2010 13th International IEEE
Annual Conference on Intelligent Transportation Systems
Madeira Island, Portugal, September 19-22, 2010

A Networking Platform for Real-Time Monitoring and Rule-Based Control of Transport Fleets and Transferred Goods

Vassilis Kapsalis, Christos Fidas, Loukas Hadellis, Christos Karavasilis, Manolis Galetakis and Christos Katsenos

Abstract— **This paper presents a networking platform which provides real-time monitoring and rule-based control of transport fleets and transferred goods. Special emphasis is given in providing tools and services to fleet administrators, which, among others, comprise an object oriented rule detection mechanism based on the occurrence of predefined events which are fully configurable and are considered important for the freight transport management of dangerous goods. Conceptual and architectural design decisions considering interoperability, reusability, security and modularity issues are presented. Finally, as a proof of concept, a case study is presented in which the proposed platform has been applied to a commercial fleet of fuel and lubricant tank trucks.**

I. INTRODUCTION

TODAY'S wide area wireless networks give transportation companies the ability to have an nationwide always-on data connection at speeds approaching broadband and a way to quickly access critical information about every aspect of their fleet. Together, these tools combined with technological artefacts features a number of benefits, such as increased productivity, cost reduction, improved reliability, service quality, safety and improved shipment integrity. Simultaneously, they help automate and streamline key transportation and logistics business processes, making transportation companies more efficient and more responsive.

The key advantages of enabling real-time wireless data solutions for the transportation and logistics industry have been outlined in [1], where the authors have identified key areas where wireless solutions can provide specific value addition:

– Automatic Vehicle Location (AVL), which can provide tracking of fleet vehicles and asset monitoring, through GPS technologies.
– Location-Based Services (LBS) which can be used primarily for tracking employees and can help address business issues such as driver safety.
– Proof-of-Delivery (POD) solutions, which provide delivery confirmation service.
– Scheduling and Dispatching Systems, which allow resource planning and scheduling based on field data.

In this context, one of the major potentials identified is tracking and tracing, since they provide essential real-time information on the location and the status of, usually, sensitive items during shipment, improving the safety and the operational efficiency during every day operations [2-3]. Safety presents one of the major challenges for the transport of goods [4-5].

As stated in [6], the term tracking signifies the gathering of information related to the current location and state of moving objects, whereas tracing relates to storing and retaining the history of information related to the movements of the objects. According to [7], tracking of vehicles and shipments is needed in order to provide the link between the information systems and the physical reality (the material flow). Today, fleet telematics systems allow tracking vehicles while they are travelling and can, according to [8-9], provide the necessary information required to achieve real-time computer-based decision support.

An extensive number of fleet management systems have been presented in the literature, following either the Service-Oriented Architecture (SOA) paradigm [9-13] or acting as general-purpose Middleware frameworks [14-15], aiming at the provision of communication and cooperation services between vehicles and infrastructure elements. The objective of the VISIONS project has been to enable the integration between software components running on onboard truck terminals and ground based information systems [9-10]. The system architecture, based on Web Services interfaces, allows digital service exchange between vehicles and road infrastructures (e.g., road, tunnel, terminal containers) and makes available a large set of significant vehicle data (e.g., engine status, tire pressure, cargo documents) directly to the infrastructure information system applications.

In the same context, the main goal of the CVIS project [11] has been the creation of a unified technical solution which allows all vehicles, infrastructure elements and nodes

Vassilis Kapsalis was with the Industrial Systems Institute, Stadiou str., Platani, Patras, 26504 Greece. He is now with the Technological Educational Institute of Patras, M. Alexandrou 1, Koukouli, 26334, Patras, (tel: 2610-369230; e-mail: kapsalis@teipat.gr).
Christos Fidas was with the Industrial Systems Institute, Stadiou str., Platani, Patras, 26504 Greece (e-mail: fidasch@gmail.com).
Loukas Hadellis is with the Technological Educational Institute of Patras, M. Alexandrou 1, Koukouli, 26334, Patras (e-mail: loukas@teipat.gr).
Christos Karavasilis is with the Cyclon Hellas SA, 124 Megaridos Ave. Aspropyrgos Attica, 19300 (e-mail: techref@cyclon.gr).
Manolis Galetakis was with the Industrial Systems Institute, Stadiou str., Platani, Patras, 26504 Greece (e-mail: mgaletakis@gmail.com).
Christos Katsenos was with the Industrial Systems Institute, Stadiou str., Platani, Patras, 26504 Greece (e-mail: katsenos@teipat.gr).

