EUROPEAN COMMISSION

DG INFORMATION SOCIETY & MEDIA

SEVENTH FRAMEWORK PROGRAMME

THEME 3

‘INFORMATION AND COMMUNICATION TECHNOLOGIES’

Collaborative Project – CONTRACT N. FP7-216353

D1.2 – SMARTFREIGHT Final Report

Deliverable no.	D1.2
Dissemination level	Public
Work Package	WP1
Author(s)	Hans Westerheim (SINTEF)
Co-author(s)	Marit Natvig (SINTEF), Tor Kjetil Moseng (SINTEF), Ola Martin Lykkja (Q-Free ASA), Antonio Marques (ETRA), Lola Alacreu (ETRA), Terje Reitaas (NPRA), Eoin Farrell (DTO/NTA), Fraser McLeod (SOTON-TRG), Tom Cherret (SOTON-TRG), Andrea Archelli (COBO), Stig Franzén (Chalmers), Karen Vancluysen (POLIS), Mar Cervera (ADL)
Status (F: final, D: draft)	Final
Date	2011-06-22
Project Start Date and Duration	01 January 2008, 30months


SEVENTH FRAMEWORK
PROGRAMME

TABLE OF CONTENTS

SMARTFREIGHT D1.2 – Final Report

Grant Agreement number: FP7-216353

Project acronym: SMARTFREIGHT

Project title: Smart Freight Transport in Urban Areas

Funding Scheme: STREP

Period covered: from 1 January 2008 to April 2011

Name of the scientific representative of the project's co-ordinator[1], Title and Organisation:

Hans Westerheim, Senior Adviser. SINTEF ICT

Tel: +47 73 59 29 56

Fax: +47 73 59 29 77

E-mail: hans.westerheim@sintef.no

Project website address: www.smartfreight .info

[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

ABREVIATIONS

APA	Access and Priority Assignment
API	Application Programming Interface
APO	Access and Priority Offer
CALM	Communication Access for Land Mobiles, ISO standard
CEN	The European Committee for Standardization
CVIS	Cooperative Vehicle-Infrastructure Systems, European project
DSRC	Dedicated Short-Range Communication
EU	European Union
FDMC	Freight Distribution Management Centre, FDMS included
FDMS	Freight Distribution Management System
FOT	Field Operation Test laboratory
FP	Framework Programme
HGV	Heavy Goods Vehicle
HMC	Host Management Centre
HMCA	Host Management Centre Agent
ICT	Information and Communication Technology
I2V	Infrastructure-to-Vehicle
IP	Internet Protocol
ISO	International Standards Organization
ITS	Intelligent Transport Systems and services
LAN	Local Area Network
MAIL	CALM Media Adapted Interface Layer
M5	CALM M5. The ISO 21215 standard that incorporates WAVE (WAVE PHY/MAC is the IEEE 802.11p standard)
NEMO	Network Mobility
OAGi	Open Applications Group Inc.
OBE	On-Board Equipment
OGE	On-Goods Equipment
RFID	Radio Frequency Identification
SOA	Service Oriented Architecture
TC	Technical Committee
TMC	Traffic Message Channel
TNS	Transportation Network Status
TOP	Transport Operation Plan
UMTC	Urban Traffic Management Centre, UMTS included
UTMS	Urban Traffic Management System
V2V	Vehicle-to-Vehicle
WS	Web-Service

XML	Extensible Markup Language
2G	Second Generation GSM mobile network
3G	Third Generation GSM mobile network

Executive summary

SMARTFREIGHT has specified, developed, demonstrated and evaluated technical solutions that can make urban freight transport more efficient, environmentally friendly and safe. The solutions support among others access control to areas or transportation network sections; priorities; monitoring and control with dangerous cargo; pre-bookings of loading bays; and information exchange between traffic management and freight distribution to support better planning of transport operations. A holistic and generic approach has been followed where individual freight vehicles can be controlled and monitored depending on their properties like type of engine, weight, size, type of cargo, etc.

The overall objective of SMARTFREIGHT has been to make urban freight transport more efficient, environmentally friendly and safe. The aim has been to enable:

1. *New traffic management measures towards individual freight vehicles that benefit the* cities by means of open ICT services, on-board equipment and an integrated heterogeneous wireless infrastructure within the framework of CALM
2. *Better interoperability between traffic management and freight distribution management systems* by means of open ICT services.
3. *Better coordination of all freight distribution in a city* by means of open ICT services, on-board equipment, the heterogeneous wireless communication infrastructure and CALM MAIL implementations in on-board and on-cargo units.
4. *Documentation of new knowledge and specification of open and generic solutions* that are adaptable to future needs and are applicable to a variety of European cities.

The results are listed below:

- *A* clarification of the user needs (D2.1 and D2.2).
- The SMARTFREIGHT framework (D5.2). It defines concepts and generic service interfaces for urban freight transport that facilitates solutions for cities with different needs.
- Specifications of CVIS and CALM extensions for the on-board and on-goods equipment interactions (D4.1 and D4.2). This includes new CVIS facilities; seamless vertical handover by means of IPv6 and NEMO; implementation of the on-board equipment by means of CALM MAIL and new use of DSRC.
- An assessment of wireless technology for the transport sector (D4.4).
- Prototypes demonstrating new functionality in urban freight traffic management and freight distribution management (D3.1); on-board and on-cargo equipment (D4.1 and D4.2); and applications for basic access control, dynamic tunnel access control and cargo monitoring and reporting (D3.2 and D4.3).
- A demonstration in Trondheim
- A summary of proof of concepts and verification of ICT solutions (D6.1). Winchester and Bologna simulated SMARTFREIGHT issues, while Dublin carried out desk top studies.
- An impact analysis on urban freight and generic findings on urban transport and a future outlook confirmed that SMARTFREIGHT results met the requirements (D7.1 and D7.2) .
- Dissemination and profile results like the SMARTFREIGHT leaflet, newsletters, fact sheets, web-site and dissemination plan (D8.1)
- A business model and an exploitation plan (D9.2 and D9.3)

The impact of the SMARTFREIGHT framework architecture (D5.2) is many-sided. It is the ITS and cooperative system part of the Common Framework and includes among other service interfaces that enable new traffic management measures towards individual vehicles. These service interfaces may also have impact on transport related services within standardisation and in the future Internet concept. The CALM and CVIS extensions have impact on CALM standardisation and implementation.

The SMARTFREIGHT web-site can be accessed on**:** http://www.smartfreight .info/

1 Project context and objectives

Freight transport has a central role for the business and life of a city. However, freight transport has a negative impact on environment, traffic congestion and safety. Still, commercial traffic has never been given much attention in the transportation planning process. So far it has not been possible to take traffic management measures towards individual freight vehicles based on information about the vehicle and the current traffic situation; traffic management systems have not served those organising freight transports in the city; and limited access to resources like loading bays has caused traffic problems and unreliable deliveries.

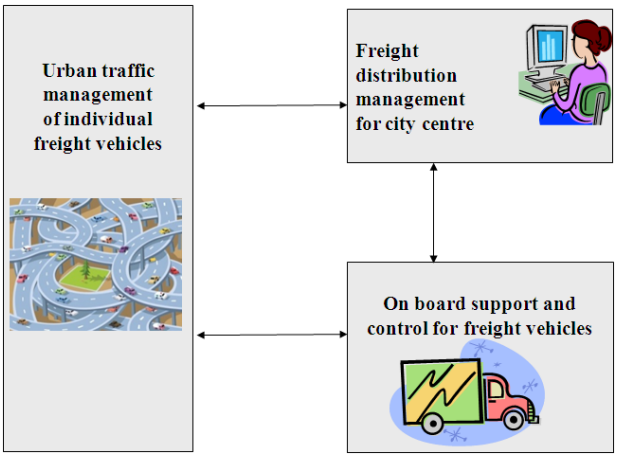


Figure 1: The SMARTFREIGHT idea

The overall SMARTFREIGHT idea was to address these challenges by using knowledge, generic concepts and technology to create the SMARTFREIGHT solutions. These solutions allow the urban traffic management and freight operators to exchange information and to identify and communicate with the individual freight vehicles.

When the SMARTFREIGHT project started, cooperative systems within the ITS area enabled interactions between the relevant stakeholder and towards the vehicle. The CVIS platform was under development and CALM standards were established. SMARTFREIGHT aimed to utilize existing technology and to enhance it.

1.1 Problems addressed

The following problems have been addressed by SMARTFREIGHT:

- *The negative effects of freight vehicles in urban areas:* Freight vehicles are of many types. Typically they produce more noise and pollution than passenger cars, and they make more use of space in the traffic flow. Due to weight, some of them are slower than the rest of the traffic. The traffic management functions and traffic management systems of today are not able to identify, monitor and control individual freight vehicles based on their characteristics. This is mainly due to lack of communication possibilities with the vehicles in the traffic, but also due to lack of information about each of the vehicles, the destinations (transport plans) and the carried cargo.
- *Safety risks due to transport of dangerous cargo in urban areas:* There are different types of dangerous cargo. The different types might cause different risks in different parts within an urban area (and also in tunnels). The current traffic management systems cannot monitor and control individual dangerous cargo freight vehicles carrying dangerous cargo and take pro-active measures to increase the safety.
- *Scarcity of loading bays in urban areas:* Many urban areas have scarcity on loading bays. This is in many cases a physical lack of such or the utilisation of them is not optimal. This causes problems for deliveries and pick-ups for the freight vehicles.

- *Information exchange between traffic management and freight distribution management:* The traffic management functions and traffic management systems have information about the actual and foreseen traffic situation in an urban area. Meanwhile, the freight distribution management functions and systems have information about the transportation tasks, the vehicles, the drivers and the cargo present in the same urban area. Information exchange between these is not present today.
- *New requirements related to the CVIS platform:* The CVIS platform, which was selected as the realisation platform in SMARTFREIGHT, did not support smart freight distribution services. On-goods tags based on DSRC for cargo monitoring could not be integrated with the in-vehicle and roadside equipment since the CALM Media Adaption Interface Layer (CALM MAIL) was not implemented as a part of the platform. Thus, the communication with battery-powered units like on-goods tags could not be supported.
    - *Needs for new and generic functions and open ICT services for the transport sector:* European cities have different requirements with respect to traffic management and they also have different ICT infrastructures. The CALM protocol family provides a promising solution that was not fully explored. Before SMARTFREIGHT, it was not defined how the issues listed above could be addressed in a generic way for all cities by means of generic functions and open and generic ICT services that enable integration of systems that support freight transport in urban areas.

1.2 Project objectives

The overall objectives of SMARTFREIGHT were to develop knowledge, a framework and technology that can benefit the society by making urban freight transport more efficient, environmentally friendly and safe. The detailed objectives have been to address:

5. *New traffic management measures towards individual freight vehicles that benefit the* cities by means of open ICT services[1], on-board equipment and an integrated heterogeneous wireless communication infrastructure within the framework of CALM[2]. The project has addressed how to:
    a. Assign different service levels to freight vehicles depending on their environmental profile, the type of goods transported and the destination;
    b. Assign priorities and access rights (e.g. to green areas, roads and lanes) depending on the level of service and the traffic situation;
    c. Assign routes and time slots to freight vehicles to minimise conflicts and congestion;
    d. Track/monitor vehicles carrying dangerous cargo;
    e. Collect information for statistics;
    f. Support control that enables enforcement;
    g. Support awareness in case of incidents (e.g. on dangerous cargo inside a tunnel).

[1] The term service here is used about a distributed software system composed of cooperating applications designed to support interoperable machine-to-machine interaction over a network. The service is provided by one of the applications, the other is the user. Such a service is open if its interfaces are well-defined and publicly available.

[2] CALM - the ISO approved framework for heterogeneous packet-switched communication in mobile environments (developed by ISO TC204/WG16). CALM is currently the most promising communication platform for car-to-car and car–to-roadside communication. The CALM framework supports user transparent continuous communications across various interfaces and communication media such as 802.11, 802.11p, 802.15, 802.16e, 802.20, 2G/3G/4G cellular systems, national ITS systems, etc.

6. *Better interoperability between traffic management and freight distribution management systems* by means of open ICT services. The project has addressed how to provide information that improves the route planning to transport companies (e.g. more accurate transport network information, traffic information and travel time information).
7. *Better coordination of all freight distribution in a city* by means of open ICT services, on-board equipment, the heterogeneous wireless communication infrastructure and CALM MAIL[1] implementations in on-board and on-cargo units. The project has addressed how to do this for all freight vehicles in a homogeneous way:
    a. Routing and re-routing for scheduled freight and service vehicles;
    b. Provide information that improves the efficiency for these fleets;
    c. Manage the use of loading and unloading areas;
    d. Track freight vehicles;
    e. Track cargo;
    f. Monitor the status of the cargo.

It has also been an objective of SMARTFREIGHT, with respect to the goal 1, 2 and 3 above, to document new knowledge and to specify open and generic solutions that are adaptable to future needs and are applicable to a variety of European cities.

1.3 Project activities

The project was organised into five main activity types

- *Acquisition of user requirements:* This was done in two ways: A user needs review where findings in other projects and activities were collected; and stakeholder consultations
- *Specification of solutions:* A SMARTFREIGHT framework that specifies a holistic solution that fulfils all relevant requirements was specified. In addition specifications were established for the applications that were demonstrated (the prototype implementations) as well as specifications of the CALM and CVIS extensions.
- *Realisation of solutions*: The prototype implementation and the CALM and CVIS extensions were realised and demonstrated in Trondheim
- *Test site studies and demonstration:* In Winchester and Bologna issues of relevance for SMARTFREIGHT were simulated. In Dublin desktop studies were carried out. The technology was demonstrated in Trondheim
- *Validation of whether SMARTFREIGHT specified and realised the right solutions:* The framework, the ICT solutions and the test site findings were validated.

[1] CALM MAIL enables DSRC communication with small battery-powered units.

