REDUCTION
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Deliverable D 7.3 Second periodic report

29/01/2015

Public Document

Project acronym: REDUCTION

Project full title: Reducing Environmental Footprint based on Multi-Modal Fleet management Systems for Eco-Routing and Driver Behaviour Adaptation

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1.0	29/11/2013	Initial version
1.1	17/01/2014	Review comments processed
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1.4	31/08/2014	Updated to reflect changes in the implementation
1.5	29/01/2015	Updated to reflect changes in the implementation

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Declaration by the scientific representative of the project coordinator

I, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate) [1]:
  - X has fully achieved its objectives and technical goals for the period;
  - ☐ has achieved most of its objectives and technical goals for the period with relatively minor deviations.
  - ☐ has failed to achieve critical objectives and/or is not at all on schedule.
- The public website, if applicable
  - X is up to date
  - ☐ is not up to date
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 6) and if applicable with the certificate on financial statement.
- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 3.7 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Name of scientific representative of the Coordinator: Prof. Dr. Lars Schmidt-Thieme

Date: 07/02/2014

For most of the projects, the signature of this declaration could be done directly via the IT reporting tool through an adapted IT mechanism.

[1] If either of these boxes below is ticked, the report should reflect these and any remedial actions taken.

Executive Summary

This deliverable summarizes the work progress achieved in all work packages by the consortium during the second year of the project (01/09/2012 – 31/08/2013). The document reports on the effective planning and monitoring of the tasks and outcomes as well as individual work done in the work packages. On the basis of summaries done for each work package on the progress achieved the REDUCTION consortium can measure the achievement of goals as stated in the grant.

The deliverable also includes a summary of the management activities done during the second year of the project including project meetings, monitoring of timely submission of deliverables and milestones, the progress in updating the project website, dissemination activities and publications as well as quality management.

An important part of this deliverable is the controlling of resources including person months and budget, which is meant to give an overview of resource expenditure. The deliverable also contains an explanation on the use of resources especially with the focus on deviations or budget changes or shifts.

Finally, a risk assessment plan is meant explore potential internal and external risks which may negatively affect the progress of the project.

1. Introduction

1.1 Project Overview

Reduction of CO_2 emissions is a great challenge for the transport sector nowadays. Despite recent progress in vehicle manufacturing and fuel technology, still a significant fraction of CO_2 emissions in EU cities is resulting from vehicular transportation. Therefore, additional innovative technologies are needed to address the challenge of reducing emissions. The REDUCTION project focuses on advanced ICT solutions for managing multi-modal fleets and reducing their environmental footprint. REDUCTION collects historic and real-time data about driving behaviour, routing information, and emissions measurements that are processed by advanced predictive analytics to enable fleets enhancing their current services as follows:

1) Optimising driving behaviour: supporting effective decision making for the enhancement of drivers' education and the formation of effective policies about optimal traffic operations (speeding, braking, etc.), based on the analytical results over the data that associate driving-behaviour patterns with CO_2 emissions;

2) Eco-routing: suggesting environmental-friendly routes and allowing multi-modal leads to reducing their overall mileage automatically; and

3) Support for multi-modality: offering a transparent way to support multiple transportation modes and enabling co-modality.

REDUCTION follows an interdisciplinary approach and brings together expertise from several communities. Its innovative, decentralised architecture allows scalability to large fleets by combining both V2V and V2I approaches. Its planned commercial exploitation, based on its proposed cutting edge technology, aims at providing a major breakthrough in the fast growing market of services for "green" fleets in EU and worldwide, and present substantial impact to the challenging environmental goals of EU.

1.2 Objectives of Work Package 7

In WP 7 the management team establishes effective lines of communication and reporting procedures to ensure the adequate planning, implementation and coordination of project activities and an independent continuous assessment of progress for the entire project duration. The management team, assisted by an administrative manager, ensures proper financial management within the consortium and the appropriate communication of related matters to the European Commission. A continuous effort is undertaken by the management team to ensure the timely submission of deliverables, milestones, financial statements and reports.

Monitoring the progress in the project is a second focus of the management team. This is ensured through implementation of quarterly progress reports and the use of a communication platform. The

Quality Management Handbook created by the Administrative Manager during the first year of the project defines a set of rules on cooperation, organisation and quality management procedures within the project.

Regular General Assembly meetings taking place at least on a biannual rhythm and steering committee meetings done in person or by telephone conference are meant to support the flow of information in the consortium.