978-1-4244-7658-9/10/$26.00 ©2010 IEEE

to communicate with each other in a continuous and transparent way using a variety of media, with enhanced localization, that would enable a wide range of potential cooperative services to run on an open application framework in the vehicle and in roadside equipment. The CVIS architecture is based on the OSGi framework, which specifies services based on Java interfaces.

Furthermore, GOOD ROUTE [12] has been a project aiming at the development of a cooperative system for dangerous goods vehicle routing, monitoring, re-routing (in case of need), enforcement and driver support, based upon dynamic, real time data, aiming to minimize the societal risks related to their movements, while still generating the most cost efficient solution for all actors involved. Among other subsystems, GOOD ROUTE developed a collaborative platform, capable to gather and process in real time vehicle and cargo as well as environmental data as input to an optimal routing and route guidance system.

In [13], a middleware architecture, based entirely on Web Services, that addresses the needs of a distributed system made of mobile sensors is presented. The report describes and discusses the implementation of this middleware architecture in a mobile sensor network comprised of vehicles and intersections producing traffic related data for traffic safety and operations.

Finally, in [16] the authors proposed a complete monitoring and tracking solution for truck fleets, which is able to check at the same time the position and the mechanical status of the vehicle, as well as the conditions in the cargo bay. The system, which employs a ZigBee-based wireless sensor network, a GPRS link and a GPS positioning system, has been deployed in a real environment, and some performance evaluation tests have been carried out.

On the other hand, BITX is a Machine-to-Machine (M2M) middleware framework for telematics applications, which has been designed to meet the requirements of machine to machine communication, providing the capability to control various types of electronic devices at a distance [14]. The most important element is the M2M middleware which turns raw machine data into information that companies can use to automate their processes and make decisions. However, BITX constitutes a rather restricted solution, since it is based on a specific gateway which features a fixed number of interfaces and limited I/O capability.

A similar approach is followed by mTelematics, which is a middleware platform that provides the core functionalities of the middleware such as user and asset management, authentication and access control, real-time event monitoring and reporting, data logging, etc., to enable easy creation and management of M2M applications by enterprises [15].

In general, the aforementioned systems may address a diverse number of requirements related to intelligent transportation, ranging from legacy fleet management functionality to advanced e-services in a number of specific application areas, such as road network management and freight transport and logistics, involving a diverse number of stakeholders in the transportation sector. Nowadays there is an increasing demand for safety and shipment integrity of the freight transport of dangerous goods, such as flammable liquids [2], [4]. One important aspect in this context is to provide accurate and real-time tracking, controlling and monitoring of information related to the status of the shipment. The freight transport of dangerous goods features a high similarity with demanding industrial applications, regarding the following aspects:

– The number and the heterogeneity of the monitored items, which may be quite high. Since a tank truck may contain a great number of separated compartments and for each compartment several items may need to be monitored (level, temperature, cover/valve status, etc.), there is a need for a considerable number of supported I/Os, using sensors with different control networking technologies (fieldbusses) for their interconnection.
– The significance of the monitored/controlled cargo, either in terms of harmful effects that may cause and/or in terms of commercial value, which requires an advanced rule-based mechanism for the early detection of critical situations with fast response capabilities.
– The configuration requirements regarding the application functionality which has to be performed remotely and in an intuitive way, in order to provide customization, tailored to the domain-specific requirements.

Furthermore, a high-level protocol that ensures the end-to-end delivery of information is mandatory to cope with the quality variability of the mobile communication infrastructure [17].

The research projects and the commercially-available middleware platforms, presented previously, can hardly meet the above requirements, since they are oriented towards a wide range of transportation e-services, which involve a diverse number of stakeholders in the transportation sector [9-13] or they are restricted in terms of I/O capability and/or supported platforms [14-15].