2 Main S&T results and foregrounds

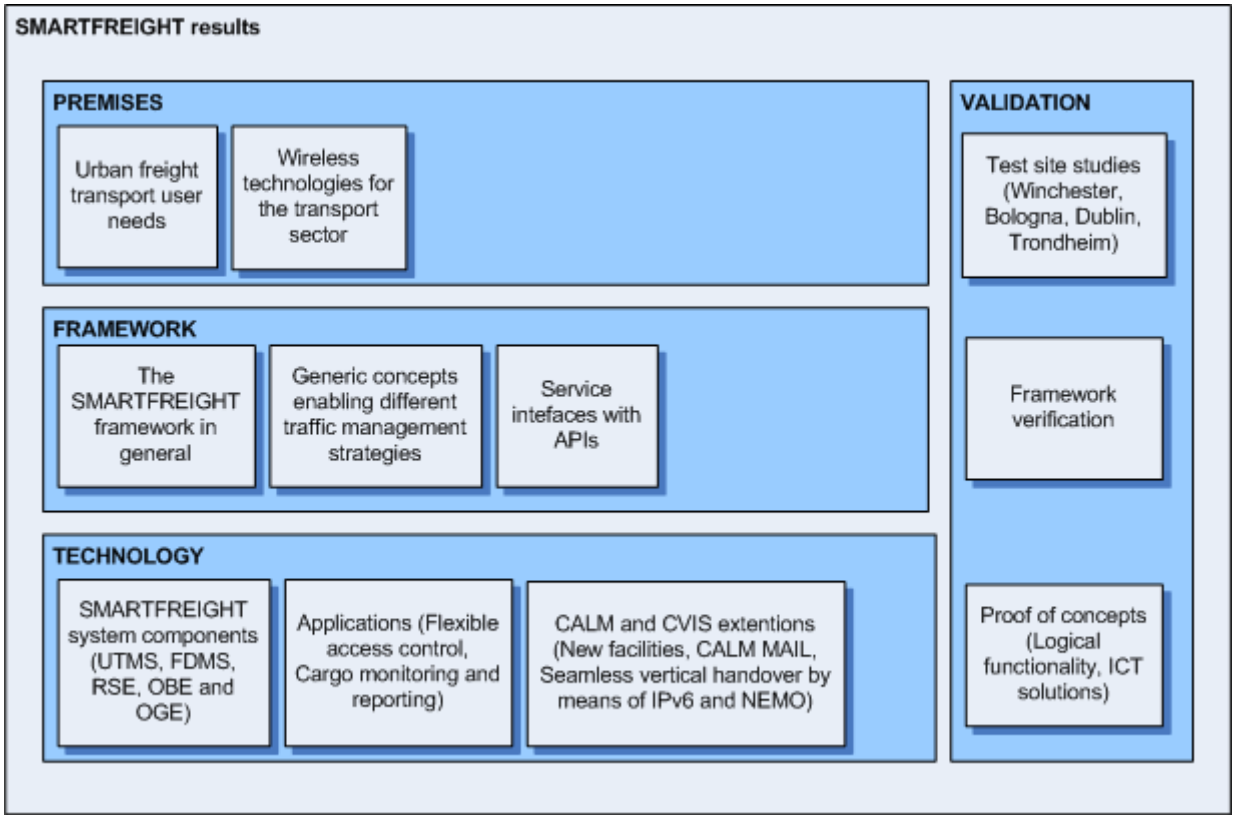


Figure 2 Main results structured into categories

Figure 2 provides an overview of the main results from SMARTFREIGHT. The results are categorised into four groups:

- Results clarifying the *premises* for the work. User needs were defined in close cooperation with both the local and the European reference groups. Wireless technologies of relevance for the transport were assessed.
- The *framework* results define the SMARTFREIGHT concepts and specify generic ICT solutions for urban freight transport. It is emphasized that the framework shall facilitate solutions for cities with different needs and different ICT infrastructures.
- *The technology* results were specified, realised and demonstrated in the Trondheim demonstration and included a selection of the issues addressed by the generic framework. Existing technology like the CVIS platform was used as a basis for the implementation. Some of the results are mainly implemented for demonstration purposes. However, the CVIS and CALM extensions are technology results that are of general interest and commercial value.
- The *validations* results provide assurance to that the other results meet the requirements. The validation results are the outcome from the test site studies, the framework verification and the proof of concepts related to the logical functionality and the ICT solutions.

The main results are described in the following. The headings are pre-fixed with the category of the result.

2.1 Premises – Urban freight transport user needs

A user needs review and stakeholder consultations were undertaken to identify generic user needs and to quantify and qualify the needs for information exchange between urban traffic management systems (UTMS), freight distribution management systems (FDMS) and individual freight vehicles. It should be noted that the scope of this investigation did not extend to the general user needs of the individual parties involved, as these have been covered already, in detail, by other projects (e.g. BESTUFS). A long list of user needs was identified. The most important information needs are listed below.

The study in Dublin confirmed that the user needs to a large extent covers the requirements that the freight operators have. The user needs were also discussed with the local reference group in both Winchester and Trondheim, and the representatives for both the operators and the city authorities confirmed the user needs collected.

Extensive information on user needs:
D2.1 User needs review
D2.2 Stakeholder Consultation and System Performance Scenarios
The deliverables are public, and is available on the project website at: www.smartfreight .info

UTMS needs for freight-related information

Many existing UTMS currently do not have any specific need for freight-related information as they make no special provisions for freight vehicles and do not generally need to know the whereabouts of lorries on the road network. However, in the case of a lorry breakdown causing network delays, information about the individual vehicle would potentially be useful in managing the road network.

Some UTMS (e.g. Dublin, London) restrict heavy goods vehicle (HGV) access and need enforcement systems to do this. Enforcement systems typically employ automatic number plate recognition (ANPR) cameras and a database containing vehicle registration details for exempt users or for registered users who must pay a fee. Any other registration plates recorded may be subject to a penalty charge.

Freight statistics are likely to be needed by city authorities for planning purposes, such as developing freight access plans; however, this is normally considered to be outside the remit of the core UTMS functions of traffic management and control and collection and provision of traffic data and information.

The needs for information exchange related the control of individual vehicles was identified.

FDMS and lorry driver needs for traffic and parking information

It was considered that traffic and parking information could be potentially useful for FDMS rather than being a fundamental need since many existing FDMS currently operate with little or no traffic data being used. Among others, the following issues were identified:

- Up-to-data information about specific problems such as traffic jams, bottlenecks, accidents, roadwork or other incidents is desired.
- Incident information must be accurate in terms of location, severity and likely duration.
- Ideally, information should be tailored to the individual driver and to the travelled route.
- Delay information is perceived as being more useful than journey time information.
- Dynamic route guidance information in response to real-time traffic conditions is highly desirable, particularly for rerouting around an incident. Reasons for rerouting would also be useful. Static traffic data is generally considered to be of rather limited value.
- A variety of media for delivering traffic information will be needed.
- Traffic information services and/or systems need to become pan-European.
- The ability to pre-book a loading bay slot was considered to be useful.

2.2 Premises – Wireless technologies for the transport sector

SMARTFREIGHT has made an overview of the difference between the air interfaces that may be incorporated in on board equipment. They vary largely in terms of range and QoS performance as well as maturity. They are therefore in most cases non-overlapping when it comes to services. CALM IR and CALM MAIL are best suited for toll collection and similar services, CALM M5 and possibly the future CALM MM are best suited for safety critical V2V and V2I services, WiFi networks are well suited for non-mobile users. Public broadband networks like 2G, 3G and LTE/WiMAX networks are well suited for long range IP communication without strict latency requirements.

Extensive information can be found in:
D4.4 Assessment of wireless technologies
The deliverable is public, and is available on the project website at: www.smartfreight .info

Table 1 Evaluation of different air interfaces for SMARTFREIGHT services

Interface	Evaluation
IR	IR air interface is not well suited for SMARTFREIGHT services as infrared communication does not provide ubiquitous coverage in urban areas.
MAIL	MAIL is primarily used for toll collection and does consequently not provide ubiquitous coverage. SMARTFREIGHT has however demonstrated communication with on-goods equipment by means of DSRC.
M5	The M5 technology is currently tested at various test beds such as the one in Trondheim. The technology is therefore not yet mature enough for commercial solutions. As it matures it may however become an alternative for SMARTFREIGHT services.
Wi-Fi	Wi-Fi may be used for communications at parking lots and delivery zones. It is however not suitable for communications while the vehicles are on the road.
MM	Millimetre wave communication is at an early stage of development. The technology will have more than sufficient data rate capabilities and low latency. The propagation conditions at 64 GHz will however prevent widespread connectivity between vehicle and infrastructure in urban areas. This technology will therefore not be well suited for SMARTFREIGHT services.
2G/3G	Both 2G and 3G networks currently cover most urban areas in Europe, and the networks are generally scaled to meet the demand. The latency performance is not good compared to CALM M5, but considered sufficient for SMARTFREIGHT services. From experience, the reliability is not excellent, although the exact numbers are not known. Some high level protocol should therefore assure that messages are not lost.
WiMAX	Mobile WiMAX has been developed as a competing technology to future cellular communication systems, but is recently been included in ITU's family of IMT-2000 technologies. It is expected that as time progresses, these technologies will be deployed and seamlessly integrated in the mobile communication network much in the same way as was done for 3G systems a few years ago. So although this is currently a relatively immature technology, it (or a similar technology such as LTE) is expected to become a candidate for SMARTFREIGHT services in the same way as 2G/3G networks are today.

In SMARTFREIGHT, vehicles communicated with back offices. The SMARTFREIGHT services are characterised by long-range communication with low latency requirements and low to moderate data rate requirements. With the current communication infrastructure in European cities, 2G/3G networks constitute the only realistic means of communication. However, the emerging CALM M5 technology based on WAVE and IEEE802.11p provides an interesting alternative. Firstly, this is a dedicated infrastructure for ITS, which means that the reliability of the communication does not depend on congestion and other problems related to the public 2G/3G network. Secondly, there may also be economically advantageous to use such a network rather than to use public telecommunication operators. In test beds and FOTs it is therefore of interest to test SMARTFREIGHT services through current test facilities.

2.3 Framework– The SMARTFREIGHT framework

The SMARTFREIGHT framework was established through a holistic and top-down approach, based upon the ARKTRANS framework[1], and the results are also provided as input to the work on the Common Framework. The SMARTFREIGHT framework is an important result for several reasons.

- The framework puts the SMARTFREIGHT solution into a broader context, e.g. how it depends on the traffic management strategy; how it affects freight distribution planning; etc.
- The framework defines the SMARTFREIGHT concepts that arrange for generic solutions that can be adapted to local needs. This includes transportation network concepts (see chapter 2.4) and services and APIs (see chapter 2.5) that arrange for the required interoperability between FDMS – UTMS, FDMS – vehicle, UTMS – vehicle and vehicle – cargo.

- *Extensive information on SMARTFREIGHT framework architecture:*
  - ***D5.2 SMARTFREIGHT framework architecture***
- *The deliverable is public, and is available on the project website at: www.smartfreight .info*

The SMARTFREIGHT framework is based on the user needs (see chapter 2.1) and state of the art knowledge about traffic management functions and freight distribution functions and provides a specification of the SMARTFREIGHT solutions. The framework is organised in different abstraction levels.

- The overall conceptual layer defines the scope of SMARTFREIGHT by means of a Reference Model. Roles representing generic responsibilities of relevant stakeholders, and objects representing generic abilities of relevant resources, equipment, solutions and technologies are defined.
- The logical aspects define the SMARTFREIGHT solutions from a logical point of view (i.e. independent of technologies). The functional viewpoint describes use cases related to the activities carried out by the different roles. The process viewpoint describes processes where the activities of different roles interact. The information viewpoint defines the information content that is exchanged in the interactions, and detailed information models are used to define open service interfaces and APIs that support the required information exchange.
- The technical aspects specify the realisation of the interactions by means of the CVIS platform.

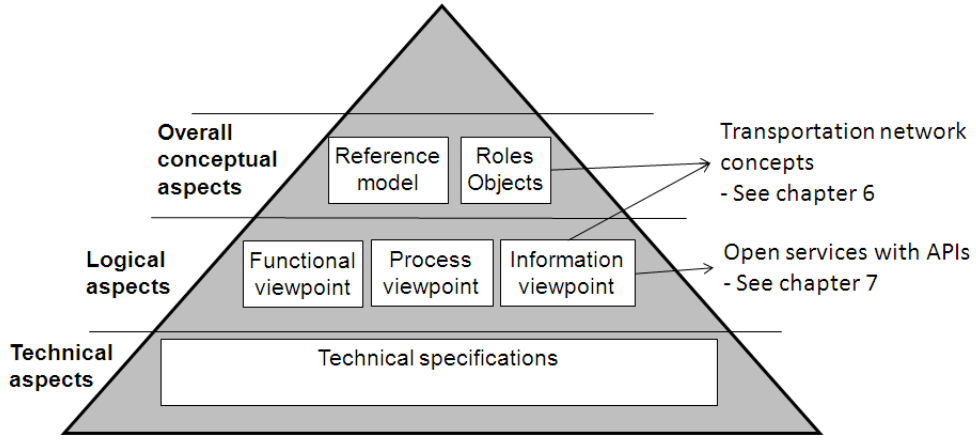


Figure 3 The content of the SMARTFREIGHT framework architecture

[1] www.arktrans.no

2.4 Framework - Generic concepts enabling different traffic management strategies

All cities are different, and the traffic management strategies towards freight distributions also differ. Some cities have broad streets and prefer deliveries by few larger vehicles, whilst others have narrow streets and require deliveries by smaller vehicles. Different areas and road segments may need access restrictions or monitoring due to safety, environmental or efficiency reasons; and the access assignment strategies to resources like loading bays may vary. Hence, the cities should be allowed to define their traffic management policies depending on local needs.

Extensive information on SMARTFREIGHT framework architecture:
D5.2 SMARTFREIGHT framework architecture
The deliverable is public, and is available on the project website at: www.smartfreight.info

To support the diversity among cities, the conceptual and logical parts of the SMARTFREIGHT framework (see chapter 2.2) defined a set of generic concepts. By means of these concepts the SMARTFREIGHT framework architecture can handle different traffic management strategies in a common and generic way. Some of the concepts are related to the transportation network:

- Controlled Area - i.e. area or section of the transportation network that is monitored or has a priority or access restriction schemes. Controlled areas may for example be tunnels where vehicles carrying dangerous goods are monitored or green areas of cities where access is given to only green vehicles.
- Transportation Network Resource - i.e. section of the transportation network that can be assigned to individual vehicles, for example loading bays that have to be pre-booked.
- Checkpoint – i.e. location where information is collected from or provided to vehicles.

