however long term development towards intelligent cargo systems. As requirements, self and context aware shipments:

- Include bi-directional communication capabilities that are considered as expensive, presently
- Need to handle huge data pools, either in a back end system or at cargo level

Most experts consider self and context aware shipments as a further step on the migration path towards (full) Intelligent Cargo Systems. Capabilities to make autonomous decisions based on self and context information is considered as an add-on-technology enhancing autonomous systems.

Applications are seen for high value goods or for specific transport chains, however not suited for open systems. The employment of self and context aware applications are considered as a vision for which a proof of concept is not given, yet. Furthermore, experts doubt on the existence of business case since only a very low percentage of the shipment would ask for autonomous decision support capabilities.



### 3.2.4 Secure information access

Most operators have (real time) tracking and tracing systems installed. The added value of these systems comes from generating directed information (e.g. EDIFACT). The concept of providing real time information to all actors involved in the supply chain has been proven by several supply chains (food, pharmacy). Two central issues need to be taken into account on establishing secure information access:

- Access of data needs to be arranged among all different actors of the supply chain. Information which will be shared with other stakeholders needs to be secured against unauthorised use.
- Data protection and data security has to be guaranteed by common standards. Trusted parties or intermediaries need to be involved to collect the data and to disseminate this to all parties in the logistic chain.

Examples for application on secure information access as suggested by the experts are a combination of real time tracking and tracing with supply chain event management systems. Such applications are partly implemented on ocean shipping routes since disturbances on these routes have large impact on the supply chain planning. Experts however, see the need for such systems on European level limited, since for European hinterland the supply chain reliability is much higher and the control over these chains can be much better handled.

Most experts consider a secure data access as technologically feasible; however they see in the implementation a visionary approach.

### 3.2.5 Ubiquitous data availability

Experts showed different views on the concept of ubiquitous data availability. Key question has been if data is hosted on the cargo level or if there is a combination of planning system and cargo unit:

- In the case data is hosted centrally a shipment can be equipped with a "simple" identification label (barcode). Routing of shipments takes place over interlinked data bases and services running in the back end that will provide all specific information for the journey.
- In the case data is hosted decentrally, all data need to be available on the cargo unit. The shipment proceeds an autonomous planning by collecting the data needed and creating an own routing.

The autonomous planning approach is considered as visionary by most experts. As technological requirements experts see high investment costs in communication and data standards providing access to the data. Furthermore the communication costs per shipment would enormously increase. Further barriers in implementing the concept are:

- A full transparency on data over the supply chain across the different partners is given, which is not wanted by most stakeholders.
- A huge amount of data needs to be transferred and high communication costs are expected.
- The reliability of data needs to be ensured.

Some experts consider the concept of ubiquitous data availability as the last step towards Intelligent Cargo Systems. Other modules like self and context awareness or bi directional communication links need to be implemented before.

### **3.2.6 Bi-directional communication**

Most experts consider the feature of bi-directional communication as a key technology towards Intelligent Cargo Systems. The necessary communication infrastructure needs to be installed. On terrestrial areas mobile communication and WLAN might be employed. On global level satellite communication might be needed.

Technically, the approach is not questioned by the experts. Operation costs are considered as the main barrier since these costs are expected to remain on a high level.

### **3.2.7 Standard data formats**

In the field of electronic data interchange, cargo identification, communication and transport documentation standardisation initiatives are implemented since years. EDIFACT is one example for a standard for data exchange used by various companies. Towards Intelligent Cargo Systems experts see the need for additional standardisation:

- To exchange identification information with other systems along the transport chain
- To carry all relevant documents paperless along the transport chain
- To retrieve data from different data bases

- To communicate with other systems (also if using other standards)

Lots of different implementations of standard data formats are possible. The main problem is how to deal with the interoperability of these different implementations. Experts see the development of common standard formats and interfaces as a first activity towards Intelligent Cargo Systems. General frameworks need to be defined describing the roles, responsibilities and the information need for each actor in the transport chain.

### **3.2.8 SME Inclusion**

SMEs need to be involved in the development of intelligent cargo. And also a positive business case for them needs to be developed in order to show them the benefits of intelligent cargo for themselves.

## **3.3 Major changes as expected by experts**

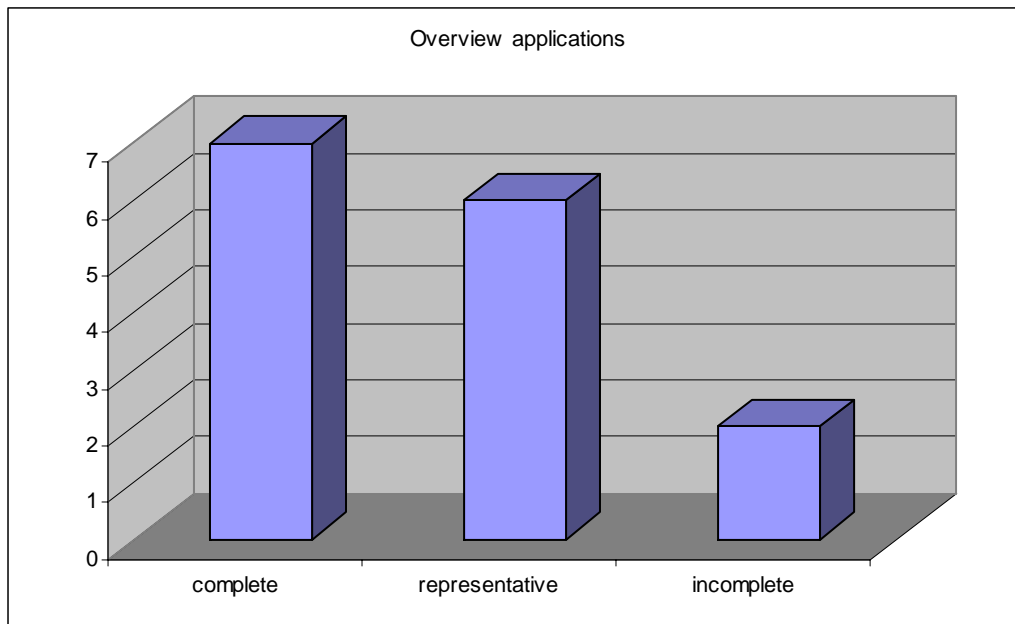
Besides the discussed criteria for a possible future Intelligent Cargo System the interview partners have been asked what kind of major changes they expect regarding future transport systems (question 2). Major changes which have been mentioned are:

- Enhanced and enlarged data availability in transport chains
- Market change in logistics (consolidation)
- Faster and improved transport processes (efficiency gains)
- Environmental issues and energy efficiency will affect transport more and more

Any statements regarding these questions which have been made during the interviews are being shown in Annex 4 structured per respondent group.

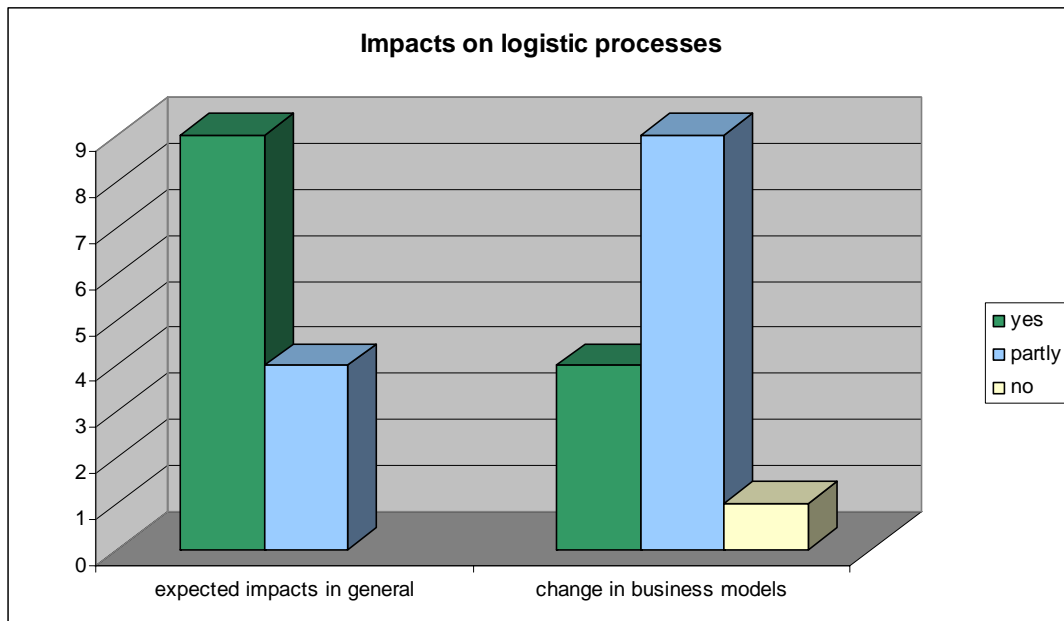
The completeness of the application categories, as provided by the consortium has been evaluated by the experts (question 3). Most experts indicated that the list was complete, and/or representative. Some remarks that were made are the following:

- Security related applications could perhaps be mentioned as a separate category.
- Applications in the area of more environmental friendly, sustainability, etc could be added

**Fig. 3: Evaluation of completeness of applications categories**

### 3.4 Impacts expected by the experts

Within question 4 it should be evaluated whether the experts expect impacts from Intelligent Cargo Systems in the future on the logistics businesses. Moreover the experts have been asked about possible changes of business models of the companies in transport/ logistics sector. Most experts indeed mentioned that they expected significant impacts. Some experts mentioned that they expected moderate impacts.

**Fig. 4: Impacts expected on logistics processes**

The impacts that are expected are mainly related to efficiency improvements. The following impacts were mentioned:

- Simplification of operations;
- Better usage of transport systems;
- Increase of load factor;
- Less empty running;
- Reduction of unnecessary trips;
- Error reduction (replacing manual labour);
- Increased speed of transport (due to being better informed).

Not all experts provide information about the magnitude of the impacts. Some experts indicated a wide range of impacts to be expected, varying from 10-15% to 25%-50%. Most experts however expected impacts in the range of 10-20%. Some important remarks need to be made here:

- An important question is: How can the potential benefits are realized in practice?
- The benefits are being realised in practice only after a certain start-up period.

The development of Intelligent Cargo Systems can lead to changes in the business models used in the logistics chain. The major effect of intelligent cargo that is expected to happen is better information and more transparency in the logistic chain. This can lead to changes in the business models which are used, for example:

- Possible change in the preference for a certain modality (when the detailed results of each transport trip are known and can be compared).
- Stronger insight in liabilities. More transparency will provide more information which partner is responsible when problems have happened during the transport. This can be used to make new arrangements regarding liability between all the partners involved in the chain.

Several socio-economic impacts are also expected by the experts:

- With respect to the employees, it is expected that efficiency of the employees will increase. Employees will need to learn new tasks and there will be an increased requirement of the driver, as a result of the introduction of intelligent cargo in the logistic chain.
- In the area of safety a positive impact is expected, due to the availability of more information. This could for example lead to fewer accidents, or this information could be used to act quicker when a certain accident has happened, etc..
- With respect to security also a positive impact is expected. A better cross reference of data is possible. More data is available which can be examined and analysed in order to increase security. The security checks can also be carried out faster, when more information is digital available.

The overall evaluation of the statements regarding socio-economic impacts (question 5) can be found in Annex 4

### **3.5 R&D focus and development path**

Some relevant issues for R&D focus were also mentioned by the experts (question 6):

- European standards need to be developed.
- The focus should be on developing a framework/ architecture, instead of developing stand-alone applications.

A development path for intelligent cargo in general was mentioned by several experts. This could be the following:

- Develop a Framework/ architecture,
- Develop the legal framework,
- Develop business cases for various stakeholders,
- Carry out pilots and test,
- At the end large scale implementation is possible.

Full overview about the statements is being shown in Annex 4

Some experts mentioned issues for a development path regarding different intelligent cargo criteria:

- Ubiquitous data availability is often mentioned as the last step. First all the other issues need to be arranged and implemented, like standardisation, stakeholder involvement, secure data access, autonomous cargo, etc. Once this has been done, ubiquitous data availability can be realised.
- There is a need for global developments, as logistics business is a global business.
- The development of stand-alone applications needs to be avoided; otherwise implementation at a large scale will not be realized. Therefore the most relevant stakeholders need to be involved in order to establish a critical mass. And in order to get the other stakeholders in the chain involved. As a framework needs to be developed first. Once this is done, applications can be developed based upon this framework.
- Technology is not the problem with respect to intelligent cargo. Available technologies can be used, or technologies which will become available in the near future. The focus should be on other issues, like organisational, legal, stakeholder involvement, etc.

### 3.6 Interim conclusions - summary

Putting together the results from the research for applications, approaches and innovation streams regarding intelligent cargo and the results from the interviews some key conclusions can be used to draw future scenarios.

The projects and applications identified are focusing either on different sectors (e.g. technology applications to certain requirements) or trying to cover more or less every aspect which is relevant for an Intelligent Cargo System. Apart from the categorization or allocation of criteria to projects and applications (if not already implemented) more or less all struggle when it comes to the issue of sector-wide adoption of standardized data and information access for different stakeholder groups. For several sectors technologies are to be developed or are even already available to detect and to transfer cargo related data in a secure way. Also the processing of these data in allocated centralized planning/ management systems is possible. However, a comprehensive approach on European or even global level that integrates technologies, data exchange and communication across sectors remains a vision.

Interviews have shown that the feasibility of intelligence on cargo level is less on the technology side but more to create a common framework that is accepted by all relevant stakeholder groups. Additionally the criterion of intelligence is not relevant for all cargo items. Business cases are not well defined, yet that show to each user the gains and benefits of the concept. Key issue will also be the acceptance and integration of the employees on every level of expertise. Qualification requirements and job profiles will change.

Detecting data and information on far more detailed level than nowadays (regarding item and timeslots) will face the connected planning and management systems with huge requirements on trusted data security and fast and effective data management. With regard to intelligence on cargo level the necessary infrastructure to enable such systems is not given, yet.



## 4 Scenarios

Scenarios are stories or narratives that portray what might happen, why it might happen, and with what consequences. Scenarios can be very powerful tools to contemplate the range of possible futures that could develop from the influence of key drivers, events and issues. Scenario planning aims not to find the right or wrong answers. Instead, it aims to outline what is possible, what is probable and what is desirable and feasible.

Scenario building is one of the most used methods in future studies. Scenario building can be described as an instrument that aids decision-makers by providing a context for planning and programming, lowering the level of uncertainty and raising the level of knowledge, in relation to the consequences of actions, which have to be taken, or are going to be taken, in the present.

Within ICSS the aim is to develop two scenarios of future transport logistics systems based on intelligent cargo technologies and to refer to one reference scenario that describes the current situation including the actual trends.

### 4.1 Scenario building approach

Further structuring and consolidating the experts statement the following issues should be key to derive the scenarios:

- How is the transport chain organized and planned?
- How are transport instructions provided and monitored?
- How is documentation handled along the transport chain?
- How is communication taking place?

This structuring also refers to the work carried out in the FREIGHTWISE reference model.

In a first step a clear distinguishing was made by the experts on what are realistic and what are visionary applications towards Intelligent Cargo Systems. Ranking the ICSS Intelligent Cargo Systems categories as described in chapter 2 experts assess the development of standards as the basement and the most realistic approach towards Intelligent Cargo Systems. In parallel or in combination with the standardization work applications allowing a paperless documentation and an autonomous steering of shipments is indicated by the experts also with high

relevance. In a final development application allowing a full intelligence should be included, such as self and context awareness, secure information access and the ubiquitous data availability. An overview of the ranking is given below:

1. Open accessible systems (standardization of formats and interfaces)
2. Paperless documentation
3. Autonomous cargo units
4. Bi-directional communication (exchange of data)
5. Self and context awareness
6. Secure information access
7. Ubiquitous data availability

Based on the expert suggestions on ranking and structuring intelligent cargo systems a further consolidation of the criteria can be made as follows:

- Open accessible systems (standardization of formats and interfaces)
- Paperless documentation
- Autonomous, self and context aware cargo units
- Bi-directional communication and secure information access
- Ubiquitous data availability

Applying these categories a reference scenario and two future scenarios describing a realistic and a visionary future on Intelligent Cargo Systems will be derived. More specific, the future scenarios will differ from each other regarding the adoption of the different criteria. It is assumed that in realistic future the top level criteria paperless documentation and standardization will be fulfilled in an integrated and holistic way. The visionary future scenario will then describe the adoption of all mentioned criteria notably on single cargo item level. The following table shows the structuring as well as the adoption level of intelligent cargo systems in the different scenarios.

**Table 6: Scenarios regarding the categories**

Category	Reference	Realistic future	Visionary future
<b>Standardization (formats, interfaces)</b>	On company or branch level	On European level realized for traditional business processes, e.g. transport documents, tracking and tracing	On European/International level realized for transport business, transport processes and local operational levels
<b>Paperless documentation</b>	Normally with paper accompanying the transport  For some branches, or part of the transport chain there are paperless business transactions	All processes (B2B and B2A) are covered  Common standards are used  On European level implemented	All processes (B2B and B2A) are covered  Common standards are used  On European level implemented
<b>Autonomous, self and context aware cargo units</b>	No computation power on cargo level  Bar code is dominating, partly RFID to replace the bar code  Planning, monitoring and steering on central level  No self and context awareness	No computation power on cargo level  Bar code is dominating, partly RFID to replace the bar code  Planning, monitoring and steering on central level  No self and context awareness	Cargo is equipped with computation power  Autonomous planning, self monitoring and steering  Full intelligence to steer and monitor all processes in self and context aware manner
<b>Bi-directional communication and secure information access</b>	On load unit level only one way communication Secure information exchange is not widely in place	In most transport segments only one way communication on load unit level  For some transport segments (e.g.	Bi-directional communication is fully implemented  Paperless business messages and documents can be

	Hesitation to share and to exchange data via networks and common data servers	dangerous goods, high value goods) there is already two way communication in place  Paperless business messages and documents can be safely exchanged via networks  Transport data is entrusted to common data servers that provide authentication to defined parties	safely exchanged via networks  Transport data is entrusted to common data servers  Regulations are in place for the authentication and data security on cargo level
<b>Ubiquitous data availability</b>	Needed data is often not available	Back end systems are interlinked to allow a complex retrieval of the needed data  On cargo level simple labels are attached	Data is kept decentrally where cargo has all information it needs, e.g. also for taking decisions

## 4.2 Description of scenarios

The different scenarios are described in detail in the following chapters.

### 4.2.1 Reference scenario

The reference scenario is based on the current situation, meaning typical and implemented ICT infrastructure and transport operations as of today. It can be observed that the development of enhanced technologies which are useful to increase transport and energy efficiency and to reduce environmental impacts slowly proceeds. Yet, the integration among different stakeholders still faces several obstacles. Even between the participants in the same field (e.g. Logistic Service Provider) it remains difficult to share the relevant data in a paperless and standardized manner. Data exchange is also difficult, no trusted third parties and/or intermediaries are available at this moment that can carry out the exchange of data for the logistic sector for the whole of Europe. Missing secure information access is another barrier. No standard systems are available which are trusted by all relevant stakeholders. Mobile communication costs are still high at this moment, which prevents the uptake of intelligent cargo applications which require sending a lot of

data. The usage of intelligent cargo solutions by SMEs is still quite limited. While at the same time, there is already a positive business case for the bigger logistic companies.

In this context planning processes have still “closed shop”-character, partly integrated planning across different stakeholders can be seen. Efforts for the integration of planning and organization of transport processes across different stakeholders are at a high level and synergies are not exploited, yet.

Standardized data formats and interfaces allowing an easy data accessibility are a key enabling factor for integrated systems. Examples for standard data formats are given for material flow related processes, e.g. EDIFACT and subsets. Barcode and RFID attached to the cargo unit create the link between the transport process and the material flow. With regard to transport processes also specific EDIFACT messages exist related to the information flow before, during or after the (physical) transport process. However the implementation of EDIFACT messages in practice is quite expensive at the moment and is in most cases only attractive for bigger logistic companies. First applications using RFID and the related standard EPCglobal are under development.

In the Reference scenario transport related standards such as

- Common regulations for vehicle dimensions and operation procedures during the trip (e.g. dangerous goods routing),
- Common communication standards between vehicles and planning systems,
- Common data formats for communication,

are not given on European level. Member states still have national regulations and technology standards. Operators with specialised equipment and know how are serving specific regional markets or segments. The exchange of data is handled on operator level and characterised by different formats and interfaces.

Documentation is needed for the different transport processes and cargo levels in different formats. Paperless documentation in the reference scenario is given for single processes. Customs declarations or eWaybill or eDelivery note are examples for implemented paperless documentations for single processes. The reference scenario shows no integrated approach for a paperless documentation of transport processes. Transport processes are carried out with paper documents accompanying the transport. Some large operators will have started with the implementation of single paperless processes. Although the involved operators can be quite big, this concerns only a limited part of the total logistic sector in Europe.

Ubiquitous data availability in the logistic sector in Europe does not exist, yet. Data in the reference scenario are hosted individually; there is no common infrastructure to which systems can be linked to.

Transport units are rather passive and not intelligent. The interaction with the units can be characterized by the following means:

- Identification, e.g. by barcode systems on containers or by container numbers.
- Tracking and tracing of the units is made by means of positioning technologies (GPS, Inmarsat etc.), but satellite communication is still quite expensive.
- Information on the unit can be given to data providers distributing the information to the relevant stakeholders.
- Additional information, e.g. coming from sensor data are attributed to the unit information.

Autonomous cargo units are not yet, or only very limited available. Also, almost no computation power is available at cargo level (e.g. active RFID tags). In the reference scenario there is no common view on the load unit data. Data is captured on operator level (port to port, terminal to terminal, distribution etc.), a door-to-door view over the entire supply chain is only possible by collecting the information by the different operators in the transport chain. Self and context awareness of the units is not given or can only be seen by a human interaction due to specific service agreements made with operators to monitor the units and to react in the case of deviations.

Bidirectional communication and the secure information access in the reference scenario is a limited communication taking place between the operators responsible for a part of the transport chain and his cargo unit. A continuous communication is most common for intermodal transport and loading units; if a transport chain is interrupted there is also a break in the communication. If there are delays in the transportation process in most cases the planning is not automatically adapted, but human intervention is needed to update the planning. Often the delays are not communicated to all the parties in the supply chain, which leads to additional delays and increasing costs. Communication processes are characterised by inquiries made to a communication device linked to a loading unit or vessel. Bidirectional communication takes place mainly between dispatchers and drivers.

### 4.2.2 Realistic future

The realistic future scenario is referring to the input from the experts of whom a majority have given the statements that some of the main criteria for intelligent cargo systems will be fully adopted in near future. These criteria are mainly on using standard formats and interfaces as well as paperless documentation (see ranking in 4.1) in the logistics sector. Main characteristic of the realistic future scenario is that planning, monitoring and steering are done at a central level for the whole supply chain. Standard formats and interfaces as well as fully paperless documentation are given. Looking at the criteria of autonomous systems, bi-directional communications and data access as well as for ubiquitous data availability some main barriers still exist limiting the full adoption of Intelligent Cargo Systems. Autonomous cargo units and self and context aware cargo are not available at a large scale in Europe, but only for specific transport chains or market segments (dangerous goods, high value goods).

Regarding transport related processes common standards for transferring data and for exchanging information between different systems are given on European level. In the realistic future scenario there are standards for the identification, location and data protection, for the carrying of paperless documents along the journey and for the retrieval and sending of data. Main information carrier for cargo units in movement are 2D barcodes. The scenario considers that RFID and the implementation of an open RFID based infrastructure for ubiquitous data availability and bidirectional communication are still too expensive. Furthermore, transport business decided to use 2D barcodes since global transport business changes fast and the set up of an RFID infrastructure is not in line with this dynamic development. Standard data sets for data transmissions are used. Since 2D barcodes are not based on automated transmission, there is no need for standard frequencies and transmission protocols. Data protection is ensured by providing authentication to defined parties over back end systems.

Paperless documentation will be realized for the most relevant industry processes and administrative requirements. A paperless administrating of transport processes from booking, transport execution, invoicing and documentation is possible. Interlinked back end systems will organise the document declarations and issuing among the different stakeholders. The scenario on paperless documentation includes an integrated approach of related administrative and commercial processes. Regarding administrative processes the following issues are concerned:

- The electronic declaration in the EU
- Interoperable IT systems, on national level
- A management of customer procedures on European level

- Implementation of single windows, e.g. in ports or air ports for customs declaration

Technically, a paperless documentation is realised by using standard messages (for example based on XML) communicating with ERP systems of different stakeholders in the transport chain. Identification of cargo units takes place mainly over barcode, partly RFID. Handhelds and readers can read out the codes enabling the access to the data.

In the realistic scenario a limited approach on ubiquitous data availability is given. Data availability is ensured by back end systems that are interlinked allowing a complex retrieval of data from other systems. 2D barcodes can be read out by mobile devices at any location in the world. Access to data and services from different sources will provide a comprehensive picture on the necessary requirements and conditions for planning the journey. Data and services, e.g. to show the availability of load units and transport services, traffic situation on roads, ports and terminals, weather conditions, routing advises etc. are made available.

The characteristic of intelligence in the realistic scenario is made by separating information generation and availability on cargo level and on the back end systems:

- Intelligence in the back end systems is created by the linking up to various other systems, applications and services. The back end systems have the capability to monitor and steer the cargo units on the movement.
- Intelligence on the cargo level is kept low, limited to the necessary data needed to support material and transport flow.

Compared to the reference scenario, semi-autonomous cargo units are available now. Identification of the cargo units takes place by means of (intelligent) bar codes providing all relevant information related to the material and transport process. Tracking and tracing take place at global/European level by means of satellite positioning technologies (GALILEO) cellular networks and WIMAX (replacing WLAN) as well as by readers at a local level. Tracking and tracing information is generated continuously in a central data system by combining data from different sources (e.g. the vessel transporting the cargo, scans etc.). A selection will be made concerning the relevant data source. The realistic scenario includes tracking and tracing over the entire supply chain. No self and context aware cargo units are available at a large scale in Europe in this scenario. Secure information access and authentication will be available, like alarming supply chain partners in case accidents happen (Supply Chain Event Management Systems), communication with road operators and communication with logistic partners in an intermodal supply chain.



Specific cargo units are equipped with special tags allowing a communication between back-end systems and cargo in a two way direction. Such devices are employed for specific use cases like for dangerous goods and sensitive or high value goods. Reasons for this partial implementation will be mostly the relatively high amount of investment costs. This will limit the enhanced applications and implementation of cargo intelligence to dangerous goods and high value/ high sensitive transport chains.

Especially in these fields like dangerous goods, high value supply chains or sensitive goods supply (chemical, pharmaceutical, etc.) the cargo units will be equipped with enhanced technologies for data detection and transfer/ communication to other hosting/ processing systems. These are linked with other systems, applications and services providing restricted information access and processing to all relevant stakeholders also beside the supply chain. Bidirectional communication on autonomous level is possible for specific applications where business cases are given.

### **4.2.3 Visionary future**

In the future visionary scenario it is assumed that all criteria on an Intelligent Cargo System as mentioned within section 2 are adopted. Core of this scenario are intelligent tags equipped with computation power accompanying the full process from ordering to fulfillment. In a typical process a consignee schedules an order to a producer. Immediately an intelligent tag is produced starting transmitting information on the identification and status of the cargo from production to the actual delivery. This means that material flow related data and transport related data are more and more integrated. The information flow between supply chain partners is now complemented by a cargo related data hosting with the generation of information right on the intelligent tag.

In the visionary future scenario autonomous planning is now possible. Cargo units are fully autonomous, self and context aware due to self monitoring and steering at cargo level. For non-containerized items like oil or bulk products, the intelligence is located at cargo load unit level, and not at cargo item level. Cargo units are aware on the type of cargo and the specific requirements for the transport (e.g. food transport can not be combined with chemical goods; cargo unit needs to be fitted for transport on sea etc.). Also cargo units communicate for example delays to other parties in the supply chain and after negotiations between the different actors in the supply chain, the planning is automatically updated. Mass production costs for RFID tags are low and also a dense network with ubiquitous data availability and bidirectional communication is in place. A seamless identification and localization of cargo is possible along the transport chain. Compared to the realistic future

scenario there are additional open standards on automatic local wireless information exchange implemented.

Also, standards make the unhindered data flow and processing between different systems in the transport chains and in relation to all kinds of stakeholders possible that are established on European level. Standard formats and interfaces for material flow include data on the transport processes as well. There are no limitations to bridge interfaces and to exchange data between cargo on movement and individual data and planning systems. In the same way as the Internet is now available for individual users at a European (and global) level, which consists of data being available on lots of local servers. Now an Internet of cargo will be available, where all cargo data is available in small local databases, which can all be reached by each other. Of course secure access is provided to ensure that not everyone has access to all data.

For the paperless documentation common standards on data exchange and communication are established. Since, the realistic scenario already addressed a full adoption of this criteria the visionary scenario is more or less identical. The difference in the visionary scenario is that the technology employed is located on cargo level rather than on back end systems using EDIFACT standard messages. All relevant administrative documents and procedures are placed on computation powered tags attached to the cargo. Declarations and content information can be handled in a semantically interoperable manner. Necessary documents, e.g. for road side checks can be read out (e.g. by handhelds) by control personal for further processing.

Ubiquitous data availability is fully implemented in the visionary scenario. All data relevant for transport is hosted on cargo level. Cargo units are able to host data but also retrieve data from different sources and make use of services provided at different points along the journeys. Example for such services could be port information systems providing information and services to navigate save and quickly through the port. Central data hosting or planning infrastructure will have less importance.

All needed and relevant information regarding the cargo is detected and available on every single cargo item. Cargo items (seen as the smallest unit within the transport chain) in the visionary scenario are able to detect their status (self awareness), to detect the surrounding (context awareness) and to communicate with different systems. They are equipped with computation power capable to carry out routing activities and communication needed along the transport chain. At an aggregated level, at cargo load unit level (which contains several cargo items) data storage and processing units are installed as well as sensors, positioning and communication devices. The cargo load units in the visionary scenario are capable to communicate with all relevant stakeholders in a bidirectional way. Data can also be collected at other levels, like case, pallet, or yard level. Automated

communication between planning or individual back end systems can take place, e.g. in the case of events.

Increased transparency and online availability of status information is given by real time tracking and tracing for every cargo item anywhere in the transport chain. It takes place as a combination of satellite positioning and RFID readers installed along the transport chain. Supply chain operators are informed on the current status as well as on deviation compared to the initial planning. All deviations are captured and handled first on cargo level. Similar as for the realistic scenario also other services besides tracking and tracing are possible, like alarming, communication with road operators and communication with intermodal supply chain partners. There is no need for central data bases or back end systems to connect the different stakeholders in the supply chains because an Internet of cargo is available. Transport data is entrusted to de-central data servers at local level.