This paper presents a networking platform featuring, beyond the legacy fleet management operations, an advanced functionality, addressing the heterogeneity of the control networks, incorporating a rule-based event detection/ action mechanism with remote configuration capabilities, ensuring an end-to-end delivery over mobile communication channels. The paper is structured as follows: first the conceptual design of the proposed platform is presented based on user requirements analysis, aiming to identify and organize system and user requirements. Next, the architectural design is presented, followed by a case study in which the deployment of the proposed networking platform in a large commercial fleet is described. The work presented in this paper is a result of the SHMA project [18], funded by the Regional Operational Program of the Region of Attica, Greece.

II. CONCEPTUAL DESIGN

A. Requirements Identification

Aiming at gathering user requirements, related to the anticipated functionality of a networking platform for transport fleets of dangerous goods, a focus group was conducted. [19]. A detailed analysis of the focus group study, taking into account the insights from telematics industry specialists, revealed that, in addition to the main functionality provided by an ordinary fleet management system, additional requirements were stated, which are related to the following aspects: a) run–time operation, b) user modelling, c) physical-to-logical mapping and d) configuration.

B. Run – Time Operation

1) Collecting Raw Data: A large number of physical items have to be monitored and/or controlled per each truck's compartment by a multitude of sensors/actuators, which are interconnected by different fieldbusses.

2) Processing, Storage and Monitoring: The ability to process raw sensor data in order to produce meaningful information, e.g., calculating the average, min, max values, etc. Often, the processing involves more than one item and custom functions. The processed parameters have to be stored at the vehicle's database for alert/alarm detection and for monitoring and (optionally) control purposes.

3) Transmitting: The measurement data and the alerts/alarms have to be transmitted to the control centre in several modes (polling, periodically, on-event). The communication has to be based on the prevailing internet technologies, incorporating a high-level protocol that ensures the end-to-end delivery of information.

4) Aggregating and Central Monitoring: The vehicles' measurement data have to be aggregated and stored at the control centre in a structured way, implementing a central-level image of the vehicles' state. The timely and accurate knowledge about the status of any vehicle and its freight, during the transportation process needs to be constantly monitored.

5) Event detecting and acting: Specific logical rules that apply to several raw and/or processed data are needed for the detection of abnormal conditions that need immediate action. These rules have to run both at the vehicle and at the control centre. An effective event detection and action mechanism has to notify the authorized personnel about the detected alerts/alarms, which may consist of simple or composite events.

6) Security: A major concern expressed during the user requirements phase, was the security issue. Specifically, four concepts have been mentioned as the main characteristics of secure communications: authentication, confidentiality, integrity and authorization.

C. User Modelling

Regarding the system users, a hierarchical user model was required, comprising the following roles: a) the administrator, b) the manager of a vehicle category, c) the monitoring user of a vehicle category, d) the vehicle manager and e) the vehicle driver. The system users' rights follow the hierarchical model, e.g., the administrator inherits the rights of the manager of each vehicle category, as well as the rights of the monitoring user, vehicle manager and vehicle driver.

D. Physical-to-Logical Mapping

A level of abstraction between the physical layer and the data model was required. Thus, a mapping function which could bind physical sensors and abstract items was mandatory in order to create a logical association between physical entities and virtual generic items (Fig. 1). This logical association operates as an integration framework for the heterogeneous physical entities that uncouples the information level from the sensor level, creating a physically-independent data model.

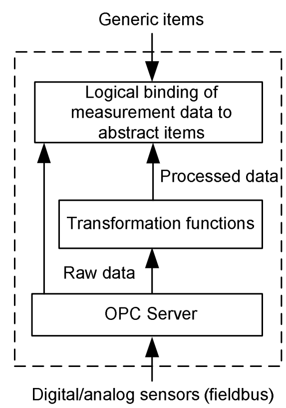

Fig. 1. Mapping physical layer sensors to abstract entities

E. Configuration

The networking platform should support the configuration of the following operational parameters:

- Measurement item types
- Processing functions applied to raw data
- Logical mapping between physical sensors and abstract items
- Vehicle categories
- User categories and access rights
- Rules for the detection of critical events
- Communication settings

III. ARCHITECTURAL DESIGN

The system architecture followed by our approach is based on the hub-and-spoke model [20]. This model is based on an intermediary, residing at the control centre, which mediates any request between the service users and the vehicle subsystems, performing content inspection and filtering, in order to enforce access control rules. Thus, security issues related to authentication and authorization are centrally managed. The system consists of the following separated entities: a) the vehicle subsystem and b) the control centre.

