Cooperative Logistics for Sustainable Mobility of Goods
Maria Pia Fanti1, Giorgio Iacobellis1, Angelica Gallone1, and Noemi Augenti1

1Department of Electrical and Electronic Engineering, Polytechnic of Bari
{mariapia.fanti,giorgio.iacobellis}@poliba.it, angelicagallone@libero.it, noemi.aug@hotmail.it.

Abstract. Road freight transport has grown dramatically over the last 20 years. The process chain for the delivery of freight uses mainly conventional methods, partly due to the diversity of parties and the small size of many companies involved.

The Polytechnic of Bari (the Laboratory of Automation and Control) is partner of European CIP project of the seventh framework program “Cooperative Logistics for sustainable mobility of goods - CO-GISTICS”.

CO-GISTICS deploys and integrates cloud-services in seven logistics hubs, with cooperative systems technologies, to support and enhance the logistic process and the effectiveness of the fleet to substantially improve the results of the transportation community, economically as well as in sustainability.

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1 Introduction

Road freight transport has grown dramatically during the past two decades, both internally in the EU and for external trade. European logistics stakeholders are under increased pressure to reduce impact their operations have on the environment and increase road safety, at the same time as they are put under strong economic challenges, with profit margins being minimal. According to European Environment Agency, road transport is responsible for 72% of the CO2 emissions from the overall transport in Europe. A vast amount of technologies (systems and services) are already
available today to manage different aspects of goods movements (from fleet management, to traffic operations management to e.g. ferry terminal operations). However, these existing systems are currently not linked to each other, thus missing the opportunity to optimize the performance of their cooperation, thus leaving a large room for improving certain aspects of goods management, e.g. and guaranteeing reliable real-time information exchange for goods movements between transport modes.

This paper describes the project CO-GISTICS, the first European project fully dedicated to the deployment of cooperative intelligent transport systems applied to logistics. With 33 partners including public authorities, fleet operators, trucks, freight forwarders, terminal operators and logistics providers, the CO-GISTICS consortium will install the services on at least 325 vehicles and will run for 3 years (2014-2016).

We focus on the main objects of the project: five services and activities directed to create cooperation with third parties, stakeholders, as well as with other European and international initiatives. In particular, we enlighten the important and basic role of the Polytechnic of Bari in the project development with the specification and design of a Decision Support Systems that adds intelligence to the proposed services.

This contribution is organized as follows. Section 2 describes the project aim and the partnership. Moreover, Section 3 presents the pilot site in which is involved the Polytechnic of Bari and its responsibilities. Finally, section 4 reports the conclusions.

2 The Project

CO-GISTICS is the first European project fully dedicated to the deployment of cooperative intelligent transport systems (C-ITS) applied to logistics. The Main objective of CO-GISTICS are [1]:

• to effectively increase energy efficiency by reducing fuel consumption and equivalent CO2 emission and lower pollution for sustainable mobility of goods;
• to improve the efficiency of logistics through the convergence of Machine to Machine (M2M) communication and cooperative systems technologies.

To achieve these goals public authorities, fleet operators, freight forwarders, industrial partners and other stakeholders will jointly implement the following five piloted services (see Fig. 1):

• intelligent truck parking and delivery areas management, i.e., optimising the vehicle stops along their route, the delivery of goods in urban areas and the interface with other modes of transport;
• multimodal cargo, i.e., supporting planning and synchronisation between different transport modes during the various logistic operations;
• CO2 footprint estimation and monitoring, i.e., measuring the CO2 output of the vehicles and providing an estimation of CO2 emissions of specific cargo operation;
• **priority and speed advice**, i.e., saving fuel consumption, reducing emissions and heavy vehicle presence in urban areas;

• **eco-drive support**, i.e., supporting truck drivers in adopting a more energy efficient driving style and therefore reducing fuel consumption and CO2 emissions.

These services have been chosen based on:

• the **actual needs of the key stakeholders** setting up strategies in pilot sites;

• **service's potential in bringing concrete benefits** in terms of increasing energy efficiency, reduced CO2 emissions but as well increased road security thus supporting wider sustainability of these services;

• **technical maturity** level of the pre-selected services.

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![Fig. 1. CO-GISTICS Services](image1)

![Fig. 2. CO-GISTICS pilot sites](image2)
The services will be deployed and piloted in seven pilot sites across Europe (see Fig. 2). Each of these sites has been chosen for their specific suitability to strongly contribute to deployment of cooperative logistics services and intelligent cargo.

- **France – Bordeaux** (Harbour) is an important logistics hub, while the City of Bordeaux is one of the early adopters of cooperative services in Compass4D.
- **Germany – Frankfurt** (Airport) is a major intermodal hub in Europe.
- **Greece – Thessaloniki** has a strong background in implementing state-of-the-art logistics concepts.
- **Italy – Trieste** (Harbour and Rail) is an intermodal hub between road, sea and rail connections.
- **Romania – Arad** represents one of the Eastern European fleets driving across the continent.
- **Spain – Bilbao** has strong background in urban logistics and mobility pilots.
- **Spain – Vigo** is one of the leading centers for development and deployment of cooperative services in Europe.