Secure information flow is guaranteed and due to strong regulations no more “anonymous” cargo units can be sent out. Authentication and secure data access is arranged at local level. The system elements on every level have no limitations with regard to different stakeholders or company size. Which means every company in the transport chain involved independent from their size can use the system or is even part of it. SMEs are informed and aware of the possibilities intelligent cargo applications offer to them. Positive business cases have been developed for SMEs and therefore intelligent cargo applications are now implemented at a large scale also for the SMEs in the logistic sector in Europe.

## 5 Impact assessment regarding the scenarios

In the previous task two future scenarios have been developed, the realistic scenario and the visionary scenario. And a reference scenario has been added, which will be needed to assess the impacts. In this chapter an assessment of the impacts of the two future scenarios will be done, where the two scenarios are both compared with the reference scenario. These impacts will concern impacts in efficiency, sustainability, safety and security.

### 5.1 Approach

Two consecutive steps have been carried out:

#### *Step 1: Impact chain development*

The first step was to develop a qualitative description of the impacts mechanism of the scenarios. The stakeholders affected are being indicated and subsequently how these stakeholders are affected by the scenario. This description is visualised by developing impact chains. Such impact chains provide a comprehensive view on how a certain scenario may eventually lead to a certain outcome. The impact chains are presented in the next section.

#### *Step 2: Further assessment of the impact*

First the impacts on efficiency and sustainability are presented and thereafter the impacts on safety and security.

Regarding the impact on efficiency and sustainability, the impacts on business processes (company internal), and on the transport process are distinguished. For both a qualitative description of the impacts and where possible a quantitative estimate is given. This will be done by exemplary effect calculation and key figure analysis. Based on the scenarios these calculations are extrapolated to EU level.

In the assessment of the impact, the scenarios are operationalised to a more concrete level. This implies that for certain aspects key assumptions will be made of which the impact will be reviewed.

The impact on safety and security are described largely qualitatively. When possible a quantitative scope of the impacts is indicated.

## 5.2 Impact chains

The scenarios are describing different future situations of possible intelligent transport systems. In order to extract the impacts of different developments some key use cases are derived out of the scenarios. These key use cases cover the main aspects of the scenarios and clearly differentiate from each other. The use cases consolidate overlapping issues and developments regarding the different criteria and make a detailed impact analyses possible. Based on these use cases the impact chains related to the relevant impact parameters and stakeholders can be drafted.

An analysis of the two future scenarios led to the development of the following use cases:

### ***Realistic scenario:***

- UC1: Standard formats, interfaces for systems, data and documentation, paperless;
- UC2: Semi-autonomous intelligent cargo units with bi-directional communication in specific market segments;
- UC3: Integrated planning over supply chains.

### ***Visionary scenario:***

- UC4: Autonomous intelligent cargo units with bi-directional communication;
- UC5: Decentralized planning at cargo level, and decentralized IT infrastructure on cargo/ node and actor level.

*Some important remarks regarding the different use cases are the following:*

- UC1 mainly concerns standard formats and paperless documentation. It is assumed that the impacts for UC1 will be realized in the realistic scenario and that the impacts for the visionary scenario concerning standard formats and paperless documentation are the same.
- UC2 concerns semi-autonomous intelligent cargo units in specific market segments like dangerous cargo and high value goods. In these markets it is considered worthwhile to invest much earlier in issues like intelligent cargo tags and bi-directional communication. UC4 also concerns intelligent cargo units. But now the use case concerns all sectors and not only some specific ones.

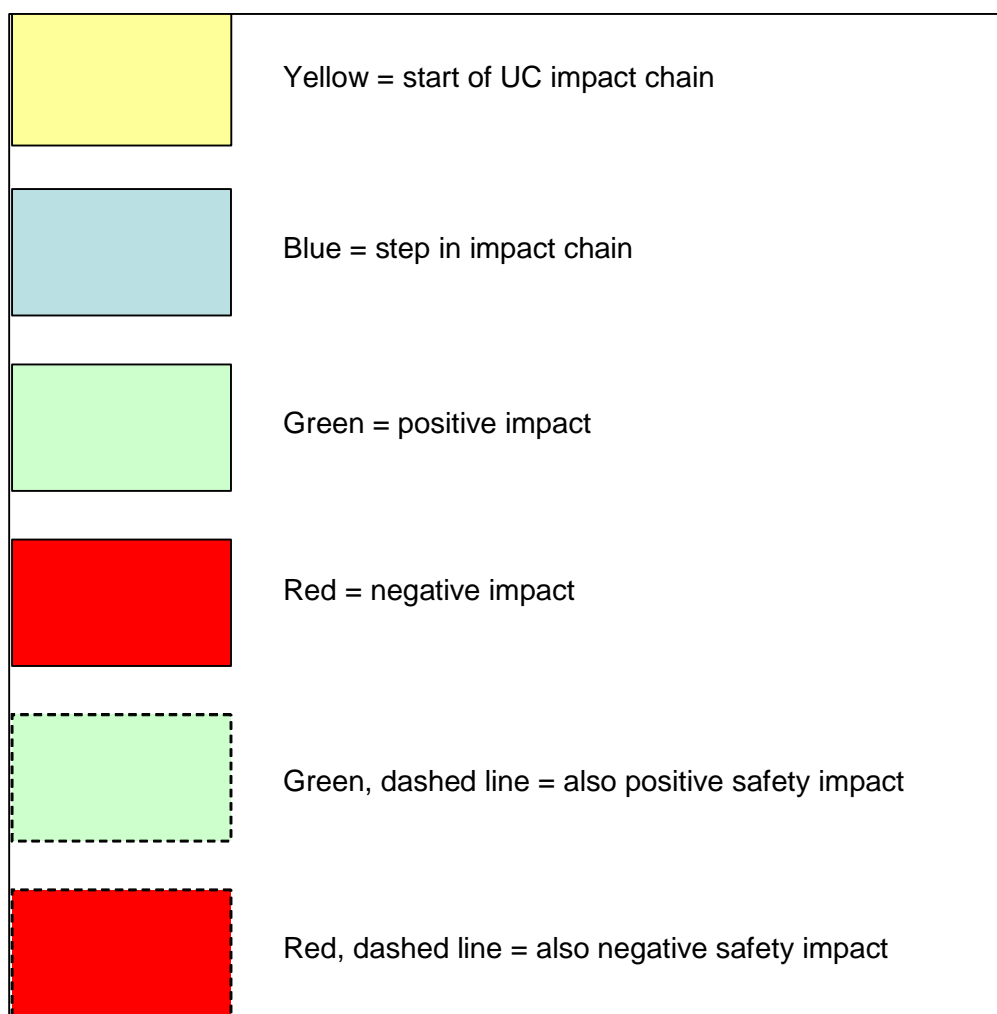
- UC3 is related to introducing integrated planning for the whole supply chain in the realistic scenario. UC5 is also related to planning, but now decentralized planning at cargo level is introduced in the visionary scenario. No central planning and monitoring is needed anymore, since all data needed for these tasks is available locally for all relevant stakeholders.

The overview and description of the use cases out of the different scenarios is consolidated via the following structure:

***Overview of use case, parameter and impacts:***

- Use case: name of the use case;
- Short description of use case and main assumptions;
- Overview and description of impact chains;
- Examples of impact chains: some practical examples are provided;
- Overview of impacts per stakeholder: summary of impacts per stakeholder;
- Integrated or available technologies or applications: main technologies which are needed;
- Sources or relevant data for assessment and deriving figures: sources for additional information.

The next figure provides a legend, explaining the figures and colours which have been used in the impact chain diagrams for each use case.

**Fig. 5: Legend to the impact chains within the Use cases**

## 5.2.1 Use Case 1

Headline: Standardization and paperless documentation

timeline

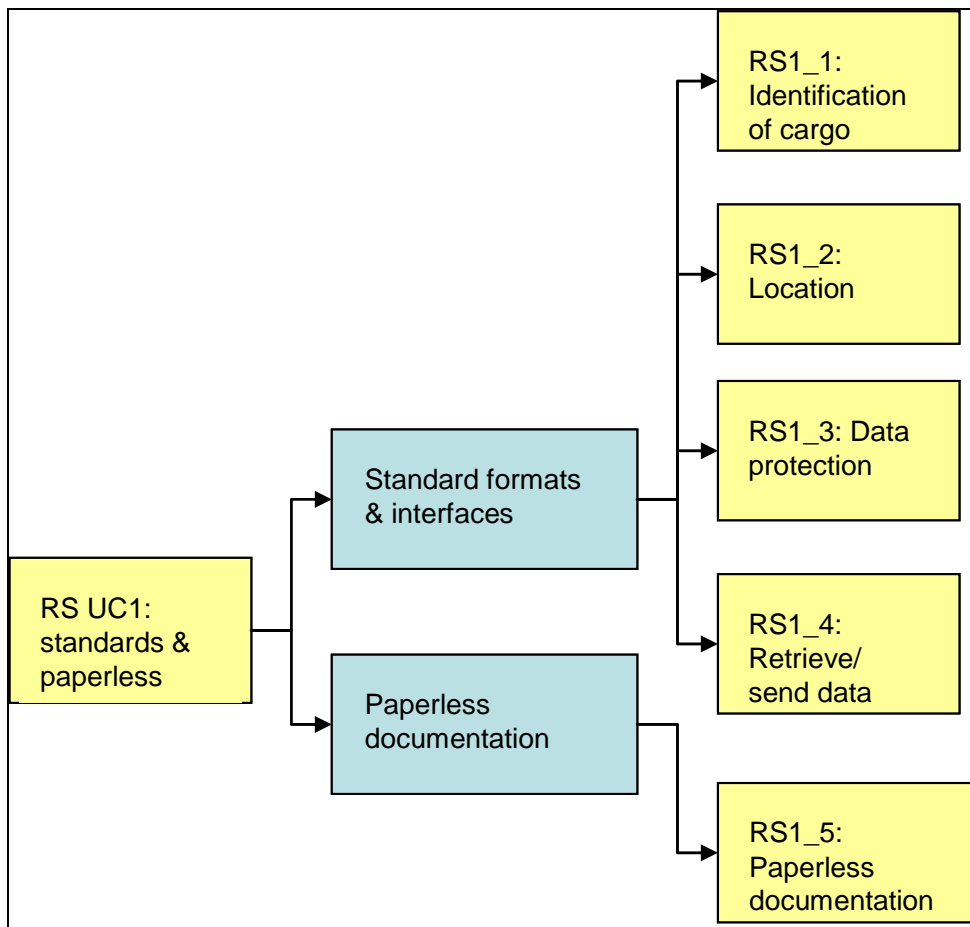
### **Use case I: Standard formats, interfaces for systems, data and documentation, paperless** **RS**

Use case description and main assumptions:

- Standard formats/interfaces available on EU level for business processes, Paperless documentation widely applied (only very limited in reference scenario), key issues for realistic scenario are standards and paperless doc.
- Standards for the transfer, identification (one ID for cargo along the transport chain), localisation (e.g. common status information) and use of data within the supply chain will be implemented, a thorough use of common standard(s) will be possible over different parts of the transport chain.
- The protection of data will be ensured by protocols and agreed standards for data use, access etc.
- Interfaces for sending / transmitting data.
- Enhanced transparency of process status.
- Corrections/ changes possible during process.
- Paperless documentation will be regular within the entire transport process, which means no paper needed for transportation documents.



Impact chains:



This use case can be split into two parts:

- Standard formats & interfaces
- Paperless documentation

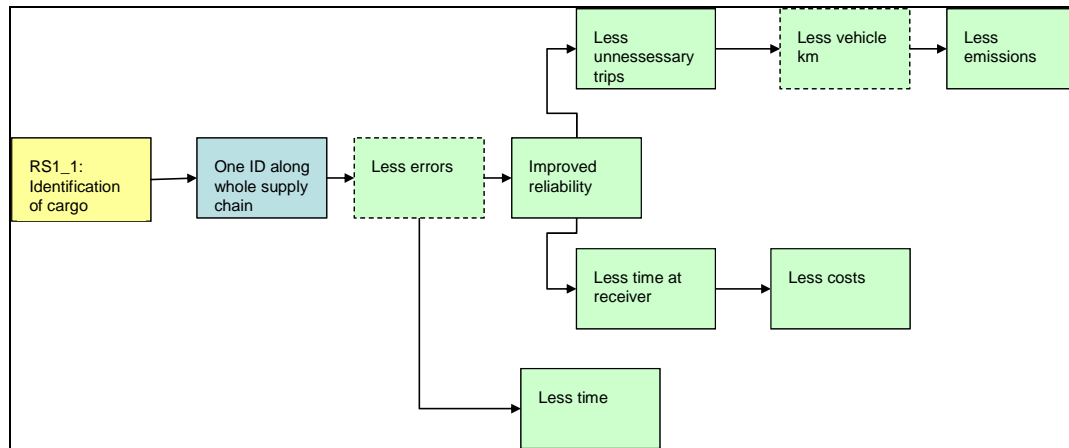
#### **Part 1: Standard formats & Interfaces**

Standard formats & interfaces consists of the following parts:

- RS1\_1: Identification of cargo
- RS1\_2: Location
- RS1\_3: Data protection
- RS1\_4: Retrieve/ send data

#### **Part 2: Paperless documentation**

## RS1\_5: Paperless documentation



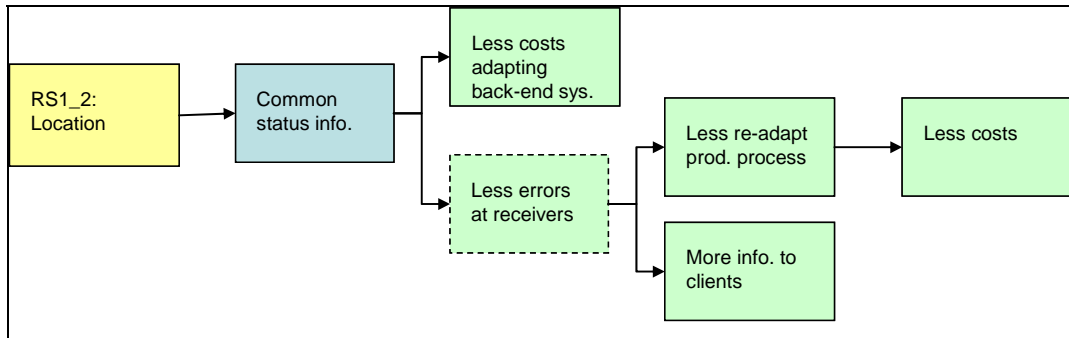
### ***RS1\_1: Identification of cargo***

Identification of cargo concerns issue related to ID's in the supply chain which are used to identify cargo. In the RS one ID will be available for all stakeholders within the supply chain to identify cargo. In the reference scenario, different stakeholders in the supply chain often use different ID's to identify the same cargo items. Using the same ID will reduce the number of errors when processing cargo ID's in the systems of the different stakeholders, no new ID needs to be entered, the same ID can be used throughout the whole supply chain. Fewer errors also have a positive safety impact.

This will lead to time savings for the different partners, like shipper, LSP, and receiver, because fewer errors need to be corrected.

Using one ID will also improve reliability. Since fewer errors are made, fewer trips need to be arranged to pick up goods which were delivered at the wrong address. Also less trips are needed to bring the right goods to the client, in case a mistake has been made during the delivery. This will result in a reduction of the number of vehicle kilometres driven, which will lead to less emissions. Less vehicle kilometres driven also has a positive safety impact, because less kilometres driven reduces the chances on accidents.

On the other hand, improved reliability will also lead to less time needed for handling the goods at the receiver. Tighter time windows can be used by the receiver, which means that costs can be reduced.

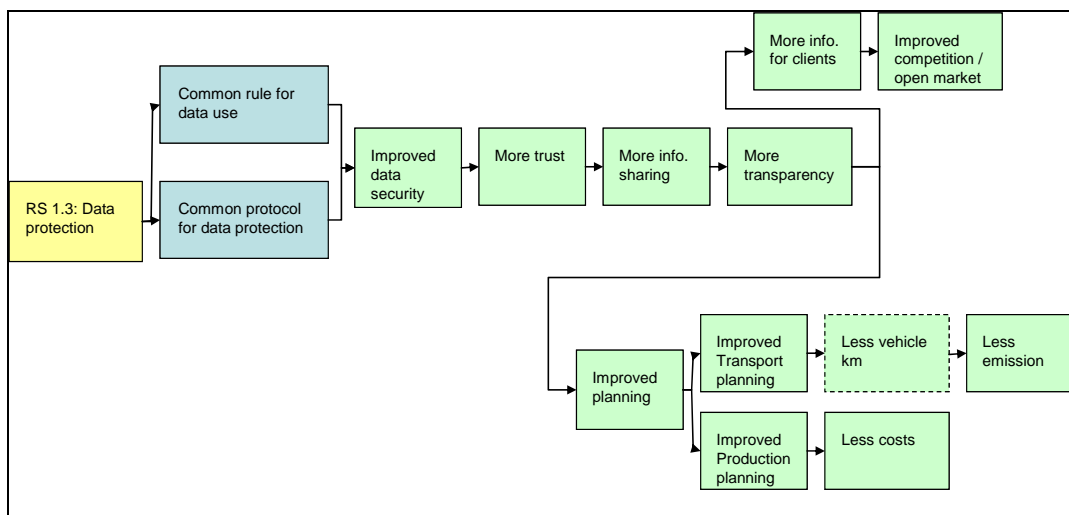


### RS1\_2: Localisation of cargo

One way to indicate locations will be used for the whole supply chain. As a result of these common messages for indicating status information can be used. The same status messages can be used in all the systems of the supply chain partners.

This will lead to fewer costs for adapting back-end systems, because similar status information is used.

This will also reduce the number of errors at the receiver, since status information doesn't need to be converted in another format. This will lead to fewer changes to the production process, which will lead to a cost reduction. Also more information can be provided to the clients, since the same status information formats are used along the whole supply chain.



### RS1\_3: Data Protection

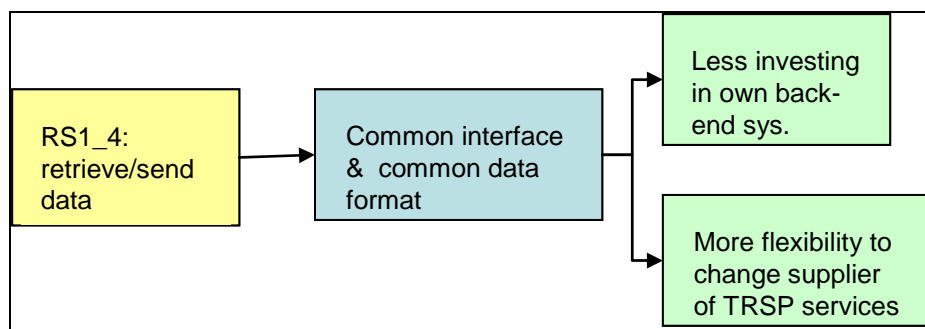
Another aspect is data protection. Common rules for the use of data in the supply chain can be used, and a common protocol for data protection can be agreed, both for the whole supply chain. Overall, this will improve data security in the supply chain. This will result in more trust among the supply chain partners.

Therefore more information can be shared between the different partners. This will lead to more transparency in the supply chain.

More information can be provided by the supply chain partners to the clients. In the end this will lead to a more open market and will improve competition in the logistic sector.

More transparency will also lead to an improved planning. Delays will be visible for all partners, and the planning can be updated to cope with the expected delays. This will lead to an improved transport planning, which will result in a reduction of the vehicle kilometres driven. Fewer kilometres driven also has a positive safety impact, and will also result in less emission.

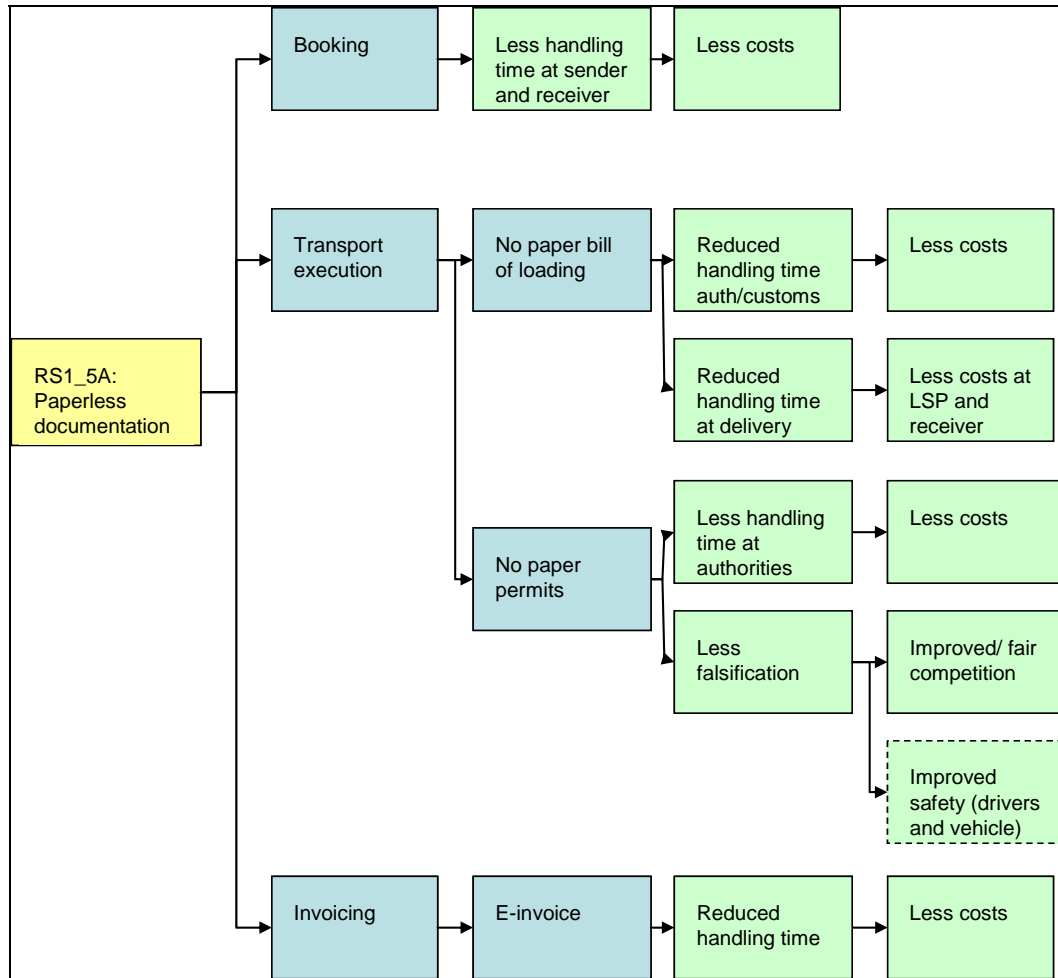
An improved planning will also lead to an improved production planning, which will result in cost savings for the producer.



#### **RS1\_4: Retrieve/send data**

Another important aspect is retrieval and sending of data. Common interfaces and common data formats will be agreed between supply chain partners. This will make it easier to connect the different systems of the supply chain partners together. Since common interfaces and data formats are used, less updates of the back-end systems are needed. This will reduce the investment costs in the back-end systems.

Since common interfaces and common data formats are used in the supply chain, it is easier to change the supplier of transport services.



### RS1\_5A: paperless documentation

Paperless documentation will have impacts on the whole transport process, from booking to transport execution, invoicing, and documentation. Also the linking of back end systems is an important aspect. The first three issues will be covered in RS1\_5A, the last two aspects will be covered in RS1\_5B.

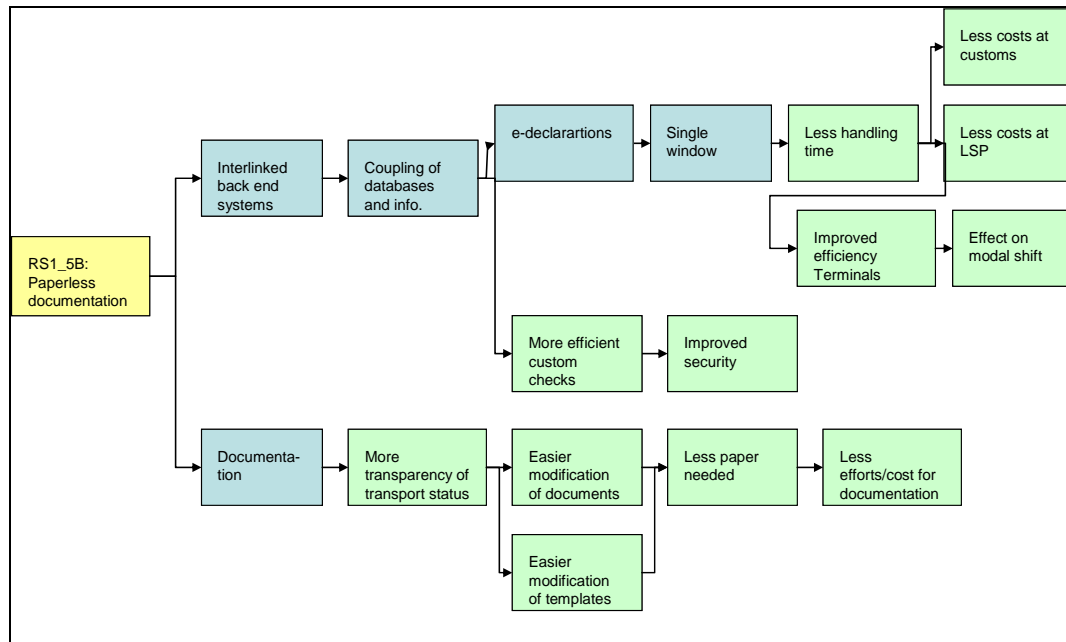
With respect to booking, paperless documentation will lead to less handling time for both the sender and receiver of the booking. The bookings are now provided electronically, instead of via fax. This will result in a cost reduction.

It also has an effect on the execution of the transport. No more paper bill of loading is needed. This reduces the handling time for authorities and customs, which will lead to cost reductions. Also the handling time at the delivery can be reduced, which again results in cost reductions, now for both the LSP and the receiver.

No more paper permits are needed for the driver. This will reduce the handling time of the authorities, resulting in cost reductions. Also falsification of permits will

be more difficult, no the permits are no longer paper documents. This will improve competition in the logistic market. Also safety is improved for both the driver, and the vehicle.

The invoicing process will also be affected. E-invoicing can be used instead of paper invoices. This will reduce the handling time of the invoices and will lead to cost reductions.



### RS1\_5B: Paperless documentation

Paperless documentation will have an effect on the links between the different back-end systems. The database and available information of the different partners can be coupled now. Electronic declarations will be possible. A single window will be available for providing all electronic documents to the authorities and/or customs. This will reduce the handling time of all these documents. This will lead to cost reductions for both the customs and the LSPs. It will also improve the efficiency of the terminals. This can lead to a change in the modal shift.

The coupling of databases and information will also make custom checks more efficient. They can carry out more checks electronically, and have a better overview of all the transport flows in the supply chain. This will lead to an overall improvement of security.

Finally, paperless documentation will also have an effect on the documentation process. Process related impacts mean improvements regarding the transparency of process status, i.e. the documentation exchange will be much faster. In terms of flexibility the modifications of document templates will be easier, corrections and modifications regarding the transport documents (information and data on

transport/ cargo) will be possible at any time during the process if necessary. This will lead to less need for physical transport of transport documents, less need for paper and less efforts/ costs for paper documentation (printing, changes etc.)

Some examples for the different impact chains:

#### **RS1\_1: Identification of cargo**

One product code is used by all stakeholders in the supply chain. For example for dangerous goods it is agreed by all stakeholders that UN codes will be used to identify these goods and only the list of UN-codes will be used by all stakeholders. The UN codes will be part of the product code which will be used.

#### **RS1\_2: Location**

One location code is used by all stakeholders in the supply chain. This will make it easier to exchange status information between the supply chain partners.

#### **RS1\_3: Data protection**

One approach for data protection is used by all stakeholders in the supply chain. This will make it possible to define common rules for data use and a common protocol for data protection.

#### **RS1\_4: Retrieve and send data**

Common interfaces and common data formats are agreed between all partners of the supply chain. This will make it easier to exchange data between the partners.

#### **RS1\_5: Paperless documentation**

Digital documents are used instead of paper documents. For example permits are now electronically, instead of in paper format.

Overview impacts per stakeholder:

<b>Impacts/ stakeholders Auth.</b>	<b>LSP Society</b>	<b>Manufacturer</b>	<b>Employees</b>	<b>Receiver</b>	<b>Admin/</b>
Efficiency	X	X	X	X	X
Sustainability	X		X		X
Safety	X		X	X	X
Security	X	X	X	X	X

Technologies:

No specific technologies are used. This use case is more related to defining common formats and interfaces which will be used. And agreements about paperless documents which can be used.

Examples for applications, sources for information useful for impact assessment:

- IATA eFreight – standard and paperless in air transport, SMART-CM, E-train
- Article “The “Long Tail” of eCommerce standards” in Supply chain quarterly Q1 2009
- eRailFreight – electronic bill of lading , project UIC and other partners (UIC pdf presentation available from 24/10/08 eBusiness conference)

## 5.2.2 Use Case 2

Headline: intelligent cargo in specific markets

timeline

**Use case II: semi-autonomous intelligent cargo units with bi-directional communication in specific market segments**

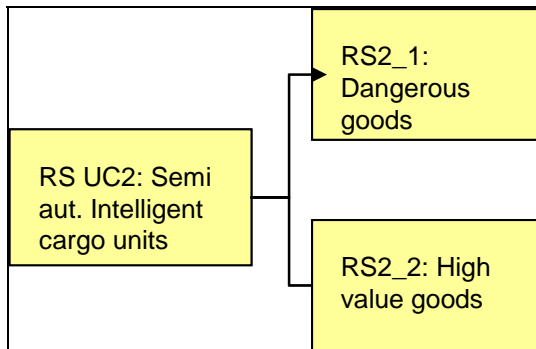
**RS**

Use case description and main assumptions:

- Intelligence at cargo level implemented for specific goods, like dangerous goods, high value goods.
- Intelligent tags are available but still very expensive which limits the business cases to these specific markets (e.g. Semi-autonomous intelligent transport system in dangerous goods and High value chains with intelligent transport).
- The units will be able to communicate with back end systems/ infrastructure concerning their status and all relevant data, these cargo related information can be changed via bi-directional communication from planning and steering side, for example in the case of events or necessary changing regarding transport execution (mode, route, timeslots etc.).
- This semi-autonomous intelligent cargo system enhances the communication between cargo & home offices.