A. *The Vehicle Subsystem*

The vehicle subsystem consists of the following components (Fig. 2):

- An embedded vehicle gateway (VG) computer.
- A fieldbus network for connecting to the vehicle sensors/actuators, featuring an OPC capability [21], in order to address the fieldbus heterogeneity.
- A communication infrastructure, such as a GPRS modem and a secure TCP/IP stack.
- A GPS receiver which provides the coordinates of the vehicle, the speed, etc.
- A software application, featuring direct manipulation features with touch screen capabilities, which manages the communication and acts as an interpreter between the control centre and the vehicle monitored I/Os, providing the capability for the acquisition, processing, storage and transmission of the local data to the control centre, as well as the event detection and action.

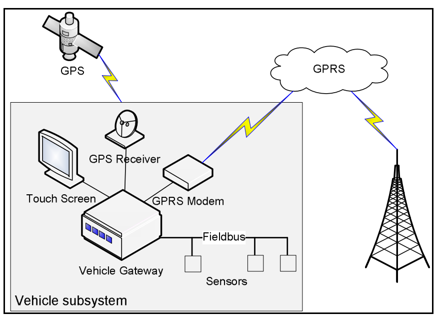

Fig. 2. The vehicle subsystem

B. *Control Centre*

The control centre comprises the middleware of the system, which converts the data received by the vehicle gateways into usable information and operates as an active intermediary for any requests issued by the service users. The data received from the vehicle gateways are presented to the service users through the appropriate web interfaces, implementing a high-level image of all the vehicles' data. Concerning the user management, the system provides the appropriate functionality for the management of the user categories and the assignment of the user rights. Also, it enables the management of the vehicle subsystems. Furthermore, it features an access control mechanism for controlling access to the system functionality. Finally, it manages the application logic layer, which includes a fully configurable, rule-based event detection mechanism that processes composite events and produces several actions (Rule-based Event-Control-Action (ECA) module).

1) *Rule-based Event-Control-Action (ECA) module*

The ECA module plays a significant role regarding the application logic layer, enabling the creation of logical rules for the detection of specific situations and their subsequent handling. The ECA module is based on the sense-and-respond model, partitioned in two parts: a) a set of rules that operate on both low- and high-level events (position updates and cargo measurements) and b) Boolean logic that acts on these events, which may be deployed both in the vehicle subsystems and/or in the control centre. Each defined rule is based on a decision making model which has one hypothesis part and precisely one decision part. The administrator selects certain properties/attributes, sets the desired values and associates them with the appropriate logical connective. Furthermore, custom defined Boolean functions can be defined in order to achieve concrete system behaviour. For instance, the IF connective applies to an AND expression, while the AND connective, applies to an OR expression and to a property of an entity. Using such an environment, one may construct fully parenthesised expressions of arbitrary complexity that are according to the following formal grammar:

```
Expression = if Construct then Construct
           | if Construct then Construct else Construct
Construct = (Construct and Construct)
      | (Construct or Construct)
      | not (Construct)
      | (Entity_Property_or_Attribute or Custom_Function)
```

The model-checking module operates as follows: First, the reference model and the current situation model are converted using model-preserving formulas in equivalent Conjunctive Normal Forms (CNF). After that, the two models are compared and the results of the comparison are raised intermediately and can be optionally visualized, e.g. in the form of a comparison table. Finally, the mechanism decides on the appropriate feedback message that should be given to the vehicle driver or the administrator.

The ECA module consists of a certain number of submodules, which are illustrated in Fig. 4. The detection of any context change is based on an event-based mechanism, which involves both distributed agents, residing on the vehicles (*Vehicle Agents*) and the *ECA Collector Bus*, which is responsible for collecting and processing of the incoming items and forwarding them to the responsible modules. These raw data are then forwarded to the *Aggregating Submodule*, which groups them in order to form meaningful pieces of vehicle oriented information, according to the aforementioned data model, that have a higher value and can help the system to decide for certain behavior through the *Controlling/Acting Submodules*. These *Submodules* combine dynamic and static context information related to user-defined rules and act accordingly, as defined by the system administrator. Finally, the *Monitoring & Rules Editor Submodule* enables the setting up and the monitoring of rules. It assists the administrator, through the *Rules Editor*, a user-friendly web interface tailored to non-programmers, to specify rules based on information included in the data model. These rules can be related to whether a vehicle is in a predefined geographical area, or how long a vehicle spends on a certain place, the speed of a vehicle, etc. Furthermore, complex rules can be applied by combining existing rules with Boolean expressions. Compared to TEDS [22], a telematics service that features a similar functionality and requires low-level programming from the application developer, our system features a significant advantage, since it enables non-programming experts to create and manage complex rules by using direct manipulation user interfaces as shown in Fig. 6.