### 3 Polytechnic of Bari Contribution

The Polytechnic of Bari is a partner of CO-GISTICS and collaborates for the deployment of the Trieste pilot site and in particular the specification of a Decision Support System (DSS).

#### 3.1 Trieste Pilot Site

Trieste is a cosmopolitan city, the capital of the autonomous region Friuli-Venezia Giulia. The city is part of the TEN-T Core Mediterranean Corridor linking the Iberian Peninsula with the Hungarian-Ukrainian border so to establish closer transport connections between Western and Eastern Europe. The Trieste pilot site will implement all the five CO-GISTICS services to support the daily operation of the Inland Terminal Fernetti. The terminal consists of 24,000 sqm of warehousing and 130,000 sqm of open space for parking/customs bond/storage yards and is directly connected to the railway station of Villa Opicina, authorised for inter-container traffic; the motorway to Venice (route to Italy – Switzerland – France – Spain); Treviso (route to Austria – Germany) and Ljubljana (route to Slovenia – Central Southern Europe). Since June 2012, the whole truck flow (about 100,000 per year) leading to Turkey through the RO-RO shipping system from the port of Trieste, has been organized in such a way as to pass through Fernetti in order to alleviate the heavy city traffic. Such a new flow through Fernetti proposes interesting challenges that could be faced in the
pilot case. In more recent times, the Fernetti terminal activated a RO-RO rail service to and from Salzburg including up to three scheduled departures a day in each direction. Beforehand, the same service originated from the Trieste port. Each train can carry up to twenty trucks. Moving the terminal station from the port to the Fernetti terminal, besides speeding operations and shortening travel times, helped to alleviate congestion problems in the city and the port. This enhances the multimodality aspect of Fernetti, and, at the same time, proposes opportunities to the pilot site in terms of coordination among different modalities.

### 3.2 Trieste Pilot Site Architecture

The pilot architecture represents the system framework that would be realized to achieve the project objectives. It aims to be interoperable and able to model and integrate the different fragmented elements of the CO-GISTICS actors. For this reason, it exhibits a modular and open structure. In detail, an open architecture will allow all elements, existing services, actors and the new applications to co-operate optimizing the transports and allowing a reduction in costs and a significant reduction of CO2 emissions. For that purpose, CO-GISTICS will adopt an open architecture for interoperable cargo, vehicle and infrastructure, supporting real-time adaptive connectivity between physical logistics objects like intelligent cargo, vehicle devices, cooperative traffic management systems and transport infrastructure (including the local sites and related software systems). In order to draw the architecture of the pilot site of Trieste it is necessary to start from the system components and to define how these components interact with one another, then we have to identify which technologies to employ [2]. Therefore, in order to support the specific pilot requirements, the project aims to adapt and implement an effective architecture based on the following modules (see Fig. 3):

- **real system**;
- **devices**;
- **sensors**;
- **actors**;
- **interface and decision module**.

The **real system** represents all the real elements coming from the pilot site of Trieste. The **devices** are the most common devices used nowadays such as Tablets, smartphones, PCs etc. They are very important because they will allow the communication between final users and the CO-GISTICS architecture (services offered).

The **sensors** are the most common and simple sensors such as:
- sensors for environmental monitoring;
- sensors for vehicle management;
- sensors for detection of the plates;
- sensor for the traffic monitoring.
For the Trieste pilot site, the actors (stakeholders) that are involved in the process are:

- the port;
- the inland (dry-port) terminal;
- the highway society;
- the shipping company (agents);
- the transporters (fleet operators).

The interface and decision module represents the communication channel between the services and the actors, in particular it is responsible to:

- collect data coming from all field sensors;
- convert raw data in order to get them usable by the services;
- give back information from the services to the final users;
- offer the possibility to have a decisional-oriented approach inside the pilot architecture.

Such tools provide the basis for the implementation of a Decision Support System (DSS) usable by the service modules. The services module includes the five services to be implemented in CO-GISTICS:

- Intelligent truck parking and delivery areas management;
- Priority and Speed advice;
- Multimodal Cargo;
- CO2 Footprint estimation and monitoring;
- Eco-drive support.
3.3 Decision Support System Structure

The Polytechnic of Bari is responsible of the development of a Decision Support System (DSS), which would support decisions of the actors involved, in order to optimize and improve the system performances and the customer satisfaction.

The DSS is designed to take tactical and operational decisions of the intermodal transport system management by applying the modern Information and Communication Technology (ICT) tools [3]. The DSS is a platform that is devoted to improve the services by adding “intelligence” to them [4]. Tactical decisions are made on a medium-term basis (e.g. monthly or quarterly) and include the off line planning of:

- operations and vehicle scheduling,
- timing, sequencing of resource allocation,
- storage allocation, order picking strategies, transportation mode selection, consolidation strategies etc.,
- parking fare management,
- vehicle routing

Operational decisions are made on a daily basis or in real-time and include warehouse order picking, shipment and vehicle dispatching, booking operations, reactive and rescue actions to unpredictable events (blocking, accidents, hazardous weather, etc.).