A third focus of the project is the overall monitoring of scientific achievements. As a whole REDUCTION aims at developing advanced solutions that combine mechanical / measurement technologies with information and communication technologies for the management of multi-modal fleets, in order to reduce their environmental footprint. An important role in the achievement of the proposed objective is the evaluation of risks in the work packages and the elaboration of solutions in order to overcome the risks.

A risk management plan was already set up in the very beginning of the project by DDE covering both internally and externally induced risks. The risk management plan is constantly updated, e.g. if environmental conditions change such as unforeseen novel developments in fleet management systems. To this end, the plan will cover actions and activities that will enable the consortium to continue its work, e.g. by transferring responsibilities between participants.

1.3 Objectives of Deliverable 7.3

Deliverable 7.3 aims at monitoring the progress of tasks and work done in all work packages during the 2nd year of the project. The deliverable also aims at monitoring the expenditure of person months and budget resources during the 2nd year of the project. The timely submission of deliverables is also being monitored. Another goal of this deliverable is to establish an overview of all dissemination activities and publications in the reporting period in order to monitor the exploitation of scientific results of the project (see table 1: Objectives of Deliverable 7.3).

The constant evaluation of risks (table 1) is also an important objective as it contributes to a better monitoring of the achievement of goals in the project. The partners figure out solutions for these risks and evaluate these once more in the next reporting period.

Table 1: Objectives of Deliverable 7.3

Objectives	How to meet
Project coordination	Monitor project progress Controlling person months and costs Controlling of timely submission of reports, deliverables, cost statements, certificates on the financial statements Ensuring the distribution of documents and information in the consortium
Progress Monitoring	Monitoring of scientific progress through the progress reports written by each partner
Risk management	Evaluation of risks for all work packages Elaboration of solutions to overcome the risks

2. Project objectives, work progress and achievements, project management

2.1 WP1 Onboard Technology and Wireless Communication

2.1.1 Summary of WP 1

WP 1 deals with basic communication infrastructure and wireless communication. Its objective is to develop the on-board technology taking also into account the requirement for supporting multi-modal fleets.

2.1.2 Work package objectives for the current reporting period

The activities in WP 1 in the 2nd reporting period include the testing of intelligent V2V and V2I Communication. REDUCTION also focuses on taking advantage of using multiple OBC protocol interfaces to exploit V2V and V2I capabilities at the same time, with the objective to increase communications efficiency and handle the interplay between V2I and V2V data transmission and computation distribution.

For vehicle detection applications (apart from the traditional loop detectors) the in-car systems, currently available in most of the modern cars, can be used to determine the average travel time. Most in-car systems have on board Bluetooth to connect to smart phones for hands free telephone calls. These Bluetooth devices (in-car systems and smart phones) can be detected by use of Bluetooth detectors. Two Bluetooth detectors are installed at the beginning and end of a route. The detectors can determine the unique address of the Bluetooth device and between two points, the average travel time can be calculated.

Task 1.4 pursued during reporting period 2 has the goal of describing the framework and setup of the environment for testing the communication between the Bluetooth detectors and the in-car system, the results of the tests and the conclusion.

2.1.3 Progress towards the objectives and tasks completed

Corrections after 1st Technical Review

Task 1.1

No updates on the collection of requirements on the overall architecture of the on-board technology are to be reported.

Task 1.2

Delphi adapted the hardware and software of the in-vehicle Communication and Control Unit (CCU) to meet the requirements of the Reduction project defined is task 1.1. These requirements were supplied by partners at different stages during the project. Collection of the CCU system requirements lead to the following modifications of the CCU features.

- CPU speed increased from 500 MHz to 1GHz
- RAM capacity increased from 256MB to 1GB
- SSD with 4GB storage space for various logs (e.g. CAN/GPS data logs)
- High-Speed CAN now supplied instead of optional

Task 1.3

The work on wireless communications and vehicular networking aspects of REDUCTION during the first year of the project revealed the benefits of the two layer architecture in combination with a packet scheduling/routing mechanism that guarantees throughput optimality and at the same time strives for low delay in packet dissemination. In the context of these efforts, it needs some further work with respect to evaluating the considered and proposed clustering protocols, and efforts to tuning the developed backpressure protocols into a fully distributed algorithm, since now it depends a lot of a centralised controller.