Other concepts, that support the traffic management, are related to the transport network concepts:

- Access and Priority Assignment (APA) policy – i.e. a formal definition of the traffic management rules for a Controlled Area. There must be default APA policies for normal traffic conditions. In addition there may be dynamic APA policies in case of traffic situations that require specific measures. The APA policy defines how access rights and priorities are assigned to vehicles depending on their properties (e.g. weight, engine type, etc.); and information to be reported from vehicles with specific characteristics (e.g. vehicles carrying dangerous goods) to arrange for monitoring and control.
- Access and Priority Offer (APO) – i.e. priority and access right assigned to an individual vehicle for a Controlled Area. APOs may be defined in two ways. Normally APOs depend on the vehicle properties and are dynamically derived from the APA policy as the vehicle drives through the transportation network. However, APOs may also be assigned to vehicles on request, for example in return of a fee.

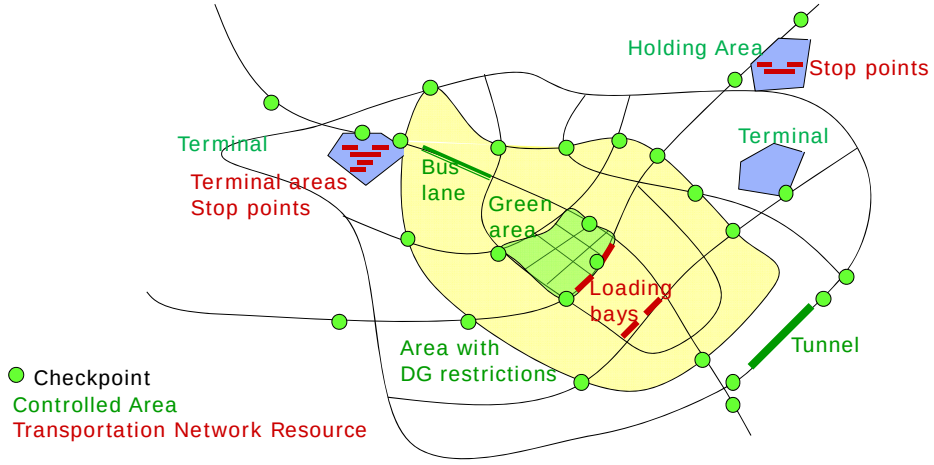


Figure 4 Transportation network concepts

2.5 Framework - Services interfaces with APIs

The SMARTFREIGHT framework architecture has defined services with Application Program Interfaces (APIs) that arrange for the exchange of information between UTMS and FDMS; UTMS and vehicle; FDMS and vehicle; and vehicle and cargo. These APIs ease the integration of the services into existing UTMSs and FDMSs.

Extensive information on SMARTFREIGHT framework architecture:
D5.2 SMARTFREIGHT framework architecture
The deliverable is public, and is available on the project website at: www.smartfreight.info

The services are generic and applicable to solutions serving cities with different needs. The services are building blocks that enable the implementation of several applications.

Table 2 Service interfaces with APIs defined by the SMARTFREIGHT framework architecture

Service Interfaces	The APIs that are provided support
Resource Management	Request for/provision of resource booking, e.g. loading bay booking
	Provision of info on deviation for booked resource
	Resource booking cancelation or update
	Request for/provision of info on resource availability
Traffic Management	Request for/provision of APA policy (as a well defined data structure)
	Update of APA policy on a RSE (Road Side Equipment) for local provision of such info
	Provision of notifications
	Request for/provision of APO
Traffic and Network Status	Request for/provision of TNS (i.e. network and traffic situation information)
	Update TNS on a RSE for local provision of TNS information
Vehicle Reporting	Request for/provision of tracking info
	Request for/provision of vehicle info - e.g. for statistics.
	Request for/provision of entry notification for controlled area
	Request for/provision of exit notification for controlled area
	Request for/provision of vehicle safety status
	Request for/provision of vehicle status (e.g. mileage information)
	Provision of transport problem information
Transport Operation Plan	Request for/provision of TOP (transport operation plan) - deliveries, pickups, etc.
Transport Operation Status	Request for/provision of TOS (transport operation status)
Route guidance	Request for/provision of route guidance
Item	Request for/provision of item tracking (i.e. goods item tracking)
	Request for/provision of item status (e.g. temperature condition)
	Request for/provision of item info (i.e. type of goods, amount, etc.)

The services and APIs (see Table 2) are novel in several ways:

- The concepts in chapter 2.4 arrange for *generic services that cover many purposes*. APIs for booking of resources may be used to book loading bays, parking lots, terminal areas, etc. (i.e. Transportation Network Resources). APIs for provision of APA policy can provide traffic management policies covering "all" aspects related to priorities and access conditions, including reporting requirements for vehicles.
- The top-down and holistic approach of the framework ensures *solutions that consider both the needs of the city and the needs of the commercial transport operators*. The APA policy may for example prioritise access for vehicles that have booked loading bays and direct other vehicles to holding areas. This will benefit the city as fewer vehicles will be driving around looking for a loading bay, and it will benefit operators who act in a preferable way (i.e. booking of loading bays in advance). These operators will get more reliable and efficient deliveries. The APA policy is traffic management, but the freight operators can also use the policy in transport operation planning.
- Services and applications are decoupled from the underlying communication protocols- they *can be configured for different ICT infrastructures*. Thus, the transferability of the SMARTFREIGHT concept is not necessarily tied to the transfer of specific technologies.

2.6 Technology - SMARTFREIGHT system components

Figure 5 shows the SMARTFREIGHT system components. The Control Centre (CC) and Host Management Centre (HMC) from the CVIS project are included for a complete picture.

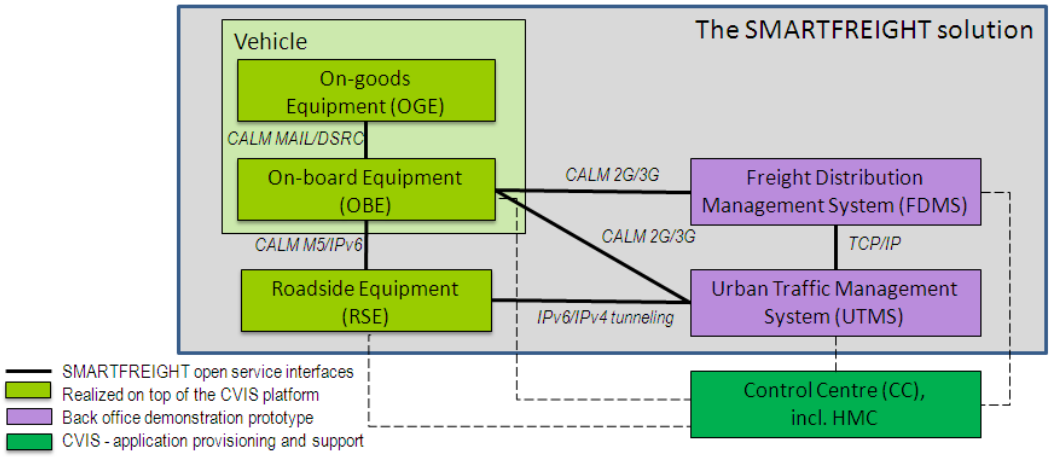


Figure 5: The SMARTFREIGHT system components

Extensive information on the system components:
D4.1 Prototype of on-board equipment
D4.2 Prototype of on-cargo equipment
D5.2 SMARTFREIGHT framework architecture
The deliverables are public, and is available on the project website at: www.smartfreight.info

FDMS, UTMS and RSE

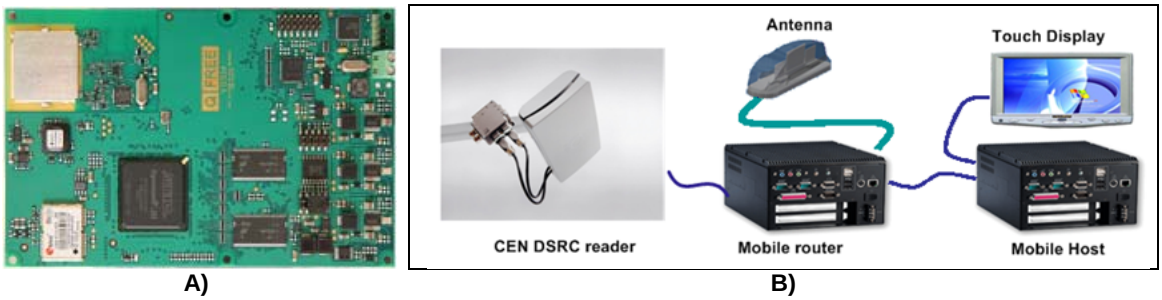
The FDMS and UTMS can communicate with the in-vehicle systems through service interfaces (see chapter 2.5) over CALM. Existing UTMSs and FDMSs can also use these services interfaces to take advantage of the SMARTFREIGHT concepts. Parts of the UTMS functionality were distributed to RSEs that uses the CVIS platform and CALM M5 to communicate with the vehicles.

On-Goods Equipment (OGE)

Software and hardware for the OGE were developed during the lifetime of SMARTFREIGHT, and demonstrated in Trondheim. The implementation is a single-board platform, designed with sensors, a DSRC transponder and a processing unit. External power supply (battery) is needed.

On-Board Equipment (OBE)

The OBE is based upon CVIS results, i.e. the mobile host computer, display, mobile router, and an antenna for different air interfaces. SMARTFREIGHT has added a DSRC reader for communication with the cargo. The CVIS software has provided an effective application development platform for SMARTFREIGHT with a set of common services, i.e. *facilities*, among others the CALM Connection Manager that handles the communication over CALM for different bearers. SMARTFREIGHT used CALM MAIL/DSRC, CALM M5, and CALM 2G/3G as information bearers.



A) B)

Figure 6: A) The OGE board B) The SMARTFREIGHT in-vehicle hardware

2.7 Technology - Applications

Three applications were implemented and demonstrated at the Trondheim test site, two on access control and one on cargo monitoring and reporting.

Extensive information on the applications:
D3.1 Implementation specification for new extended traffic management and freight distribution management functionality
D3.2 Prototype enabling testing of urban freight traffic management and freight distribution management
D4.3 Prototype of on-board application
The deliverables are public, and is available on the project website at: www.smartfreight.info

Access control in general

By using SMARTFREIGHT applications, vehicles are allowed to enter Controlled Areas depending on the individual characteristics of the vehicle. Green areas may for example be Controlled Areas where only low emission vehicles are allowed access. Individual Access and Priority Offers (APOs) are derived from comparing the vehicle characteristics with the Access and Priority Assignment (APA) policy of the Controlled Area. The computation of the APO can be done in three different ways:

1. Centralized access control. Information about the characteristics of each vehicle has to be communicated to a central processing entity, which sends individual APOs to the vehicles.
2. Access control distributed to the RSE. The vehicle communicates with a RSE and provides its characteristics to the access control application residing in the RSE or an associated area controller. The RSE provides the APOs to the vehicles.
3. Access control distributed to the OBE. The vehicle will receive the relevant APA policies through the ICT infrastructure and computes its own APOs.

Alternative two and three were realized (see below), and as far as we know, SMARTFREIGHT is the first project to specify and implement the complete distributed approach in alternative three. This solution is more scalable with respect to processing and communication and it preserves the privacy. As far as we know, SMARTFREIGHT is also the first to define a data structure that can express simple as well as advanced traffic management policies (i.e. APA policies – see 2.4). This opens for exchange of pre-defined policies as well as dynamic policies that can be used in case of abnormal traffic situations.

Application demonstrating basic access control

The basic access application realizes a citywide access control. The access control was distributed to the individual vehicles (alternative three) as follows:

- The basic access control application is defined as a mandatory application for the city area, and is triggered by the broadcasting of a Service Advertisement (SA) messages (a service available through the CVIS library of facilities[1]). When the vehicle enters a RSE coverage area, the vehicle receives a SA message containing an URL of wherefrom the access control application can be downloaded. This is a mechanism that scales well.
- APA policies define controlled areas with access requirements (here: type of cargo and engine class). Controlled areas, requirements and locations are all defined in XML. The APA policies are also distributed by the SA service, where the SA message informs wherefrom the APA policy is available for downloading (e.g. from a RSE or centrally in the UTMS).

[1] Facilities are the CVIS term for common services that are included in the CVIS service platform and used by the applications. See Section 0 that describes the facilities contributed by SMARTFREIGHT.

- When an APA policy is downloaded to the OBE, the access requirements are compared to the vehicle characteristics (including cargo information). The results of the comparisons are then presented to the driver, which in the future can be integrated with the navigation system.

Application demonstrating dynamic tunnel access control

Each vehicle was assigned a conditional access depending on a dynamic parameter, which in this case was the amount of dangerous cargo inside the tunnel at the time of arrival. At arrival, the OBE interacted with the tunnel controller through the RSE to access the tunnel. The following steps were involved:

- The conditional access requirements for the tunnel were pre-defined in an APA policy.
- Download of the dynamic tunnel access control application to the OBE was triggered by a SA message broadcasted by a RSE.
- When the vehicle approached the tunnel, the tunnel controller (through a RSE) initiated an SA message to notify the OBE about the APA policy. Inside the tunnel approach area the OBE provided data about the cargo on-board (dangerous goods), and requested to access the tunnel.

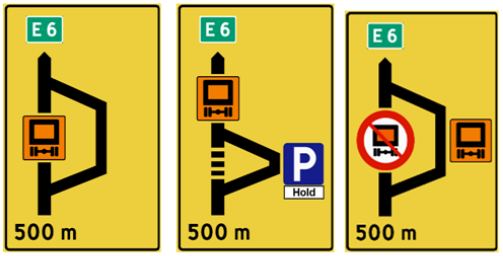


Figure 7 Tunnel signs

- Based on the current amount of dangerous goods inside the tunnel, the driver was notified about three possible outcomes: Access granted (proceed), access permanently denied (use bypass), or access temporarily denied (hold and wait in holding area) (see Figure 7).
- If told to hold and wait, the tunnel controller maintained a queue of arriving vehicles by utilising IPv6 and NEMO to sustain the communication with the OBEs.
- When entering and leaving the tunnel, the vehicle informed the tunnel controller about its dangerous goods on-board. Such information can support any decisions taken in case of any incidents or accidents.

Application for cargo monitoring and reporting

The basis of the SMARTFREIGHT cargo monitoring application was the developments of the OGE and the implementation of CALM MAIL (see chapter 0), an adaption layer for using DSRC as the lower layer communication medium. CALM MAIL gives the cargo, via the OBE, a continuous connection to the freight manager over CALM. The use of CALM as communication protocol supports the holistic view in SMARTFREIGHT by providing a cooperative and integrated environment for cargo, vehicle and back office systems (i.e. the UTMS and FDMS).