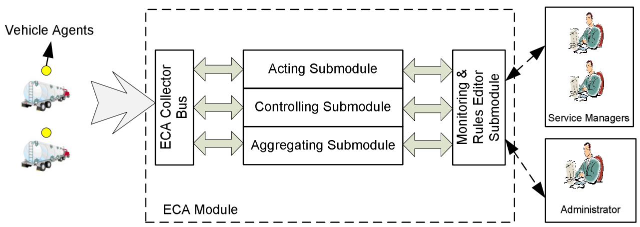

Fig. 4. The ECA module

2) *Security & Communication Protocol*

Security of an information system requires measures in a wide range of layers. Both the system operation and the system physical parts must be protected against external threats. To provide security three main layers should be considered: a) physical security of the vehicles, b) secure communication and c) security of the control centre. Regarding the communication security, a direct authentication mechanism, where the vehicles authenticate directly to the control centre and vice versa, has been applied, based on credentials (certificates) on each site by using the SSL/TLS protocol within a Virtual Private Network (VPN), ensuring data confidentiality, data integrity and authentication. Regarding the security design of the control centre it consists of the following elements: a) an independent system acting as firewall, b) an intrusion detection system, c) traffic throttling, d) an input data filter, applied to received data, in order to prevent SQL injection attacks and e) an access control list, which addresses authentication and authorization issues.

IV. APPLYING THE PROPOSED PLATFORM - A CASE STUDY

The networking platform deployed in a transportation fleet, consisting of forty fuel and lubricant tank trucks and was tested extensively for a period of several months during the daily fleet management operations. In order to depict the functionality of the proposed platform, a typical operational scenario is illustrated in this section.

A. *Configuration*

Initially, the system was configured according to the specific application requirements (creation of vehicle categories, users, etc.). The following measurement items were defined per tank compartment:

- *Digital*: cover state, overfilling state, valve state, ventilation state
- *Analog*: upper and lower temperature (2 inputs), level, mass, pressure, volume
- *GPS*: longitude, latitude, altitude, speed

The sensors where connected to an RS-485 fieldbus network, through the Advantech ADAM-4000 I/O modules. The fieldbus network was accessed through the Merz® OPC Server. The GPS receiver and the GPRS modem were connected to the vehicle gateway through the two RS-232 connections. The user interface was provided by an 8" TFT touchscreen (Fig. 5).

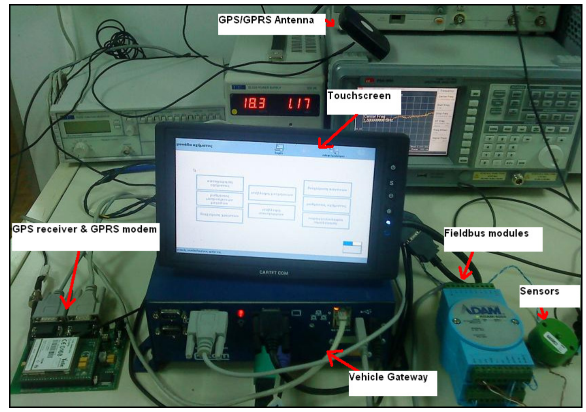

Fig. 5. The vehicle subsystem

Furthermore, a number of application logical rules where defined, both for each vehicle category and for individual vehicles, addressing shipment safety and integrity issues. Concerning the shipment safety, an event of major significance is the liquid leakage which may be detected if the liquid level (mass or volume) decreases without any corresponding valve opening. This event may be detected by the rule:

$$(\text{DecreasingValue}([\text{Level}],10) > 0.0) \text{ AND } ([\text{Valve State}] = \text{false})$$