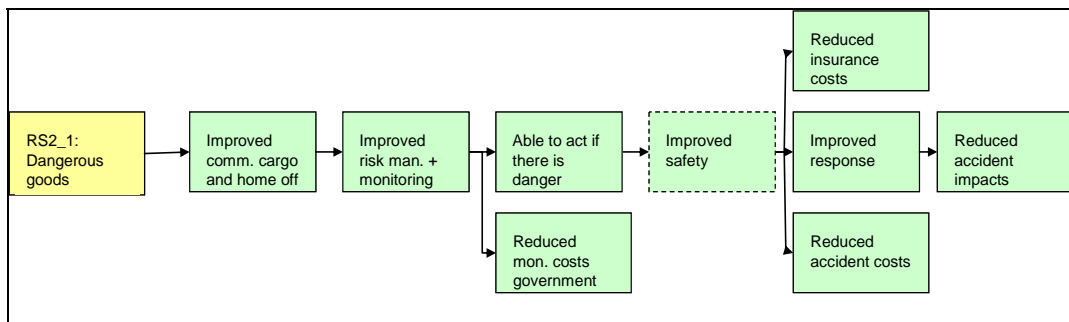


Impact chain:



This use case can be split into two parts:

- RS2\_1: Dangerous goods.
- RS2\_2: High value goods.

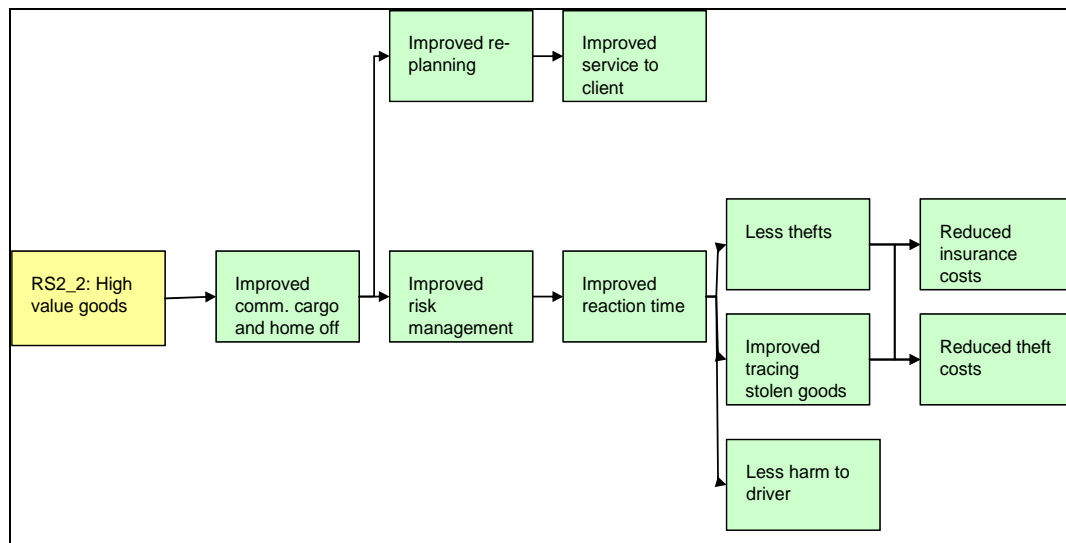


### RS2\_1: Dangerous goods

This impact chain concerns the sector dangerous goods. Improved communication will be available between the cargo units and the home office. For example active RFID chips are used for the dangerous cargo units, which can give a signal when the temperature rises. Also all cargo details are available at the cargo unit and can be used by the home office to decide how to respond in case an accident happens.

The improved communication can be used to improve risk management and monitoring. More detailed information is available, and the information is available real time. This offers the possibility to act if there is a danger, which will improve safety. Since the required information is directly available, the response can be improved. And the impacts of an accident can be reduced. The accident costs can be reduced, because the detailed information about the actual cargo will make it possible to have a more effective response when the accident happens. In time,

less accidents and improved safety can also lead to reduced insurance costs.



### RS2\_2: High value goods

This impact chain concerns the sector high value goods. Improved communication will be available between the cargo units and the home office.

The improved communication can be used to adapt the planning, in case there is for example a delay with a specific very expensive package for a client. A new planning can be made to ensure that the specific package is delivered on time to the client. This will improve the service to clients.

Improved communication can also be used to improve risk management. Actual information about all high value cargo units is available, and can be used to monitor that for example all goods are provided on time. In case delays are occurring, an immediate response is now possible, leading to a reduction of the reaction time. This will lead to fewer thefts, because all high value goods are now better monitored. Less cost means that the costs related to thefts are reduced. Also the high value goods can be better monitored when they are stolen. In time this can result in lower insurance costs.

A faster response can also reduce the possibility that the driver is harmed in case a dangerous situation is encountered.

Some examples for the different impact chains:

### RS2\_1: Dangerous goods

For dangerous goods, for example national and European monitoring centres could be established. These centres could actively monitor all dangerous goods transports in Europe and act in case an accident happens.

## RS2\_2: High value goods

For high value goods, for example each high value cargo item can be provided with an active RFID tag, which will make it possible to better monitor the transport process.

Stakeholders:

Impacts/ stakeholders	LSP Admin/Auth.	Manufacturer Society	Employees	Driver	Receiver
Efficiency	X	X	X	X	X
Sustainability	X		X		X
Safety	X		X		X
Security			X		

Technologies:

For this use case the further developed Intelligent tags (RFID-tags) are needed for the different cargo units. The tags have to be able to store data, to transfer data and to communicate with back-end systems. Furthermore enhanced sensor technologies are needed to read out the allocated data and information from the tags. Additionally an enhanced wireless network infrastructure between tags, sensors, mobile clients and back end systems is required. Within these sectors the requirements for secure data access and transfer are very high, therefore encoding and encryption technologies and software solutions will have large importance. Middleware solutions could play the role of secure interfaces between communication/ data transfer, data bases and mobile applications.

Examples for applications, sources for information useful for impact assessment:

- ATS,
- TRAMP,
- CVIS/CF&F,
- Hazardous material tracking,
- CARIN
- RTLS
- LAENDmarKS
- Article "Middleware solutions" in Funkschau 03/2009

### 5.2.3 Use Case 3

Headline: integrated planning over supply chains

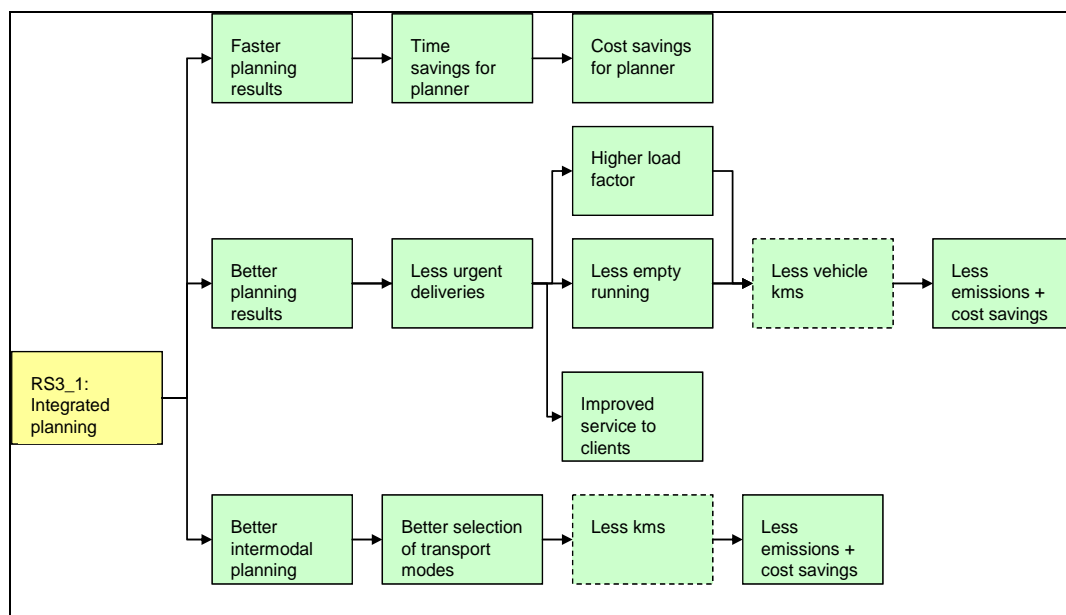
timeline

#### Use case III: integrated planning over supply chains RS

Use case description and main assumptions:

- Integrated planning is possible through better connected stakeholders and data availability over the entire supply chain.
- Real-time data for the most relevant status information of cargo will be available for any requesting system at the transport chain; these systems will be connected over standardized interfaces , data on infrastructure, transport modes, routes and planning relevant issues will be available.
- Planning and steering will be processed on a central level.
- Localisation, detection will mainly be done via enhanced barcode systems throughout the supply chain.

Impact chain:



#### RS3\_1: Integrated planning over supply chains

This use case concerns integrated planning for all partners over the whole supply chain, instead of different plannings made by several partners.

An integrated planning will result in faster planning results. This will lead to time

savings for the planner, which will result in cost savings for the planner.

An integrated planning also results in better planning results. These results can be used to reduce the number of urgent deliveries. Since the planning is done for the whole supply chain, available capacity of other partners can be used for certain urgent deliveries. This could lead to: higher load factors, in case more goods can be transported in a certain vehicle; and less empty running, by better combining the usage of all vehicles of all partners in the supply chain. Overall, this will result in fewer kilometres driven. This also has a positive safety effect. And less vehicle kilometres means less emissions and cost savings.

Less urgent deliveries also lead to an improved service to clients.

Finally, an integrated planning also leads to better intermodal planning. Since an overall planning for the whole supply chain is made, the transport modes which will be used can be better selected. And the most optimal one can be chosen. For the whole supply chain, this will lead to a reduction of the total kilometres, which also has a positive safety effect. This will result in less emissions and cost savings.

Some examples for the different impact chains:

### **RS3\_1: Integrated planning over supply chains**

One integrated planning is now made for the whole supply chain, for example in the automotive sector. This concerns the delivery of cars from the producer to the clients.

Stakeholders:

<b>Impacts/stakeholders</b>	<b>LSP</b>	<b>Manufacturer</b>	<b>Carrier</b>
Efficiency	X	X	X
Sustainability	X		X
Safety	X		X
Security			

Technologies:

- Standard protocols for the secure and easy data transfer and access between cargo related hardware, interface systems and other back end systems.

- Dense network of data communication and transfer with sensors throughout entire supply chain, enhanced barcode labels and readers are requested to provide data availability.

Examples for applications, sources for information useful for impact assessment:

- INWEST – intelligent steering of container via tracking and tracing
- INTEGRITY – Intermodal global door-to-door container supply chain visibility
- SMART-CM
- DHL SmartSensor Temperature; <http://www.smartsensor-temperature.de/en/index.html>
- LogNetAssist – assistance to steer intelligent logistics networks
- Secure Trade lane
- i-scheduler for road transportation

## 5.2.4 Use Case 4

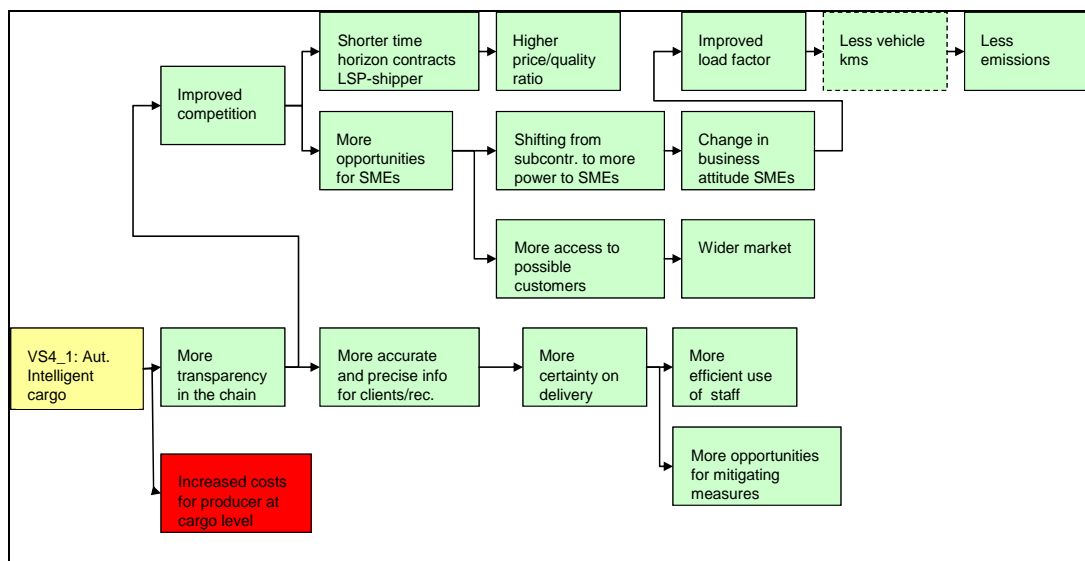
Headline: intelligence at cargo level with autonomous planning timeline

### Use case IV: autonomous intelligent cargo units with bi-directional VS communication

Use case description and main assumptions:

- Intelligence at cargo level implemented independent from market segments
- Intelligent tags are widely available, cost efficient use for any stakeholders in the transport chains possible (autonomous intelligent transport system)
- Different levels of information (time factor, cost, status, character etc.) are being placed on cargo level (using an intelligent tag) right after manufacturing (Communication between cargo and cargo and systems enhanced)

Impact chain:



### VS4\_1: Autonomous intelligent cargo units

The usage of intelligent tags for all goods which are produced will lead to more transparency in the chain. Via the intelligent tags cargo data will be available for all stakeholders, if they have indeed access rights to the specific cargo data.

More transparency in the supply chain will lead to improved competition. The performances of all parties in the supply chain can be easier compared with each

other. Especially for the LSP there will be a shorter time horizon for the contracts with shippers, because shippers can more easily shift to another LSP. This will lead to a better price/quality ratio.

Improved competition will also offer more opportunities for SMEs. For the SMEs this will also result in less subcontracting to one or only a few clients, and more opportunities for providing services to a great number of clients. This will lead to a change in the business attitude of SMEs. The focus will be less on driving as much as possible kilometres for a relative low price per kilometre to an attitude of trying to improve their performance. This leads to an improved load factor, which will result in less vehicle kilometres driven. Less vehicle kilometres driven also has a positive effect on safety, because less kilometres driven reduces the number of accidents. Less kilometres driven will also reduce emissions.

More opportunities for SMEs will also provide more access to possible customers. This will result in a larger market for the SMEs.

More transparency in the supply chain will also lead to more accurate and precise information which will be available for both the clients and the receivers of the goods. There will be an improvement of the certainty of the deliveries. This will lead to a more efficient use of the available staff needed to receive the goods. And also provide more opportunities for mitigating measures for receiving the goods.

Planning is still done at a central level for each LSP, but improved planning opportunities for LSPs will lead to an increase of service level for clients. This will result in improved reliability, less delays, less damages, etc.

On the other hand there will be an increase of costs for the producer to provide all cargo items with intelligent tags. However, due to the large number of intelligent tags which are needed in Europe, the costs per tags are limited, compared to the costs of an intelligent tag nowadays.

Some examples for the different impact chains:

#### **VS4\_1: Autonomous intelligent cargo units**

- The producer places intelligent tags on the goods, when the orders are placed by the clients. For example active RFID tags can be used. All needed information and data regarding the transport and supply chain process are being saved on the intelligent tag
- The intelligence at cargo level means a random access memory system of data management on every cargo item, furthermore the ability to communicate self-controlled



## Stakeholders:

<b>Impacts/ stakeholders</b>	<b>LSP</b>	<b>Manufacturer</b>	<b>Employees</b>	<b>Driver</b>	<b>Receiver</b>	<b>Admin/Auth.</b>	<b>Society</b>
Efficiency	X	X	X	X	X		
Sustainability	X			X			X
Safety	X			X			X
Security							

## Technologies:

- Intelligent RFID tags (random access, rewriteable),
- RFID readers,
- Wireless applications and technologies for transfer and communication,
- Intelligent sensor devices (gates, tunnels),
- Antenna, GSM/
- Service oriented architectures (SOA)

## Examples for applications, sources for information useful for impact assessment:

- VitOL – Intelligent sensor nodes for cargo and infrastructure
- Cargobox – intelligent cargo container solution <http://cargobox.info>
- Intelligent container – agent based system for autonomous transport
- RAEWatch sensor module
- (Machine Talk)

## 5.2.5 Use Case 5

Headline: IT infrastructure

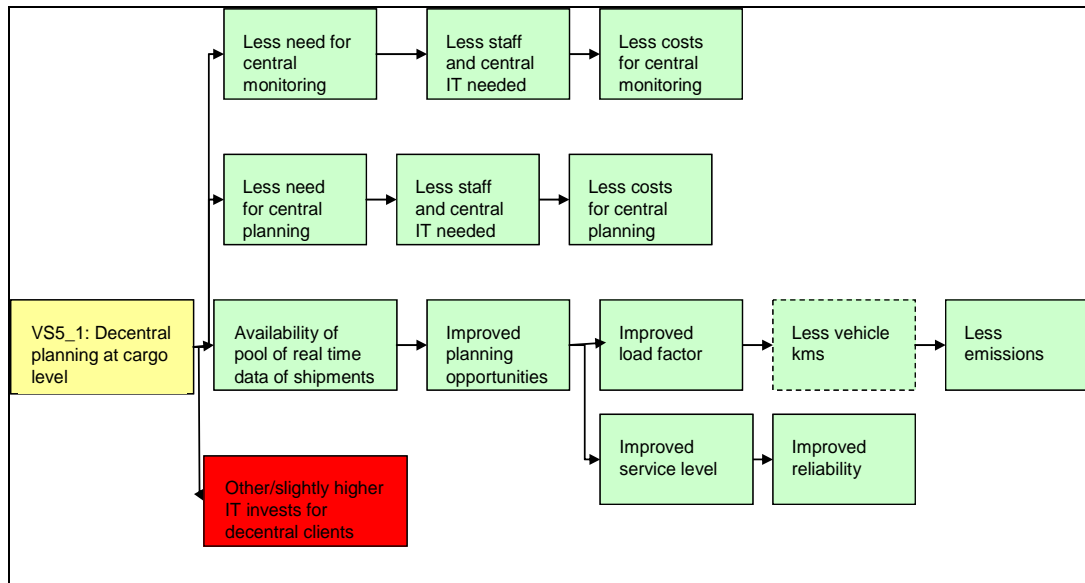
timeline

**Use case V: Decentral planning at cargo level, and  
decentralized IT infrastructure on cargo/ node and actor level**

**VS**

*Use case description:*

- Decentralized enhanced clients taking over several planning, monitoring and steering tasks, within the supply chain (Decentralized approach for planning and monitoring of cargo).
- Decentralized planning: planning decisions can be made at cargo level e.g. cargo units can decide about given alternatives (transport modes, carrier etc.) planning parameter are being processed decentral at node/ cargo level, therefore enhanced IT devices (mobile clients) are needed.
- Clients used on the interfaces (at loading/ unloading, on vehicle), within the supply chain are being enhanced with more IT and optimization capacity which leads to a decentralized and widely diversified IT landscape, central databases and planning systems are not needed.
- These decentralized enhanced IT systems (e.g. clients) on several single parts of the transport chain are being enabled to communicate with the cargo units, to process order management and to take over several planning and optimization tasks.
- Throughout the supply chain the needed infrastructure/ devices for sensing, tracking, tracing, wireless communication and data transfer are being installed and are working reliable.

**Impact chain:****VS5\_1: Decentralized planning at cargo level**

Due to the decentralized planning at cargo level, there is less need for central monitoring in the supply chain. Monitoring is done by the intelligent cargo units, once the intelligent tags have been placed. Less central monitoring means less staff and central IT needed. This will reduce the costs for central monitoring.

Planning is also improved when intelligent cargo units are involved in the planning process. There is less need for central planning in the supply chain, when planning is carried out decentral at cargo level. Again, less staff and central IT is needed. This will result in fewer costs needed for central planning.

There will also be the availability of a large pool of real time data of shipments. The intelligent cargo units are actively involved in planning their own trip at a decentral level. This will increase the planning opportunities for especially the LSPs. It is however important to keep a good overview of the relevant information, within the large pool of real time data of shipments. Instead of only working for a few clients a whole market place is available, which contains a great number of potential clients. This will improve the load factor for LSPs. This will result in less vehicle kilometres driven, which also has a positive safety effect. Less kilometres driven leads to less emissions.

Improved planning opportunities will also lead to an improved service level for clients. This will result in an improved reliability for the clients. On the other hand, decentralized planning and using decentralized IT systems will result in other and/or slightly higher IT investments in decentralized enhanced IT-systems (e.g. clients).

This use case can be considered as a paradigm shift in logistics and supply chain planning. The various impacts described above and this shift may be anticipated to decrease overall supply chain costs. Lead times may be reduced, with less frictions as result, which could lead to a decrease of the overall capital needed for supply chains. Together, this may imply a significant impact for businesses in the sector.

Some examples for the different impact chains:

### VS5\_1: Decentralized planning at cargo level

The intelligence at cargo level means a limited data storing and computing ability on every cargo item and furthermore the ability to communicate self-controlled. The intelligent cargo units will be able to carry out their own planning at a decentralized level, and are able to monitor and control this planning. The here mentioned intelligence and abilities of cargo units must not necessarily be fully provided “on-board” but can be reached by using respective servant services which are always offered in the vicinity of the units by the surrounding infrastructure.

Stakeholders:

Impacts/ stakeholders	LSP	Manufacturer	Employees	Driver	Receiver	Admin/
Auth.	Society					
Efficiency	X	X	X		X	
Sustainability	X			X		X
Safety	X			X		X
Security						

Technologies:

- Enhanced mobile devices are needed for the enhanced decentral functionalities.
- IT infrastructure,
- Service oriented architectures (SOA); for more flexible, decentral and comfortable services/ applications the concept of cloud computing could be used.
- Middleware solutions could be the interface systems between the hardware components RFID tags and gates (sensors), or mobile devices and other systems at customer side.

Examples for applications, sources for information useful for impact assessment:

- VitOL – Intelligent sensor nodes for cargo and infrastructure

- EURIDICE intelligent cargo architecture
- MECD- mobile edge computing

## 5.3 Impacts on efficiency and sustainability

### 5.3.1 Impacts overview

The next table provides an overview of all efficiency and sustainability impacts per use case and indicates which impacts are described qualitatively only and which are also quantified. All impacts have already been briefly described qualitatively in the previous section.

**Table 7: Overview on efficiency and sustainability impacts**

Use case	Type <sup>1</sup>	Impact	Only qualitatively	Also quantified
UC1	E	UC1-1: Less unnecessary trips		X
	S	UC1-1: Less emissions		X
	E	UC1-1: Less waiting time receiver		X
	E	UC1-1: Less time needed for correcting errors		X
	E	UC1-2: Less costs adapting back-end systems		X
	E	UC1-2: Less costs re-adapting production processes		X
	E	UC1-2: More info. to clients	X	
	E	UC1-3: Improved market competition/open market	X	
	E	UC1-3: Less vehicle kms (improved transport planning)		X
	S	UC1-3: Less emissions		X
	E	UC1-3: Improved production planning	X	
	E	UC1-4: Less investing in own back-end systems		X
	E	UC1-4: More flexibility to change supplier of transport services	X	
	E	UC1-5: Booking: less handling time sender/receiver		X
	E	UC1-5: Tr execution: Electronic Bill of lading		X
	E	UC1-5: Tr execution: Electronic permits		X
	E	UC1-5: Invoicing: electronic invoices		X
	E	UC1-5: Interlinked back-end systems	X	
	E	UC1-5: Documentation	X	
UC2	E	UC2-1: Dangerous goods: reduced costs due to improved response	X	
	E	UC2-1: Dangerous goods: reduced monitoring costs government	X	
	E	UC2-2: High value goods: Improved service to client	X	
	E	UC2-2: High value goods: Reduced insurance costs		X

<sup>1</sup> Type “E” is efficiency impact, and type “S” is sustainability impact.

	E	UC2-2: High value goods: Reduced costs related to thefts		X
	E	UC2-2: High value goods: Less harm to driver	X	
UC3	E	UC3: Cost savings planner		X
	E	UC3: Less vehicle kms due to less urgent deliveries		X
	S	UC3: Less emissions		X
	E	UC3: Improved service to clients	X	
	E	UC3: Better intermodal planning leading to less kms	X	
	S	UC3: Less emissions intermodal transport	X	
UC4	E	UC4: Higher price/quality ratio	X	
	E	UC4: Less vehicle kms SMEs		X
	S	UC4: Less emissions		X
	E	UC4: Wider market	X	
	E	UC4: More efficient use of staff		X
	E	UC4: more opportunities for mitigating measures	X	
UC5	E	UC5: Less costs for central monitoring		X
	E	UC5: Less costs for central planning		X
	E	UC5: Less vehicle kms due to improved planning opportunities		X
	S	UC5: Less emissions		X
	E	UC5: Improved reliability	X	

It is obvious that the scenarios that have been developed contain a series of uncertainties. Many aspects of the scenarios are still of an uncertain character, also in the realistic scenario. Therefore, in order to make a quantitative estimate of the impacts, a set of assumptions have been made. It has to be stressed that the quantitative impacts presented in this chapter are completely related to the assumptions we have made. The reader should interpret the figures as rough orders of magnitude, presenting what could occur if certain developments work out as put in the assumptions.

The most relevant general input data and assumptions which are used are the following:

#### General input data

- Statistics with freight Transport data, like tkm, vehicle km, journeys, etc. Main sources are: DG TREN, Eurostat.
- Statistics with data about enterprises: Eurostat.
- Ratio PPP GDP EU-27/ PPP GDP NL (0,775), source Eurostat.

## General assumptions

- Prognoses tonnes-kilometres (1.8% per year) based on DG TREN study: "Trends to 2030"
- Emission factors tonnes CO<sub>2</sub> per km; tonnes NO<sub>x</sub> per km and tonnes PM per km, source: TREMOVE model, estimates for 2010.
- Annual thefts in road transport (8,2 billion euro), source: Europol "Cargo theft report, 2009"
- Average euro saved per reduced km for road transport EU-27 (0,97 € per km), source: study "Factorkosten, NEA" and using PPP GDP ratio EU-27/ PPP GDP NL.
- Average hour wage logistic sector EU-27 (23 € per hour), source "Transport in cijfers, TLN, 2009" and using PPP GDP ratio EU-27/ PPP GDP NL.
- Percentage high value goods journeys, compared to total journeys (1,49%), based on assuming 10% of transported goods with NSTR 24 (miscellaneous articles) are high value goods.
- Insurance cost high value goods (500 € per journey), based on a number of assumptions and interview with Dutch insurance company TVM.
- Investment costs monitoring (500 € per large firm), based on investments in tracking and tracing software, source: "Transport in cijfers, TLN , 2009".
- Investment costs planning (500 € per large firm), based on investments in trip planning software, source: "Transport in cijfers, TLN , 2009".

An overview of the other detailed input data which are used and the main general assumptions which are made is provided in Annex 1. The specific assumptions which are made per use case are presented separately for each use case.

Using the above mentioned input data and assumptions the efficiency and emission impacts have been calculated. We first present the results for two snapshot years. For the realistic scenario the results for 2020 are presented. For the visionary scenario the results for 2035 are presented, taking into account that it will take much longer (25 years) to implement the visionary scenario. At the end of the sections on the realistic scenario and the visionary scenario, we will present in addition, the overall development of the benefits for each scenario for the timeframe 2010-2035, rather than presenting only one snapshot year.

For most assumptions, a minimum and a maximum figure for the specific assumption is mentioned. Based on these minimum and maximum figures also the



minimum and maximum impacts per use case are calculated. These provide a bandwidth for the expected impacts; instead of only providing one single figure per impact.

### 5.3.2 Impacts of the realistic scenario

The realistic scenario consists of three use cases (UC1-UC3), which are presented in detail above. The impacts for these use cases are estimated here. Per use case first a short summary of the use case is given, then the specific assumptions are provided and finally the impacts are shown.

#### **UC1 Standard formats & interfaces and paperless documentation**

This use case mainly concerns the introduction and usage of standard formats & interfaces within each supply chain. The same formats and interfaces will be used by all supply chain partners, instead of using different formats and interfaces by different partners to communicate within the supply chain. Also paperless documentation formats are developed and implemented, together with the authorities in order to ensure that the electronic documents indeed can be used to replace paper documents within the supply chain.

As shown in the UC1 impact chain diagrams in the previous section using standard formats & interfaces and paperless documentation will lead to timesavings for the different stakeholders, and kilometre and emission reductions when transporting the goods to the clients. Also fewer costs will be needed for adapting back-end systems. More concrete, the main assumptions used for this use case are the following:

- UC1-1: reduction of unnecessary trips (minus 0,1%), assuming an improvement of 99,5% reliability to 99,6% reliability.
- UC1-1: number of wrong shipments (0,1%)
- UC1-1: less waiting time receiver (saving of 5-15 minutes), due to improved reliability the availability of the receiving personnel can be better planned, and less time is lost waiting for a delayed shipment.
- UC1-1: less time needed for correcting errors (saving of 5-15 minutes)
- UC1-2: SMEs: less costs adapting back-end systems (saving of 2-4 working hours per year).
- UC1-2: Large transport companies: less costs adapting back-end systems (saving of 20-40 working hours per year).

- UC1-2: Manufacturers: less costs re-adapting production process (20-40 hours per year).
- UC1-3: Reduced kms due to improved transport planning (reduction of 1-2%).
- UC1-4: SMEs: less investing in back-end systems (saving of 2-4 working hours per year).
- UC1-4: Large transport companies: less investing in back-end systems (20-40 hours per year).
- UC1-5: Booking: less handling costs sender and receiver (5-10 minutes).
- UC1-5: Percentage bookings not yet handled electronically (50%).
- UC1-5: Transport execution: Bill of lading: reduced handling time authorities/customs (1-2 minutes).
- UC1-5: Transport execution: Bill of lading: reduced handling time LSP + receiver (2-4 minutes, for international trips).
- UC1-5: Transport execution: Bill of lading: reduced handling time LSP + receiver (1-2 minutes, for national trips).
- UC1-5: Transport execution: Electronic permit: reduced handling time authorities/customs, LSP (1-2 minutes, per road check).
- UC1-5: Transport execution: Electronic permit: percentage vehicles checked (1%).
- UC1-5: Transport execution: Electronic permit: additional time savings LSP related to road checks (10-20 minutes, per road check).
- UC1-5: Electronic Invoicing: reduced handling time invoices (1-2 minutes).
- UC1-5: Electronic Invoicing: percentage invoices not yet handled electronically (75% minutes), assumed to be higher than percentage for electronic bookings.

Using the above mentioned assumptions the impacts have been estimated. The next tables present the estimated impacts for the use cases in a min.-max. range.