The SMARTFREIGHT OGE is connected to sensors measuring shock, tilt and temperature. The DSRC sender on the OGE to the OBE transmits these values. This periodic cargo monitoring and reporting will ensure that the OBE is updated on the cargos' conditions. The OGE's DSRC signal strength is in addition to accelerometer information used in an algorithm to mark the cargo's presence within the vehicle. The freight manager may thus acquire both real-time status and condition information for the freight management processes, planning and deviation handling included.

The cargo monitoring application was demonstrated through real-time condition monitoring and during unloading and loading. The condition monitoring may for example depend on service requirements from the cargo owners. Condition violations will trigger further action.

2.8 Technology - CALM and CVIS platform extensions

SMARTFREIGHT are using the ISO family of CALM standards to enable the best available connection between vehicles and the infrastructure. The CALM protocols were made available as services by CVIS, and are integrated in the facility layer of the CVIS architecture. SMARTFREIGHT extends this implementation by also including CALM MAIL as an adaption protocol for using CALM FAST over DSRC. The usage area for DSRC in SMARTFREIGHT is to enable information exchange between the cargo and the vehicle (i.e. to connect the OGE with the OBE). Because of the SMARTFREIGHT scenarios, and limitations of existing CVIS facilities, SMARTFREIGHT developed some facilities as part of the facility layer in the CVIS architecture (see below).

The CVIS technology used by SMARTFREIGHT necessitates the support of IPv6 – though there is a need of IPv4 tunnelling over non-supported networks like the 2G/3G cellular network in the Trondheim test site. SMARTFREIGHT does not extend IPv6 directly, but has continued the work on the IPv6 Network Mobility support protocol (NEMO) from CVIS. Based on the work in SMARTFREIGHT, the NEMO implementation now supports vertical handover in a reliable, fast and seamless way. Besides, IPv6 and NEMO provide new opportunities that are utilised in SMARTFREIGHT and demonstrated through the dynamic tunnel access control application.

Extensive information can be found in:
D4.1 Prototype of on-board equipment
D4.2 Prototype of on-cargo equipment
The deliverables are public, and is available on the project website at: www.smartfreight.info

SMARTFREIGHT facilities in CVIS

SMARTFREIGHT has developed some services, called *facilities* within the CVIS terminology, related to simulation, smart cargo and positioning. These are used by the SMARTFREIGHT applications, and they are all candidates for inclusion in the CVIS service platform. The simulation facility has eased the testing and better supported incremental testing during the software development process. The smart cargo facility handles the cargo that communicates with the OBE. It maintains a list of current cargo including statuses and events. The positioning facilities provided by CVIS are built on proprietary solutions, which is not a feasible approach for further use of the technology. SMARTFREIGHT has provided an open-source positioning facility ready for future use (e.g. in the eCoMove project).

Implementation of CALM MAIL and new use of DSRC

Direct Short Range Communication (DSRC) is a communication bearer operating in the 5.8 GHz band for low bit rate applications[1]. DSRC provides an accurate and reliable transmission of information, and is currently intended as a RFID technology for V2I communication. The currently main area of application is to use DSRC as a RFID payment system for toll collection. CALM Media Adaption Interface Layer (MAIL) is an adaption layer to enable use of DSRC as a communication bearer for the CALM FAST network protocol[2].

SMARTFREIGHT has extended the CALM implementations from CVIS by implementing the CALM MAIL protocol to integrate the DSRC technology into the ISO family of CALM standards. This is the first implementation of CALM MAIL, and enables use of DSRC as the information bearer between the OGE and OBE. For an enabler of cargo condition information, the use of DSRC is a valuable addition to the research on RFID technologies and the concept of Intelligent Cargo. Some lessons were learned in the process when trying to use a strictly transaction based protocol for frequent and periodic information. The DSRC protocol did not expect the high frequent information exchange between the reader and the same transmitter. However, the system was stable during the

[1] There is not one common definition of a DSRC system in the world, but SMARTFREIGHT uses the European definition, which is standardised through CEN. This is also in compliance with CALM MAIL.

[2] Due to the short frame sizes supported by the DSRC equipment used, it was not possible to use IPv6.

SMARTFREIGHT demonstrations, but would require some more research to get stable long-term results.

Seamless vertical handover by means of IPv6 and NEMO

There are many benefits of using IPv6 instead of IPv4. Examples are better security, more efficient network usage, larger address space to support the concept of Internet of Things, and the issue explored in SMARTFREIGHT – Network Mobility (NEMO) with enhanced support for symmetrical V2I communication. NEMO provides mobility support for entire networks that change their point of attachment. SMARTFREIGHT has contributed to this protocol by continuing the work in CVIS to ensure a seamless vertical handover (i.e. handover between different communication bearers like e.g. from 3G/UMTS to CALM M5). SMARTFREIGHT has further provided a good example of how IPv6 can be utilized in a traffic management scenario by demonstrating the prototype for dynamic tunnel access control (see 2.7).

When a vehicle approaches a tunnel, the OBE tunnel application interacts through a roadside station with the tunnel's tunnel controller, which is aware of the traffic situation inside the tunnel. If the vehicle may not enter due to the current situation, it is either rerouted or asked to hold on a given area. Due to the OBE's IPv6 address, the tunnel controller may keep track of the vehicles at the holding area (and inside the tunnel as well), and asynchronously contact each OBE since the OBEs' IPv6 addresses are retained during the whole session.

IPv6 and NEMO are enablers to maintain the link to the OBEs involved. Using IPv4 would have made it impossible to sustain a fixed IP address – all communication would have to be initiated by the vehicle itself. IPv6 and NEMO could also been used for APA policy updates in case of unexpected situations. By knowing the receivers IP-addresses, the policy update could be handled in a seamless fashion.

2.9 Validation – Framework verification

The validation of the SMARTFREIGHT framework was threefold. It had to be verified that the framework fulfils the user needs (see chapter 2.1); specified ICT solutions that fulfil the functionality required by the objectives of SMARTFREIGHT (see page 10); and could be realised. The latter was verified by the solutions realised and demonstrated at the Trondheim test site.

Extensive information on SMARTFREIGHT framework architecture:
D5.2 SMARTFREIGHT framework architecture
The deliverable is public, and is available on the project website at: www.smartfreight.info

A detailed mapping between the user needs and the relevant parts of the SMARTFREIGHT framework was done to ensure that all relevant requirements can be fulfilled.

The concepts and the service interfaces and APIs (see chapter 2.4 and 2.5) supported the functionality required by the objectives of SMARTFREIGHT as described in the second columns in Table 3.

The Trondheim demonstration was realised according to the principles defined by the SMARTFREIHGHT framework. Some simplifications were done since this was a prototype implementation. However, the main decisions taken in the framework were demonstrated in a successful way, among others decentralised and conditional access control related to controlled areas and communication with the on-goods equipment (see chapter 2.7). The right column in the table summarises the verification by means of the demonstration.

Table 3. Verification of concepts and services and APIs

Functionality derived from objectives	Realisation by means of concepts and services from the framework	Demonstration
Traffic management measures depending on vehicle properties (Objective 1a + 1b)	The area to be controlled must be defined as a Controlled Area. The APA policy for this Controlled Area must be defined. Different "service levels" are represented as different sets of vehicle properties. The priorities and access rights associated with the different sets of properties are defined. The APA policy with access rights and priorities is provided to the vehicles so that they can compute their APOs. Associated service interface: Traffic Management	Fully demonstrated (see chapter 2.7)
Conditional route assignment, including green areas (Objective 1c)	Access rights are provided to the vehicles as a part of the APA policy (see above), and the vehicles can compute their APOs and plan their routes accordingly. Thus, those vehicles that do not have access can avoid green areas. APOs that arrange for specific routes can also be assigned to vehicles on demand, independent of the APA policy. A vehicle may also request routing support. Associated service interfaces: Traffic Management, Route Guidance	Green areas were demonstrated (see basic access control in chapter 2.7). The routing was not demonstrated (assumed to be done by the navigation system)
Tracking and monitoring of dangerous goods (Objective 1d + 1e)	The area in which the tracking/monitoring shall take place must be defined as a Controlled Area, and the APA policy for the area must define the properties of the vehicles that are to be tracked/monitored. The APA policy must also define how the information from the vehicle is to be reported. The APO computed by the vehicle will reflect this. The information can be reported in different ways depending on the purpose and the communication infrastructure: • To arrange for monitoring, vehicle information may be reported at certain intervals or locations (e.g. defined by geofencing) by means of 2G/3G. • To arrange for awareness about vehicles in controlled areas, e.g. tunnels, entry and exit information may be reported to roadside stations on entry to/exit from the controlled area The same mechanisms may also be used to ensure that the vehicle reports	Demonstrated. The OBE acquired cargo type information from the OGE. The tunnel controller (see chapter 2.7) requested information on dangerous goods and monitored the presence of such cargo in the tunnel.

	information that can be used in statistics. Associated service interfaces: Traffic Management, Vehicle Reporting	
Incident management and enforcement support (Objective 1 f + 1g)	Entry and exit notifications that support awareness about vehicles in controlled areas and tracking of selected vehicles (see above) may support both enforcement and incident management. Incident management can be supported through awareness about the presence of for example vehicles with dangerous goods in tunnels. Vehicles may also be asked to report safety related information. Awareness about the safety status of vehicles may also support incident handling. Dynamic access assignment to controlled areas is also supported and can support incident management, e.g. on incidents in tunnels. Vehicles approaching the tunnel may receive notifications telling them that access to a Controlled Area not is granted. Associated service interfaces: Traffic Management, Vehicle Reporting, Item	Demonstrated. The OBE acquired cargo information from the OGE. The information was sent to the tunnel controller. Thus, the controller (see chapter 2.7) was aware of the amount of dangerous cargo in the tunnel. This awareness may support incident handling.
New data exchange UTMS- FDMS (Objective 2)	Many types of information may support the freight distribution planning. The UTMS may on request provide: traffic data, traffic condition information, APA policy information, route information, etc. Associated service interfaces: Transportation Network Status, Traffic Management, Route Guidance	The APA policy was demonstrated. (DATEX II was suggested for the other information flows)
Reliable deliveries (Objective 2 + 3a + 3b + 3c)	Access to default APA policies supports the planning of deliveries. The routes and time schedules can be planned depending on the APA policy. Adaption to the policy, e.g. use of environmental friendly vehicles, will give privileges that may increase the efficiency Resources such as loading bays can be booked to fit with the plan. Resources can also be re-booked and cancelled in case of changed plans. The APA policy may refer to holding areas that can be used when vehicles have to wait for their time slots. Associated service interfaces: Traffic Management, Resource Management, Route Guidance	The APA policy was demonstrated, but not the planning (not considered as SMARTFREIGHT functionality). Resource booking was not demonstrated (see remark below).
Transport operation management (Objective 3d + 3e + 3f)	Transport operation plans can be exchanged, and transport operation status (e.g. loading/unloading status, goods condition, etc.) can be reported, information on the condition of the cargo included. Associated service interfaces: Transport Operation Plan, Transport Operation Status, Item simplified	Exchanged of a simple transport operation plan and status information on cargo condition and events were demonstrated. Cargo information was sent from the OGE to the OBE.

The resource booking (in this case booking of loading bays) was not demonstrated since similar functionality is demonstrated by other projects, among others CVIS. The SMARTFREIGHT solution is however more generic and holistic. A transportation network resource is a generic concept that can be booked and managed in a generic way, and the APA policy may assign privileges to vehicles with such bookings.

2.10 Validation - Test site studies

The Winchester, Bologna, Dublin and Trondheim test sites gave insights into how the SMARTFREIGHT concepts and the solutions will work and what positive outcomes could be expected when they are implemented in real life. In Trondheim the technical solutions were validated and demonstrated. In Winchester and Bologna the validation was done by means of simulations. In Dublin a desk top study was carried out.

A set of ideal future services and functions for urban freight transport was identified in the user needs and translated into generic concepts in the SMARTFREIGHT framework architecture. Selected functions were demonstrated and proved by means of the SMARTFREIGHT ICT solutions, and the usability of the functions at the different test sites was evaluated.

Extensive information on the validation:
D6.1 Summary of proof of concepts and verification of ICT solutions
D7.1 Impact analysis on urban freight
The deliverables are public, and is available on the project website at: www.smartfreight.info

Winchester results

A simulation study on loading bays has demonstrated that it works well in the ideal case when lorries arrive at the loading bays on time and with no delays, etc. As soon as delays (from low levels to rather high) are introduced there are no benefits to be found. However, this result leads to the conclusion that holding areas and other physical infrastructure instalments must be added to a loading bay scheme in order to cope with disturbances. Furthermore, it should be investigated if the APOs given should be more flexible and allow for on-the-spot actions to minimise the delay.

The simulation study on shard bus lanes demonstrated some benefits, but not in all scenarios. The street section in Winchester used was perhaps also too short (less than 200 metres) to assess this extended service in a fair way. Furthermore, in practice the public transport solution (time tables, type of buses, quality of bus stops, etc.) was not taken into account in a detailed way. It should be noted that the local authorities in the city have not supported the idea of a shared bus lane between freight and public transport. The risk of introducing new types of disturbances was seen as too high.

Bologna results

The actual functionalities addressed were not the ones originally stated. The tests showed instead a positive environmental and trip distance effect, using the route optimisation tool that is a part of the Van Sharing system and platform. These results were unexpected but originated from the Bologna case where the SMARTFREIGHT ideas was adopted but the realisation of urban freight transport was built on already existing technology solutions. This gave us also an example of that the SMARTFREIGHT concepts are independent of the realisation technology.

Dublin results

The survey study in principle confirmed the user needs (see chapter 2.1). However, one specific item should be noted. The share of “own-account” companies was high, i.e. the technical solutions implemented must not be directed towards the “big companies” but have an equal focus on both large and small actors on the urban scene.

Trondheim results

The implementation of the SMARTFREIGHT concepts in Trondheim has been successful; the technology works. Three applications were demonstrated (see chapter 2.7): Basic access control, dynamic tunnel access control, and cargo monitoring. These are all examples of a realization of the more generic concept specifications in the framework architecture. The applications demonstrated also show the technological potentials of SMARTFREIGHT by utilizing elements like the CVIS service platform, CALM communication, and Internet technology like IPv6 and NEMO.