This rule evaluates to true if there is a decreasing liquid level while the valve is closed. Note that the rule comprises a composite condition, consisting of the user-defined function "*DecreasingValue(val, period)*", which detects value decreases in a time period and the condition "*[Valve State] = false*", which checks the valve state. If the alarm occurs, then the pre-programmed actions will take place: an SMS and an e-mail will be sent, a message will inform the vehicle driver about the situation and the control centre will illustrate the alarm event. Furthermore, rules for the detection of high temperatures in each tank compartment were defined. Concerning the shipment integrity, an event that may indicate a possible illegal action is the opening of a tank cover or a valve that takes place outside the eligible places (e.g. gas stations that have been scheduled for bunkering):

$$(([\text{Cover State}] = \text{true}) \text{ OR } ([\text{Valve State}] = \text{true})) \text{ AND}$$
$$(\text{GPSInRegion}(3812.9330, 2145.2692, 500) = \text{false})$$

Fig. 6 illustrates the *Rules Editor Submodule*, which consists of the following parts: a) the rule title, b) the rule editor, c) the rule component entailing the measurement items, the custom defined functions, the Boolean expressions and/or other rules and d) the rule action area in which the place of the rule evaluation is selected (vehicle or control centre) and the actions that will take place.

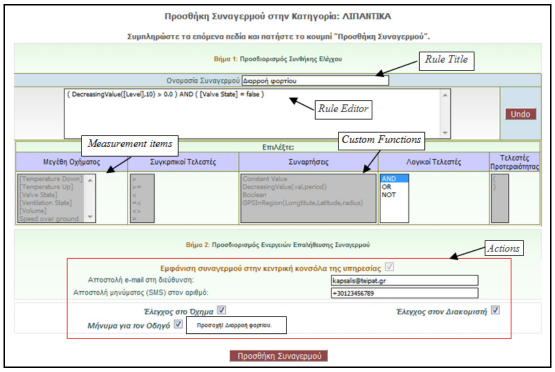

Fig. 6. Rule configuration for alert/alarm detection

B. *Run-Time Operation and Results*

During the run-time operation of the system, the tank trucks send periodically (or on-demand) data related to their position and their cargo status. During disconnections due to communication problems, the data are stored locally and are transmitted whenever the connection gets re-established. The vehicle positions and the measurement data are presented through the corresponding web interfaces, which are accessed by the service users. Also, these data are stored in the control centre and are available for reporting purposes (freight tracing). Before the system deployment, the routine work was carried out manually, suffering inaccuracy and undetected critical events. The new system helped significantly the fleet managers with their daily routine work, eliminating the missed events and thus improved the shipment safety and integrity, proving its reliability and its high level of performance under real circumstances.

V. Conclusion

In this paper, a networking platform which provides real-time monitoring and rule-based control of transport fleets and transferred goods was presented. The platform meets the requirements imposed by freight and asset tracking applications, tailored specifically to the transportation of dangerous goods, such as flammable liquid fuels. The design has been based on open architecture principles, following the prevailing industry and internet technologies, featuring interoperability, openness, reusability and extensibility. Its fully configurable capabilities make it an excellent candidate for a number of diverse applications beyond the transportation domain, which fall into a wider Machine-to-Machine (M2M) area. The offered services enable a detailed tracking and tracing of the freight, ensuring shipment safety and integrity during transportation. In the future, the proposed platform is planned to be tested in diverse application areas, which feature similar requirements, regarding mobility, interoperability, reusability and security.

References

[1] Cingular Wireless Business Markets Group, "Driving Efficiencies with Real-Time Wireless Data", Cinuglar Wireless LLC, 2005.

[2] The Freight Technology Story: Intelligent Freight Technologies and Their Benefits, U.S. DOT Federal Highway Administration, Report No. FHWAHOP-05-030, EDL No. 14118. June 2005. Benefits ID: 2008-00568.

[3] C. Janker and R. Lasch, "Telematik im Straßenguterverkehr – Stand der Umsetzung und Nutzungspotenziale", In Logistik Management - Supply Chain Management und e-Business, Teubner Stuttgart, pp. 245–255, 2001.