The DSS is designed to cooperate with different objects by exchange data and messages: the traffic control centre, the infrastructure, the market place, the fleet management centre, and the emergency centre. Services that may be provided in the pilot Trieste –Feretti for drivers, transport companies, terminal operators and shippers are:

- parking fare management;
- parking management (timing, sequencing, positioning);
- timing, sequencing of resource allocation;
- vehicle routing based on info mobility and weather;
- vehicle routing to and from the port;
- booking operations;
- rescue and emergency actions eco driver support.

Although personal qualifications remain valuable, the increasing complexity of modern business environment and the vast volume of available data that could be taken into account, make the use of advanced modelling and systematic quantitative methods that will be computerized a necessity. One way to accomplish the goal of bringing together the appropriate information and models for informed decision making is to use a DSS. In general we can say that DSSs are computer-based systems that bring together information from a variety of sources, assist in the organization and analysis of information, and facilitate the evaluation of assumptions underlying the use of specific models. In other words, these systems allow decision makers to access relevant data across the organization as they need it to make choices among
alternatives. The DSS allow decision makers to analyze data generated from transaction processing systems and other internal information sources easily. In addition, DSS allow access to information external from the organization. To achieve the decision support, there are three components, which comprise a DSS, as shown in [5]. They are:

- the database;
- the model base;
- the user interface.

The Database, or in advanced systems known as a Data Base Management System (DBMS) or a data warehouse, consists of structured, real-life information, such as customer account records, product sales history, employee schedules, or manufacturing process statistics. The DBMS provides access to data as well as all of the control programs necessary to get those data in the form appropriate for the analysis under consideration without the user programming the effort [6]. The data include facts about internal operations, trends, market research and/or intelligence, and generally available information. The DBMS should be sophisticated enough to give users access to the data even when they do not know where the data are located physically. In addition, the DBMS facilitates the merger of data from different sources. Again, DBMS should be sufficiently sophisticated to merge the data without explicit instructions from the user regarding how one accomplishes that task.

The Model Base, or Model Base Management System (MBMS), contains one or more models for the kind of analysis the system will perform. The MBMS performs a similar task for the models in the DSS [7]. In that way, it keeps track of all of the possible models that might be run during the analysis as well as controls for running the models. This might include the syntax necessary to run the jobs, the format in which the data need to be put prior to running the model (and to put the data in such a format), and the format the data will be in after running the job. The MBMS also links between models so that the output of one model can be the input into another model. Furthermore, the MBMS provides mechanisms for sensitivity analyses of the model after it is run. Finally, the MBMS provides context-sensitive and model-sensitive assistance to help the user question the assumptions of the models to determine if they are appropriate for the decision under consideration [8].

The User Interface provides the decision maker with controls for and possibly feedback about managing the data and the models. In effect, IT provides great power to the decision maker who must know what kind of questions to ask of the information and how to process the information to get those questions answered.
Fig. 4 shows the specific components of the proposed DSS that is composed by:

- **user Interface**: it enables the actors to communicate with the DSS; they pass information and data to the DSS, which are necessary for its computations and decisions. If it is necessary it converts and processes data in order to store them in the correct format;
- **Data Component**: in which are stored data received by the actors involved;
- **Decision Module**: it contains algorithms and models that the DSS uses to make its decisions;
- **Communication Module**: it is similar to the “user interface module” because it permits to pass the DSS decisions to each service.

The last modules in each level of Fig. 4 represent the other pilot sites. Indeed, one of the requirements of CO-GISTICS project is the interoperability between the different pilot sites. As it is shown in Fig. 4, for this “actor”, there are also the other corresponding modules: the user interface module (in Fig. 4 indicates as Other Pilot Sites Interface) and the service (in Fig. 4 indicates as Communication Service). In this way it is possible the data, information, procedures, services exchange between the different pilot sites and it is not necessary that all the pilot sites use the same standard. The interfaces have a function of middle-agent between different actors and so allow communication and use of applications, platforms, programs or data, which have different format or are written in different languages and which also can be physically located in other sites.

The proposed architecture is modular and it is possible to add new actors and/or services (in addition to those one it will be implemented with this project). In our approach the other pilot sites are different actors of the system.
The main advantage of the modular approach is related to possibility to add new actors in a very easy way, all you need is to create a specific interface module for your actors; it is quite similar to the plug and play approach in which you have to create only a diver before to start to use a new device.

4 Conclusions

This contribution presents the aims and the structure of CO-GISTICS, the first European project fully dedicated to the deployment of cooperative intelligent transport systems applied to logistics. With 33 partners including public authorities, fleet operators, trucks, freight forwarders, terminal operators and logistics providers, the CO-GISTICS consortium will install the services on at least 325 vehicles.

In particular, we enlighten the important and basic role of the Polytechnic of Bari in the project development: the Polytechnic is responsible of the Decision Support System, a smart system that has to add intelligence to the services and helps the stakeholder in taking optimal decisions.

References