2.11 Validation - Proof of concepts

The proof of concepts addressed two issues: The first issue was the development of the SMARTFREIGHT functionality (i.e. new traffic management measures, better collaboration between urban traffic management and fleet operators, and improved on-board control and support) into something acceptable to the priorities expressed by the stakeholders concerned. The second issues was the development and verification of a technical (ICT-based) realisation of the SMARTFREIGHT concept

D6.1 Summary of proof of concepts and verification of ICT solutions
D7.1 Impact analysis on urban freight
D7.2 Generic findings on urban transport and a future outlook
The deliverables are public, and is available on the project website at: www.smartfreight.info

Functionality

SMARTFREIGHT addresses a series of new functions. The different stakeholders in the urban transport community, i.e. from both the UTMS and the FDMS sides, have identified them as important in the near future.

As the stakeholder act on different time horizons these functions (and the functional modules that together constitutes them) are subdivided into strategic, tactical and operational levels. This approach has resulted in a firm base on which urban transport services (with a focus on urban freight) can be realised in practice. Such a realisation has been demonstrated by the Trondheim test site activities and the logical functionality is further clarified by means of the SMARTFREIGHT framework.

The new functions will require decision taking based upon the total situation – traffic situation as well as transport operations. Decision support and decisions can partly be supported by ICT, but still it is important to highlight the understanding of how human actors (or decision-makers) have limited cognitive resources available to relate to the new functions. A solution is given that takes care of the problem that actors on one abstraction levels have little or no link to how actors on other levels have to think and cope with their tasks. In the SMARTFREIGHT case a virtual AP (Access and Priority) Centre is created to cover such a situation and to avoid unnecessary problems in system operations. The SMARTFFREIGHT framework architecture defines the Access and Priority Assignment (APA) policy concept that will result in Access and Priority Offers (APO) for individual SMARTRFREIGHT equipped vehicles. The AP Centre was introduced in parallel with the vehicle fleet dispatcher unit (as part of the FDMS) to serve as a picture on one way of applying the SMARTFEIGHT services in an urban area.

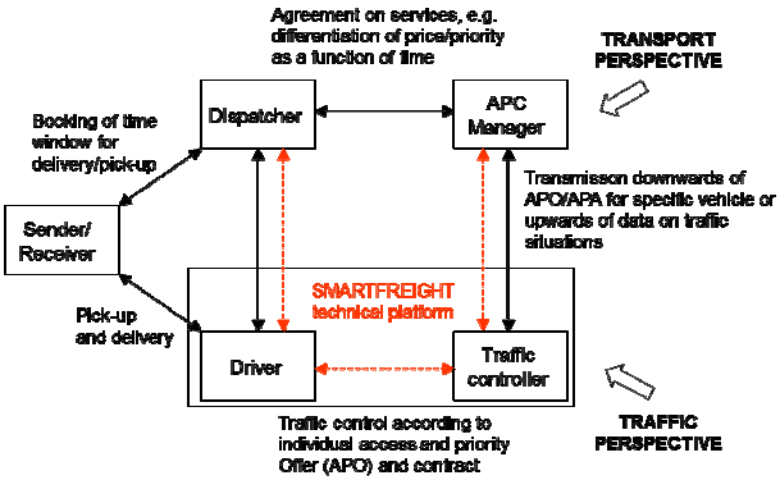


Figure 8 Collection and distribution of goods in a SMARTFREIGHT environment

Another result is that by using the Sjöstedt/Ridley model structure, the SMARTFREIGHT solutions can be “positioned” in the total transportation process. Other ICT-based systems are present at the

same time and some of these are related to logistical functionalities not covered in SMARTFREIGHT . However, they constitute an area of future R&D work with the goal to find ways to better cope with the urban transportation process as a whole (covering both freight and travel).

Due to many reasons there has not been developed (as was indicated in the DoW) specific local scenarios for the test site activities. Instead the test sites have put together a priority list of functionalities relevant for their city in the near future. This approach led to a list of extended functionalities for each site to be realised when possible; it is noticeable that they had much in common. It is evident that the present state-of-the-art in the UTMS and FDMS fields brings forward the same problem areas and that SMARTFREIGHT is well positioned and “in line with” these priorities.

ICT solutions

Technical tests of the SMARTFREIGHT concepts were performed in October 2010. The demonstration performed in Trondheim was a verification of the ICT solution applied.

Furthermore, the tests performed in Bologna (not using the CVIS/CALM approach) demonstrated that also other ICT infrastructure approaches can work. In the Bologna case the implementation was based on more traditional UTMS solutions.

The SMARTFREIGHT framework also supports the use of different communication technologies and ICT infrastructures. The realisation technology will very much depend on the application and services to be deployed, existing ICT infrastructure, economy, etc. Many applications will not require the advanced setup that was demonstrated in Trondheim (an infrastructure based upon the CVIS communication platform and use of roadside stations). If applications with different requirements to realisation are to be deployed, CALM will provide vehicles with continuous communication based on available mediums. The horizontal protocol stack defined by ETSI TC ITS[1] is used and makes a closely integration of lower communication layers with the applications obsolete. Access control can for example be triggered by GPS geofencing and the communication can be done via 2G/3G communication, or roadside stations may trigger and interact with the vehicle. The SMARTFREIGHT framework supports both alternatives. The latter may be required for extended services that demand provision of some sort of local information by roadside stations. The use of CALM is beneficial, as CALM will provide vehicles with continuous connection to the infrastructure, and supports the services in choosing the best communication channel available.

[1] ETSI EN 302 665 V1.1.1 (2010-09) Intelligent Transport Systems (ITS); Communications Architecture, ETSI TC ITS, September 2010.

2.12 Lessons learned and open issues

Where can the SMARTFREIGHT results be applied?

The results from SMARTFREIGHT can be of use when one or more of the following issues are of relevance:

- The city (i.e. traffic management of the city) would like to offer updated traffic information and dynamic traffic management strategies to freight operators or freight vehicles
- The city (i.e. traffic management of the city) would like to control the individual vehicles in a way that benefits those with desired behaviour, e.g. those who use green vehicles
- Freight vehicles and operators are willing to provide overall information about their transport operations (e.g. safety related information, information for statistics, etc.) to the city. In return they may get access rights and priorities if they comply with desired behaviour, and they may pre-book resources like loading bays.
- Information and communication technology is to be used to manage how the freight vehicles are using the road network and resources (e.g. loading bays). This may include
    - Booking and re-booking of resources like loading bays
    - Dynamic access and priority offers to freight vehicles depending on their properties and the traffic situation
    - Monitoring of selected freight vehicles
    - Holistic solutions where access assignments depend on resource bookings and safety assessments

SMARTFREIGHT provides input to both the planning process and the actual realisation. The implementation of the SMARTFREIGHT concepts has to be based upon:

- A road network where the areas or sections in which vehicles are to be controlled and monitored can be localised
- Formally defined traffic management strategy and policy related to the relevant parts of the road network (i.e. an APA policy)
- An ICT infrastructure that supports communication needs that are adapted to the strategy
- A traffic management system that can be extended with SMARTFREIGHT functionality. This also implies that the required input to the functions can be provided
- Freight distribution management systems that can utilise new and more reliable traffic information and information about the traffic management policy

Independence of ICT infrastructure is achievable

The Trondheim prototype was realised in an infrastructure composed of several CALM M5 stations with CVIS software. However, it is important to notice that the SMARTFREIGHT concept is not necessarily tied to the transfer of specific technology, which opens the possibility of soft exploitation of the SMARTFREIGHT umbrella concept with regard to research and consultancy to design functional applications on an existing local infrastructure. Most of the services that were specified and demonstrated can be realised without an infrastructure such as the one in Trondheim.

If M5 stations are not used, the APA policy may be downloaded over a 2G/3G connection, where reporting requirements are based on GPS positions or geofencing. The use of roadside station may however have advantages, and the use of such stations should be considered at specific locations, e.g. locations for APA policy provision.

Localisation issues – need for standardised solutions

AGORA C was used for on-fly location referencing in the SMARTFREIGHT framework. AGORA C provides a method to unambiguously locate something on a map without any pre-coding or location tables (like in TMC). Two location-referencing purposes are addressed: Applicable to define problem or status locations; and applicable to use in routing to destinations. AGORA C relies on specific attributes that are available in current digital map databases for navigation systems and other ADAS applications. Recently, many projects prefer Open LR to AGORA C due to the AGORA C license

fees. Open LR does however at the time of the project not include area referencing, which is required in SMARTFREIGHT.

Privacy *can be ensured*

The security issues addressed in one of the annexes of the SMARTFREIGHT framework architecture can be used to ensure the required privacy. In addition, the distributed approach for access control (as suggested by SMARTRANS) is the best alternative with respect to privacy. The vehicle does not have to provide any information to the traffic management system.

The SMARTFREIGHT solution can improve safety

The generic mechanisms for realisation of access control and monitoring are suggested by SMARTFREIGHT, can be used to improve the safety. Vehicles with specific properties that indicate an increased risk level, e.g. vehicles carrying dangerous cargo, can be monitored and their access to areas or transportation network sections, e.g. tunnels, can be managed. This can be used for pro-active measures. Just one vehicle carrying dangerous cargo can be allowed inside a tunnel at a time, or such vehicles can be denied access to specific areas and parts of the transportation network.

A need for more comprehensive verifications of the effects of the SMARTFREIGHT solutions

In neither Winchester, Bologna nor Dublin the needs for the new functionality were addressed. It was however not validated how the solutions specified by SMARTFREIGHT could have been implemented, e.g. which Controlled Areas that would have been beneficial, how the APA policies related to the controlled areas could have been defined, etc.

2.13 Fulfilment of project objectives

Table 4 describes how the elements of the overall objectives of SMARTFREIGHT are fulfilled.

Table 4 Fulfilment of overall objectives

Issue addressed by overall objective	Fulfilment
Develop knowledge	SMARTFREIGHT has developed knowledge that is documented in the deliverables of SMARTFREIGHT and disseminated via different channels (see section 3.4).
Develop a framework	The SMARTFREIGHT framework (see 2.3, 2.4 and 2.5) provides a generic and holistic specification of solutions that can make urban freight transport more efficient, environmentally friendly and safe.
Develop technology	SMARTFREIGHT has specified, realised and demonstrated technology that includes a selection of the issues addressed by the SMARTFREIGHT framework. Existing technology like the CVIS platform is used as a basis for the realisation. Some of the results are mainly implemented for demonstration purposes. However, CVIS and CALM extensions are technology results that are of general interest (see section 2.6, 2.7 and 2.8)
Make urban freight transport more efficient	Open service interfaces that support new traffic management measures (priorities, access control, monitoring, etc.) and other measures that may affect the efficiency • APA policies for different traffic situations can be defined and used in automatic traffic management that arrange for improved traffic flow and more efficient deliveries. • APA policies that assign privileges to vehicles with desired behaviour, e.g. deliveries outside rush hours. Such deliveries will be more efficient than others. • Pre-booking of loading bays gives more reliable and efficient deliveries. • Information for statistics can be acquired and contribute to knowledge that can give traffic management strategies (i.e. APA policies) that support efficient freight transport.
Make urban freight transport more environmentally friendly	Open service interfaces that support new traffic management measures (priorities, access control, monitoring, etc.) and other measures that can make freight distribution more environmentally friendly: • APA policies for different traffic situations can be defined and used in automatic traffic management that prevent congestions, and in case of congestion freight vehicles can be asked to wait in holding areas to prevent emissions. • APA policies can assign privileges to green vehicles and to vehicle with environmental friendly behaviour (e.g. vehicles with high load factor and deliveries outside rush hours). • Pre-booking of loading bays can reduce the mileage – the vehicles do not have to drive around looking for loading bays.
Make urban freight transport more safe	Open service interfaces that support new traffic management measures (monitoring and control) that make freight distribution safer. APA policies can be defined to: • Control the access for vehicles carrying dangerous cargo to for example tunnels. The amount of dangerous cargo in a tunnel can for example be controlled. • Request reporting from vehicles carrying dangerous cargo to arrange for awareness about the presence of such cargo in for example tunnels and densely populated areas. • Request tracking information from vehicles carrying dangerous cargo • Deny heavy vehicles and vehicles carrying dangerous cargo access to certain areas (e.g. areas around schools) to reduce the risk for accidents.

The detailed objectives have been to address as described in Table 5. All objectives are met by the SMARTFREIGHT framework, which provides generic specifications of among open service interfaces that support the required functionality. In addition, some of this functionality is also realised and demonstrated at the Trondheim test site. The right column in the table indicates how the objective is fulfilled. "F" denotes that the framework specifies the functionality, and "D" denotes that the functionality in addition also is demonstrated.