**Table 8: Impacts overview for UC1 of the realistic scenario**

<b>UC1 results Realistic scenario (2020)</b>	<b>Values (min – max)</b>
KM reduction (Billion kms)	2-4
Emissions: CO2 (Million tonnes)	1-3
Emissions: NOx (Thousand tonnes)	12-22
Emissions: PM (Thousand tonnes)	0,2-0,4
Time savings (in Billion minutes)	14-28
Total monetarized impacts (in Billion euro)	7-14

It can be seen that the expected annual kilometre reduction is between 2 – 4 Billion kilometres in 2020. The expected CO2 reductions are between 1 – 3 Million tonnes of CO2. The total monetarized impacts in 2020 are between 7 – 14 Billion Euro.

In addition to the above mentioned quantitative impacts, also a number of qualitative impacts (which could not be quantified) need to be taken into account. These qualitative impacts are the following:

- UC1-2: More information to clients: Less errors with status information will improve the quality of information which is provided to the clients.
- UC1-3: Improved market competition/open market: More transparency and more information which is provided to clients will lead to an improved competition and a more open market, because the performance of the different supply chain partners can be better compared by the clients.
- UC1-3: Improved production planning: Improved planning will also lead to an improved production planning for the manufacturers, because fewer changes in the production planning will be needed.
- UC1-4: More flexibility to change supplier of transport services: Since common interfaces and data formats are used it is easier to select another company which can provide the logistic services. This new company can easily connect its system to your system, using the common interface and data format.
- UC1-5: Interlinked back-end systems: Due to the introduction of paperless documentation the different back-end system can be better linked to each other, for example in the case of e-declarations.
- UC1-5: Documentation: Introduction of paperless documentation also improves the documentation process itself, less paper is needed, and less costs need to be made for documentation.

From the values as indicated in the table above, an analysis has been made which aspects contribute most to the magnitude of the impacts. The next table presents the most important impacts for this use case.

**Table 9: Main impacts for UC1 of the realistic scenario**

UC1 results Realistic scenario (2020)	Values min.- max.
UC1-2. Manufacturer: time savings adapting prod process (Billion minutes)	2-5
UC1-2. Manufacturer: cost savings adapting prod process (Billion euro)	1-2
UC1-3. Reduced kms due to improved transport planning (Billion kms)	2-4
UC1-3. Reduced kms-costs due to improved transport planning (Billion euro)	2-4
UC1-5. Booking: less handling sender + receiver (Billion minutes)	6-12
UC1-5. Booking: less handling costs sender + receiver (Billion euro)	2-4
UC1-5. Tr execution: int trips, time saving elec. Bill of lading auth.(Billion minutes)	1-2
UC1-5. Tr execution: int trips, cost saving elec. Bill of lading auth.(Billion euro)	0.4-1
UC1-5. Invoicing: less handling time elec. Invoices (Billion minutes)	2-4
UC1-5. Invoicing: less handling elec. Invoices (Billion euro)	0.6-1.2

The table above shows that the main impacts are related to UC1-5: paperless documentation. These are related to using electronic forms for: bookings (2 – 4 Billion euro), Bill of Lading (0,4 – 1 Billion euro) and invoices (0.6 – 1.2 Billion euro). Other important impacts related to using standard formats are cost savings for manufacturers (2 – 5 Billion euro) in UC1-2 (location/common status info) and reduced kms (2 – 4 Billion kms) due to improved transport planning in UC1-3 (data protection).

### **UC2: Semi-autonomous intelligent cargo units with bi-directional communication in specific market segments**

UC2 concerns specific market segments, namely dangerous goods and high value goods. In these segments it has an added value to use more expensive technologies or applications, like active tags and bi-directional communication. In the case of dangerous goods this added value is mainly related to the impacts on society. Negative impacts due to serious accidents can be reduced with improved monitoring. In the case of high value goods, the added value is related to improved monitoring of the goods.

Improved monitoring will lead to fewer thefts of high value goods. Taking this into account, the main assumptions used for this use case are the following:

- UC2-2: High value goods: reduced thefts (20-25%), based on source “Cargo theft report, 2009”, aim of NL action plan is to reduce cargo theft in road transport with 25%
- UC2-2: High value goods: reduced insurance costs (5-10%)

Using the above mentioned assumptions the impacts have been estimated. The next table present the estimated impacts for this use case.

**Table 10: Overview impacts UC2 realistic scenario**

<b>UC2 results Realistic scenario (2020)</b>	<b>Values min. – max.</b>
KM reduction min (Billion kms)	0
KM reduction max (Billion kms)	0
Emissions: min CO2 (Million tonnes)	0
Emissions: max CO2 (Million tonnes)	0
Emissions: min NOx (Thousand tonnes)	0
Emissions: max NOx (Thousand tonnes)	0
Emissions: min PM (Thousand tonnes)	0
Emissions: max PM (Thousand tonnes)	0
Time savings min (in Billion minutes)	0
Time savings max (in Billion minutes)	0
Total monetarized impacts (in Billion euro)	1.3 – 1.6

No kilometre reduction and reduced impacts are expected for this use case. The main expected impacts are a total monetarized annual impact of between 1.3 and 1.6 Billion € in 2020.

In addition to the above mentioned quantitative impacts, also a number of qualitative impacts (which could not be quantified) need to be taken into account. These qualitative impacts are the following:

- UC2-1: Dangerous goods: reduced costs due to improved response: the accident costs and accident impacts can be improved due to better monitoring of dangerous goods transports in Europe.
- UC2-1: Dangerous goods: reduced monitoring costs government: The improved monitoring of dangerous goods also reduces the monitoring goods of the authorities.
- UC2-2: High value goods: Improved service to client: Improved re-planning of high value goods transports makes it possible to deliver these goods on time to the clients, even in case unexpected delays have happened.
- UC2-2: Less harm to driver: the improved reaction time makes it possible to react faster in case incidents happen which concern the driver and this will in the end lead to less harm to the driver.

From the values as indicated in the table above, an analysis has been made which aspects contribute most to the magnitude of the impacts. The next table presents the most important impacts for this use case.

**Table 11: Main impacts of UC2 realistic scenario**

UC2 results Realistic scenario (2020)	Values min.-max.
UC2-2. Reduced thefts luxury goods + improved tracing (Billion euro)	1.3-1.6

It can be seen that the quantified impacts are caused by the reduction of the costs related to thefts of high value goods. It has to be mentioned that the impacts for UC2-1 (dangerous goods) could not be quantified, and therefore are only described qualitatively in the previous section.

### **UC3: Integrated planning over supply chains**

The back-end systems of all supply chain partners are connected to each other, using standardised interfaces. This will make it possible to make one integrated central planning for all supply chain partners, and to monitor and steer the supply chain at central level by the supply chain leader. All relevant status information of cargo can be provided to all partners in the supply chain.

As shown in the U3 impact chain diagram in the previous section integrated planning over the whole supply chain will lead to time savings for the planner. Better planning will result in less kilometres driven. More concrete, the main assumptions used for this use case are the following:

- UC3: Time savings for planner (1-2 minutes)
- UC3: Less empty kms due to better planning (1-2%)
- UC3: Less laden kms due to better planning (1-2%)

Using the above mentioned assumptions the impacts have been estimated. The next table present the estimated impacts for this use case.

**Table 12: Overview impacts of UC 3 realistic scenario**

UC3 results Realistic scenario (2020)	Values min. – max.
KM reduction (Billion kms)	2-4
Emissions: CO2 reductions (Million tonnes)	1-3
Emissions: NOx (Thousand tonnes)	11-21
Emissions: PM (Thousand tonnes)	0.2-0.4
Time savings (in Billion minutes)	2-5
Total monetarized impacts (in Billion euro)	3-6

The table above indicates that the expected kilometre reduction in 2020 is between 2 – 4 Billion kilometres. The expected CO2 emission reduction is between 1 and 3 million tonnes of CO2. The total monetarized annual impacts are between 3 and 6 Billion € in 2020.

In addition to the above mentioned quantitative impacts, also a number of qualitative impacts (which could not be quantified) need to be taken into account. These qualitative impacts are the following:

- UC3: Improved service to clients: Less urgent deliveries will improve the service to clients, because deliveries will be combined as much as possible. And will be only delivered separately in case this is really necessary.
- UC3: Better intermodal planning leading to less kms: An integrated planning for the whole supply chain will make it possible to better select if intermodal transport can be used. This will lead to less kilometres for the total transport of all goods using different transport modes.
- UC3: Less emissions intermodal transport: Less kilometres will also lead to less emissions.

From the values as indicated in the table above, an analysis has been made which aspects contribute most to the magnitude of the impacts. The next table presents the most important impacts for this use case.

**Table 13: Main impacts of UC3 realistic scenario**

UC3 results Realistic scenario (2020)	Values min.-max.
Timesaving planner (Billion min)	2-5
Timesaving planner (Billion euro)	1-2
Less empty kms due to better planning (Billion kms)	0,5-1
Less empty kms due to better planning (Billion euro)	0,5-1
Less laden kms due to better planning (Billion kms)	1-3
Less laden kms due to better planning (Billion euro)	1-3

For UC3 the main impacts are km reduction, related to less empty kms (0,5 – 1 Billion km) and less laden kms (1 – 3 Billion km). The other important impact is timesavings for planners (1 – 2 Billion euro).

#### ***Overall impacts (UC1-UC3) of the realistic scenario***

The next table provides the main results for the realistic scenario.

**Table 14: Summarized impacts of the realistic scenario**

Total results Realistic scenario (2020)	Values min.-max.
KM reduction (Billion kms)	4-8
Emissions: CO2 (Million tonnes)	3-5
Emissions: NOx (Thousand tonnes)	22-44
Emissions: PM (Thousand tonnes)	0,4-1
Time savings (in Billion minutes)	17-33
Total monetarized impacts (in Billion euro)	11-22

It can be seen that between 4 – 8 Billion kms reduction can be realized per year, if the assumptions that are made are realised. The expected CO2 emission reductions are between 3 – 5 Million tonnes of CO2. The estimated time savings are estimated between 17 – 33 Billion minutes annually, while the total monetarized impacts amount to 11 – 22 Billion € per year.

In addition to the quantified benefits which have been presented in the table above, there are also a number of qualitative impacts, which have been already described in this section before. These qualitative benefits also have a monetary value, but unfortunately these benefits could not be quantified.

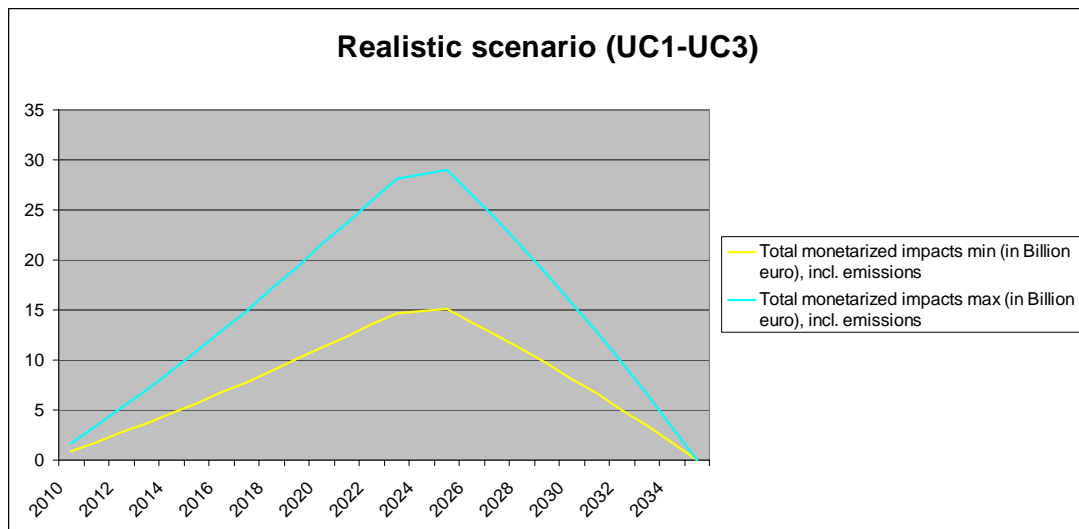
#### ***Overall benefits for the timeframe 2010-2035***

For both scenarios, a development path has been drafted between 2010 and 2035. We refer to section 6.2. for a detailed description of this development path. In this section we will present the gradual increase of the impacts in accordance with this development path for the realistic scenario. After all, as indicated before, the



impacts in the realistic scenario are expected to gradually increase from 2010 onwards. It does not last until 2020 before the first benefits accrue to stakeholders. Therefore we present the development of the impacts in the entire timeframe between 2010 and 2035. The impacts presented for the realistic scenario constitute the sum of the impacts for UC1 – 3.

Like in the previous chapter, we have distinguished a minimum and maximum scenario. The benefits include the quantified benefits of emission reductions.



The benefits from the realistic scenario are anticipated to gradually increase up till 15-29 billion euro in 2024, and then gradually decrease again. Section 6.2. in the next chapter provides more insight on the background behind this development.

### 5.3.3 Impacts of the visionary scenario

This section describes the impacts for the various use cases in the visionary scenario. Again we first present our assumptions made, and then we present the results for the year 2035.

#### **UC4: Autonomous intelligent cargo units with bi-directional communication**

In this use case autonomous intelligent cargo units will be used in all sectors, instead of only in a few sectors like in UC2. All relevant cargo information will be available locally at cargo level, via an intelligent tag which is attached to each cargo item.

Introducing autonomous intelligent cargo units in all sectors will have an effect on the SME market. It is expected that less vehicle kilometres will be driven by SMEs. It is also expected that theft of high value goods will be further reduced using autonomous intelligent cargo units. To make this more concrete, the main assumptions used for this use case are the following:

- UC4: Less vehicle kms SMEs due to the changed business attitude in visionary scenario (5-10%)
- UC4: average number of vehicles per SME (2 vehicles)
- UC4: More efficient use of staff due to more certainty on delivery (5-10 minutes per shipment)
- UC4: High value goods: reduced thefts (40-50%), assumed to be twice the value of reduced thefts of UC2.

Using the above mentioned assumptions the impacts have been estimated. The next table present the estimated impacts for this use case.

**Table 15: Overview impacts for UC4 in visionary scenario**

<b>UC4 results Visionary scenario (2035)</b>	<b>Values min.-max.</b>
KM reduction (Billion kms)	0,5-1
Emissions : CO2 reductions (Million tonnes)	0,4-0,7
Emissions: NOx (Thousand tonnes)	3-6
Emissions: PM (Thousand tonnes)	0,1-0,1
Time savings (in Billion minutes)	19-39
Total monetarized impacts (in Billion euro)	11-20

The total expected kilometre reduction is between 0,5 – 1 Billion kilometres. The expected CO2 emission reduction is between 0,4 – 0,7 Million tonnes of CO2. The total monetarized annual impacts in 2035 are estimated between 11– 20 Billion euro.

In addition to the above mentioned quantitative impacts, also a number of qualitative impacts (which could not be quantified) need to be taken into account. These qualitative impacts are the following:

- UC4: Higher price/quality ratio: The time horizon of contracts between LSPs and shippers will become shorter. This will lead to an improved price/quality ratio.
- UC4: Wider market: More access to possible customers will offer the SMEs a wider market, compared to the current situation.
- UC4: more opportunities for mitigating measures: More precise and accurate information is provided to clients, which will provide more certainty on the delivery of the goods. This provides more possibilities to cope with unexpected events in case they do happen.

From the values as indicated in the table above, an analysis has been made which aspects contribute most to the magnitude of the impacts. The next table presents the most important impacts for this use case.

**Table 16: Main impacts for UC4 in visionary scenario**

UC4 results Visionary scenario (2035)	Values min.-max.
More efficient use of staff (Billion min)	19-39
More efficient use of staff (Billion euro)	8-15
Reduced thefts luxury goods + improved tracing (Billion euro)	3-4

The table above shows that the main impacts are related to more efficient use of staff (8 – 15 Billion €), and reduced thefts of high value goods (3 – 4 Billion euro).

#### **UC5: Decentralized planning at cargo level**

Decentralized enhanced clients can take over several planning, monitoring and steering tasks within the supply chain. These tasks can now be arranged at a decentral level instead of at a central level. Decentralized IT systems at a local level are implemented instead of using advanced IT systems at a central level.

Introducing decentralized planning will lead to less central planning and monitoring. Improved planning opportunities are also expected to result in less kilometres driven. More concrete, the main assumptions used for this use case are the following:

- UC5: Large companies no longer needing new monitoring software (50-75%), based on NL companies using tracking and tracing software (source: Transport en cijfers, TLN)
- UC5: Large companies no longer needing new planning software (30-45%), based on NL companies using trip planning software (source: Transport en cijfers, TLN)
- UC5: more efficient use of staff (1-2 FTE reduction per large company)
- UC5: Less empty kms due to improved planning opportunities (1-2%)
- UC5: Less laden kms due to improved planning opportunities (1-2%)

Using the above mentioned assumptions the impacts have been estimated. The next table present the estimated impacts for this use case.

**Table 17: Overview impacts for UC5 in visionary scenario**

UC5 results Visionary scenario (2035)	Values min.-max.
KM reduction (Billion kms)	6-12
Emissions: CO2 reduction (Million tonnes)	4-8
Emissions: NOx (Thousand tonnes)	35-70
Emissions: PM (Thousand tonnes)	1-1
Time savings (in Billion minutes)	4-8
Total monetarized impacts (in Billion euro)	8-17

It can be seen that the expected kilometre reduction is between 6 – 12 Billion kilometres. The expected CO2 emission reduction is between 4 – 8 Million tonnes of CO2. The total monetarized annual impacts in 2035 are estimated between 8 – 17 Billion euro.

In addition to the above mentioned quantitative impacts, also a number of qualitative impacts (which could not be quantified) need to be taken into account. These qualitative impacts are the following:

- UC5: Improved reliability: Improved service levels will lead to improved reliability of deliveries to the clients.

From the values as indicated in the table above, an analysis has been made which aspects contribute most to the magnitude of the impacts. The next table presents the most important impacts for this use case.

**Table 18: Main impacts for UC5 in visionary scenario**

<b>UC5 results Visionary scenario (2035)</b>	<b>Values min.-max.</b>
Less central monitoring + planning personnel needed (Billion euro)	1-2
Less empty kms due to improved planning opportunities (Billion kms)	1-2
Less empty kms costs due to improved planning opportunities (Billion euro)	1-2
Less laden kms due to improved planning opportunities (Billion kms)	2-5
Less laden kms costs due to improved planning opportunities (Billion euro)	2-5

For UC5 the main impacts are km reduction due to improved planning opportunities, related to less empty kms (1 – 2 Billion km) and less laden kms (2 – 5 Billion km). Another important impact is less central monitoring and planning personnel needed (1 – 2 Billion €).

#### **Overall results visionary scenario (UC4-UC5)**

The next table provides the main results for the visionary scenario.

**Table 19: Summarized impacts of the visionary scenario**

<b>Total results Visionary scenario (2035)</b>	<b>Values min.-max.</b>
KM reduction (Billion kms)	7-13
Emissions: CO2 reduction (Million tonnes)	5-9
Emissions: NOx (Thousand tonnes)	38-76
Emissions: PM (Thousand tonnes)	1-1
Time savings (in Billion minutes)	23-47
Total monetarized impacts (in Billion euro)	20-38

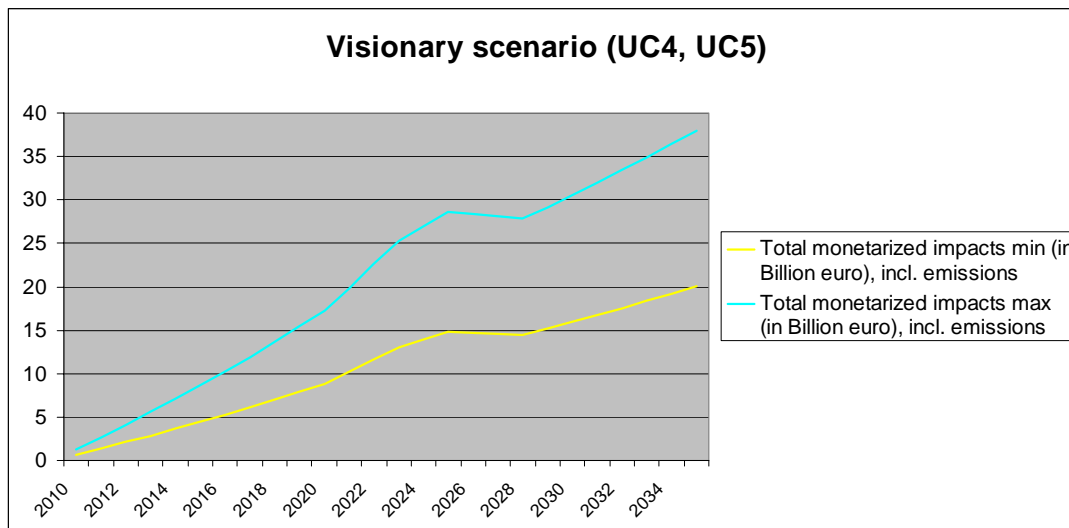
It can be seen that between 7 – 13 Billion kms reduction can be realized per year. The estimated CO2 emission reductions are estimated between 5 – 9 Million tonnes of CO2 annually. And the total monetarized annual impacts amount to 20 – 38 Billion euro in 2035.

In addition to the quantified benefits which have been presented in the table above, there are also a number of qualitative impacts, which have been already described in this section before. Additionally, as discussed in the previous section, the changes that are presented in this use case represent a paradigm shift in logistics and supply chain planning, resulting in a more optimal supply chain, expressed in the impacts as mentioned above. This in turn could lead to an overall decrease of a need for capital in the supply chain that leads to costs savings for stakeholders. This multiplier effect is expected to apply, but it has not been possible to quantify it in the frame of this study.

### Overall benefits for the timeframe 2010-2035

For both scenarios, a development path has been drafted between 2010 and 2035. We refer to section 6.2. for a detailed description of this development path. In this section we will present the gradual increase of the impacts in accordance with this development path for the realistic scenario. After all, as indicated before, the impacts in the visionary scenario are expected to gradually increase from 2010 onwards. It does not last until 2035 before the first benefits accrue to stakeholders. Therefore we present the development of the impacts in the entire timeframe between 2010 and 2035. The impacts presented for the realistic scenario constitute the sum of the impacts for UC 4 and 5.

Like in the sections above, we have distinguished a minimum and maximum scenario. The benefits include the benefits from emission reduction.



The benefits of the visionary are expected to gradually increase to 20 to 38 billion euro in 2035, in accordance with the development path as sketched in section 6.2.

### 5.3.4 Analysis of results

In this section the quantified impacts of the two scenarios are further analysed. For this purpose, the impacts are compared with actual figures and EC targets in the area of transport and energy (e.g. reduction of congestion and energy reduction).

The next list provides an overview of some EU measures<sup>2</sup> in these two areas, which will be used to compare with the impacts for the two scenarios:

- Congestion and accidents

<sup>2</sup> Source: Freight vision, Freight transport foresight 2050, "Management summary on policy, technology & external factors", March 2009.

- Road Telematics (ITS): -2,5% kms driven and -5.000 fatalities per year.
- Emission and energy dependency
  - TEN-T programme: -6,0 million tonnes of CO2
  - Transport emissions to reduce by 5%(10%) of 1990 levels by 2020.

Some relevant actual figures<sup>3</sup> for the EU27 are:

- Vehicle kms road freight transport (2007): 188 Billion vehicle km.
- EU27, real GDP (2009): 12191 Billion euro
- EU27, turnover road freight transport (2006): 280 Billion euro
- EU27, CO2 emissions road transport (2006): 902 Million tonnes of CO2 emissions

The main impacts of the two scenarios which will be analysed in this section are the following:

**Table 20: Main impacts of the two scenarios**

Impacts	Realistic scenario (2020)	Visionary scenario (2035)
Km reduction (Billion km)	4 – 8	7 – 13
CO2 emission reduction (Million tonnes)	3 – 5	5 – 9
Monetarized impacts (Billion euro)	11 – 21	20 – 38

Comparing the expected km reduction with the actual vehicle kms for road freight transport indicates that the expected reductions for the realistic scenario vary between 2,1 – 4,2% compared to the total actual vehicle kms, and for the visionary scenario the reductions vary between 3,7 -6,9% compared to the total actual vehicle kms. As is mentioned before, the estimated reduction of vehicle kms based on the Road telematics (ITS) programmes is aiming at a 2,5% reduction. This figure is quite comparable with the estimated impacts for the realistic scenario. The impacts of the visionary scenario are about three to four times this value.

Comparing the expected CO2 emissions with the actual CO2 emissions for road transport, shows that the estimated CO2 reductions for the realistic scenario are between 0.3 – 0.6% of the total CO2 emissions for road transport. And the estimated CO2 reductions for the visionary scenario are between 0.5 – 1% of the

<sup>3</sup> Main sources are: Eurostat and DG TREN statistical pocketbook (2009)

total CO<sub>2</sub> emissions for road transport. It has to be mentioned that the greatest part of the emissions in the transport sector are related to passenger transport<sup>4</sup> (passenger cars), and other freight transport modes and not to road freight transport. These reductions are much smaller than the total target of reduction of CO<sub>2</sub> emissions for transport in 2020.

Comparing the expected monetarized impacts to the total turnover of the transport sector shows that for the realistic scenario the monetarized impacts vary between 4 – 7% of the current total turnover in the transport sector in the EU27. And for the visionary scenario this varies between 7 – 13% of the current total turnover in the transport sector in the EU27. Hence compared to the annual turnover of the transport sector these impacts are quite significant. It has to be mentioned however, that the expected total monetarized impacts for the two scenarios are including monetarized emissions.

If we compare the monetarized impacts with the total real GDP for all sectors of the EU27, the monetarized impacts vary between 0,1 – 0,2% of the total real GDP of the EU27. And for the visionary scenario this varies between 0.2 – 0.3% of the total real GDP of the EU27. So compared with the total real GDP of the EU27 the expected impacts are only a fraction of this figure.

## 5.4 Impacts on safety and security

Impacts on safety and security should be specified. Therefore a definition respectively explanation of the terminology is useful. Safety and security are very close connected terms which are being used mostly in combination when speaking of the secure (or safe) aspects of systems. In general it can be described with prevention of risks or protection against external incidents or threats. While *safety* is more related to the reliability of a system or the stability against failures, especially regarding IT systems, the term *security* more focuses on the protection against threats from the outside (like terrorism, hacker attacks etc.)

Based on the described use cases and the allocated impact chains different impacts on safety and security can be expected. In this chapter mainly a qualitative analysis of the impacts is being outlined. Following the structuring of previous sections this impact assessment will also be structured along the use cases from the realistic to the visionary scenario.

An overview of the different use cases and the allocated impacts on safety and security can be seen in the following table:

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<sup>4</sup> Source: TREMOVE model



**Table 21: Overview of impacts of the use cases**

Use case	Type	Impact	Only qualitatively	Also Quantified
UC1	Sa	RS 1-1 less errors (due to better identification)	X	
	Sa	RS 1-1 less vehicle km		X
	Sa	RS 1-2 less errors at receivers	X	
	Sa	RS 1-3 less vehicle km		X
	Se	RS 1-5b improved security	X	
UC2	Sa	RS 2-1 improved safety (faster reaction on accidents)	X	
	Se	RS 2-2 Less harm to drivers	X	
	Se	RS 2-2 less thefts	X	
	Se	RS 2-2 improved tracing of stolen goods	X	
	Se	RS 2-2 less insurance costs	X	
UC3	Sa	RS 3-1 less vehicle km		X
UC4	Sa	VS 4-1 less vehicle km		X
UC5	Sa	VS 5-1 less vehicle km		X

In this context for every future scenario enhanced IT systems and technologies are needed for the development of intelligent cargo systems of any different character. According to that safety and security aspects related to the IT systems are very important for the stability and acceptance for such systems in the society.

These different effects of possible future developments are related to several different stakeholders, processes, social aspects, etc.

Impacts regarding data security can be discussed differently. Made the assumptions that stable technologies and robust encryption techniques for sensitive data are available for the data processing and transfer in future the requirements for secure data handling can be fulfilled. It should be clear though that the rising amount of cargo related data and the rapid transfer of these data volumes can complexify the requirements for data security. This aspect could be coped then with interoperable and clear defined standards.

**Table 22: Structure and systematic of safety and security impacts**

		Safety	Security
		impacts	
Fields of impacts	Traffic systems/ infrastructure	Prevention of accidents	Protection from terrorism
	IT systems/ data management	Better Reliability and stability	Ensure integrity, authentication, confidentiality
	Processes	Better stability and failure resistance in integrated processes	Secure availability and access
	Vehicle/ cargo	Less accidents, losses, damages	Prevention of theft, burglary
	Driver	Less accidents	Less harm, assaults

***Safety and security related impacts in the different fields:***

Error rates regarding the ID of cargo units could be reduced with standardization, distinct and consistent identification of cargo, more accurate information and data on cargo. With an integrated security concept the costs resulting from criminal incidents within the transport chain could be reduced. For example the amount of direct costs for damages/ losses resulted from theft/ burglary in logistics for 2006 in the European Union is being estimated to 8.2 Billion EUR. Whereas experts say that the indirect costs (e.g. for higher insurance rates, loss of reputation) are up to 5 times higher. (Source: "The dark side of logistics", DVZ Germany Nr. 61/62, 23.05.09).

Better and more accurate information on cargo in these segments and stabile real time tracking and tracing throughout the entire supply chain with the ability for bi-directional communication can also enhance the security regarding the vehicle/cargo and the driver (see above). To be mentioned in this specific field is that the risk for theft and burglary for high value goods is naturally rather high. Here one can speak from a race or contest between the security technologies/ systems and the criminal side where different technologies or even weapons are being used for the assaults.

Integrated planning over the supply chain can have impacts also related to safety aspects in an indirect way. If integrated planning of the transport chain will have better planning results, less vehicle km per cargo unit can be expected. This also implies a decreasing risk of accidents. Considering a study about HGV (Heavy Goods Vehicle) accidents and allocated costs for fatalities, noise and environmental related impacts the number of fatalities attributable to HGV in the EU 27 in 2006 was 6.443<sup>5</sup>. The study has analysed safety data from the EU CARE database from 2006 and derived the involvement percentage of HGV in accidents with fatalities and injuries. Making the assumption that the reduction of vehicle-km (see above chapter) will lead to an equal reduction of accidents/ fatalities in road transport involving HGVs the following data could be used for an impact assessment per scenario:

**Table 23: Road safety data in EU 27 (2006)**

<b>EU 27 safety data (2006) CARE Database and CE Delft Study</b>	<b>Values</b>
Total # of people injured in accidents on roads	1.694.964
Serious injuries attributable to HGV	20.716
Slight injuries attributable to HGV	72.317
Total # of fatalities on roads	42.953
Fatalities on roads attributable to HGV	6.443

Source: CE Delft study (see below)

According to the CARE database the total number of injuries in accidents on roads was 1.694.964 in 2006. As a result of the CE Delft Study the numbers of injuries which can be attributed to HGVs are for serious injuries (hospital care needed) 20.716, for slight injuries 72.317 and for fatalities 6.443.