[4] "Mobility 2030: Meeting the Challenges to Sustainability", The Sustainable Mobility Project, World Business Council for Sustainable Development, 2004, available at: http://www.wbcsd.org/web/publications/mobility/mobility-full.pdf.

[5] [EXTR@Web Project] P. Delle Site & M.V. Salucci, "Third Annual Thematic Research Summary – Freight Transport", Deliverable D2.E-1.2, Issue 1.0, 2006.

[6] K.-J. van Dorp, "Tracking and tracing: a structure for development and contemporary practices," Journal of Enterprise Information Management, vol. 15, no. 1, pp. 24–33, 2002.

[7] G. Stefansson and B. Tilanus, "Tracking and tracing: principles and practice," International Journal of Services Technology and Management, vol. 2, no. 3/4, pp. 187–206, 2001.

[8] M. Kaarkkainen, T. Ala-Risku, and K. Fraamling, "Efficient tracking for short-term multi-company networks," International Journal of Physical Distribution and Logistics Management, vol. 34, no. 7, pp. 545–564, 2004.

[9] Martino Fomasa, et. al., "VISIONS: a Service Oriented Architecture for Remote Vehicle Inspection", Proceedings of the IEEE 2006 IEEE Intelligent Transportation Systems Conference, ITSC 2006, pp. 163-168.

[10] Martino Fomasa, et. al., "Development of a Service-Oriented Architecture for the dynamic integration of mobile remote software components", 10th IEEE Conference on Emerging Technologies and Factory Automation, 2005. ETFA 2005, pp. 661-664.

[11] Paul Kompfner, Zeljko Jeftic, Mariana Andrade, Peter Christ, "Cooperative Vehicle-Infrastructure Systems" D.CVIS.2.1: System Concept Definition, 2007.

[12] GOOD ROUTE IST-4-027873-STREP, D10.3: Final Report "Dangerous Goods Transportation Routing, Monitoring and Enforcement", January 2009, available at: http://www.goodroute-eu.org/documents/good_route-d10_3.pdf.

[13] Christian Manasseh, Raja Sengupta, "Middleware for Cooperative Vehicle-Infrastructure Systems", California Path Research Project, UCB-ITS-PRR-2008-2, available at: http://database.path.berkeley.edu/reports/index.cgi?reqtype=displayrecord&record=312.

[14] "BITX The M2M application development ecosystem", available at http://www.bitx.com/attach/75/BITX_SYS_INTRO_ENG_1.31.pdf.

[15] "mTelematics, M2M Middleware Platform", available at http://www.mtelematics.com/mtelematics_middleware.php.

[16] Fabio Valente, Giammarco Zacheo, Pierfrancesco Losito, and Pietro Camarda", A Telecommunications Framework for Real-Time Monitoring of Dangerous Goods Transports", Proc. of Int. Conf. on ITS Telecommunication, ITST, Lille, France, Oct., 2009.

[17] Samik Ghosh, Nilendu G. Jani and Sajal Das, "Enabling real-time fleet route planning and execution in a pervasive transportation environment", in 2nd International Symposium on Wireless Pervasive Computing, ISWPC'07, 2007.

[18] "SHMA – Intelligent System of Bidirectional Communication and Telematics Management of Tank Trucks for the Transportation of Liquid Fuels and Lubricants", Project Application Form, Regional Operational Program of Attica Region Greece.

[19] Kitzinger, J. "Qualitative research: Introducing focus groups", British Medical Journal, 311, 299-302, 1995.

[20] Vassilis Kapsalis, Konstantinos Charatsis, Manos Georgoudakis, Efstratios Nikoloutsos, George Papadopoulos, "A SOAP-based system for the provision of e-services", Computer Standards & Interfaces, Elsevier Science B.V, Vol. 26, Issue 6, pp. 527-541, October 2004.

[21] OPC DA 2.05a Specification, available at "http://www.opcfoundation.org/DownloadFile.aspx?CM=3&RI=66&CN=KEY&CI=283&CU=69".

[22] Jonathan Munson, SangWoo Lee, DaeRyung Lee, David Wood, Gerry Thompson, Alan Cole, "A Rule-based System for Sense-and-Respond Telematics Services", in EESR '05: Workshop on End-to-End, Sense-and-Respond Systems, Applications, and Services, pp. 31-36.