Table 5 Fulfilment of detailed objectives

Detailed objectives	More specific	Fulfilment	How

New traffic management measures towards individual freight vehicles that benefit the cities by means of open ICT services, on-board equipment and an integrated heterogeneous wireless communication infrastructure within the framework of CALM. *Objective 1*	In general	All required information exchange is specified in open service interfaces and realized in a heterogeneous wireless communication infrastructure within the framework of CALM is also specified. The test site studies and proof of concept in WP6 and WP7 also confirms that the objectives are achieved.	F/D
	Assign different service levels to freight vehicles depending on their environmental profile, the type of goods transported and the destination;	The service level concept is realised by means of a formal representation of the vehicle properties (engine class, type of cargo on-board, vehicle weight, etc.). The traffic management measures taken towards the vehicle depend on these properties and can be adapted to the needs of different cities, different areas of the cities and different section of the transportation network.	D
	Assign priorities and access rights depending on the level of service and the traffic situation;	The computation of access rights and priorities is de-centralised to the OBE and is based on the APA policy (i.e. the local the traffic management strategy). The APA policy may be adapted to the traffic situation.	D
	Assign routes and time slots to freight vehicles to minimise conflicts and congestion;	The calculation of route is distributed to the vehicle as this is found to be the most efficient solution, or the vehicle may get the route from its operator. In any case, the calculation must consider the access rights of the vehicle (see above). Thus, the traffic management influences on the route planning by means of the APA policies that are provided to the vehicles and to the operators. Access rights can also be assigned to vehicles on-request, independent of APA policies (e.g. in return of a fee).	F
	Track/monitor vehicles carrying dangerous cargo;	The APA policy may require that such vehicles (other vehicle properties can also be specified) provide tracking information or report about their entries to and exits from specific areas/transportation network sections (e.g. tunnels).	D
	Collect information for statistics;	A vehicle can be asked to provide information of relevance to statistics.	F
	Support control that enables enforcement;	A vehicle can be asked to report about entries to areas or transportation network sections and to provide information about its access rights. Such information can be used to detect illegal entrances and can be used in enforcement.	D
	Support awareness in case of incidents.	As mentioned above vehicles with specific properties can be tracked/monitored. This will support awareness, e.g. awareness about dangerous cargo inside tunnels..	D
Better interoperability between traffic management and freight distribution management systems by means of open ICT services. *Objective 2*	In general	All required information exchange is specified in open service interfaces and realized in a heterogeneous wireless communication infrastructure within the framework of CALM is also specified. The test site studies and proof of concept in WP6 and WP7 also confirms that the objectives are achieved.	F/D
	Provide information that improves the route planning to transport companies.	The APA policy that defines how different vehicles will be treated can be provided to the operators. The operators can use the APA policies in both their long term and short term planning processes (based on foreseen APA policies and actual APA policies). Real time traffic information (travel times included) can be provided to support the short term planning. .	F
Better coordination of all freight distribution in a city by means of open ICT services, on-board equipment, the heterogeneous wireless	In general	All required information exchange is specified in open service interfaces and realized in a heterogeneous wireless communication infrastructure within the framework of CALM, including the CALM MAIL implementation (see 2.8). The test site studies and proof of concept in WP6 and WP7 also confirms that the objectives are achieved.	F/D
	Routing and re-routing for scheduled freight and service vehicles;	Service interfaces for provision of route and transport operation information (with route information included) are specified.	F
	Provide information that improves the efficiency for	Service interfaces for provision of traffic situation information are specified	F

communication infrastructure and CALM MAIL implementations in on-board and on-cargo units. *Objective 3*	these fleets;	- such information can support the driver. Service interfaces for provision of transport operation information – such information may include route specifications and information about pick-ups and deliveries.	
	Manage the use of loading and unloading areas;	Service interfaces support that information about resources like loading bays can be acquired, the resources can be booked and re-booked, and the bookings can be cancelled.	F
	Track freight vehicles;	Service interfaces support tracking of vehicles.	F
	Track cargo;	Service interfaces support tracking of cargo.	F
	Monitor the status of the cargo.	Service interfaces support the provision of status information.	D
To document new knowledge and to specify open and generic solutions	Document new knowledge	See Table 4	NA
	Specify open and generic solutions that are adaptable to future needs and are applicable to a variety of European cities.	The top-down and holistic approach of the SMARTFREIGHT framework ensures that both the needs of the city and the needs of the commercial transport operators are considered. The APA policy may for example prioritise access for vehicles that have booked loading bays and direct other vehicles to holding areas. This will benefit the city as fewer vehicles will be driving around looking for a loading bay, and it will benefit operators who act in a preferable way (i.e. booking of loading bays will facilitate more reliable deliveries). The APA policy can be adapted to the needs of different cities, and the open service interfaces can be implemented by means of different ICT infrastructures (the CVIS infrastructure is just one of these).	F/D

3 Potential Impact

SMARTFREIGHT targets freight transport in an urban context with the use of Information and Communication Technology (ICT). The potential impacts of SMARTFREIGHT are structured in how SMARTFREIGHT can make impact on technical solutions for the transport sector, on the urban transportation, and on European policies and standards that both directly and indirectly affect the transportation sector.

3.1 Technical impacts

SMARTFREIGHT has developed technical solutions that can give an impact to future solutions in both the transport sector and other sectors.

Extended and new use of DSRC

DSRC is a passive RFID technology. The DSRC goods tag will send information when the DSRC reader triggers it connected to the in-vehicle hardware structure. The actual transmission of data worked well by using DSRC and can serve as a good example of its capabilities. DSRC has started to be used within parking management, but SMARTFREIGHT believes that DSRC can be utilized within several other areas as well. One example is within traffic management, where its use as an area entrance notification mechanism (like in tolling stations) could be further enhanced in cooperation with other SMARTFREIGHT concepts like the generic access control to different controlled areas.

Another point in the promotion of DSRC is its strong linkage with the ISO-family of CALM protocols. As CALM becomes the primary way of handling multiple communication interfaces in high mobility environment as the transport sector, DSRC will through the CALM MAIL standard find its way as a viable alternative transmission medium for many type of applications.

Intelligent Cargo

“Intelligent Cargo is cargo able to process, retain and communicate information about itself and its surroundings”[1]. Given this definition, SMARTFREIGHT has contributed to both process and retain information about the cargo itself and its surroundings through the OGE developed and demonstrated, in addition to communicating the information over DSRC as described above. The current SMARTFREIGHT OGE is however not capable to handle all requirements for a future intelligent cargo device, but has been designed for further development and use in future research projects – of both commercial nature and not.

The SMARTFREIGHT OGE communicates directly status information to the in-vehicle OBE, which may further forward such information to the freight distribution manager, or use this information in traffic management solutions as also shown in SMARTFREIGHT (the goods is part of the vehicle properties used in the access control). SMARTFREIGHT demonstrated means to how the traffic management may shift from a traffic flow view to more individual vehicle based control and monitoring. A further evolution towards incorporating the goods more into the decisions is a probable path. For example, the focus on dangerous goods in SMARTFREIGHT is a valid example of current interest. The OGE will be an important piece in such a scenario.

IPv6 and NEMO in transport

IPv6 enabled services will continue to grow – more now than ever due to the limited number of IPv4 addresses available for use. For the transport sector this means new opportunities as IPv6 provides, among others, better bandwidth efficiency and mobility support. In addition, the increased number of IP addresses may give each vehicle and its different parts (including the cargo) globally reachable and unique identifiers. The improved mobility support includes Mobile IPv6, which provides better route optimization and handover, and Network Mobility (NEMO). NEMO gives router mobility

[1] From a discussion of the Intelligent Cargo definition on the Intelligent Cargo Forum group within LinkedIn.

(including associated nodes), which is necessary in ITS systems based on the ETSI Communication Architecture as different hosts and sensors will still be available when the vehicle moves. The applications implemented and demonstrated in SMARTFREIGHT were based on IPv6[1], and especially the tunnel access control application serves as a good example of how IPv6 and NEMO can impact the design of transport sector applications.

This SMARTFREIGHT example shows how elegantly IPv6 and NEMO solve the communication between the OBE and the roadside station. This situation information is preserved when the vehicle moves to another roadside station's coverage area (e.g. the one covering the tunnel's exit), and even when moving to a different wireless communication bearer. The SMARTFREIGHT implementation extends CVIS to give a seamless handover when going from one media (e.g. CALM M5) to another (e.g. 2G/3G).

Positioning facility

A range of applications is depending on a vehicle's position. SMARTFREIGHT applications are based on the technology developed in the CVIS project. However, the positioning service within the CVIS platform is dependent on closed-source proprietary and licensed components, which makes it hard and expensive to use in new applications. SMARTFREIGHT has replaced these services with open-source alternatives that are fully compatible with already developed applications, while new applications can use either alternative. The new services also support both simple low-cost GPS devices and more sophisticated Inertial Navigation Systems with higher accuracy.

Closed solutions that require licensing will clearly hinder further application development in general and in this case on the CVIS platform. The work SMARTFREIGHT has done to open these positioning services will enable new application developments on the area, and especially impact on who is able to participate in this development. Small third party application developers (often 1 or 2 persons) would be more or less unable to participate in the development of CVIS applications requiring some sort of positioning. SMARTFREIGHT has even further improved the possibilities of these actors by also developing simulation modules for positioning, which enables more desktop application development and testing.

Another closely related service made open by SMARTFREIGHT is the geofence service created in CVIS. This service can, among others, be used to define controlled areas in the access control. The CVIS implementation suffered from serious flaws and was not open-source.

New cooperative applications

SMARTFREIGHT has shown how to integrate the cargo and vehicle with both the traffic management and freight distribution centres. This has been achieved by specifying open services with clearly defined service interfaces on top of the CVIS application platform and CALM communication framework. The applications implemented and demonstrated in SMARTFREIGHT were all developed from the services specified in the SMARTFREIGHT framework architecture. As these services are open, they may be further used to develop cooperative applications that integrate the cargo and vehicle to the back office systems. A possible arena for such open transport services is the on-going work on the Future Internet initiative.

For application developers working on the CVIS platform, the SMARTFREIGHT services (i.e. both the facilities and end-user services developed) can be used as another available CVIS service. Consequently, the SMARTFREIGHT services will thus have a migration path in the context of the CVIS platform where they may impact on how cargo, vehicle, and back office information can be integrated for cooperation.

[1] The vehicle-to-roadside communication over CALM M5 was all IPv6, while the communication over the cellular system was tunnelled in IPv4 packets.

3.2 Urban transportation impacts

Today, urban freight distribution is sub-optimised by the freight companies on an individual level, while the traffic is managed without looking at the individual vehicles; there are no special measures for individual freight vehicles. Consequently, urban freight distribution is far from optimal from the society's points of view.

Impact for the transport logistics

Today transport logistics means the daily operation management of vehicles as the most important production resource in the company. Problems related to the traffic, e.g. traffic congestion, are identified as one of the major problems for utilizing the fleet of vehicles, and consequently affecting the companies' profits. The use of ICT facilitates complex planning of the use of resources. Thus there is a great potential for dynamic adaption to the traffic situation. SMARTFREIGHT has in this context provided support for cooperative exchange of information that may improve the freight distribution planning such as updated traffic information and APA policies (i.e. traffic management policy information that might be dynamically adapted to the traffic situation) between the urban traffic management system and the freight distribution management system. The work started in SMARTFREIGHT will impact the way transport logistics can acquire real-time information to support their actions, and how the traffic management can offer real-time information to users.

The transport sector must provide quality to its users – including the cargo owners and retailers in the city centre. Quality relates to timely pick-ups and deliveries, and the cargo handling. SMARTFREIGHT has addressed booking of loading bays and APA policies that can give priorities to those who have booked such resources. Provision of real-time traffic information, as described above, will improve the planning and support more reliable deliveries. The cargo-vehicle communication and monitoring services developed in SMARTFREIGHT will in addition impact how cargo is treated by giving the transport users more control and monitoring possibilities of the cargo during the transport. The solutions will also give potential impacts into the concept of Intelligent Cargo, which deals with self-aware cargo with processing and communication capabilities.

Impact for the traffic management

Traditionally, the traffic management has monitored and controlled flows of vehicle. Through the SMARTFREIGHT solutions the traffic management are presented for mechanisms that allow monitoring and control of individual vehicles. Traffic management information is given to vehicles based on generic and technology independent services over CALM, which gives an ICT infrastructure independent implementation. Automatic detection of incidents and traffic violations, and increased awareness for emergency preparedness are important effects that are provided by the solutions.

The APA policy is a mean for the traffic management for both pro-active measures, but also during traffic situations that require special handling like e.g. accidents, road works, congestion, etc. The possibility to define strategies for the handling of all such situations in one single format is very beneficial both for planning and day-to-day operations. The policy was tested in the Trondheim demonstration, but it is designed to be scalable for larger cities as well since it can use a hierarchical structure where a city is divided into several Controlled Areas with different APA policies.

The Trondheim demonstration showed, among others, how state-of-the-art roadside equipment based on CVIS/CALM and short range 5.9 GHz communications can be used to i.a. manage a tunnel and the traffic inside. However, the SMARTFREIGHT solutions and the underlying CALM protocol framework are independent of the ICT infrastructure. While some functionality will be lost, the services can be deployed in most European cities due to the support of cellular technology like 2G and 3G communication. Avoiding large-scale infrastructure changes is in many places a requirement for new traffic management services. Automated detection of violations will benefit reliable transport companies that comply with the desired behaviour

Impact for the society

A better control of “all” freight distribution vehicles in the city, improved information exchange, and traffic management measures for individual freight vehicles are aspects that will improve the way transportation impacts the society. Transportation in urban areas affects the society as it closely operates where people work and live. The SMARTFREIGHT results have targeted the mentioned aspects, and have as a result made a potential impact on the society related to:

- **Safety**: The traffic management measures developed have especially targeted dangerous goods and how the transport of such cargo both can be monitored and controlled. Pro-active measures can be taken to avoid accidents, and the management of incidents and accidents can be managed in a better way due to improved awareness about the situation. Monitoring and control of cargo is not restricted to cargo classified as dangerous cargo, and also not to only cargo; all vehicles and all types of cargo can in principle be supported. The monitoring and control of specific vehicle and cargo properties are part of the generic traffic control measure defined by the APA policy, which targets both pro-active and dynamic safety management.
- **Environment**: Freight vehicles typically produce more noise and pollution than passenger cars. While some freight vehicles have new propulsion technology, there are still many high polluting vehicles. SMARTFREIGHT enables the traffic management to monitor and control individual freight vehicles based on their characteristics, including environmental properties like engine type and class and filling percentage. Consequently, such traffic management measures can protect sensitive areas and distribute the traffic according to settlements and appropriate transportation infrastructure. In the long term, transport operators will have to adapt accordingly with more environmental friendly freight vehicles in order to enter low emission areas.
- **Transport costs**: Standardised information exchange, enabled by the SMARTFREIGHT open service interfaces, may reduce the current need for different proprietary in-vehicle systems. The investment costs may be reduced, and this will in the long term affect the costs for transport users. Better planning and route calculations may improve the margins for the transport operators, and may also in the long term lead to lower costs.
- **Transport optimization**: The urban freight distribution can be improved based on real-time information from the SMARTFREIGHT integrated network of cargo, vehicles and stakeholders. Routes, load factor, deliveries and pick-ups can me optimised in a way that gives considerable effects on the transport efficiency and the traffic flow in cities.
- **Transport reliability and quality**: The consignors and consignees can due to new traffic management measures, improved planning, and real-time status information expect more reliable transport services. The cargo monitoring will also ensure better quality on the transport as both freight managers and cargo owners and receivers may follow the cargo and its condition and handling closely.
- **New services**: Open and standardized ICT will arrange for new and improved services to the buyers of transport services that may have positive effects on their businesses, e.g. improved tracking, improved status and condition information, and related traffic information.