**Table 24: Reduction of km and fatalities, injuries – realistic scenario**

<b>Total results realistic scenario (2020)</b>	<b>Values min.-max.</b>
KM reduction (%)	2,1 - 4,2
Reduction fatalities attributed to HGV	135 - 271
Reduction slight injuries attributed to HGV	1.519 - 3.037
Reduction serious injuries attributed to HGV	435 - 870

Using the assumptions on km reduction for the Scenarios in chapter 5.3.4 the reduction of fatalities in road transport involving HGVs in the RS vary between 135 and 271. The reduction of slight injuries has a range between 1.519 and 3.037, whereas the serious injuries could be reduced by 435 to 870.

<sup>5</sup> Source: Den Boer E., et al; „Are trucks taking their toll?, Study about environmental, safety and congestion impacts of trucks, CE Delft, January 2009, p 28f

**Table 25: Reduction of km and fatalities, injuries – visionary scenario**

Total results visionary scenario (2035)	Values min.-max.
KM reduction (%)	3,7-6,9
Reduction fatalities attributable to HGV	238-445
Reduction slight injuries attributable to HGV	2.676-4.990
Reduction serious injuries attributable to HGV	766-1.429

Same approach for the visionary scenario lead to reduction numbers for fatalities between 238 and 445, for slight injuries between 2.676 and 4.990 and for serious injuries between 766 and 1.429.

In UC 2 it is mentioned that the risks for external threats in specific fields can be reduced. For the UC4 these risk factors could be reduced throughout the entire supply chain independent from sector.

## 5.5 Conclusion

In this chapter an indicative assessment of impacts has been made, based on a set of assumptions. In this respect, the two scenarios have been compared with a reference scenario.

It can be concluded that both the realistic scenario and the visionary scenario are expected to generate substantial impacts. These impacts accrue both to businesses in the transport and logistics sector and to shippers, as well as to the society in the form of reduced kilometres driven and the subsequent reduced emissions.

The realistic scenario is expected to generate impacts that are already significant. When looking in detail, the analysis shows, that the three main aspects of the scenario (paperless transport, the use of semi-autonomous intelligent cargo units, and integrated planning) each contribute significantly to the overall total of the impacts anticipated. In addition, there are a number of impacts that have not been quantified. The impacts accrue both to the business sector and to the society as a whole.

Additionally, the visionary scenario is expected to generate benefits as well, on a higher level than the realistic scenario. Again, both aspects of the scenario, autonomous intelligent cargo units and decentralized planning, both contribute significantly. Additionally, the impact of the shift to decentralized planning is expected to lead to a multiplier effect in terms of a reduction of the amount of capital needed for supply chains. Also in this scenario, the impacts accrue to businesses and society.

For safety and security some significant impacts could be quantified based on assumptions. Yet other impacts are difficult to assess, especially regarding the security issues. It is clear however that optimized and more reliable transport planning and monitoring systems will contribute to an enhanced security of supply chains in general.

Finally, it has to be mentioned once more that the scenarios that have been developed contain a series of uncertainties. Many aspects of the scenarios are still of an uncertain character, also in the realistic scenario. Therefore, in order to make a quantitative estimate of the impacts, a set of assumptions have been made. The quantitative impacts presented in this chapter are completely related to the assumptions that have been made.

## **6 Migration path and recommendations**

Based on the two scenarios described in chapter 4 a migration path from the situation today to the visionary scenario will be described, where the migration path towards the realistic scenario will only be addressed as long as it is related to the other path. The two scenarios are not alternatives and experts expect that the technology progress is targeting or moving first towards the realistic scenario, thus, the realistic scenario will be reached first and the visionary scenario second.

The migration path will outline the influencing factors and indicate needed key ICT development steps as well as potential barriers and obstacles. Together with the available effects and impacts identified in the last chapter also a cost/benefit reflection will be shown. Depending on the benefit owners of single development steps there will be suggestions about who shall initiate or financially support respective steps. The final part of this chapter will provide recommendations which are derived out of the migration path, the envisaged visionary scenario and the results and experiences of all study tasks.

### **6.1 Paradigm shift**

The change from the current central control approach in freight transport to a decentralized concept must be seen as a paradigm shift. Shippers and transport operators might feel to loose control because the pre-determined transport path with allocated transport means is now replaced by a system, where decisions on the path and means to use are taken locally and while the freight is in transit.

In order to allow the shift of a segment of transports of a shipper to this new approach it is needed that the intelligent cargo concepts are implemented along the full supply chain of this transport segment. Therefore it is foreseeable that the new

decentralized approach will be established in parallel to the conventional one and that both solutions will coexist for a transition time. The transition time itself will depend on the success of the new structures and the savings to expect.

## **6.2 Migration path to the visionary scenario**

The migration path is described by different phases leading to the visionary scenario as described in chapter 4. Overall, the visionary scenario will be reached over 3 phases. Each phase will cluster activities at different development stages starting from present (2009). The three phases are as follows:

The first period of 8 to 12 years is characterised by development and progress in different ICT fields applied in either the eFreight domain or in the wider Internet of Things domain. Common frameworks and architectures, intelligent tags, communication technology, data security, etc. are important development streams to be developed in order to establish the technological basis for the visionary scenario. While the level of implementation of the visionary scenario in the first phase is low the dominating applications are related to the realisation of the realistic scenario focusing on the integration of different back end systems. Important standardisation processes for paperless information exchanges – being a prerequisite for the realisation of the visionary scenario in the future phases - have to reach a mature development level and an accepted market position in this period.

With regard to the realisation of the visionary scenario the first phase focuses on the development of the necessary concepts and technologies demonstrating the feasibility of decentralized decision mechanism in autonomous cargo systems and its effects.

The second phase of the migration path will last 7 to 10 years. In the second phase results and developments towards the visionary scenario are integrated and implemented in such a way, that first solutions appear. These realisations shall demonstrate in practice at least key visionary scenario elements, prototypically or the full visionary scenario functionalities in a limited scope, e.g. a single supply chain. Main characteristic of the transport structure in the second phase of the migration path is that no consistent network structures are implemented. However, more and more applications on autonomous cargo systems appear replacing dedicated supply chain approaches.

The third phase will last 5 to 8 years and offers a full implementation of the visionary scenario in the European logistics economy. All transport processes are carried out on an intelligent and autonomous level across transport networks.

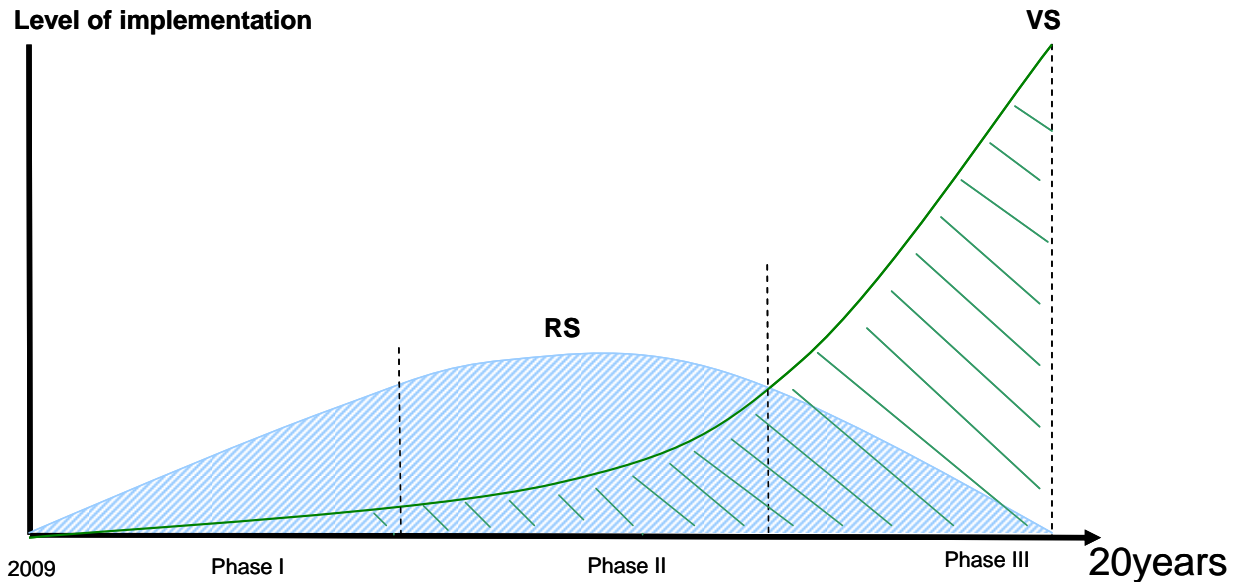
The development speed towards the visionary scenario depends on several influencing factors such as:

- The financial commitment of industrial partners to develop the required ICT developments
- The information management and clustering towards the visionary scenario
- Progress in standardisation of communication and data transfer
- The consensus in the logistics community to employ autonomous cargo systems

Since, there will be strong efforts needed not only regarding technological developments but also to support a mental change process supportive measures that accelerate the development are needed. Therefore a time span of 20 to 30 years is considered depending on the strategy and road map to be employed to reach the visionary scenario.

The migration path can be outlined in the following picture considering a fast implementation realised in 20 years. A slower implementation speed extends both (realistic and visionary) scenarios over all phases.

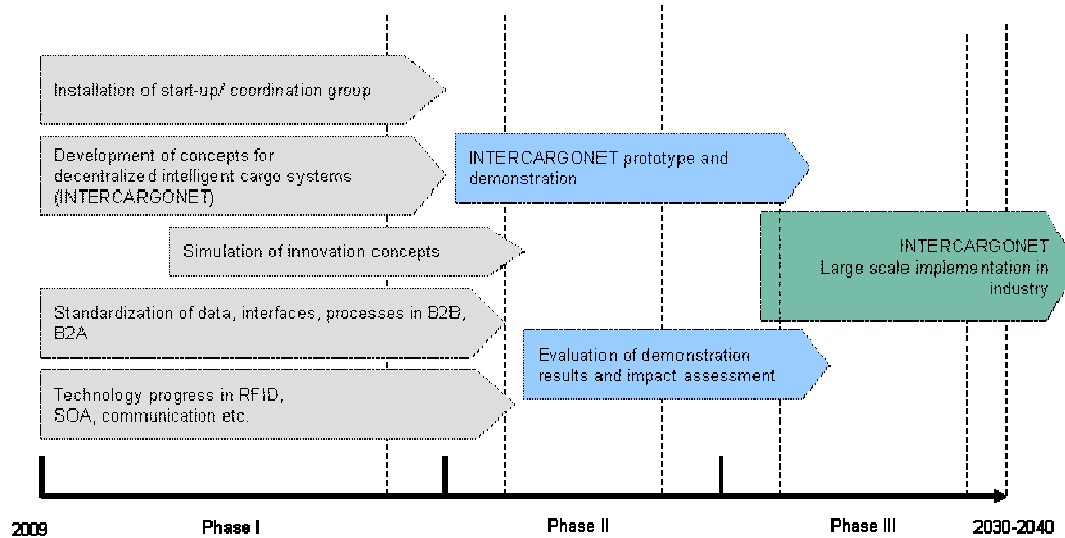
**Fig. 6: Migration path**



It is expected that the needed steps with highest priority are at first technological developments cost efficient intelligent tags, communication and transfer technologies suited for logistics applications and services, adapted technologies for autonomous cargo navigation and steering. An immediate step for the realisation is

to enhance standardization processes for communication and data transfer. A key application will be the implementation of a paperless documentation that forms the basis for the realistic as well as for the visionary scenario.

**Fig. 7: The development phases of the migration path**



The migration path can only be implemented successfully, if milestones to the end of each phase can be reached. Roughly, milestones can be described as follows:

- MS1: To the end of the first phase a proof of concept is given and an overall architecture for the INTERCARGONET is given. All needed ICT developments are available
- MS2: To the end of the second phase single applications for autonomous planning and steering of cargo units are implemented. The underlying technology is ready for large scale implementation
- MS3: To the end of the third phase a full network for autonomous cargo systems is established

It should be noted that MS1 will be crucial for the further progress of the migration path towards the visionary scenario. Although, the development of intelligent mobile devices and networks with ubiquitous data availability will be a major strategy of telecommunication companies the integration of the cargo community is not ensured, presently. Obviously, strong efforts and concerted actions are needed to reach the MS along the migration path. It will be not sufficient to provide stimulating measures for the industry such as research or co-ordination support. Concerted actions and collaboration need to be established involving the different stakeholders from industry, research and policy. Therefore, the installation of a cluster initiative will be a core element for the successful implementation of the visionary scenario in the first phase.



As a first action proposed for the first phase is to establish a start up group consisting of a smaller group of researchers (enlarged by industry stakeholders) and EC representatives that determines all preparatory steps, especially for the set up of the cluster initiative. In a first action the group should formulate the overall targets and promote the vision towards intelligent cargo systems, including a proposal for an overall architecture. The group should be established as a long term community accompany the progress over all phases of the migration path.

Based on the preparatory work of the start up group a cluster of industry stakeholders should be formed that take over the realisation work on technological developments, business models and commercialisation approaches etc. Forming a cluster initiative the following benefits are expected:

- Collaboration of key industry stakeholders on autonomous cargo systems in order to generate synergies
  - Set up a network across different disciplines
  - Establish know how transfer
  - Actively acting at the interfaces of interdisciplinary collaboration
- Initiating of start ups
- Initiating of flagship projects

Such a cluster initiative is expected to be able to realise the needed ICT and on the other side enhance also the competitiveness of European industry. Since, from the commercialisation of the results all benefits and costs will be realised on industrial level a full industrial funding of the developments is considered. For some issues of high research priority a shared public private funding is recommended. The EC needs to take over an active role in this start up phase and provide supportive measures at different levels. In the following table an overview for EC related measures, actions and estimated costs to support and accelerate the development is shown:

**Table 26: Overview EC related measures**

Measure	Action	Estimation EC cost share	Timing
1. Establish a start up group	<ul style="list-style-type: none"> <li>• Installation of start up group, with regular consultations</li> <li>• Preparatory work on political level and on business level</li> <li>• Take into account ongoing developments, e.g. Intelligent Cargo Forum</li> <li>• After the start up phase the group should take over co-ordination functions along the entire migration path</li> </ul>	1 Mio Euro/a	Start in year 1
2. Join forces to realise the concept on autonomous systems	<ul style="list-style-type: none"> <li>• Establish a cluster of key ICT and logistics companies (30 to 40) aiming to develop an operational approach</li> <li>• Build up on ICT research initiatives and projects (EURIDICE, SMART CM)</li> <li>• Business models need to be defined</li> <li>• Address key issues of decentral computing and autonomous decision making</li> </ul>	50 Mio Euro/a	Starting in year 4
3. Enhance RFID development	<ul style="list-style-type: none"> <li>• Important will be to reach a critical mass of users. Leading industrial companies need to employ RFID on large scale</li> <li>• Cost for RFID need to come down. Support by research on technological development is needed, e.g. pilot studies should be given to overcome the current impediments for massive uptake.</li> <li>• Data and technological standards need to be agreed upon and its transfer supported</li> </ul>	15 Mio Euro/a	To be available until end of the second phase
4. Data security needs to be ensured	<ul style="list-style-type: none"> <li>• A European approach for Data security needs to be defined. An IT council is suggested to be implemented.</li> <li>• Solutions on hardware and software level as well as on exchange rules need to be developed</li> </ul>	5 Mio. Euro/a	To be available until end of phase 1
5. Standardisation for paperless	<ul style="list-style-type: none"> <li>• Establish a paperless</li> </ul>	5 Mio.	To be

transport	documentation over all phases of the transport process (booking, execution, invoicing). The necessary administrative regulations need to be established and process security for the transport industry provided	Euro/a	available until end of phase 1
6. Establish a communication infrastructure for cargo(basic element of a future INTERCARGO NET)	<ul style="list-style-type: none"> <li>Start with the development of cargo to infrastructure communication services and related example applications. E.g. that a chilled package is asking the thermometer in the room about the environment temperature.</li> </ul>	20 Mio Euro/a	To be available until end of phase 1
7. Promote intelligent logistics services (basic elements of a future INTERCARGO NET)	<ul style="list-style-type: none"> <li>Development of intelligent services promoted by funded research programmes</li> <li>Development of an intelligent tag prototype to start experimentation. Important are the needed functions, capacities, capabilities while the prize and dimensions are not important at this stage.</li> </ul>	20 Mio Euro/a	To be available until end of phase 1
8. Develop services and core functionalities for the INTERCARGO NET	<ul style="list-style-type: none"> <li>Provide research support to accompany the technological development with research on planning, routing, tracking and tracing systems operating in the INTERCARGONET</li> </ul>	20 Mio Euro/a	To be available until end of phase 1

In the following chapters the priority developments on technologies and standardisation in order to realise the visionary scenario are described.

### 6.2.1 ICT requirements

The visionary scenario is based on innovative ICT solutions whose development and realisation is crucial reaching the forecasted development of the migration path. The milestones along the migration path are marking an orientation or a stop point for the further progress along the predicted development. This section describes the most important ICT groups that are considered as key technologies to be realised. Key issues for further developments are outlined and a positioning in the migration path is given.

### 6.2.1.1 SOA and Cloud computing

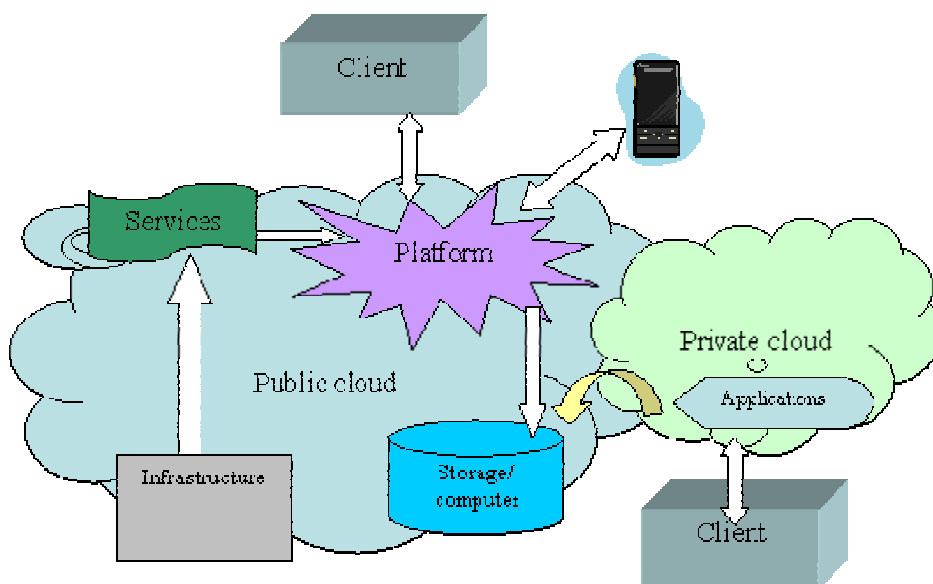
Emerging IT architectures like “Service Oriented Architecture (SOA)” or “Cloud Computing” will accompany the migration to intelligent transport systems.

Core of a Service Oriented Architecture (SOA) are web services that are structured in brokers, consumers and providers. There are also services that consist of a combination of services. Services are also a prerequisite for agent networks that can be described as autonomous systems following certain objectives. Agents are able to assess context and to communicate with objects. Communication takes place over web services. Software as a service (SAAS) – as a feature of SOA - can be described as the on demand availability of software applications via the internet. Enhanced applications and software solutions for any kind of use cases would be available with easy and fast access for users.

Further features of future IT architectures are embedded systems that are micro processors and other computer elements steering single devices. Attached to cargo units embedded systems are the devices giving intelligence to these units. Such units have the ability for self monitoring and context awareness. Running with own operating systems a major issue is the bridging of interfaces with other systems.

Cloud computing as a buzz word is meaning further development and evolution of the SOA architecture by sharing processing resources. A virtualisation of IT systems is resulting out of this concept driven by an outsourcing of IT resources and services. To meet these demands at first the approach of grid computing has been implemented which means networked connection of different IT systems.

**Fig. 8: Concept of Cloud-Computing**



Source: “Evolution Cloud Computing”, Funkschau 6/2009

The migration path to the visionary scenario describes two development steps on bridging the gap between the real world on physical transport flows and the information systems underlying the transport processes. While the realistic scenario creates the link between the real world and the information flow by means of 2D barcodes the visionary scenario goes a step beyond placing autonomous steering in the centre. Main characteristic of the realistic scenario is that supply chains are centrally planned, steered and monitored. A central unit is administrating and optimising the supply chain. The visionary scenario is introducing a decentralized approach using intelligent tags taking over an autonomous steering through the supply chain.

SOA and Cloud Computing are approaches that are presently in place at single company level. Therefore, the realistic scenario describes the “natural” development in using and integrating these architectures into the transport processes of logistics companies. Presently, mainly larger companies and service providers are steering the supply chain. Integrating SME will be a key development path towards the successful extension of the approach.

Core of the visionary scenario are intelligent cargo units, operating in a network of “open” transport services that are steered by software services in a co-operative way. Key argument for the development towards decentralised structures is that the high data volumes, generated by the individualisation of objects and increasing geographical coverage can not be handled by centralized computing resources. Sharing computing resources, as e.g. proposed by Cloud computing might be an approach to overcome this bottleneck. Introducing a paradigm shift towards a decentralised steering is a further option. Expected advantages of a decentralized planning are an increased robustness and flexibility of the systems since no central administrating and processing unit is needed.

In the first phase of the migration path the proof of concept for the visionary scenario will be needed that demonstrates the feasibility of the approach namely the decentralised autonomous steering of cargo units. Open frameworks, e.g. Java Agent Development Framework (JADE), core functionalities, e.g. communication protocols and management functions need to be defined and completed. The third phase should focus on the implementation and further extension towards a critical mass of user groups.

#### **6.2.1.2 Intelligent tags, RFID and Identification**

Fundamental for the development of future intelligent cargo systems is the implementation of different ICT devices and equipment especially in the field of RFID technology. These devices are necessary for the data storage on cargo level, the sensing, tracking and tracing and processing of these data plus the transfer and communication of cargo related data.

RFID is likely to become the key technology for identification and information retrieval of cargo units (vehicles, pallets, containers etc.) While the large scale introduction on item level is considered with less certainty, clear statements are given that such an implementation will happen on unit level.

For control and reading purposes RFID equipped cargo units are using passive tags that are presently available for costs less than 20 cents. The introduction of intelligent tags as needed for the visionary scenario requires for a cheap and robust active tag technology beyond the current state of the art to be developed within the first phase of the migration path. Presently, there is no common view on the standards for RFID transponder communication and data exchange (on the upper levels of the communication architecture layers) existing, especially on global level. Furthermore, prices can be seen of up to 1000 Euro per tag. Regarding a large scale introduction prices need to come down to a level of cents or few Euros maximum per tag in order to become economically viable.

There are today few single and more experimental examples where cargo is already equipped by RFID transponders along a supply chain, e.g. METRO/DHL. Access control at ports, terminals or ramps is a further application field where RFID tags are currently introduced. Most common related processes are:

- Reading the information and transmitting the data to a middleware for further processing
- Connecting ERP systems to retrieve additional data
- Interpreting information and triggering of follow up actions

The realistic scenario describe a practical approach using 2D barcodes while intelligence is provided by the extensive inter connection of back end systems, services and data basis while in the visionary scenario RFID based intelligent tags will be employed. As stated in the expert interviews a large scale introduction of RFID is presently limited due to technical maturity of the tags, price of the tags and the lack of data and communication standards.

Within the first phase of the migration path the 2D barcode will still be the technology used on large scale in the industry for the identification and for information carrying of cargo units, while the development of advanced RFID based approaches will be further intensified (technical and standards). Priority should be on the development of technically reliable, cost efficient and standardised tags leading to the visionary scenario. The advanced technology will slowly and continuously take over the leading role in industry in the second and third phase.

A parallel development path is to enhance the interconnection of ERP systems, supply chain planning tools, data bases and services. Moving towards real time

tracking and tracing systems with dynamic planning abilities is another key feature of the migration path.

### **6.2.1.3 Data security and privacy**

The system as described in the visionary scenario is developing towards co-operative systems in which data is exchanged between individual cargo units, between cargo units and surrounding infrastructure elements, and between cargo units and ERP systems, back end systems, data basis and services accompanying the cargo units along the journey. The communication for this type of systems requires mobile and high speed data networks. In addition where the coverage of terrestrial networks can not be achieved satellite communication and technology will be needed. Transmission of data will be more and more wireless. Network access control, electronic signature, unique message/ data set ID, are key issues to be addressed. For the development success and especially the user acceptance a high level on data security and communication privacy has to be guaranteed. Security and privacy has to be ensured on all levels addressing:

- Authentication, identity, authorisation
- Intellectual property protection
- Governance rules

Examples of data security and privacy on information flows are:

- The inter cargo unit communication; Cargo units exchange information about the current position, destination or status.
- Infrastructure services; Cargo units provide data to different reading devices along the infrastructure, e.g. at terminals, ports or logistics hubs. In return, they receive specific information or services in order to adapt the routing.
- Data backend; Communication providers and private companies collect, aggregate and analyse private information used for additional services or added value services.

Today, data security and privacy issues are handled first of all on a company internal level. For the realistic scenario there are efforts needed in the first phase of the migration path to allow the change towards a reliable and safe paperless document exchange between companies and towards administrations. The technology needed is rather available in research laboratories but needs to be harmonised in standardisation processes and implemented in practice.

Also in the first phase of the migration path and aiming at the visionary scenario a general architecture needs to be defined allowing the enforcement of privacy policies for intelligent cargo units navigating autonomously through the supply chain. It has to be carefully analysed in how far the different information components of a cargo are sensible and need to be protected. Hardware components to be integrated in communication devices to ensure that communication will only take place between the parties concerned have to be developed and demonstrated. Entrusted data bases and services to manage the communication have to be established providing data security and privacy as well as control mechanisms.

#### **6.2.1.4 Communication, services and applications**

Intelligent transport and cargo systems as described in the scenarios need new services, applications, information exchanges and business models for implementation. In addition a new form of communication structure and management are needed. The following gives a non exclusive overview on key ICT requirements for services and communication structures to be addressed within the migration path.

##### *Communication services*

The scenarios set enhanced requirements on the communication network needed to steer cargo units. The realistic scenario employs 2D barcodes containing specific object information. In combination with other data a precise planning can take place on a door to door level. The visionary scenario describes a communication network of autonomous units, e.g. organised comparable to software agents. In order to steer cargo units different kind of data are needed. On the one side data and communication that is needed to steer the cargo unit from origin and destination. On the other side the data and communication that is needed to inform stakeholder groups concerned. Key requirements that need to be addressed in the migration path are:

- Securing the consistency of data,
- Definition of data formats and interfaces.

The diversity of heterogeneous technologies to be employed in autonomous transport systems need for technologies allowing a spontaneous linking up of intelligent devices, e.g. by means of middleware. New strategies are needed that enable the self organisation and self configuration of intelligent tags and software systems.

The realistic scenario can be characterised by relying on existing communication technologies and communication structures while the visionary scenario demand for



the implementation of new structures. In the visionary scenario the implementation of new data protocols like IPv6 will play a decisive role for the identification and autonomous communication of cargo units. It will be an important element of the migration path to demonstrate an autonomous and intelligent transport system environment on the basis of IPv6.

#### *Real time tracking & tracing*

Visibility of services and the real time tracking and tracing on all points along the supply chain is a key feature towards intelligent cargo systems. The unique identification of cargo units is a core functionality that is relevant for the realistic scenario as well as for the visionary scenario. Based on such systems an enhanced transparency on the condition of the cargo unit in real time can be achieved.

The realistic scenario will show in the first phase of the migration path that a dynamic interlinking of ERP systems towards seamless and real time tracking and tracing systems can be established in the transport business. Smart integration software of 4PL might be developed and demonstrated offering real time services over the entire supply chain.

The visionary scenario demands for engines and services that gather information from cargo units in movements in order to distribute it to stakeholders concerned. In the first phase of the migration path the set up and demonstration of these services need to take place.

#### *Event management system*

Real time tracking of cargo units, the aggregation and the interpretation of status information are core features to assess the situation and to react in the case of disturbances. Decisions are based on collected information gathered from multiple sources or systems including data about cargo and processes associated to the cargo. On a higher domain level decision or actions can be triggered. The set up of adequate event management systems deriving decisions on the further continuation of the transport process (in consultation with stakeholders) demand dynamic adaptive routing and auto-reconfiguration. Besides dynamic data updating key information like critical data links or identity codes must be retained over the entire chain. Coordination and interoperability with multiple commands or legacy (ERP) systems operating in vastly separated locations are a key element of intelligent event management systems.

The migration path for both scenarios includes to develop adequate methods to set up context systems for cargo units that retrieve information on the current situation and the environment in order to improve the decision making process. For doing that cognitive and semantic systems will be needed that are able to analyse the

specific situation and to interpret the information against the targets of the cargo unit and context variables.

### *Dynamic routing*

Distributed data from multiple sources is dynamic, often sporadic and volatile. To make use of distributed data from various sources the following engines are needed to feed applications: predictive and forecasting tools, event management systems scheduling and updating services, planning and optimisation tools. Decentralized routing at autonomous cargo unit level needs to make use of distributed data and services in order to adapt to the situation at single network nodes. Attributes that are relevant for the routing decision are:

- Availability of transport services to continue the journey
- Restrictions and limitations on the overall transport journey (time windows, total costs)
- Traffic situation at single nodes in order to avoid congestion
- Additional information related to the routing to be included, e.g. on customs.

Dynamic routing methods are considered as a key element towards intelligent transport and cargo systems. For the realisation adequate algorithms and services need to be developed and established. At first, dynamic routing methods need to be applied to optimise routing along the supply chain on back end system level. Afterwards for the visionary scenario, smart dynamic routing algorithms to be employed on embedded systems attached to the cargo units will be asked for. In the first phase of the migration path such methods and applications need to be developed and implemented.

### *Time table and data management*

Transport services of different service providers are included by direct business contact and information exchange. The visionary scenario demands for an open publishing of transport services. Movement in the visionary scenario is dependent on transport service providers publishing their services in the Internet in a manner that can readily be used by independent web based transport management systems. This requires both stakeholder engagement in the promotion of open networks and innovative but practical supports including an open registry of services. Present developments, e.g. in FREIGHTWISE towards a standard single transport document are target leading approaches that are needed in the migration process.