3.3 European policies and standards impact

The impact of the SMARTFREIGHT results on the longer term strategic objectives is twofold. Firstly, the results may impact the strategic policies set by the policy makers, and secondly, the results may impact the standards defined by organizations like ETSI and ISO.

Impact on the Common Framework for Information and Communication Systems in Transport and Logistics[1]

The Common Framework for Information and Communication Systems in Transport and Logistics (in short called Common Framework) is an initiative taken by different projects within the DGs INFSO, MOVE and ENTERPRISE, and SMARTFREIGHT is one of these. The main objective is to support the exchange of information between stakeholders in freight transport and logistics through improvement of the interoperability between the systems deployed in the sector. This initiative has emerged by seeing that cooperation will benefit all stakeholders involved – both from a research and an industrial point of view.

The SMARTFREIGHT framework architecture covers several of the targeted areas, and constitutes parts of the Common Framework that so far have been missing: Freight operator's transport operation management, traffic management, on-board management – and the combination of these, especially those issues related to cooperative systems. In the SMARTFREIGHT framework architecture, the OGE is also adapted to and provides an initial approach to the intelligent cargo concept. However, much more work remains on this issue within the Common Framework.

Impact on the ITS Action Plan

The scope of the ITS Action Plan is to accelerate and coordinate the deployment of ITS in road transport, including interfaces to other transport modes. The SMARTFREIGHT architecture, the on-board and on-goods prototypes and the specified interfaces together support many of the actions listed in the ITS Action Plan. The SMARTFREIGHT architecture is a good starting point for the harmonised information exchange asked for by the ITS Action Plan, and it is also a part of the Common Framework and is related to the EasyWay architecture. The developed services and applications can either be the ones asked for in the ITS Action Plan, or be good starting points for further developments and refinements.

Impact on ETSI standardization of V2X applications and use cases

ETSI has defined a set of basic applications[2] as guidelines for European wide deployment. The SMARTFREIGHT applications may impact the further work for defining the set of basic applications as SMARTFREIGHT provides a generic and holistic approach to the applications, and also on how the set of applications will be realized.

Impact on ISO standardization of CALM MAIL

On a global scale, CALM MAIL is under standardization in the ISO TC204 WG16[3]. The standard is applicable to the DSRC standards in Japan, Korea and Europe. SMARTFREIGHT has, through the implementation of the CALM MAIL protocol for communication between the on-board equipment and the on-goods-equipment, provided input to the CALM MAIL standardisation process, and this input will be brought into the next revision of ISO/DIS 24103.

---

[1] One Common Framework for Information and Communication Systems in Transport and Logistics, version 1.0. Available [online]: http://www.intelligentcargo.eu/node/55

[2] ETSI TR 102 638 v1.1.1: Intelligent Transport Systems (ITS): Vehicular Communications; Basic Set of Applications; Definitions, Technical Report, ETSI TC ITS, June 2009.

[3] ISO/DIS 24103:2009 Intelligent transport systems -- Communications access for land mobiles (CALM) -- Media adapted interface layer (MAIL), ISO TC204, 2009.

Impact on the Future Internet

In EU's ICT work programme 2011, transport is identified as a research area related to the future Internet[1]. SMARTFREIGHT support thematic concepts like *Internet of Things* (IoT), and *Internet of Services* (IoS) within the future Internet. The concept of IoT opens for a transport sector where "everything" is equipped with information and communication technology and more or less continuously connected, while the concept of IoS opens for a transport sector where the same *things* provide services to each other.

SMARTFREIGHT impacts both the concepts of IoT and IoS by integrating *things* (i.e. cargo, and vehicles to the back office systems) and *services* (i.e. through open service interfaces) over continuously available Internet accesses by using CALM and IPv6.

Impact on the further development of cooperative systems

The concept of Cooperative Systems as used within the scope of ITS, targets how vehicles are connected with each other and with the roadside infrastructure. Proof-of-concept applications and services that demonstrate the interoperability are developed through activities like CVIS and the CALM standardization. However, holistic solutions that integrate the vehicles with the backend systems like urban traffic management systems (UTMSs) and freight distribution management systems (FDMSs) have to a lesser degree been targeted by initiatives defined under the concept of cooperative systems. SMARTFREIGHT has here taken the cooperative systems concept further. The missing integration is addressed by means of transportation network concepts; a top-down approach that takes the whole transport sector into consideration; and open service interfaces that arrange for interoperability between in-vehicle systems and existing UTMSs and FDMSs.

SMARTFREIGHT has enables traffic management measures towards individual vehicles, depending on their individual properties. The interactions with the vehicles and cargo can also improve the awareness about the traffic situation (e.g. dangerous goods inside tunnels) and data collection for traffic statistics. The information exchange with the cargo puts SMARTFREIGHT in the border of the Intelligent Cargo concept as well. There are many commercial solutions that integrate the cargo with the vehicle by using RFID-based technologies. The novel issue in SMARTFREIGHT is the use of the ISO CALM MAIL standard for information exchange over the 5.9 GHz short ranged CEN DSRC. DSRC is an accurate and reliable technology with low power consumption, which is a promising technology to impact the field of both cooperative systems and intelligent cargo.

[1] Future Internet is a summarising term for the further development of the original Internet, and focus is on critical shortcomings such as performance, reliability, scalability, security as well as societal, economical and business related aspects.

3.4 Dissemination activities

Extensive information can be found in:
D8.1 Dissemination plan
The deliverable is public, and is available on the project website at: www.smartfreight.info

Date	Type	Title	Journal / Event	Location
02-2008	Briefing	*SMARTFREIGHT Project kicks off*	Info POLIS newsletter	n.a
04-2008	Briefing	*SMARTFREIGHT project website online*	Info POLIS newsletter	n.a
04-2008	Publication	*SMARTFREIGHT in Dublin*	Services Engineering	n.a
05-2008	Presentation	*SMARTFREIGHT and Freight in Dublin*	Bestufs II national seminar	Dublin, IE
05-2008	Leaflet	*n.a*	PROMIT workshop	Southampton, UK
05-2008	Leaflet	*n.a*	ITS Polish Congress	Warsaw, PL
05-2008	Presentation, leaflet	*Co-operation between Urban Traffic Management and Freight Distribution Management Systems*	SMARTFREIGHT - Managing freight more effectively through co-ordinated Traffic and Freight Distribution Management	Southampton, UK
06-2008	Presentation	*Supporting intermodality by ICT: the experience of Bologna*	7th ITS Europe	Geneva, CH
06-2008	Presentation, leaflet	*SMARTFREIGHT*	7th ITS Europe	Geneva, CH
06-2008	Leaflet	*n.a*	Bestufs II Final Conference	Athens, GR
07-2008	Briefing	*SMARTFREIGHT Reference Group discusses freight needs*	Info POLIS newsletter	n.a
09-2008	Leaflet	*n.a*	Traffic Control, WiMAX Communication Systems and Traveller Information for Public Transport and Freight Logistics	Reading, UK
09-2008	Presentation	*The SMARTFREIGHT Project*	ITS on Road	Trondheim, NO
10-.2008	Presentation	*The SMARTFREIGHT Project*	Sustainable Freight Workshop (innovITS)	London, UK
10-.2008	Publication	*Towards Rational delivery*	ITS Solutions	n.a
10-.2008	Presentation	*The SMARTFREIGHT Project*	Annual Norwegian Transportation and Logistics Conference	Oslo, NO
10-.2008	Presentation, leaflet	*SMARTFREIGHT : Transporte Inteligente de Mercancías en entornos urbanos*	ITS Spain	Oviedo, ES
11-2008	Presentation	*SMARTFREIGHT*	ICT in Transport Logistics workshop (EURIDICE-Good Route projects)	Lucerne, CH
11-2008	Publication	*Tenker, lyttern snakker*	www.adressa.no/forbruker/bil/article118444 3.ece	n.a.
11-2008	Publication, Presentation, leaflet	*Smart Freight Transport in urban areas*	15th World Congress on ITS	New York, US
11-2008	Presentation, leaflet	*Smart Freight Transport in urban areas*	Annual POLIS Conference	Barcelona, ES
11-2008	Presentation	*City logistics in Bologna: actual scenario and future perspectives*	City Logistics Expo	Padova, IT
03-2009	Presentation, leaflet	*ITS and the Freight Delivery Plan of Bologna*	Kick-off Meeting of the SUGAR project	Bologna, IT
03-2009	Stand, leaflet	*SMARTFREIGHT*	ICT For Energy Efficiency	Brussels, BE
04-2009	Briefing	*SMARTFREIGHT at the ICT 2020 Energy Efficiency Event*	Info POLIS newsletter	n.a
06-2009	Presentation	*The Freight Distribution Plan and the access to the Environmental Zone in the City of Bologna*	I National Congress on Mobility and Goods Distribution	Madrid, ES
09-2009	Presentation	*Modelling the impacts of shared freight-public transport lanes in urban centres*	Logistics Research Network conference	Cardiff, UK
09-2009	Presentation	*Technologies for Sustainable Mobility'*	European Mobility Week 2009	Bologna, IT

		and 'The Van Sharing project of the City of Bologna'		
09-2009	Publication, Presentation	*SMARTFREIGHT -a generic approach to ITS for smart urban freight distribution*	16th ITS World Congress Stockholm	Stockholm, SE
09-2009	Presentation, leaflet	*SMARTFREIGHT - smart freight transport in urban areas*	16th ITS World Congress Stockholm	Stockholm, SE
10-2009	Presentation	*La regolazione degli accessi e la distribuzione urbana delle merci del Comune di Bologna*	Mobility Tech-International Forum on Technological Innovation for Mobility and Transport Improvement	Milan, IT
10-2009	Presentation	SMARTFREIGHT	2nd European Conference on ICT for Transport Logistics (ECITL)	Venice, IT
10-2009	Briefing	*SMARTFREIGHT consultation and ICT for Energy Efficiency Award*	Info POLIS newsletter	n.a
11-2009	Presentation, leaflet	*Freight Issues & Smart Solutions*	FTA meeting	Dublin, IE
12-2009	Presentation	SMARTFREIGHT	ACIDD Intermediary Conference	Strasbourg, FR
12-2009	Presentation, leaflet	*Strategies for a new urban mobility in Bologna*	Site visit -Representatives of the Flemish Government	Bologna, IT
12-2009	Presentation	*Projects for City Logistics*	International Conference on 'Mobility and City Logistics -local productive contest'	Bologna, IT
12-2009	Presentation	*Traffic Control Centre in Bologna (CISIUM)*	Site visit -Representatives of the Utrecht Public Authorities	Utrecht, NL
12-2009	Publication	*Semáforos que ayudan al conductor*	Newsletter El Mundo	n.a
02-2010	Presentation	*The SMARTFREIGHT Project*	Green Logistics Final Event	Brussels, BE
02-2010	Presentation	*Projects for City Logistics*	Meeting of the National Confederation of Crafts and SMEs	Bologna, IT
02-2010	Presentation, leaflet	*The SMARTFREIGHT Project*	POLIS-CIVITAS CATALIST urban freight workshop	Brussels, BE
03-2010	Presentation	*Smarfreight Concepts*	Discussions at the Green Logistics Consortium Meeting	Edinburgh, UK
03-2010	Presentation	*The Sustainable Business Partnership*	Green Logistics -Sustainable take-back options	Winchester, UK
09-2010	Presentation	*Loading Bay Booking and Control for Urban Freight*	Logistics Research Network Conference	Harrogate, UK
09-2010	Presentation	*Transporte de mercancías inteligente en áreas urbana*	Info day FP7 Spanish Ministry of Science	Madrid, ES
09-2010	Presentation	*European Projects on Urban Freight*	ITS Bretagne Congress	Saint Brieuc, FR
10-2010	Presentation	*(several presentations)*	SMARTFREIGHT Final Conference	Trondheim, NO
11-2010	Presentation, leaflet	*Relating the intelligent cargo concepts and technology into the CVIS platform*	European Conference on ICT for Transport and Logistics (ECITL'10)	Bremen, DE
11-2010	Presentation	*Intelligent freight Transport in Urban Areas*	ICT4LOG Conference	Zaragoza, ES
11-2010	Leaflet	*n.a.*	Annual POLIS Conference	Dresden, DE
04-2011	Presentation	*SMARTFREIGHT - Smart freight transport in urban areas*	Progress in the freight transport in urban area	Santander, ES
04-2011	Publication	*SMARTFREIGHT*	Webpage article: http://www.ptcarretera.es	*n.a.*
04-2011	Publication	*Impact evaluation of the new concepts*	Fact sheet: www.SMARTFREIGHT .info	*n.a.*
04-2011	Publication	*Proof of concept and verification of ICT solutions*	Fact sheet: www.SMARTFREIGHT .info	*n.a.*
04-2011	Publication	*Freight transport challenges and requirements*	Fact sheet: www.SMARTFREIGHT .info	*n.a.*
04-2011	Publication	*Software development*	Fact sheet: www.SMARTFREIGHT .info	*n.a.*
04-2011	Publication	*The SMARTFREIGHT framework architecture*	Fact sheet: www.SMARTFREIGHT .info	*n.a.*
05-2011	Publication	*SMARTFREIGHT*	Web: http://www.tecnocarreteras.es	*n.a.*
06-2011	Publication, Presentation	*Smarter Tunnels*	Symposium on Tunnels and ITS	Bergen, NO

06-2011	Publication, Presentation	*Cooperative Systems for Enhanced Tunnel Safety*	Symposium on Tunnels and ITS	Bergen, NO
06-2011	Presentation	*Cooperative Systems and an Integral Part of City Freight Logistics*	8th ITS Europe	Lyon, FR

3.5 Exploitation of results

In terms of exploitation strategies, we can differentiate between three different types of stakeholders in SMARTFREIGHT consortium: Technological partners, research institutions and public authorities and associations. Depending on the type of partner, the exploitation interests and impact are different. In addition standardisation will be emphasized as described in section 3.3.

Extensive information can be found in:
D9.3 Exploitation plan
The deliverable is public, and is available on the project website at: www.SMARTFREIGHT .info

Technology partners

Their main interests of Q-Free and ETRA in exploitation of SMARTFREIGHT are to improve their current business position in the existing markets or on preparing their inclusion into new markets, and guarantee a strong position in these areas. Based on the new knowledge acquired, both Q-Free and ETRA will continue working in national and international research projects to further develop the applications and systems demonstrated during the project. The SMARTFREIGHT results will thus need some time before being available as commercial products.