## 6.2.2 Other requirements

### 6.2.2.1 Data standardisations and interoperability

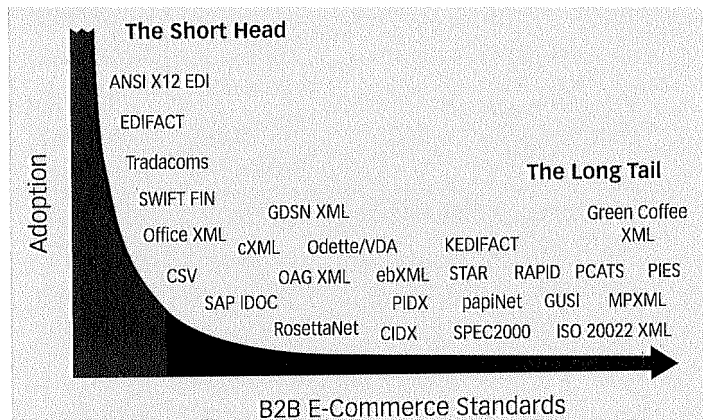
Data harmonisation and standardisation are key issues for the paperless documents of transport processes. One main requirement for a future integrated intelligent cargo system is the harmonization and standardization of processes and data formats respectively IT interfaces. The existing EDI standard is common for almost all sectors. Growing complexity and required flexibility of the different sectors have led to many different niche standards for processes or data formats existing. The XML standard as basis for this development is widely adopted and allows the flexibility for different industry sectors for individual adaptations.

**Table 27: Industry specific standards (examples)**

<i><b>Standard</b></i>	<i><b>Industry sector</b></i>	<i><b>Function/ content</b></i>
<b>RosettaNet</b>	High tech and electronics	Partner interface processes (PIP) for specifications, testing, warranty man. etc.
<b>PIDX (Petroleum Industry Data exchange)</b>	Oil and gas exploration	Library of industry related standards, code set tables
<b>CIDX (Chemicals Industry Data Exchange), now: OAGi, ChemITC</b>	Chemicals	eStandards/ set of standards for data exchange in chemical sector
<b>GUSI (Global upstream Supplier Initiative)</b>	Consumer packaged goods	Templates for four order fulfilment models
<b>SPEC 2000</b>	Airline operators and aerospace manufacturers	Based on EDIFACT, documents and processes for airspace industry
<b>papiNet</b>	Forestry and paper	eBusiness transaction standards (XML based) document templates

Source: Adapted from "The Long Tail of eCommerce standards", Supply Chain Quarterly, 01/2009

The adoption of the standards in terms of cross sector usability is being described that only a few common standards are widely adopted and a number of different (XML or EDIFACT based) standards are being used in several sectors. (see Fig. 7)

**Fig. 9: Standards and their adoption rate across different sectors**

Source: "The Long Tail of eCommerce standards", Supply Chain Quarterly, 01/2009

While the specific standards for the different sectors have the advantage for the allocated companies to better cooperate with each other the interoperability between different sectors is limited by the huge amount of different standards. Cross sector standardization is necessary though for the realisation of a multimodal, integrated and intelligent cargo system. Coping with this fact can have different solutions:

Either a few/ handful of standards will exist within a future system and therefore make the cross sector process optimization and simplification possible. This would require significant efforts of regulations for the different sectors across the European countries. The cooperation of the big players in the IT sector, the logistics sector, the public authorities and standardization institutions (ISO, GS 1) will have to be strengthened in order to develop an overall standard which is mandatory for all cargo units in every transport chain. Here there can be the "must" factors regulated (documents, templates, customs, security etc.) additionally this standard have to be open for sector specific and flexible amendments without losing the advantage for the cross sector usability for the transport flow. Maybe this "Master" standard can have the function of a standard framework for transport and logistics of any kind of goods. First efforts for cross sector standards are being made for example in North America by the Open Applications Group (OAGi, [www.oagi.org](http://www.oagi.org)), an organization which is focusing on the development and implementation of cross-sector eBusiness standards.

Further efforts in this field are being made by key players in the logistics sector together with large retailers. For example an initiative of DHL, Karstadt Warenhaus GmbH, METRO AG and GS1 Germany is the European EPC Competence Centre. The EPC has the objective to establish the RFID technology together with the Electronic Product Code (EPC) as an international cross-sector standard (Sources: [www.dhl-innovation.de](http://www.dhl-innovation.de), [www.eecc.info](http://www.eecc.info)).

Another project initiative on the logistics side is eRailFreight which is focusing on paperless bill of lading in the rail mode transport chain. Main objective is to establish a Europe wide standard paperless/ electronic bill of lading for any rail transport.

In this context it has to be ensured that the SMEs can follow and participate to the standardization process. Furthermore the different initiatives and projects for standardization should be harmonized and at least monitored to make sure no conflictive developments arise.

Another possibility is lying more on the application and software side. Several translator solutions exist in the market to make interoperability possible. For companies with diversified business in different sectors this could be quite expensive. One approach would be to shield businesses from different standards at the application layer. This means that the different standards are being processed from the application without direct and needed interaction with the user comparable to the function of an Internet browser which can display all kinds of different images. This function in eBusiness would have to be fulfilled by the ERP systems. Finally, the IT sector is actively researching the semantic network domain, where the interpretation and translation of different formats is handled on a meta-level automatically. eBusiness, eFulfilment and eCargo are attractive application fields for semantic technologies and good progress can be expected within the first phase of the migration path.

#### **6.2.2.2 SME involvement**

User acceptance has been mentioned by the interview partners as one of the main requirements for the implementation of future intelligent cargo systems. Human factor will still play a role throughout the supply chain. Definitely the role will change and more IT related education and training will be required for the employees even on the "lowest" level of qualification. This is in fact already happening, especially in the warehouses and also on vehicle level (e.g. picking, scanning of delivery status etc.). In future it will be natural to use one integrated device (e.g. company mobile phone covering all necessary functions for the transport process and sensors or devices will take over automatically some tasks. Here transparency for the actor is necessary to ensure the willingness to use the system and to trust the results and data. Trust in the implemented systems is necessary for the implementation of enhanced technologies. Appropriate efforts for usability engineering in this context are a key success factor for acceptance.

Another important factor is the compatibility of these systems for SMEs. For SMEs an important first step is awareness and being informed about the possibilities of intelligent cargo applications. The next step which is needed is an identification of

their real needs which need to be covered and the development of positive business cases for SMEs.

## 6.3 Cost/benefit reflection

In this section a cost benefit reflection is provided. The benefits are based on the impacts which have been presented in the previous chapter. It is important to underline that this chapter is called a cost-benefit reflection rather than a cost-benefit analysis. There are many uncertainties that surround the scenarios, which were sometimes of such an order that it seemed to be impossible to make any estimate of the costs. Therefore this chapter should be read as a number of reflections on the balance between the costs and the benefits for the two scenarios.

Some general starting points regarding the cost benefit reflection are the following:

- It is not possible to develop an in-depth assessment of the costs for the different use cases, because this study considers intelligent cargo solutions which are still in an early development phase or even in a visionary phase. Therefore, when possible, an indicative rough order of magnitude of the costs will be provided instead of detailed figures. The order of magnitude of the costs will be compared with the order of magnitude of the benefits.
- With respect to the benefits, for the realistic scenario it is assumed that the benefits will not be realised directly, but it is assumed that the benefits will gradually increase each year and it is assumed that the full potential of the benefits is realised around 2024. For the visionary scenario a similar approach has been chosen and it is assumed that in this case the full potential of the benefits is realised in 2035 (after around 25 years). We have aligned with the development path as depicted in figure 6 of this chapter.
- The costs for the EU have been provided in the previous section, and have been assessed at € 160 million per annum in the first phase of the migration path.

### 6.3.1 Realistic scenario

#### ***Standardisation and paperless documentation***

For standard formats it is expected that the highest costs will be made by the supply chain leader who will develop and implement the standard format for the supply chain. The other supply chain partners will have to pay investment costs for implementing the agreed standard format in their own systems, but it is expected that these costs will be much lower compared to the investment costs of supply

chain leader. Once the standard format has been implemented annual costs will need to be made, both by the supply chain leader and the supply chain partners to keep the format up to date.

With respect to the benefits related to standard formats in UC1, as has also been presented in the previous chapter, the stakeholders who gain the most benefits are the supply chain partners. This means that the main stakeholders who will have to pay the costs related to standard formats seem to be also the ones which are expected to gain most of the benefits.

For paperless documentation it is expected that there will be again higher investment costs for the supply chain leader, who will develop and implement the paperless documentation, and substantial lower investment costs per supply chain partner. The same applies to the annual costs to keep the electronic formats of the paperless documentation which will be used up to date. Paperless documents can in most cases only be implemented if the authorities agree that these electronic documents can be used instead of paper documents. Therefore these paperless documents need to be developed by the logistic sector in close cooperation with the authorities. Hence for paperless documentation, there are also investment costs for the authorities/customs, in order to implement the paperless documents in their systems as well as annual costs for keeping the electronic formats of the paperless documentation up to date.

With respect to the benefits related to paperless documentation in UC1, the stakeholders who gain the most benefits are the supply chain partners and the authorities. These stakeholders are also the ones which have to pay the costs.

To indicate the potential benefits of reducing paper documents by electronic documents, the following two figures<sup>6</sup> related to introducing e-invoices for all sectors in Europe are presented:

- The University of Hanover calculated potential savings of nearly 135 billion euro per year, based on an 80% reduction in costs and 30 billion invoices sent per year in Europe.
- The EACT project Corporate Action on Standards (or CAST) predicts a potential of 243 billion euro per annum in Europe alone.

### ***First intelligent cargo applications in specific markets***

As indicated in the previous chapter, some first applications of intelligent cargo in specific markets may appear already under the realistic scenario. This could concern applications in the dangerous goods sector and in the high value goods

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<sup>6</sup> Source: "E-invoicing 2008", EBA and Innopay, February 2008.

sector. Some costs categories that are relevant for the application of dangerous goods:

- Costs for setting up a dangerous goods monitoring centre (for example one in each European country), which could be financed by both the public and private sector.
- Annual costs for the dangerous goods monitoring centres.
- Costs of an active tag for dangerous goods.
- Investment costs needed per vehicle.

For high value goods an indication of the expected costs is given. The following costs are estimated with respect to high value goods:

- Transport companies need to make investment costs in their home office systems for improved monitoring of high value costs. These costs are roughly estimated between 10.000 euro and 200.000 €.
- Annual costs (e.g. updating and maintenance of the monitoring software) for keeping the home office system up to date (with respect to high value goods) are roughly estimated at around 10% of the investment costs.
- Costs of an active tag for high value goods are estimated at around 10 euro per tag.
- Investment costs needed per vehicle are estimated at around 500 €.

The benefits, as indicated in the previous chapter, are mainly related to improving the tracking and tracing of dangerous goods, reducing the thefts of high value goods and improving the recovery of stolen goods.

### ***Integrated planning***

As pointed out in the previous chapter, in the realistic scenario benefits also are expected from optimisation in planning due to integrated planning, resulting in time savings, and reductions in empty kilometres and less empty kilometres. For this aspect it has not been possible to estimate the costs. For an integrated planning at supply chain level a complete new infrastructure is needed to connect the back-end systems of the supply chain partners. In this use case it is assumed that there are very strong back-end systems, which are connected with each other via high capacity networks. Implementing these systems is very costly, but at the other hand these systems will not be implemented only to improve supply chain planning, and will also be used for other purposes. Apart from estimating the overall level of the



costs, additionally it is very difficult to indicate which part of the costs is related to integrated planning, and which part is related to other aspects.

### ***Conclusion***

The total benefits in the realistic scenario are expected to increase from zero in 2010, via 6-11 billion euro in 2015 to 15-29 billion euro in 2024 at the maximum. After that, these benefits are expected to decrease again, in line with the migration path, as after that date the visionary is implemented more seriously. The costs for the EU are expected to be relatively limited (except for investment costs for the authorities/customs, in order to implement the paperless documents in their systems). The majority of the costs for the EU need to be made for the visionary scenario. The majority of the costs for implementation of the realistic scenario fall at the expense of industry, as has been described above. These concern the development and implementation costs for new standards, investments for the dangerous goods applications and high value goods applications, and investments for integrated planning. It has not been able to quantify these costs.

### **6.3.2 Visionary scenario**

For the visionary scenario, it proved to be difficult as well to estimate the costs for industry, because the intelligent cargo solutions which are foreseen to be implemented in this scenario are still in a visionary state, and not much concrete.

#### ***Autonomous intelligent cargo units***

In the visionary scenario intelligent cargo units will be available in all sectors, and not only in a few sectors like in the realistic scenario. The intelligent cargo units are expected to communicate via local systems, which will be implemented mainly by the supply chain leaders. This implies that apart from required investments in systems, additionally the annual costs can be quite substantial. After all, there will be ongoing bi-directional communication, which drives the annual operational costs of the system. These annual costs might even exceed the one-off investment costs. Given the uncertainties that still surround the concept, it has not been possible to develop a costs assessment.

On the other hand, as pointed out in the previous chapter, a substantial amount of benefits is anticipated from this use case, resulting among others from efficiency gains and reduced number of kilometres. It is clear that these justify a certain costs level. The magnitude of the communication costs seem to be key in any assessment of the economic feasibility of the applications. In frame of future solutions annual communication costs should be minimised as long as these costs are high.

### ***Decentral planning at cargo level***

In the previous chapter an assessment of the benefits of this aspect of the visionary scenario has been made. It has shown that quite a substantial amount of benefits could result. Additionally, a number of unquantified benefits are envisaged, as well as a 'multiplier effect', that represent an overall decrease of capital needed for the supply chain, as the self organising supply chain leads to optimal lead times, and an optimal supply chain.

This shift in supply chain planning, sometimes called a paradigm shift, is naturally a major change that will require substantial investments in new decentralized systems. However, it is unclear how such planning system would exactly look like at this stage. Therefore it is not possible to make an assessment of the costs for such system in the frame of this study.

### ***Conclusion***

The benefits for the visionary scenario have been summarised above, and been presented in quantitative terms in chapter 5. These are expected to increase from zero in 2010, via 9-17 billion euro in 2020, via 16-31 billion euro in 2030 to 20-38 billion euro in 2035. Note these values concern only the quantified benefits; chapter 5 describes in addition a number of benefits which have not been quantified.

The costs for the EU have been estimated and provided in section 6.1. In total, a sum of € 160 million per annum is anticipated in the first phase of the migration path. This phase lasts 8-12 years, hence the total costs for the EU add up to 1.28 – 1.92 billion euro for the entire phase one.

However, the majority of the costs need to be incurred by industry, as indicated above. It has not been possible to assess the magnitude of these investments. Therefore, it is impossible as well to assess whether from an industry perspective it is cost-beneficial to invest.

In the following table, the costs for the EU and benefits are presented for each of the three phase. For the benefits, we distinguish the benefits that accrue to industry, and those that accrue to society (from emission reductions, benefits from safety and security not included).

**Table 28: Costs and benefits for the EU**

<b>billion euro</b>	<b>Phase 1</b>	<b>Phase 2</b>	<b>Phase 3</b>
Benefits total (min-max)	50-98	122-237	108-205
<i>To industry</i>	49-96	120-233	106-202
<i>To society</i>	1-2	2-4	2-3
Costs			
<i>For EU</i>	1.3-1.9	0	0
<i>For industry</i>	PM	PM	PM

PM = pro memori: there are costs but the magnitude is unknown

From the table it can be derived that the benefits for society from emission reductions seem to outweigh the costs for the public sector. While in the first phase the costs for the EU and the benefits to society seem in balance, from the second phase onwards, there are no more costs foreseen for the EU, while benefits still increase.

However, on an overall level (industry plus society) this assessment is not possible to make. It is clear that there are significant costs for industry, but it is not possible to make a conclusion in this stage whether the benefits for the industry would outweigh these costs.

## 6.4 Conclusions and recommendations on migration paths

ICT will further increase the efficiency of freight transport in the future and will lead to more sustainable transport practices with positive effects on safety and security. This is not only believed by the experts interviewed but also a result of the impact assessment considerations of this study based on two scenarios and 5 use cases.

The market forces are expected to be strong enough so that the realistic scenario can be reached without considerable public support. The pressure towards standardisation is very high in the general information society and the ICT for transport and logistics market segment will participate and profit from this overall trend. Furthermore, the still fast expanding and developing eBusiness market relying on standards and electronic document exchanges for an eFulfilment will carry away the freight transport electronic business instead of leaving it behind.

This does not mean that additional engagement or support to reach the realistic scenario would be without effect. Stimulating the progress, establishing framework conditions for industrial standardisation, offering opportunity for standardisation

processes and helping to overcome arising barriers would speed up the implementation and would strengthen the European markets.

Regarding the visionary scenario with intelligent cargo solutions it is hard to predict whether the market forces and private investment can reach a breakthrough. As it is a paradigm shift from central to decentralized organisational structures and because the central structures are well in place and are being maintained and constantly optimized it might remain a high economic barrier of establishing in parallel an additional new structure for replacing the existing ones. Here it is not yet clear how the visionary scenario will finally look like in detail and which functions and communication relationships need to be established locally and widely in order to link Internet of Things technologies with eFulfilment requirements and to elegantly provide the needed planning, control and monitoring functions for transport logistics. Furthermore, it is hard to predict the overall technological equipping in 20-30 years in which an intelligent cargo solution would be embedded.

Following the first phase of the suggested migration path, it can be recommended to stimulate and to support the transfer of innovative ICT developed in computer science into the transport logistics domain. Still, the actors and owners in the freight transport and logistics business must be recognized as a comparative conservative user group. Best practice approaches, training measures, and other means targeting at an increased penetration of advanced ICT in this domain are to be installed.

In research it is recommended to start experiments with intelligent cargo where cargo can use either own computational power or services via local mobile interfaces. These experiments should not be restrained by current limitations of current practices but should rather follow a forward strategy assuming the availability of more local cargo intelligence, local services and respective infrastructures and environments. These experiments will first be laboratory experiments but their results will very much help to further anticipate the future and to formulate expectations.

In parallel to the mentioned experiments it is recommended also for the research policy to push the development of innovative concepts for decentralized planning and control solutions for freight transport based on intelligent cargo. There could be common rules for decentralized transport decisions and for realising monitoring and control requirements. A new name like INTERCARGONET could underline these efforts and an idea contest could honour the best approaches European wide. The best concepts should be simulated and assessed in order to judge their future potential.

There is more clarity and structure needed in the 'ICT for mobility services for goods' domain in order to improve the focus of research and of supporting measures. The recommendation is to structure this domain in three sub-domains: in

a 'vehicle and traffic' oriented sub-domain, a 'transport logistics processes and intelligent cargo' oriented sub-domain and in a 'city logistics and society' oriented domain. Research in the past often focussed on the first sub-domain 'vehicle and traffic', while the migration path towards the visionary scenario requires much more engagement in the second sub-domain 'transport logistics processes and intelligent cargo'.

It is finally recommended to assess the European interest groups and political departments whether there is enough attention on the subject of ICT for mobility services for goods and on the developments and the progress towards a visionary scenario. If the assessment reveals fragmentary attention and responsibility then the appointment of an observer and advisory group should be considered. Observing the worldwide developments in standardising eBusiness, eFulfilment and the document exchange in freight transport is important in order to regularly judge on the European market position and to provide recommendations for corrective actions in an early state.

## 7 Annex 1 – Input data and assumptions

### *Input data*

- Road transport EU27 (2007): 1927 Billion vehicle tkms.
- Road transport EU27 (2007): 1300 Billion vehicle national tkms.
- Road transport EU27 (2007): 627 Billion vehicle international tkms.
- Road transport EU27 (2007): 188 Billion vehicle kms.
- Road transport EU27 (2007): 47 Billion empty vehicle kms.
- Road transport EU27 (2007): 141 Billion laden vehicle kms.
- Road transport EU27 (2007): 33 million lorries.
- Road transport EU27 (2007): 2.3 Billion journeys

### *Assumption*

- Annual growth vehicle kms, estimated at 1.80% (same as growth tkms)
- Annual growth lorries, estimated at 1.80% (same as growth tkms)
- Journeys, percentage national journeys compared to total: 67%, estimated at the same value as the percentage national tkms.
- Number of shipments per journey for national journeys: 1.1 (based on figures for NL).
- Number of shipments per journey for international journeys: 1 (assuming most journeys will be FTL (full truck loads))
- Average hour wage logistic sector: 23 euro, using hour wage logistic sector NL and PPP ratio NL and EU27.
- Number of logistic firms (2007): around 576000
- Number of logistic firms (2007): SMEs around 570000
- Number of logistic firms (2007): large firms (above 49 employees), around 6000.

- Annual growth number of logistic firms: 0.63% (based on annual growth last 10 years, EUROSTAT)
- Number of manufacturers (2007): around 2.3 million
- Number of large (more than 249 employees) manufacturers (2007): around 20,000
- Annual growth number of manufacturers: 0.5% (based on annual growth last 10 years, EUROSTAT)
- Average hour wage manufacturer: 21 € (EUROSTAT)
- Average € saved per reduced km: 0.97 € (using study factorkosten NEA, NL and PPP ratio NL and EU27).
- Average hour wage authorities/customs: 31 € (estimated at 1.5 times the hour wage of the logistic sector)
- Percentage of journeys with high value goods: 1.49% (estimated at around 10% of the total for NSTR 24: miscellaneous articles)
- Insurance costs high value goods per trip: 500 € (based on interview with NL insurance company)
- Annual thefts in road transport (2007): 8.2 Billion € (source: Cargo theft report, 2009)
- Annual salary costs planning and monitoring staff: around 37k € (based on estimated hour wage logistic sector)
- Emission factor tonnes CO2 emission per vehicle km: 0.00068 (based on TREMOVE model 2010 values)
- Emission factor tonnes NOx emission per vehicle km: 0.00000563 (based on TREMOVE model 2010 values)
- Emission factor tonnes PM emission per vehicle km: 0.00000011 (based on TREMOVE model 2010 values)

## 8 Annex 2 – Descriptions of the applications

### Advanced Tracking System - ATS

**Name of project, system, approach, application:**

Advanced Tracking System for dangerous industrial waste by Allix

**Short description/ character of the application:**

(ATS) is a complete platform that integrates different technologies to provide a valid solution to the tracking of waste transportation. It will immediately note if a truck is not following the planned road, or illegally unloading some of the waste on the way. It is a generic transportation fleet management system which has been customised for the specific needs of waste transportation in the Italian Lombardy region, and has been developed in a way to ensure it adheres to European laws on transportation of dangerous industrial waste.

**Main objectives:**

The transportation of dangerous industrial waste from its originating source to the site where it will be treated is increasing every year. Trucks carrying the waste-filled containers typically travel through several European countries for two to three days. For security reasons, and to ensure that all the waste arrives where it is intended to, an innovative tracking system has been developed to accurately track all movements of the industrial waste throughout its journey.

**Actors affected:**
**Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient


**Technical description/ technologies used/ needed:**

The system consists of a main device located on the truck which includes a GNSS receiver that operates on GPS with EGNOS overlay signals. The main device is connected via the GPRS mobile network to a central server which receives, at regular intervals, information from the main device on the exact location of the truck and any changes in the containers loaded on the truck.

Secondary devices, one on each container, operate as autonomous devices, and



monitor the status of the containers, their temperature movement, etc. The secondary devices communicate to the central device all changes to the container and its contents using the cost-effective, standards-based ZigBee wireless networking solution.

When a trailer with one or more containers is jointed to the truck, the main device registers the connection which is communicated to the central server. When the trailer and therefore the containers are disconnected from the truck, a signal is sent to the central server. In this way the central server can easily compare planned with actual routes.

**Status of the application:**

Vision/ idea	<input type="checkbox"/>
Concept	<input type="checkbox"/>
Demonstrator	<input checked="" type="checkbox"/>
Prototype	<input type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: truck

Paperless documentation: No

Self/ context awareness: Yes

Secure Information access: No

Ubiquitous data availability: No

Bi-directional communication: No

Standard data formats: No

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): industry, authorities, carrier

**Envisaged effects/ impacts:**

- impact on safety and security
- impact on efficiency

**Further sources, literature:**

<http://www.esa.int/ttp>

[www.allix.it](http://www.allix.it)

**ARKTRANS****Name of project, system, approach, application:**

ARKTRANS (multi-modal system framework architecture for freight and public transport)

**Short description/ character of the application:**

The ARKTRANS project concerns the development of a multi-modal system framework architecture for freight and public transport.

**Main objectives:**

The aim of the project is to develop a framework architecture which covers all transport modes (road, railway, sea and air) and which covers both freight and passenger transport.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

ARKTRANS is a framework architecture and covers several aspects like:

- Conceptual aspects (reference model)
- Logical aspects (functional view point, behaviour viewpoint and information viewpoint)
- Technical aspects (physical viewpoint and communication viewpoint)

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: cargo unit

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: Yes

Ubiquitous data availability: Yes

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry and several Public authorities of Norway)

**Envisaged effects/ impacts:**

- Efficiency gains
- Improved security

**Further sources, literature:**

- Presentation “ARKTRANS multimodal system framework architecture for freight and public transport”, SINTEF, 2004.
- Website:  
<http://www.sintef.no/units/informatics/projects/arktrans/arktransweb/>

## Cargobox

### Name of project, system, approach, application:

Cargobox

### Short description/ character of the application:

Cargobox is an intelligent cargo container, which can be used for multi-modal transport (air, road and rail). The cargobox is a reusable collapsible conveyance unit to be used for door-to-door transport of cargo. After more than six years of research and development cargobox will soon be introduced to the market.

### Main objectives:

The introduction of a reusable, intelligent cargo unit, which can be used for multi-modal transport.

### Actors affected:

#### Actors:

Shipper  
Forwarder  
LSP  
Driver  
Consignee Operator  
Public authority  
Recipient



### Technical description/ technologies used/ needed:

Cargobox contains an intelligent lockbar, which can contain the following:

- RFID tag
- Memory chip for data storage
- Wireless capability
- GPRS capacity
- Interconnection with handheld PDA
- Numeric keypad for back-up purposes

**Status of the application:**

Vision/ idea	<input type="checkbox"/>
Concept	<input type="checkbox"/>
Demonstrator	<input type="checkbox"/>
Prototype	<input type="checkbox"/>
Implemented	<input checked="" type="checkbox"/>
Available market solution	<input checked="" type="checkbox"/> (ready for introduction)

**Relevance towards “Intelligent Cargo System”:**

The cargobox is an intelligent cargo container solution.

Cargo level oriented: container, cargo unit

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: Yes

Ubiquitous data availability: No

Bi-directional communication: No

Standard data formats: No

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): logistic service provider, carrier

**Envisaged effects/ impacts:**

The expected impacts are:

- efficiency impacts (timesavings, reduced delays, etc leading to cost savings)
- improved security (due to using the lockbar).

**Further sources, literature:**

Website: <http://cargobox.info>

Brochure: “Cargobox efficient and safe, 2008”

**Cargoreservations.com****Name of project, system, approach, application:**

Cargoreservations.com

**Short description/ character of the application:**

Cargoreservation.com is a real-time cargo tracking system for airfreight. It offers an instant messaging tool concerning airfreight. The system offers users the possibility to track each piece of cargo, based on the information stored in the database. A part number, airbill number or container number can be used to view a real-time Aircraft Situational Display (ASD). Cargoreservations.com is a service provided by Zulunet.

**Main objectives:**

Cargoreservation.com provides a real-time B2B exchange system for air cargo industry.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

Cargoreservation.com offers a paperless Internet platform for airfreight. It is connected to system containing the real-time Flight Data from the FAA.

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: individual parts

Paperless documentation: Yes

Self/ context awareness: No
Secure Information access: Yes
Ubiquitous data availability: No
Bi-directional communication: No
Standard data formats: Yes
SME compatible: Yes
Stakeholder inclusion (industry, public, administrative..): yes
<b>Envisaged effects/ impacts:</b> <ul style="list-style-type: none"><li>• Efficiency gains</li><li>• Improved security</li></ul>
<b>Further sources, literature:</b> <ul style="list-style-type: none"><li>• “cargoReservations.com launches real-time B2B exchange for Cargo Industry”, Business Editors, 2000.</li><li>• Interface &amp; Control Systems -- Corporate Capabilities</li></ul>

**CARIN****Name of project, system, approach, application:**

CARIN (CArgo INformation)

**Short description/ character of the application:**

A project for paperless cargo transport in the Netherlands. As reward for providing electronic information about inland shipping transports concerning dangerous goods in containers in advance by shipping companies to the water police, the water police will not stop the vessels for check dangerous goods during transport anymore. After a successful pilot the concept will be implemented on the inland shipping routes between the ports of Amsterdam, Rotterdam and Antwerp.

**Main objectives:**

Reducing the time spent on checks of dangerous goods transports with inland vessels in the Netherlands. And at the same time improve the safety situation in general in inland transport.

**Actors affected:****Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

☐☒☒☐☐☒☐**Technical description/ technologies used/ needed:**

The main technologies used are a Software platform for exchanging electronic data about inland shipping transport concerning dangerous goods in containers

**Status of the application:**

Vision/ idea

☒

Concept

☒

Demonstrator

☒

Prototype

☒

Implemented

☒

Available market solution

☒



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: Yes

Ubiquitous data availability: No

Bi-directional communication: No

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry and public authorities)

**Envisaged effects/ impacts:**

- Efficiency gains (less time lost due to checks of inland shipping vessels)
- Improved security (possibility to further investigate suspicious transports when they are found in the system)
- Improved safety (better overview, access to information about dangerous goods)

**Further sources, literature:**

- Article Nieuwsblad Transport “Minder politiecontroles voor binnenvaart dankzij Carin”, 2008.
- Website “bureau Telematica Binnenvaart”: [www.binnenvaart.org](http://www.binnenvaart.org)

**CVIS / CF&F****Name of project, system, approach, application:**

CVIS/CF&F – Cooperative Vehicle-Infrastructure Systems/Cooperative Freight and Fleet

**Short description/ character of the application:**

The subproject CF&F within the CVIS project develops a cooperative/ intelligent system to enable the communication between commercial vehicles and infrastructure elements. The guidance and monitoring of dangerous goods transports are main focus.

**Main objectives:**

- enhancement of security of dangerous goods transport especially in urban areas
- optimization of delivery logistics and rest periods of drivers
- reduction of vehicle breakdowns in sensitive areas

**Actors affected:****Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

**Technical description/ technologies used/ needed:**

The following technologies are part of the CVIS architecture:

- GPS (positioning and localisation)
- 2.5/3G cellular phone and DSRC
- universal communication module as interface between vehicle and infrastructure
- traffic management applications
- Existing technologies will be designed for the new “Wi-Fi for mobiles” wireless local networking supporting both vehicle to vehicle and roadside infrastructure communications.

**Status of the application:**

Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input checked="" type="checkbox"/>
Prototype	<input checked="" type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>

**Relevance towards “Intelligent Cargo System”:**

Communication network for vehicle and road-side infrastructure. Individualised and intelligent monitoring and guidance of specific vehicle(s) groups.

Cargo level oriented: vehicle

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: No

Ubiquitous data availability: Yes

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): Yes

**Envisaged effects/ impacts:**

Safer and environment friendly logistics in urban areas

Optimized use of infrastructure

**Further sources, literature:**

Project website: [www.cvisproject.org](http://www.cvisproject.org)

**ELOGMAR-M****Name of project, system, approach, application:**

ELOGMAR-M– web-based and mobile solutions for collaborative work environment with logistics and maritime applications

**Short description/ character of the application:**

Collaborative FP 6 project creating innovative solutions for port and logistics transport management

**Main objectives:**

Establish collaborative partner pools for partners in different countries for exchange of information on the related transport routes; new work methods among partners in the different countries (e.g. electronic data exchange on different levels)

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

Internet, web based applications, mobile applications and devices, interactive Website for dynamic collaboration of partners, Focus on port solutions and e-logistics

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: vehicle

Paperless documentation: Yes

<p>Self/ context awareness: No</p> <p>Secure Information access: No</p> <p>Ubiquitous data availability: No</p> <p>Bi-directional communication: No</p> <p>Standard data formats: Yes</p> <p>SME compatible: Yes</p> <p>Stakeholder inclusion (industry, public, administrative..): industry, trade companies, logistic service provider, terminal operators</p>
<p><b>Envisaged effects/ impacts:</b></p> <p>Better information exchange, better collaboration between partners from different countries</p>
<p><b>Further sources, literature:</b></p> <p><a href="http://www.elogmar-m.org/">http://www.elogmar-m.org/</a></p>

**EURIDICE****Name of project, system, approach, application:**

EUropean Inter-Disciplinary research on Intelligent Cargo for Efficient, safe and environment-friendly logistics

**Short description/ character of the application:**

The basic concept of Euridice is to build an information services platform centred on the individual cargo item and on its interaction with the surrounding environment and the user.

**Main objectives:**

- Supporting the interaction of individual cargo items with the surrounding environment and users on the field
- Improving logistic performances through application of the intelligent cargo concept and technologies in the working practices of operators and industrial users
- Developing collaborative business models to sustain, promote and develop an intelligent cargo infrastructure
- Realizing more secure and environment friendly transport chains through the adoption of intelligent cargo to support modal shift and door-to-door inter-modal services

**Actors affected:****Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

**Technical description/ technologies used/ needed:**

The following technology mix will be integrated into the EURIDICE architecture:

- GPS (positioning and localisation)
- RFID (identification)
- ZigBee/ WiMax (wide area communication , standards)
- UMTS/GPRS/ GSM/ CDMA (geographic communication)

- Sensors (monitoring)
- ARM + memory (computational power)

The architecture will describe the multi-layer system landscape of fixed and mobile web services which support ad-hoc user cargo context interactions. Using the available state-of-the art technologies an Intelligent Cargo Integration Framework will be developed.

**Status of the application:**

Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input type="checkbox"/>
Prototype	<input type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>

**Relevance towards “Intelligent Cargo System”:**

Main focus on the capability of the cargo itself to identify, communicate with the environment. Consideration of different technologies to create a possible solution for an “Intelligent Cargo System” regarding different user requirements and roles of stakeholders

Cargo level oriented: cargo unit

Paperless documentation: Yes

Self/ context awareness: Yes

Secure Information access: Yes

Ubiquitous data availability: Yes

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (public authority)

**Envisaged effects/ impacts:**

- More secure and environment friendly transport chains
- Improvement of performance of logistic networks and processes

**Further sources, literature:**

Project website: [www.euridice-project.eu](http://www.euridice-project.eu), project presentations

**E-train****Name of project, system, approach, application:**

E-train

**Short description/ character of the application:**

E-train is a new satellite-based positioning system for real time train monitoring, introduced by Hupac. The system is based on innovative hardware components with GPS/GSM technology. A proactive information system matches the effective running data of every individual train with the selected timetable.

**Main objectives:**

E-train is an intelligent system for train monitoring

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

A hardware component, the satellite unit, is installed on each train. It is composed of a GPS satellite reception card, a GSM telephone card to communicate position and the latest-generation battery to provide energy to the two cards. The system is enclosed in a box that can be easily mounted on any wagon for combined transport.

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: vehicle/ wagon (of a train)

Paperless documentation: No



Self/ context awareness: No
Secure Information access: No
Ubiquitous data availability: No
Bi-directional communication: Yes
Standard data formats: No
SME compatible: Yes
Stakeholder inclusion (industry, public, administrative..): yes (industry)
<b>Envisaged effects/ impacts:</b> <ul style="list-style-type: none"><li>- Efficiency gains (the system is based on proactivity and automaticity, and the customers can be informed if delays are noticed)</li></ul>
<b>Further sources, literature:</b> <p>See website: <a href="http://www.railcargo.nl/index.cfm/menuid/6/Product/1211">http://www.railcargo.nl/index.cfm/menuid/6/Product/1211</a></p>

**FREIGHTWISE****Name of project, system, approach, application:**

FREIGHTWISE – Management Framework for Intelligent Intermodal Transport

**Short description/ character of the application:**

FREIGHTWISE is an integrated FP 6 project which will support cooperation in different sectors to develop and demonstrate suitable Intermodal transport solutions.

**Main objectives:**

Main objective is to support modal shift of cargo flows from road to intermodal transport. FREIGHTWISE will elaborate a system architecture for intermodal transport management. Furthermore the EC should be supported regarding legislative and future initiatives.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

Focus will be on:

Reference architecture for intermodal transport on conceptual level.

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: vehicle/ truck

Paperless documentation: Yes

Self/ context awareness: No
Secure Information access: No
Ubiquitous data availability: No
Bi-directional communication: No
Standard data formats: Yes
SME compatible: Yes
Stakeholder inclusion (industry, public, administrative..): yes (industry, public authority)
<b>Envisaged effects/ impacts:</b>
Better efficiency of freight transport, enhanced modal shift
<b>Further sources, literature:</b>
<a href="http://www.freightwise.info">www.freightwise.info</a>

## GoodRoute

### Name of project, system, approach, application:

GOOD ROUTE, cooperative system

- Development of an integrated, cost-efficient, law-abiding, fair and modular system
- Development of a minimum risk guidance system
- Development of a collaborative platform

### Short description/ character of the application:

The GOOD ROUTE system integrates routing, enforcement based real-time monitoring and traffic information for dangerous goods to a single system.

### Main objectives:

Development of a cooperative system for dangerous goods vehicles through route monitoring, re-routing enforcement and driver support, based upon dynamic, real time data, in order to minimise the societal risks related to their movements, whereas still generating the most cost efficient solution for all actors involved in the logistic chain. It offers the opportunity to integrate real-time data information (traffic and vehicle information) to a web-based dangerous good routing.

### Actors affected:

#### Actors:

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient



### Technical description/ technologies used/ needed:

#### Vehicle:

A series of on-board sensors provide real-time data to the system. Truck short and mid-range communication are utilized for dynamic data collection and fusion exchanged from Infrastructure to Vehicle (I2V) and from Vehicle to Vehicle (V2V) sources. A GPRS or UMTS connection is utilized to provide long range data communication from Vehicle to Web Service. A vehicle client being operated on a Tablet PC as human interface.

**Roadside Infrastructure:**

Road side units installed as road side equipment. Road side units are able to access road side sensors to collect data and give strict security measures and access rights to use road side actuators to provide information, advices, warnings or instructions to the traffic participants.

**Server and Web Portal:**

1 Frontend Server, 2 Backend Server, 1 Database Server are needed to operate the system (Web Portal, Decision Support Module, Conflict Resolution Module)

**Status of the application:**

Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input checked="" type="checkbox"/>
Prototype	<input checked="" type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: vehicle/truck

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: NO

Ubiquitous data availability: Yes

Bi-directional communication: Yes

Standard data formats: No

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry, public authority)

**Envisaged effects/ impacts:**

- Minimum risk guidance
- Real-time monitoring and guidance
- Reduced procedure time
- Reduction of trip length

**Further sources, literature:**

Project homepage: <http://www.goodroute-eu.org>

## Hazardous Material Tracking

**Name of project, system, approach, application:**

Hazardous Material Tracking

**Short description/ character of the application:**

The US Government developed the idea of a tracking system which provides a real time link to vehicle transporting hazardous materials. It may be used to monitor trailer break-ins using alarm sensors, monitor shipments deviating from a predetermined course, monitor an antenna cable being cut or a driver-activated single stroke emergency alert feature. The tracking systems could also be used to respond to terrorist attacks by turning off the engine, making hijacking of vehicles transporting hazardous materials significantly more difficult and risky.

**Main objectives:**

Vehicle tracking system that allows the remote monitoring of the location and the condition of a vehicle transporting hazardous materials from a central location.

**Actors affected:**
**Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient


**Technical description/ technologies used/ needed:**

The main technologies used are the following:

- Sensors
- Track and trace systems (GPS satellite, communications satellite)

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: Truck

Paperless documentation: Yes

Self/ context awareness: Yes

Secure Information access: Yes

Ubiquitous data availability: No

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry)

**Envisaged effects/ impacts:**

- Efficiency gains
- Improved security
- Improved safety

**Further sources, literature:**

Brochure: ‘The Role of Hazardous Material Placards In Transportation Safety and Security’. US Department of Transportation, 2003.

**IATA e-freight****Name of project, system, approach, application:**

IATA e-freight

**Short description/ character of the application:**

The project is an industry-wide initiative involving carriers, freight forwarders, ground handlers, shippers and customs authorities, and is facilitated by IATA. Each air cargo shipment carries with it as many as 30 papers. IATA e-freight replaces 13 of these documents with electronic messages. That will increase to 16 in 2009 and 20 in 2010.

**Main objectives:**

The IATA e-freight project aims to take the paper out of air cargo.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

The IATA e-freight business process is supported by various message standards, interfaces, integration platforms, web portal and management systems functions that can be self-developed or procured from IT solution providers.

IT solution providers in the IATA e-freight project include:

- Integration platforms providing Cargo Community Systems services (CCS), Cargo 2000 Data Management Platform (CDMP) for freight forwarders, carriers and customs, internet or private network interconnections, protocol and data transformation services, archiving and web portals to any supply chain stakeholder.
- Software editors of management systems for carriers, ground handling agents, freight forwarders, customs, customs brokers and shippers



<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input checked="" type="checkbox"/>
Prototype	<input checked="" type="checkbox"/>
Implemented	<input checked="" type="checkbox"/>
Available market solution	<input checked="" type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: cargo unit	
Paperless documentation: Yes	
Self/ context awareness: Yes	
Secure Information access: No	
Ubiquitous data availability: No	
Bi-directional communication: No	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (industry and several public authorities of Norway)	
<b>Envisaged effects/ impacts:</b>	
<ul style="list-style-type: none"> <li>Efficiency gains (lower costs, faster service, greater reliability and accuracy, and better visibility)</li> </ul>	
<b>Further sources, literature:</b>	
Website: <a href="http://www.iata.org/stbsupportportal/efreight/">http://www.iata.org/stbsupportportal/efreight/</a>	

**INTEGRITY****Name of project, system, approach, application:**

INTEGRITY – Intermodal Global Door-to-door Container Supply Chain Visibility

**Short description/ character of the application:**

Integrity focuses on the reliability and data availability of Container transport chains

**Main objectives:**

Enhanced container security tracing

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

Focus will be on:

- Supply chain visibility and data availability of global container transport chains to enhance secure flow of goods
- A methodology and IT system will be developed – Shared Intermodal Container Information System

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

<p>Self/ context awareness: No</p> <p>Secure Information access: Yes</p> <p>Ubiquitous data availability: Yes</p> <p>Bi-directional communication: No</p> <p>Standard data formats: Yes</p> <p>SME compatible: Yes</p> <p>Stakeholder inclusion (industry, public, administrative..): industry, trade companies, logistic service provider, terminal operators</p>
<p><b>Envisaged effects/ impacts:</b></p> <p>better access to data and information regarding container transport chains</p>
<p><b>Further sources, literature:</b></p> <p><a href="http://www.integrity-supplychain.eu">www.integrity-supplychain.eu</a></p>

**Intelligent container****Name of project, system, approach, application:**

Intelligent container

**Short description/ character of the application:**

The Intelligent Container is part of an agent-based system for autonomous transport. The system links technologies from the fields of RFID, sensor networks and software agents to provide a permanent and freight-specific supervision of each transport package along the supply chain.

**Main objectives:**

The 'intelligent Container' is an autonomous transport monitoring system for perishable and sensitive goods.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

The main technologies used are the following:

- RFID reader.
- Freight object (RFID)
- Sensor nodes
- Local processing unit.
- External communication

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

Self/ context awareness: Yes

Secure Information access: No

Ubiquitous data availability: Yes

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry)

**Envisaged effects/ impacts:**

- Efficiency gains (responding to sensor data)
- Improved security (using encryption)

**Further sources, literature:**

- Brochure “The Intelligent container, Application of RFID and sensor technology for autonomous transport monitoring”, University of Bremen.
- Presentation “Dynamic decision making on embedded platforms in transport logistics – a case study”, University of Bremen, 2007.

## Intelligent container seal

### Name of project, system, approach, application:

Intelligent container seal

### Short description/ character of the application:

The Intelligent Container seal provide a low-cost solution to securing and tracking cargo container shipments and assure an electronic chain of custody for shipping documentation. This solution has originally been developed to assist international shipping companies in maintaining documentation standards to meet rigid US Customs requirements, but is now customizable for other logistic applications.

### Main objectives:

The Intelligent Container Seal provides a secure method for transporting shipping and material documentation along with a cargo.

### Actors affected:

#### Actors:

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient



### Technical description/ technologies used/ needed:

The intelligent container seal consists of a reusable hardened cargo security seal with a USB digital memory storage device.

This data is accessible using most laptop, handheld or desktop computers.

Also available for custom development are container seals with integrated sensor and communications networking capability, including RFID, Sensor Mesh Networks and GPS solutions.

### Status of the application:

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: Yes

Ubiquitous data availability: No

Bi-directional communication: No

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry and customs)

**Envisaged effects/ impacts:**

- Efficiency gains (reduced paper work, reducing time needed for clearing a container)
- Improved security

**Further sources, literature:**

- White Paper “Secure Transport of Manifest Information for Containerized Cargo”, Intelli-Que, LLC, 2006
- Website: <http://www.intelli-que.com/IQ128.html>

**INWEST****Name of project, system, approach, application:**

INWEST – national research project within the German research program  
“Intelligent Logistics”

**Short description/ character of the application:**

Intelligent steering of container, BlackBox for swap trailer for identification, tracking and tracing

**Main objectives:**

Development of innovative tracking and tracing technologies for “container”, elaboration of Decision support system for optimization of transport planning by using innovative tracing technologies

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee/ Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

Identification and localisation (tracking and tracing) devices at the cargo unit, middleware software solutions

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

Self/ context awareness: No



<p>Secure Information access: No</p> <p>Ubiquitous data availability: No</p> <p>Bi-directional communication: No</p> <p>Standard data formats: Yes</p> <p>SME compatible: Yes</p> <p>Stakeholder inclusion (industry, public, administrative..): industry, trade companies, logistic service provider, terminal operators</p>
<p><b>Envisaged effects/ impacts:</b></p> <p>Better information availability on cargo container unit, better use of data and optimized transport processes</p>
<p><b>Further sources, literature:</b></p> <p><a href="http://www.intelligente-logistik.org">http://www.intelligente-logistik.org</a></p>

**i-Scheduler for road transportation****Name of project, system, approach, application:**

i-Scheduler for road transportation

**Short description/ character of the application:**

The magenta logistics i-Scheduler is based upon a multi-agent architecture. It considers individual constraints and specific preferences of customers, drivers, trucks, cargoes, etc. It is able to combine inbound and outbound deliveries.

**Main objectives:**

The i-scheduler is designed to handle large transportation networks as a whole.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

No specific hardware requirements. The i-scheduler is a multi-agent software, implemented on the J2EE platform (java).

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: truck

Paperless documentation: No

Self/ context awareness: No

Secure Information access: No

Ubiquitous data availability: Yes
Bi-directional communication: No
Standard data formats: Yes
SME compatible: Yes
Stakeholder inclusion (industry, public, administrative..): no
<b>Envisaged effects/ impacts:</b> <ul style="list-style-type: none"><li>• Efficiency gains</li></ul>
<b>Further sources, literature:</b> <ul style="list-style-type: none"><li>• “Case studies of Magenta i-Scheduler for Road Transportation”, Magenta Technology, 2006</li></ul>

**KOMODA****Name of project, system, approach, application:**

KOMODA – Co-modality towards optimized integrated chains in freight transport logistics

**Short description/ character of the application:**

KOMODA is an FP7 project that aims to create a holistic approach of an e-logistics system Europe-wide.

**Main objectives:**

KOMODA's objective is to produce a roadmap, with associated action plans, to nurture an integrated e-Logistics platform by and between modes of freight transport across Europe.

Therefore a concept or vision of an e-logistics "platform" or system landscape supporting co-modality will be elaborated.

**Actors affected:****Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

**Technical description/ technologies used/ needed:**

The conceptual work will consider the state-of-the-art technologies and applications which are being available in the different modes of transport.

- Multi-modal/ intermodal planning solutions.
- Routing and scheduling tools
- Order management and processing
- Other available applications and technologies

<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input type="checkbox"/>
Prototype	<input type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: general, up to vehicle/ truck level	
Paperless documentation: Yes	
Self/ context awareness: No	
Secure Information access: No	
Ubiquitous data availability: Yes	
Bi-directional communication: No	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (logistics service provider, industry, public authority)	
<b>Envisaged effects/ impacts:</b>	
Better efficiency of freight transport, transparent information flow, better access to data and information regarding multi-modal/ co-modal transport chains for the stakeholders.	
<b>Further sources, literature:</b>	
<a href="http://www.komodaproject.com">www.komodaproject.com</a>	

**KO-RFID****Name of project, system, approach, application:**

KO-RFID (Collaboration in RFID-supported value-added networks)

**Short description/ character of the application:**

The Ko-RFID project is funded by the German Ministry for Labor and Economics. Based on the analysis of existing value chains in the textile, automobile and kitchen furnishing industries, the relevant technical standards, interfaces and logistic applications are to be developed for RFID-based value chains.

**Main objectives:**

The Ko-RFID Project aims to make network structures more transparent for all parties involved by means of the RFID technology. The ultimate goal is to develop a benchmark and a best practice model.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

The main technology which is analysed in this project is RFID technology.

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: load unit

Paperless documentation: Yes

Self/ context awareness: No

<p>Secure Information access: No</p> <p>Ubiquitous data availability: Yes</p> <p>Bi-directional communication: No</p> <p>Standard data formats: Yes</p> <p>SME compatible: Yes</p> <p>Stakeholder inclusion (industry, public, administrative..): yes (industry)</p>
<p><b>Envisaged effects/ impacts:</b></p> <ul style="list-style-type: none"><li>• Efficiency gains</li><li>• Improved security (data security is researched)</li></ul>
<p><b>Further sources, literature:</b></p> <p>Project website: <a href="http://www.korfid.de">www.korfid.de</a></p>

**LAENDmarkKS****Name of project, system, approach, application:**

LAENDmarkKS, Logistics optimisation through automated collection and use of data concerning complex, security-related product components.

**Short description/ character of the application:**

The project concerns the development of a tracking solution covering the overall supply chain in the car industry using RFID technology.

The project consists of the following:

- Development of a uniform technical basis for a universal allocation and processing of Track&Trace data along the supply chain.
- Development of a practical RFID identification technology for the usage in the metal product and production area with focus on economy and process stability.
- Economical and feasibility verification of the acquired results from the practical conversion of a pilot application within a branch of the industry; often called “lighthouse solution”.

**Main objectives:**

The project aims to develop a fast traceability system and a way of tracking security related automotive components using RFID technologies.

**Actors affected:****Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

**Technical description/ technologies used/ needed:**

The main technologies which are used in this project are RFID technology, and the supply chain tracking and tracing system.



<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input type="checkbox"/>
Prototype	<input type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: individual components	
Paperless documentation: Yes	
Self/ context awareness: No	
Secure Information access: Yes	
Ubiquitous data availability: Yes	
Bi-directional communication: No	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (industry)	
<b>Envisaged effects/ impacts:</b>	
<ul style="list-style-type: none"> <li>• Efficiency gains</li> <li>• Improved security</li> </ul>	
<b>Further sources, literature:</b>	
Project website: <a href="http://www.laendmarks.com">www.laendmarks.com</a>	

## LogNetAssist

### Name of project, system, approach, application:

LogNetAssist, Assistance systems to steer intelligent logistics networks.

### Short description/ character of the application:

The project aims to develop an intelligent assistance system which provides decision support and calculates projections. In the course of the project life span the system will be established as a prototype and tested in the fields of “white goods” and HGV production.

The LogNetAssist system is based on components identification, transparency, reaction in real time and visualization. The data acquisition is done using RFID technology. The system contains two application levels:

- Supply chain Event management (SCEM). The SCEM takes over the analysis and interpretation of the data made available by the RFID server.
- a condition visualization of the logistics network, which contains also the determination and evaluation of action alternatives in case of unexpected events.

With the introduction and application of the system critical delivery situations and the associated costs are to be avoided by creative transparency with all partners of the logistics network.

### Main objectives:

LogNetAssist aims to combine all aspects of a logistics network and facilitates the control of logistics and production processes.

### Actors affected:

#### Actors:

Shipper  
Forwarder  
LSP  
Driver  
Consignee Operator  
Public authority  
Recipient



### Technical description/ technologies used/ needed:

The main technologies which are used in this project are RFID technology, and the supply chain assistance system.

<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input type="checkbox"/>
Prototype	<input type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: load unit	
Paperless documentation: Yes	
Self/ context awareness: No	
Secure Information access: No	
Ubiquitous data availability: Yes	
Bi-directional communication: No	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (industry)	
<b>Envisaged effects/ impacts:</b>	
<ul style="list-style-type: none"> <li>• Efficiency gains</li> <li>• Improved security</li> </ul>	
<b>Further sources, literature:</b>	
Project website: <a href="http://www.lognetassist.de">www.lognetassist.de</a>	

## Machine Talk

### Name of project, system, approach, application:

Machine Talk

### Short description/ character of the application:

'Machine Talk' are real time applications that give a signal in case of exceeding particular values (like temperature, levels, GPS), changes in status (motion, open doors) and failures. It's also possible to read out real time data acquired by sensors (temperature, GPS, motion) and track and trace systems.

### Main objectives:

Machine Talk uses machine to machine communication (M2M) to watch, manage and operate machines (freight shipments) from a distance.

### Actors affected:

#### Actors:

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient



### Technical description/ technologies used/ needed:

The main technologies used are the following:

- Sensors (GPS, motion, temperature)
- Track and trace systems

### Status of the application:

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: truck, container

Paperless documentation: No

Self/ context awareness: Yes

Secure Information access: No

Ubiquitous data availability: No

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): No

**Envisaged effects/ impacts:**

- Efficiency gains
- Improved security

**Further sources, literature:**

- Machine Talk website: [www.machinetalk.nl](http://www.machinetalk.nl)

**MECD****Name of project, system, approach, application:**

MECD (Mobile Edge Computing Devices)

**Short description/ character of the application:**

MECD is an approach, which is being investigated. MECD is introduced to in order to reduce processing and bandwidth requirements to the end servers. When a group of containers moves together, MECD is proposed to take advantage of interaction between the containers via a mesh container network instead of focusing on individual containers. In a mesh network, the network provides each node with multiple data transmission paths, forming a mesh. Routing data through intermediate nodes is not only rapid, but also self-healing, because data packets automatically reroute through an alternate path if one link fails.

**Main objectives:**

The research concerns the creation of a self-configuring container-based dynamic mesh network, which changes with each physical realignment of the containers. MECD is part of American research which aims to develop a smart container security system using RFID and Wireless Sensor Networks in order to enhance cargo container security.

**Actors affected:****Actors:**

Shipper  
Forwarder  
LSP  
Driver  
Consignee Operator  
Public authority  
Recipient

**Technical description/ technologies used/ needed:**

The containers are instrumented with 2 networks:

- An internal network, for environmental sensing and reading RFID tags.
- An external network, for node-to-node communication between containers.

The MECD architecture has three layers:

- Network sensor layer.
- MECD layer
- Enterprise server layer

<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input type="checkbox"/>
Prototype	<input checked="" type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: container	
Paperless documentation: Yes	
Self/ context awareness: No	
Secure Information access: Yes	
Ubiquitous data availability: Yes	
Bi-directional communication: Yes	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (industry)	
<b>Envisaged effects/ impacts:</b>	
<ul style="list-style-type: none"> <li>• Efficiency gains (improves scalability, flexibility and more cost-efficient)</li> <li>• Improved security (improves reliability)</li> </ul>	
<b>Further sources, literature:</b>	
<p>“Enhancing Cargo Container Security during Transportation: A Mesh Networking Based Approach”, Su Jin Kim, Guofeng Deng, Sandeep K.S. Gupta, Impact Lab, Department of Computer Science and Engineering Arizona State University, USA, 2008</p>	

## Mobile SLK

### Name of project, system, approach, application:

Mobile SLK (Shipment Localization Kits)

### Short description/ character of the application:

The Gebrüder Weiss Company developed a mobile SLK which is equipped on a shipment and consists of a positioning component for localizing the shipment and a communication component (GSM) for transmission of position- and status-specific information to the logistics server.

### Main objectives:

The 'mobile SLK' is a real time track and trace system for predefined event points using online positioning with GSM technology.

### Actors affected:

#### Actors:

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient



### Technical description/ technologies used/ needed:

The main technology components used are the following:

- RFID tag, transponder, smart label
- RFID reader
- Antenna
- GSM device without display and keyboard
- Industrial devices
- Interfaces for sensors



<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input checked="" type="checkbox"/>
Prototype	<input checked="" type="checkbox"/>
Implemented	<input checked="" type="checkbox"/>
Available market solution	<input checked="" type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: freight shipment	
Paperless documentation: Yes	
Self/ context awareness: Yes	
Secure Information access: No	
Ubiquitous data availability: Yes	
Bi-directional communication: Yes	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (industry)	
<b>Envisaged effects/ impacts:</b>	
<ul style="list-style-type: none"> <li>• Efficiency gains</li> </ul>	
<b>Further sources, literature:</b>	
<ul style="list-style-type: none"> <li>• Gebrüder Weiss website: <a href="http://www.gw-world.com">www.gw-world.com</a></li> <li>• Presentation “Tracking and tracing as the Basis for new Logistic Services”, ICT Conference, Luzern, 4-11-2008.</li> </ul>	

**RAEWatch sensor module****Name of project, system, approach, application:**

RAEWatch sensor module

**Short description/ character of the application:**

In 2004 RAE systems performed two sea trials to prove the feasibility of using sensors to continuously monitor the integrity of intermodal shipping containers from point of origin to point of destination.

**Main objectives:**

The RAEWatch sensor modules are intended to provide enhanced security and to be integrated with existing logistic systems and technology. They can be used to monitor radiation, intrusion, temperature and shock.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

The system consists of the following elements:

- RAEWatch sensors, which measure temperature, shock, humidity and radiation.
- RF Nodes.
- Network access point
- Satellite communicator

The RAEWatch sensors self-configure as a mesh network (point-to point or ad hoc, multi-hop network). This means that the network provides each node with multiple data transmission paths, forming a mesh. Each node communicates its existence as well as other information with its neighbours, allowing various algorithms to determine the best way to transmit data to the network access point.

**Status of the application:**

Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input checked="" type="checkbox"/>
Prototype	<input checked="" type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

Self/ context awareness: Yes

Secure Information access: No

Ubiquitous data availability: Yes

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry)

**Envisaged effects/ impacts:**

- Efficiency gains (faster response when certain events are detected, collection of sensor data is possible)
- Improved security (rerouting of data is possible if one link fails, and use of intrusion sensors)

**Further sources, literature:**

- White Paper “Securing the supply chain, container security and sea trial demonstration results, 2005.

**RTLS****Name of project, system, approach, application:**

RTLS (Real Time Location System)

**Short description/ character of the application:**

The automotive division of the Broekman Group has introduced a location system for locating passenger cars at their site in Rotterdam, using RFID technology. The system has been introduced to replace the current system which was based on barcodes.

**Main objectives:**

Introduction of an automatic location system for passenger cars.

**Actors affected:****Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

**Technical description/ technologies used/ needed:**

The main technologies used are the following:

- RFID-ID tags
- RFID antenna's at the car terminal
- RTL system

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: passenger cars (branch is automotive industry)

Paperless documentation: Yes

Self/ context awareness: Yes

Secure Information access: No

Ubiquitous data availability: No

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative.): no

**Envisaged effects/ impacts:**

- Efficiency gains (increased automation and visibility)

**Further sources, literature:**

- Article “Broekman Automotive volgt auto’s op afstand”, Broekman Group, 2005.
- Website Broekman Group: [www.broekman-group.nl](http://www.broekman-group.nl)

## Secure Trade Lane

### Name of project, system, approach, application:

Secure Trade Lane

### Short description/ character of the application:

Secure Trade Lane is an intelligent cargo tracking device. It has been developed by IBM together with Maersk. It allows shippers to get real-time data on their movement of their goods.

### Main objectives:

Secure Trade Lane is a new service that uses open standards and IBM technologies to deliver highly secure status updates on cargo containers as well as real-time, wireless global access to their content and location.

### Actors affected:

#### Actors:

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient



### Technical description/ technologies used/ needed:

The system consists of intelligent real-time tracking devices, called Tamper-Resistant Embedded Controllers (TRC) which are fitted to cargo containers and designed to withstand the environment in which they operate.

The system is also made up of a fully integrated network which combines data from the TREC devices with a non-proprietary sensor network and business integration system. The information gathered can be connected to decentralized databases where the participants own their content. Communication will be done via satellite, cellular bands and short range, or Zigbee connections.

### Status of the application:

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container unit

Paperless documentation: Yes

Self/ context awareness: Yes

Secure Information access: Yes

Ubiquitous data availability: Yes

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry)

**Envisaged effects/ impacts:**

- Efficiency gains (operational efficiencies and increase regulatory compliance)
- Improved security (reduced asset theft)

**Further sources, literature:**

- Brochure “The IBM Secure Trade Lane Solution, a new, open approach to optimizing the global supply chain”, IBM, 2006.
- “IBM, Maersk deliver cargo-tracking device, the intelligent tracking hardware provides shippers with real-time data”, Linda Rosencrance, Computerworld, 2005.

## Smart packages

### Name of project, system, approach, application:

Smart packages

### Short description/ character of the application:

Smart packages in logistic chain of Ministry of defence in the Netherlands using RFID technology. A pilot study to investigate the usage of a location system for containers.