Academic partners

The exploitation goals of SMARTFREIGHT academic partners (SOTON-TRG, Chalmers and SINTEF) are complementary to those of industrial partners. The technical developments and knowledge acquired during the project will be integrated into their teaching and research programmes, giving themselves a competitive edge, especially with respect to other universities. Academic partners will also make sure that these results are carried into future national and international research projects. In addition, by publishing papers about SMARTFREIGHT results in different events as congress, symposiums, newspapers or web pages, they will obtain international visibility and improve their position in attracting the best international PhD, Master and graduate level students to their institutions.

Public authorities and associations in general

The interests and priorities of NPRA, COBO, DTO/NTA, POLIS and ADL are related to implementing SMARTFREIGHT results in acquiring safer and cleaner cities, reducing the problems in congestions, loading and parking. See more detailed information for the cities below.

The focuses of SMARTFREIGHT have many parallels to the same challenges in inter-urban traffic as addressed by the EasyWay project. Thus, the SMARTFREIGHT results can be exploited in within this context.

Bologna

The main features improved thanks to the SMARTFREIGHT concept are:

- Distributed and modular architecture: the existing Van Sharing platform receives contributions via web services (using DATEX protocol) by the local traffic control centre regarding traffic events;
- Assessment of features provided to different users (to the municipality for freight monitoring, to the shopkeepers for good demands, to the freight distributors for delivery services);
- Clear and reliable technological framework

The SMARTFREIGHT concept will be used to improve architecture and algorithms of the Van Sharing platform. Without the SMARTFREIGHT project and results collected in terms of new data and knowledge acquired, probably the Van Sharing platform would have been realised at a very

later time or even it would not be carried out at all. The Van Sharing platform is performing effectively and the overall Van Sharing aims have been accomplished in practice, which is an extraordinary success with respect to the expectations regarding the SMARTFREIGHT project simulation in Bologna. Freight flow aggregation, combined with integration to advanced Urban Traffic Management Systems and the availability of Bookable Loading bays is confirmed to be a very effective approach to achieve:

- economically efficient pick-up and delivery service within city centres;
- reduction of traffic in the city context;
- reduction of pollution, and thus reduction of environmental impact;
- more efficient overall usage of parking spaces in the city.

Dublin

The information and knowledge extracted from SMARTFREIGHT, particularly from WP2, will aid the development of the NTA Transport Strategy for the GDA, and will also play a part in further studies, both undertaken independently by the NTA, and in collaboration with other Irish government agencies/local authorities.

The NTA has recently begun collaborating with Dublin City Council on an urban consolidation project investigating the potential use of sustainable vehicles in the city centre. This project is still at an early stage, but it will look at the potential for an inner city freight distribution centre, which will act as a depot for smaller freight vehicles (cargo-bikes and electric vehicles). The project will draw on the information and knowledge extract from the SMARTFREIGHT project, and the data gathered in WP2 and WP3 is currently being interrogated to add a robust supporting analysis of the potential for such a scheme in the Dublin City Council area. The NTA has also benefited from SMARTFREIGHT by getting an opportunity to review and evaluate new technologies and innovations related to freight distribution management. These technologies, although not immediately applicable to the Irish context, do present ideas and direction to future freight (and other traffic/utility) management in the future, particularly in Dublin City Centre.

Trondheim and other Norwegian cities

Several major cities in Norway want to establish a charging scheme for HGV entering city centres, based on environmental parameters of the vehicles (Euro class). E.g. fee for highest Euro class with increasing fee for lover classes. There might be denied access for old vehicles with high emissions. SMARTFREIGHT have functionality for these services.

In Trondheim the main route from south to terminal area is through the city centre. There is discussion on routing the freight transport to the terminal area using new road network under construction. The SMARTFREIGHT concepts are suitable for this individual information and guidance. Since this route involves several city tunnels the authorities needs to monitor and track transports with dangerous goods thru this traffic systems.

Norway has a lot of tunnels also in the main road network in the large cities. The authorities want for information and systems for monitoring and managing transport of dangerous goods in these tunnels. SMARTFREIGHT give concepts for such systems.

All major cities in Norway have high priority for busses and public transport often in dedicated bus lanes. There is an on-going debate about giving priority to commercial transport. This can be done by use spare capacity in bus lanes and/or priority in signal systems. Such priority will only be given to individual vehicles fulfilling policy and criteria given by the authorities.

In the immediate future the results of the SMARTFREIGHT project will be used in new R&D activities and projects. These projects may be both domestic and European. Through these projects the knowledge accumulated in SMARTFREIGHT will be put to use in a local Norwegian setting.

Already there are initiatives for such projects financed by the Norwegian Research Council, and during the next couple of years the amount of projects using SMARTFREIGHT knowledge and technology will increase.

4 Website and contact details

The SMARTFREIGHT Web-site is: www.smartfreight .info

Contact details are:

Coordinator:

Hans Westerheim
SINTEF ICT
N-7465 Trondheim
Norway.

email: hans.westerheim@sintef.no
Phone: 73592965

5 Use and dissemination of foreground

5.1 Section A (public)

SMARTFREIGHT has not produced any paper of this kind.

5.2 Section B (Confidential[16] or public: confidential information to be marked clearly)

5.2.1 Part B1

This part is not applicable for SMARTFREIGHT.

[16] Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

5.2.2 Part B2

Type of Exploitable Foreground[17]	**Description of exploitable foreground**	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	**Exploitable product(s) or measure(s)**	**Sector(s) of application**[18]	**Timetable, commercial or any other use**	**Patents or other IPR exploitation (licences)**	**Owner & Other Beneficiary(s) involved**
GENERAL ADVANCEMENT OF KNOWLEDGE	D3.2: PROTOTYPE ENABLING TESTING	YES	20/10/2010	APPLICATION SOFTWARE	FREIGHT TRANSPORT BY ROAD	N.A.	NO	SINTEF, ETRA
GENERAL ADVANCEMENT OF KNOWLEDGE	D4.1: PROTOTYPE ON-BOARD EQUIPMENT	YES	20/10/2010	HARDWARE	FREIGHT TRANSPORT BY ROAD	N.A.	NO	Q-FREE
GENERAL ADVANCEMENT OF KNOWLEDGE	D4.2: PROTOTYPE ON-CARGO EQUIPMENT	YES	20/10/2010	HARDWARE	FREIGHT TRANSPORT BY ROAD	N.A.	NO	Q-FREE
GENERAL ADVANCEMENT OF KNOWLEDGE	D4.3: PROTOTYPE ON-BOARD APPLICATION	YES	20/10/2010	APPLICATION SOFTWARE	FREIGHT TRANSPORT BY ROAD	N.A.	NO	Q-FREE

[19] A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

[18] A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

The table above gives an overview of the IPR in SMARTFREIGHT. In more detail:

- **D3.2 Prototype enabling testing**
  - *Purpose*: This is software for testing and demonstrating the back office functionality when integrated with cargo and vehicles.
  - *Possible exploitation*: Can be used to show the potential of cooperative system by also including back offices. Will probably be included in demonstrations run by SINTEF and Q-Free. Must be further developed to be useable for scientific analysis.
  - *IPR exploitable measures*: None.
  - *Further research*: Will be extended through other research projects, e.g. the national research project GOFER.
  - *Impact*: The prototypes are a first step towards quantifying back office effects of cooperative systems.
- **D4.1 Prototype on-board equipment**
  - *Purpose*: Extended the CVIS on-board equipment with DSRC reader to communicate with the cargo's on-goods equipment.
  - *Possible exploitation*: Cargo-to-vehicle communication will be more used in coming years. Here, DSRC is investigated as a potential bearer, and could give Q-Free more usage areas of their automatic toll collection technology.
  - *IPR exploitable measures*: None.
  - *Further research*: The communication protocol using DSCR must be extended to better cope with the cargo-vehicle binding.
  - *Impact*: The benefits with DSRC may impact on which RFID kind of technology that will be most used for cargo-vehicle communication.
- **D4.2 Prototype on-cargo equipment**
  - *Purpose*: Development of means for cargo to sense condition and communicate this information.
  - *Possible exploitation*: As more control and decisions are distributed to the cargo, the cargo must be able to process, store and communicate relevant information. The on-goods equipment will as a first step to be taken further in research project by Q-Free.
  - *IPR exploitable measures*: None.
  - *Further research*: The on-goods equipment is currently on a research level, which means that further refinements are necessary before any commercial use.
  - *Impact*: The on-goods equipment realizes simple, but required, functionality within the concept of *Intelligent Cargo*. It further demonstrates how DSRC can be used for the cargo-vehicle communication.
- **D4.3 Prototype on-board application**
  - *Purpose*: This is software for testing and demonstrating the cargo and vehicle functionality when integrated with back office systems.
  - *Possible exploitation*: Can be used to show the potential of cooperative system when also back offices are included. Will probably be included in demonstrations run by SINTEF and Q-Free. Must be further developed to be useable for scientific analysis.
  - *IPR exploitable measures*: None.
  - *Further research*: As all in-vehicle applications must consider the human-machine interface, the applications developed must be extended to cover this aspect.
  - *Impact*: The applications are prototypes that show how cargo-vehicle-infrastructure communication may improve both traffic and freight management.

6 Report on societal implications

A General Information *(completed automatically when **Grant Agreement number** is entered.*

Grant Agreement Number:	FP7-216353
Title of Project:	SMARTFREIGHT
Name and Title of Coordinator:	Hans Westerheim, Senior Adviser

B Ethics

1. Did your project undergo an Ethics Review (and/or Screening)? • If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 *'Work Progress and Achievements'*	***No***
2. Please indicate whether your project involved any of the following issues (tick box) :	
RESEARCH ON HUMANS	
• Did the project involve children?	NO
• Did the project involve patients?	NO
• Did the project involve persons not able to give consent?	NO
• Did the project involve adult healthy volunteers?	NO
• Did the project involve Human genetic material?	NO
• Did the project involve Human biological samples?	NO
• Did the project involve Human data collection?	NO
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	NO
• Did the project involve Human Foetal Tissue / Cells?	NO
• Did the project involve Human Embryonic Stem Cells (hESCs)?	NO
• Did the project on human Embryonic Stem Cells involve cells in culture?	NO
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	NO
PRIVACY	

• Did the project involve processing of genetic information or personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	NO
• Did the project involve tracking the location or observation of people?	
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	NO
• Were those animals transgenic small laboratory animals?	NO
• Were those animals transgenic farm animals?	NO
• Were those animals cloned farm animals?	NO
• Were those animals non-human primates?	NO
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Did the project involve the use of local resources (genetic, animal, plant etc.)?	NO
• Was the project of benefit to local community (capacity building, access to healthcare, education etc.)?	NO
DUAL USE	
• Research having direct military use	NO
• Research having the potential for terrorist abuse	NO

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	0	1
Work package leaders	3	4
Experienced researchers (i.e. PhD holders)	0	5
PhD Students	0	0
Other		

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	**0**
Of which, indicate the number of men:	0

D Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project?	○ Yes X No	

6. Which of the following actions did you carry out and how effective were they?

		Not at all effective				Very effective
❑	Design and implement an equal opportunity policy	○	○	○	○	○
❑	Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑	Organise conferences and workshops on gender	○	○	○	○	○
❑	Actions to improve work-life balance	○	○	○	○	○
○	Other:					

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

X No

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

○ Yes- please specify

X No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

○ Yes- please specify

X No

F Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

X Main discipline[19]: Information Society

X Associated discipline[19]: Transport ○ Associated discipline[19]:

G Engaging with Civil society and policy makers

11a Did your project engage with societal actors beyond the research community? *(if 'No', go to Question 14)*	○ Yes X No	

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

○ No

○ Yes- in determining what research should be performed

○ Yes - in implementing the research

[19] Insert number from list below (Frascati Manual).

○ Yes, in communicating /disseminating / using the results of the project		
11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	○ ○	Yes No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- ○ Yes- in framing the research agenda
- ○ Yes - in implementing the research agenda
- ○ Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- ○ Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

Agriculture		Energy		Human rights	
Audiovisual and Media		Enlargement		Information Society	
Budget		Enterprise		Institutional affairs	
Competition		Environment		Internal Market	
Consumers		External Relations		Justice, freedom and security	
Culture		External Trade		Public Health	
Customs		Fisheries and Maritime Affairs		Regional Policy	
Development Economic and Monetary Affairs		Food Safety		Research and Innovation	
Education, Training, Youth		Foreign and Security Policy		Space	
Employment and Social Affairs		Fraud		Taxation	
		Humanitarian aid		Transport	

13c If Yes, at which level?

- ○ Local / regional levels
- ○ National level
- ○ European level
- ○ International level

H Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	**0**
To how many of these is open access[20] provided?	
How many of these are published in open access journals?	
How many of these are published in open repositories?	
To how many of these is open access not provided?	
Please check all applicable reasons for not providing open access:	
❑ publisher's licensing agreement would not permit publishing in a repository ❑ no suitable repository available ❑ no suitable open access journal available ❑ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other[21]: ……	

15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*		**0**
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	**0**
	Registered design	**0**
	Other	**0**
17. How many spin-off companies were created / are planned as a direct result of the project?		**0**
Indicate the approximate number of additional jobs in these companies:		

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

❑	Increase in employment, or	X	In small & medium-sized enterprises
❑	Safeguard employment, or	X	In large companies
❑	Decrease in employment,	❑	None of the above / not relevant to the project
X	Difficult to estimate / not possible to quantify		

[20] Open Access is defined as free of charge access for anyone via Internet.

[21] For instance: classification for security project.

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:*
Difficult to estimate / not possible to quantify X	❑

I Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

○ Yes X No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

○ Yes X No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

❑	Press Release	❑	Coverage in specialist press
X	Media briefing	❑	Coverage in general (non-specialist) press
❑	TV coverage / report	X	Coverage in national press
❑	Radio coverage / report	❑	Coverage in international press
X	Brochures /posters / flyers	X	Website for the general public / internet
X	DVD /Film /Multimedia	❑	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

❑	Language of the coordinator	X	English
❑	Other language(s)		

***Question F-10*:** Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES

X Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]

1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)

1.3 Chemical sciences (chemistry, other allied subjects)

1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)

1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2ENGINEERING AND TECHNOLOGY

2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

X Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]

2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. SOCIAL SCIENCES

5.1 Psychology

5.2 Economics

5.3 Educational sciences (education and training and other allied subjects)

5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary , methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature (ancient and modern)

6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]