### Main objectives:

The aim of the project was to investigate the feasibility of using innovative solutions like RFID in the logistic chain of the Ministry of Defence of the Netherlands.

### Actors affected:

#### Actors:

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient



### Technical description/ technologies used/ needed:

The main technologies used are the following:

- Active RFID-ID tags
- RFID antenna's and scanners
- DT&T (Tracking and Tracing system of Ministry of Defence)

### Status of the application:

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution





**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

Self/ context awareness: Yes

Secure Information access: Yes

Ubiquitous data availability: No

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): yes (industry and Ministry of Defence)

**Envisaged effects/ impacts:**

Efficiency gains (reducing unnecessary stock, reducing time to search goods, shorter delivery times, improving flow of return cargo and reducing turnaround times of repairs)

**Further sources, literature:**

Article “Slimme Pakjes in de defensie logistieke keten”, TNO Defence e.a., 2007.

**SMART-CM****Name of project, system, approach, application:**

SMART-CM – Smart Container Chain Management

**Short description/ character of the application:**

SMART-CM aims to implement advanced technologies for more efficient and secure door to door container transport chain management.

**Main objectives:**

Main objectives within SMART-CM are:

Improved security in container door-to-door transport; better communication and data availability on container security relevant transport information. Advanced interoperability of technologies used in safe container chain management

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

Focus will be on:

- Advanced B2B applications in global container chain management
- Service platform for secure and interoperable data communications

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: container

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: Yes

Ubiquitous data availability: Yes

Bi-directional communication: No

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): industry, trade companies, logistic service provider, terminal operators

**Envisaged effects/ impacts:**

Enhanced security of container door-to-door transport chains, transparent information flow, better access to data and information regarding container management

**Further sources, literature:**

Description of work SMART-CM project

**SMARTFREIGHT****Name of project, system, approach, application:**

SMARTFREIGHT

**Short description/ character of the application:**

The SMARTFREIGHT project wants to make urban freight transport more efficient, environmentally friendly and safe by answering to challenges related to traffic management, freight distribution management, and a better coordination between the two.

**Main objectives:**

Main aim of SMARTFREIGHT is to specify, implement and evaluate Information and Communication Technology (ICT) solutions that integrate urban traffic management systems with the management of freight and logistics in urban areas.

New traffic management measures towards individual freight vehicles through open ICT services, on-board equipment and integrated wireless communication infrastructure should be developed.

Improvement of the interoperability between traffic management and freight distribution systems.

Coordinate all freight distribution operations within a city by means of open ICT services, on-board equipment, wireless communication infrastructure and CALM MAIL implementation in on-board and on-cargo units, for all freight vehicles

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

A conceptual framework architecture will be elaborated which will be covering aspects of traffic management measures, improvement of interoperability between traffic management and freight distribution and coordination of all freight distribution operations within a city. Conceptual ideas will be based on CALM technology in roadside and in vehicle equipment, open ICT services, on-board equipment and integrated wireless communication infrastructure.

<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input type="checkbox"/>
Prototype	<input type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: vehicle/ truck	
Paperless documentation: No	
Self/ context awareness: No	
Secure Information access: No	
Ubiquitous data availability: Yes	
Bi-directional communication: Yes	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (public authority)	
<b>Envisaged effects/ impacts:</b>	
More efficient urban freight transport, environmentally friendly and safe by answering to challenges related to traffic management, freight distribution management, and a better coordination between the two.	
<b>Further sources, literature:</b>	
<a href="http://www.smartfreight.info">www.smartfreight.info</a>	

## SmartTruck

### Name of project, system, approach, application:

SmartTruck – national research project within German research program “Intelligent Logistics”

### Short description/ character of the application:

SmartTruck will develop and integrate several technologies and applications for truck monitoring, transport planning, traffic flow information and RFID solutions.

### Main objectives:

Within SmartTruck a dynamic transport planning system will be developed using real-time data on vehicle position, load status and traffic situation. The data are being detected on vehicle level and transferred to the back end system which is processing the information. Actual tour status is being monitored and in needed case the tour will be recalculated and transferred to the mobile application of the driver in the vehicle.

### Actors affected:

#### Actors:

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

<input type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>

### Technical description/ technologies used/ needed:

RFID, Internet/ web based applications, mobile applications and devices, back end systems with enhanced optimization tools

### Status of the application:

Vision/ idea

☒

Concept

☒

Demonstrator

☒

Prototype

☐

Implemented

☐

Available market solution

☐

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: vehicle

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: No

Ubiquitous data availability: No

Bi-directional communication: Yes

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative.): logistic service provider

**Envisaged effects/ impacts:**

Better information exchange, enhanced efficiency in distribution processes, better and more efficient distribution tours. Reduction of vehicle-km and optimized use of vehicle capacities to be achieved.

**Further sources, literature:**

<http://www.intelligente-logistik.de>

**TRAMP****Name of project, system, approach, application:**

TRAMP (Telecontrollo del Rischio nell'Autotrasporto di Merci Pericolose - Remote Hazard Control in Road Transportation of Dangerous Materials)

**Short description/ character of the application:**

The TRAMP project consists of two phases:

- Phase 1: general architecture
- Phase 2: prototype of TRAMP system

**Main objectives:**

The aim of the TRAMP project is to improve the monitoring of transporting dangerous goods.

**Actors affected:****Actors:**

Shipper

Forwarder

LSP

Driver

Consignee Operator

Public authority

Recipient

**Technical description/ technologies used/ needed:**

The main technologies which are used for the TRAMP prototype system are the following:

- A localization system (GPS)
- Sensor to control the status of the cargo
- Deceleration sensor
- AN inclinometer
- Telecommunication devices for remote data exchange



<b>Status of the application:</b>	
Vision/ idea	<input checked="" type="checkbox"/>
Concept	<input checked="" type="checkbox"/>
Demonstrator	<input checked="" type="checkbox"/>
Prototype	<input checked="" type="checkbox"/>
Implemented	<input type="checkbox"/>
Available market solution	<input type="checkbox"/>
<b>Relevance towards “Intelligent Cargo System”:</b>	
Cargo level oriented: vehicle	
Paperless documentation: No	
Self/ context awareness: Yes	
Secure Information access: No	
Ubiquitous data availability: No	
Bi-directional communication: Yes	
Standard data formats: Yes	
SME compatible: Yes	
Stakeholder inclusion (industry, public, administrative..): yes (industry and Italian public authorities)	
<b>Envisaged effects/ impacts:</b>	
<ul style="list-style-type: none"> <li>• Efficiency gains (localization and monitoring of vehicles)</li> <li>• Improved safety/security (better risk management, possibility for emergency management)</li> </ul>	
<b>Further sources, literature:</b>	
Paper: “Italian experiences in the management of dangerous goods transport”, Luca Studer, Politecnico di Milano, 2008.	

**Truck intelligence work attendance system****Name of project, system, approach, application:**

Truck intelligence work attendance system

**Short description/ character of the application:**

The system can be used to read the weight of the vehicle and the attendance of the driver, and store the results in a monitoring database.

**Main objectives:**

The system can automatically check the weight of the truck and verify the driver's attendance.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

The main technologies used are the following:

- Data base
- Bluetooth intelligence auto check device
- Weight statistic system
- Vehicle intelligence identification card.

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution



**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: truck

Paperless documentation: Yes

Self/ context awareness: No

Secure Information access: No

Ubiquitous data availability: No

Bi-directional communication: No

Standard data formats: Yes

SME compatible: Yes

Stakeholder inclusion (industry, public, administrative..): No

**Envisaged effects/ impacts:**

- Efficiency gains (automatic reading of information)
- Improved security (usage of identification card of driver)

**Further sources, literature:**

<http://www.allproducts.com/manufacture97/koontechcn/product4.html>

**VitOL****Name of project, system, approach, application:**

VitOL – Vernetzte intelligente Objekte in der Logistik, cross-linked intelligent objects in Logistics

**Short description/ character of the application:**

VitOL focuses on the development of special purpose sensor nodes, equipment of logistical objects and used infrastructure with these sensor nodes

**Main objectives:**

VitOL develops special purpose sensor nodes which can be configured according to different needs for different goods and requirements within the transport chain.

**Actors affected:****Actors:**

Shipper



Forwarder



LSP



Driver



Consignee Operator



Public authority



Recipient

**Technical description/ technologies used/ needed:**

Based on the RFID technology the sensor nodes are being developed and integrated in existing IT system landscape

**Status of the application:**

Vision/ idea



Concept



Demonstrator



Prototype



Implemented



Available market solution

**Relevance towards “Intelligent Cargo System”:**

Cargo level oriented: cargo item/ box/ pallet

Paperless documentation: Yes

Self/ context awareness: Yes

<p>Secure Information access: No</p> <p>Ubiquitous data availability: No</p> <p>Bi-directional communication: Yes</p> <p>Standard data formats: Yes</p> <p>SME compatible: No</p> <p>Stakeholder inclusion (industry, public, administrative..): industry, vendors, service provider</p>
<p><b>Envisaged effects/ impacts:</b></p> <p>Enhanced theft prevention for expensive goods, permanent condition monitoring, improved bulk reading</p>
<p><b>Further sources, literature:</b></p> <p><a href="http://www.atl.fraunhofer.de/smart-objects">http://www.atl.fraunhofer.de/smart-objects</a></p>

## 9 Annex 3 – Questionnaire for interviews

Name of interview partner:	Institution/ Company:
	Function/ position:
<p><b>Short project overview/ introduction:</b></p> <p>PTV and ECORYS are carrying out the SMART study on behalf of the European Commission to assess the impact of the Intelligent Cargo Concept on the transport system and the actors involved.</p> <ul style="list-style-type: none"> <li>• SMART will provide a description on the <b>state of the art of intelligent cargo applications</b> and the <b>users and expert views</b> on its development.</li> <li>• SMART will develop <b>scenarios of future transport logistics applications</b> based on Intelligent Cargo Technologies.</li> <li>• SMART will perform an <b>impact assessment analysis</b> on Intelligent Cargo Systems addressing efficiency, sustainability, safety and security issues.</li> </ul> <p>SMART outcome will be a road map towards an Intelligent Transport System as basis for future EC initiatives in research and policy.</p> <p><b>Intelligent Cargo Systems</b> describe a visionary concept for future transport systems. Main characteristics for Intelligent Cargo Systems are:</p> <ul style="list-style-type: none"> <li>• Autonomous and decentralised information system on cargo level</li> <li>• Paperless documentation</li> <li>• Self/context aware</li> <li>• Secure information access</li> <li>• Ubiquitous data availability</li> <li>• Bi-directional communication</li> <li>• Standard data format</li> <li>• Compatible and applicable by SME</li> <li>• Inclusion of administrative and business stakeholders</li> </ul>	

**1. Applying the criteria below how would you describe a scenario from the present situation towards Intelligent Transport Systems?**

	<b>a) Could you assess the implementation of the criteria in future transport systems? (realistic, visionary, impossible...)</b>	<b>b) Describe the necessary requirements (technological, process, administrative etc.)</b>	<b>c) What are the main barriers/ bottlenecks?</b>
<b>More autonomous system on cargo level</b>			
<b>Paperless documentation</b>			
<b>Self/Context aware</b>			
<b>Secure Information access</b>			
<b>Ubiquitous data availability</b>			
<b>Bi-directional communication</b>			
<b>Standard data formats</b>			
<b>SME compatibility</b>			
<b>Stakeholder inclusion</b>			
<b>Additional criteria</b>			

**2. Apart from the criteria describing an Intelligent transport system what major changes do you expect with regards to future transport systems?**

**3. The following list provides an overview of different categories of the most relevant innovative applications which we have identified in the field of intelligent cargo:**

- dangerous goods applications (e.g. GOOD ROUTE project)
- container (for example track and trace applications)
- intelligent agent/ mesh network applications
- freight/cargo architecture/ frameworks (e.g. EURIDICE and, FREIGHTWISE)
- RFID applications
- sensor related applications
- Web based applications/ platforms

**Can you please indicate how you assess this list?:**

Complete <input type="checkbox"/>	representative <input type="checkbox"/>	incomplete <input type="checkbox"/>
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**3a) If incomplete, which categories would you add?**

#### **IMPACTS ASSESSMENT**

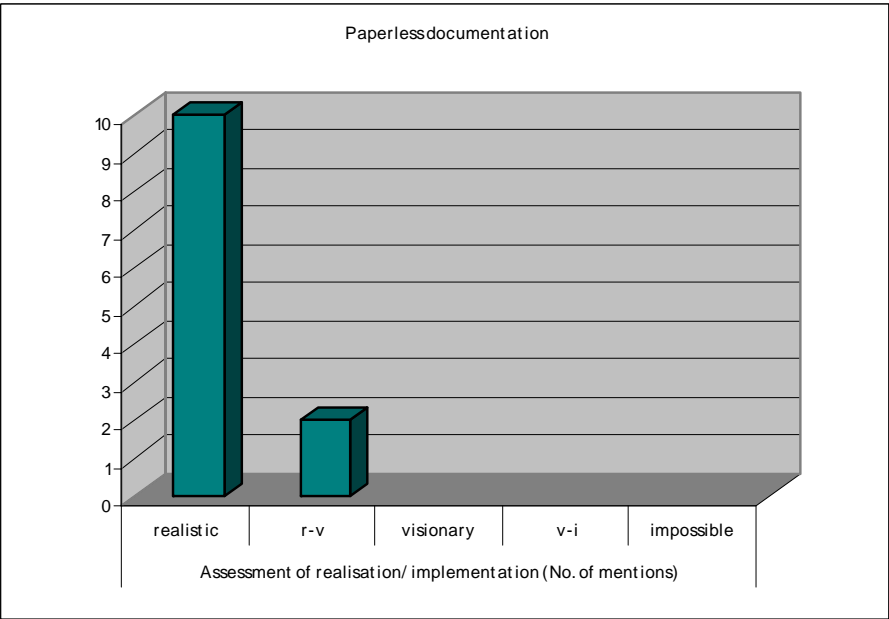
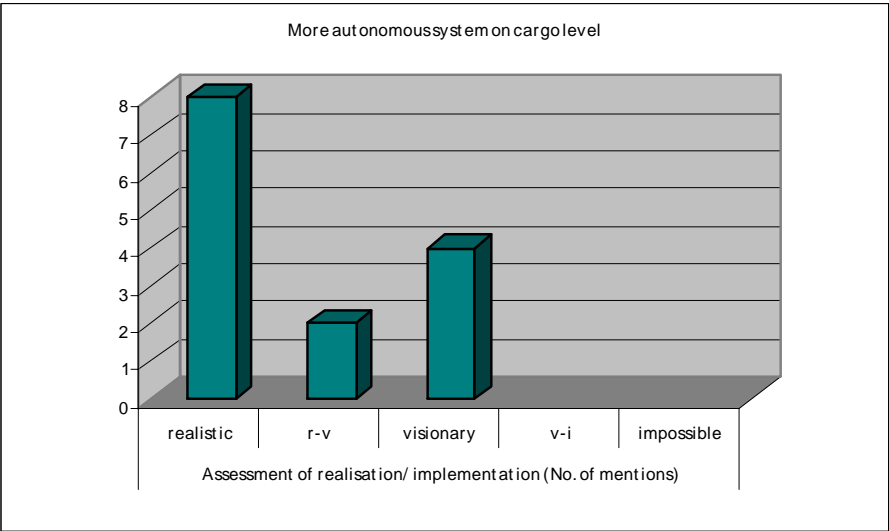
**4. Intelligent cargo systems will affect transport and logistic processes/ chains in the future in different ways. "Would you expect significant impacts in your business (if you are in the transport / logistics sector) or in the transport/ logistic sector in general (if you are an outsider)?**

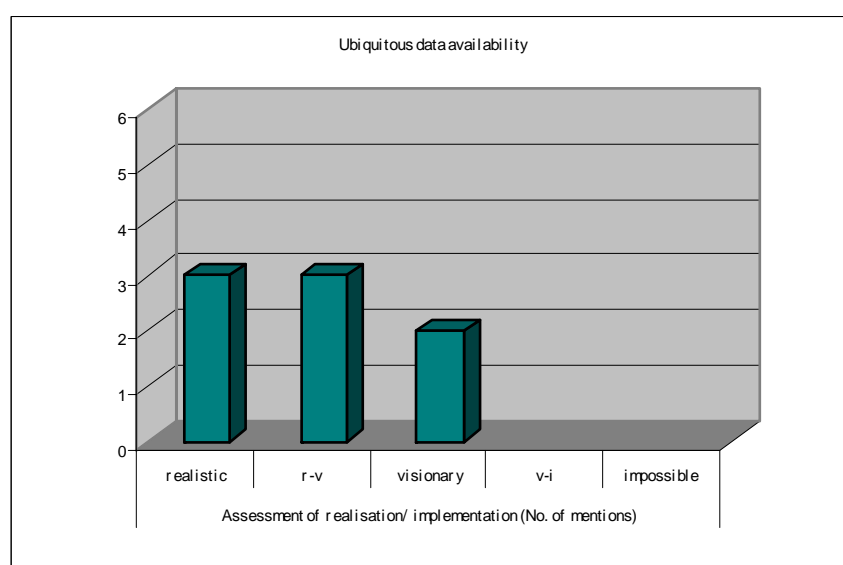
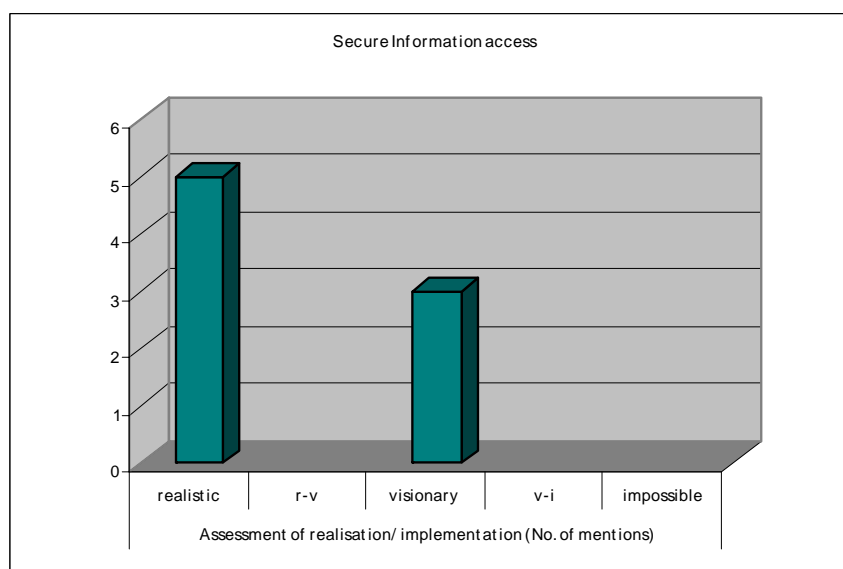
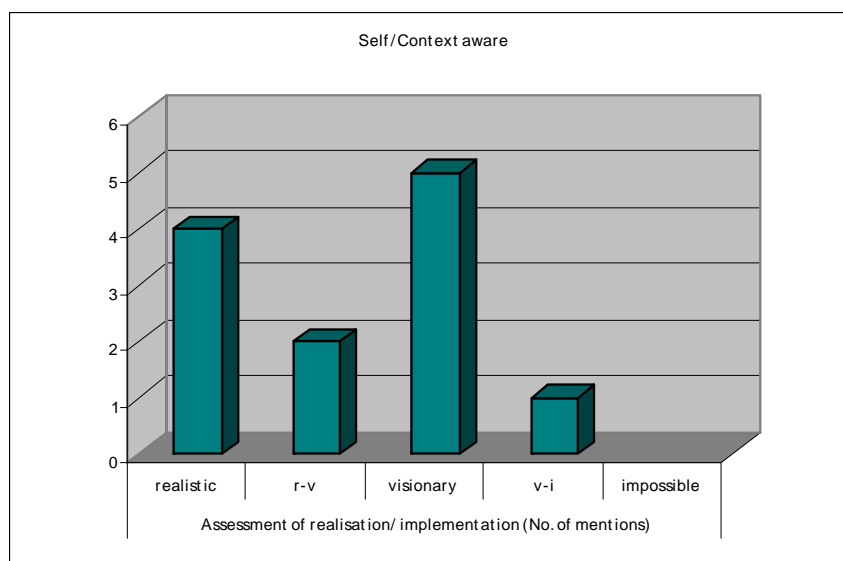


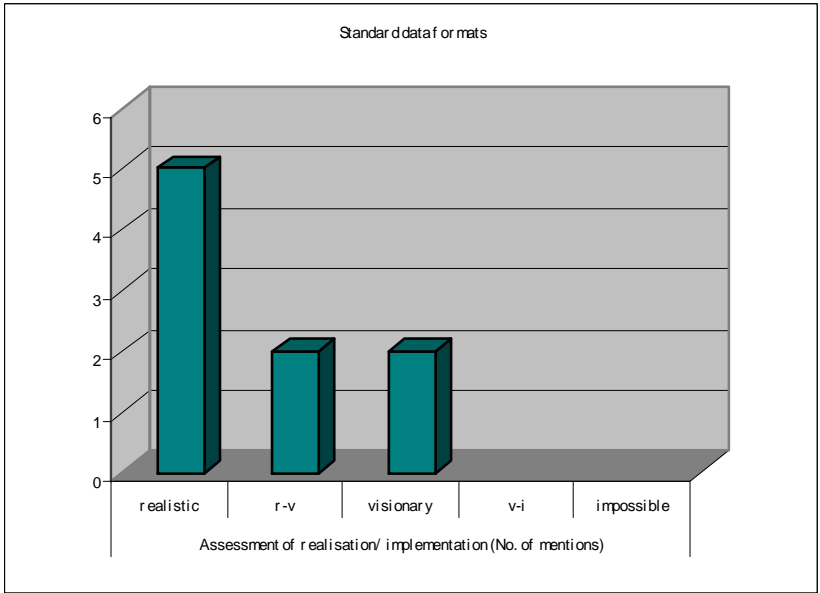
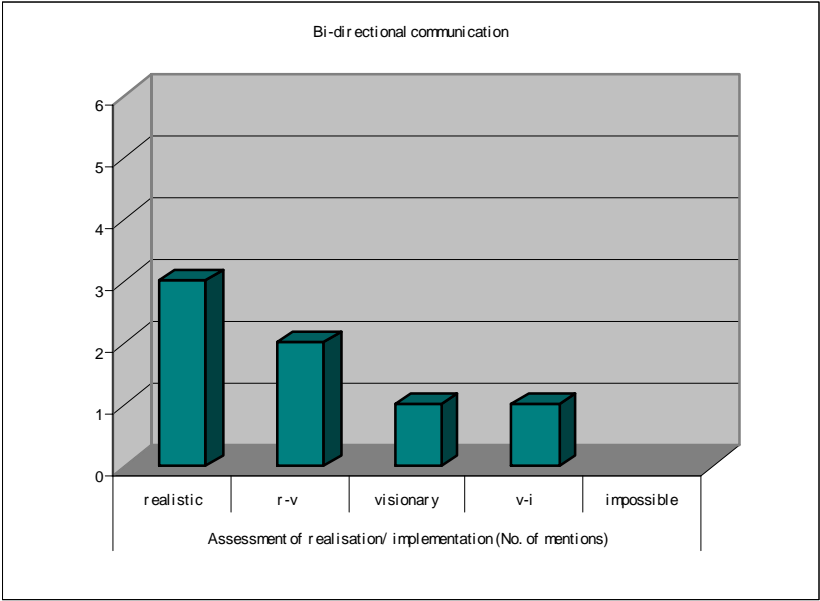
Yes	Partly	No
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<p>4 a) If you expect significant impacts could you please indicate how these expected impacts are obtained? (e.g. better cost efficiency, higher IT investments/ costs, better load factor, faster response rates, better data availability etc....)</p>		
<p>4 b) And if possible also indicate the order of magnitude of the expected impacts? (e.g. 1-2 %, 10-15%, etc)</p>		
<p>4 c) Do you expect that the development of Intelligent Cargo systems will change the business models of the companies in the transport / logistic sector?</p>		
<p>5. Which impacts could you imagine on the socio-economic side in general?</p> <p><i>Keywords: Employees, Education and training, Safety and security</i></p>		
<p>6. Research and development activities regarding Intelligent cargo should focus in the future on:</p>		
<p>7. Comments:</p>		
Interview conducted by:	Date and time:	

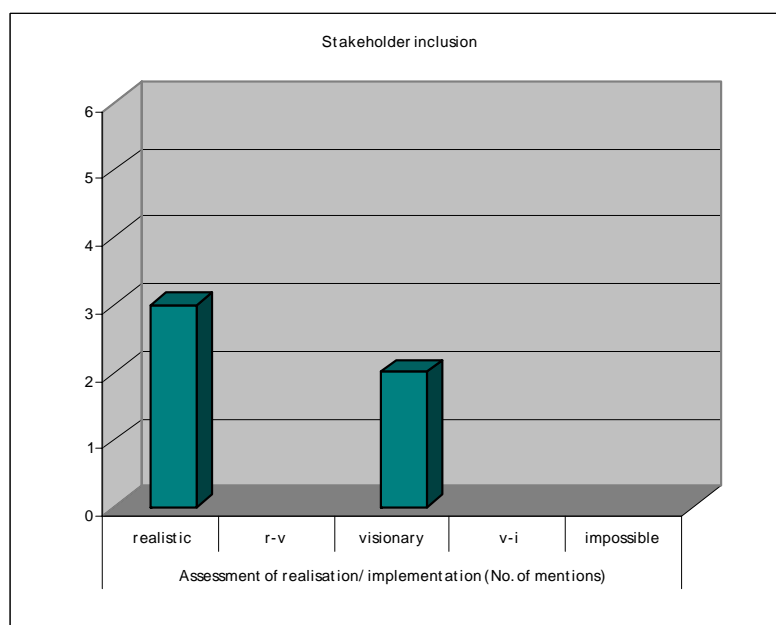
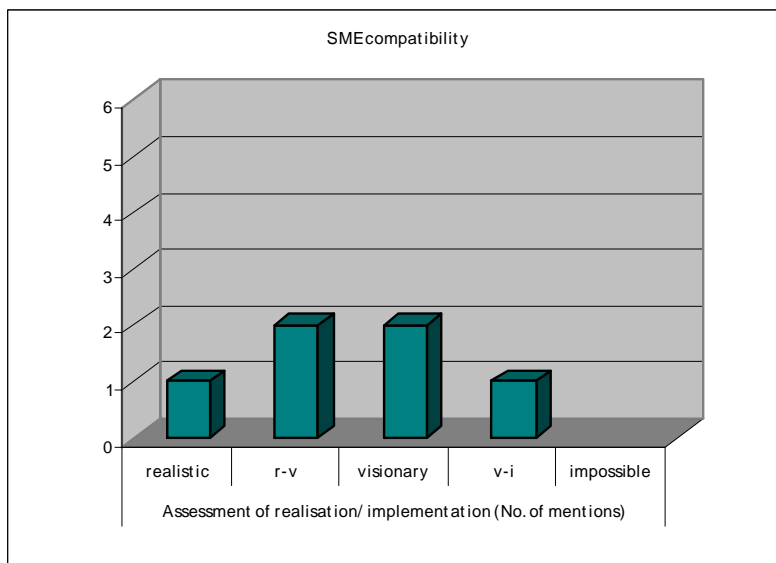
# 10 Annex 4 – Interview evaluation

## 10.1 Evaluation Question 1 – realisation of Intelligent cargo systems









## 10.2 Evaluation Question 2 – expected major changes in transport systems

Expected major changes regarding future transport systems						
statements per respondent group						
LSP	Industry	IT-Expert/ company	Branch organization	consultancy	Researcher	other (e.g. ports)
higher IT-Investments	improving supply chain planning	energy efficiency become more important	more sustainable and environmental friendly	multi-modal approach more important	improved possibilities for use of data for analyses (sustainability etc.)	amount of data (pools) could be too large for handling
higher level of automation	full adoption of paperless	more efficient use of capacities	more data availability	more consolidation of cargo	tracking of cargo and vehicles become easier	market will change, consolidation in transport market
megatrends will affect transport systems	real time t&t	better info availability on cargo level	improved importance of information flow	better cargo related data management	enlarged data availability	speed up of processes (transport & logistics)
dynamic change in production locations		more pro-active steering in terms of SCEM	multi-modal more important	more efficient transport		Decrease of RFID costs
		security issues become more important	ITS will be enabling techn.	more active and intelligent cargo		paperless on larger scale
		emission reduction more important		more intelligent container through regulations		better planning processes for terminals

## 10.3 Evaluation Question 5 – socio-economic impacts

Impacts on socio-economic side:						
statements per respondent group						
LSP	Industry	IT-Expert/ company	Branch organization	consultancy	Researcher	other (e.g. ports)
higher education requirements in logistics	optimisation in general	acceptance and awareness of technologies in different user groups	environmental issues more important	education and qualification level in logistics improve	safety on community level more important and relevant	increased qualification requirements
data security key issues		driver qualification requirements will change	change of job profile	enhanced productivity in logistics	specific qualifications needed	acceptance of technologies key factor
		earlier awareness on risks	new qualifications needed	more pro-active steering	enhanced safety for dangerous/ heavy goods	more flexibility and learning needed
		better prevention/ treatment of accidents	safety requirements and importance will rise	better supply chain visibility	change in job profile from paper handling to online monitoring and process management	safety awareness more important
		investment in employees qualification will rise	safe parking of trucks more important	acceptance will be key factor	better monitoring of dangerous goods	decrease of workload, less waiting times, better work conditions
		accidents could possibly reduced		more flexibility and qualification needed from the driver	easier security checks using different data sources	positive impacts from RFID use regarding safety and security
				improved safety in transport chain		

## 10.4 Evaluation Question 6 – focus of future research activities

Future research activities should focus on						
statements per respondent group						
LSP	Industry	IT-Expert/ company	Branch organization	consultancy	Researcher	other (e.g. ports)
organic semiconductors, cloud computing	european/ global standards	affordable hardware, technologies	architectures, legal frameworks	standardization	dangerous goods	traffic management, steering
standardization		standardization	information exchange between sectors	cost/ benefit share between partners	RFID	transport and process optimization
		improvement of energy efficiency	sustainability	demonstrators and pilots	Multi-modality	harmonization of legislations/ regulations
		sustainable logistics	pilots implementation	development path and road maps	enhancing energy efficiency in logistics	multi-modal transport planning, consolidation of cargo
		sensors on containers		pilots and implementation	standards and architectures for cargo-to-vehicle and cargo-to-infrastructure interaction	better information flow between different stakeholders/ partners
		interaction and processing of data			cooperative systems	
		regulations and standards			Information services and intelligent data analyses of the different information	