Task 1.4

Framework and Methodology for the Bluetooth detectors

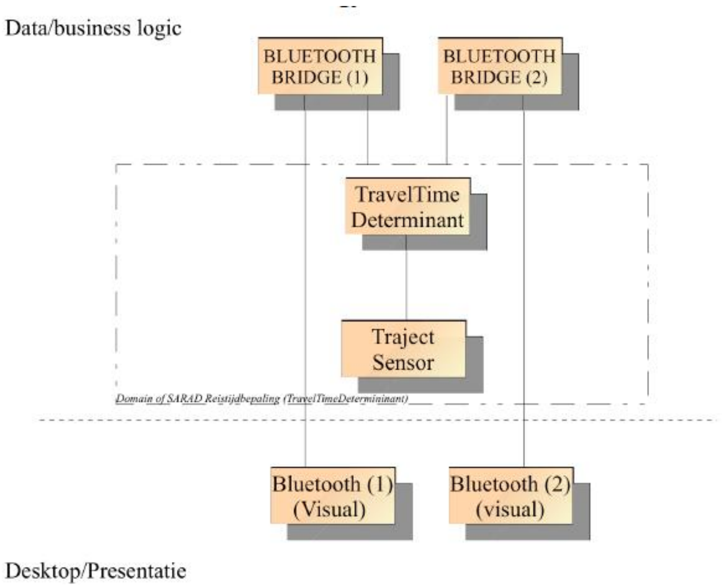

Figure 1: Object diagram Bluetooth detection

The communication components of the Bluetooth detectors are the Bluetooth bridges. Each bridge communicates directly with a Bluetooth device (dongle), which is searching for Bluetooth Identifiers (MAC addresses). The travel time determinant receives every minute the unique identifiers from each bridge and searches for matching pairs, so it can determine the average travel time between the two measurement points (see figure 1: Object diagram Bluetooth detection).

The calculated travel time is then passed to the traject sensor object, that corresponds with the actual geographical road segment that is measured by the two detectors. This information is then used by the TrafficLink to calculate route information and determine traffic management measures to be activated (see figure 2: Schematic overview of travel time measurement).

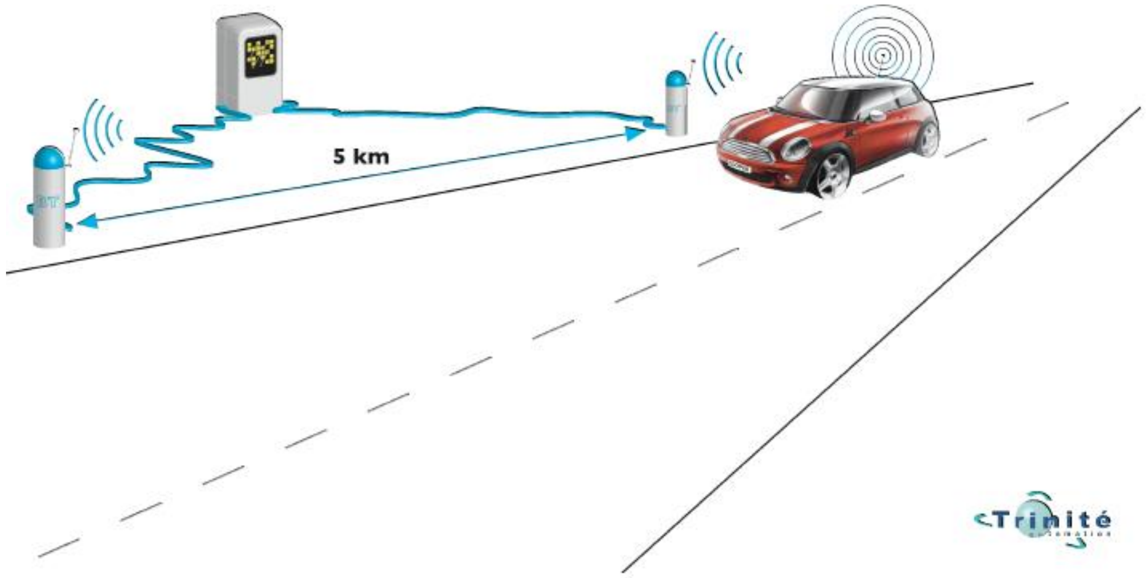

Figure 2: Schematic overview of travel time measurement

The following steps of the Bluetooth detection system are being performed (see figure 3: Sequence diagram of the Bluetooth detection):

1. During the INQUERY_LENGTH the Bluetooth bridge scans it´s surrounding for all detectable Bluetooth devices
2. Every detected ID is stored in a data sheet
3. Every minute the data sheet is send through the signal DETECTORUPDATE to the travel time determinant object
4. After sending the data, the data sheet is emptied

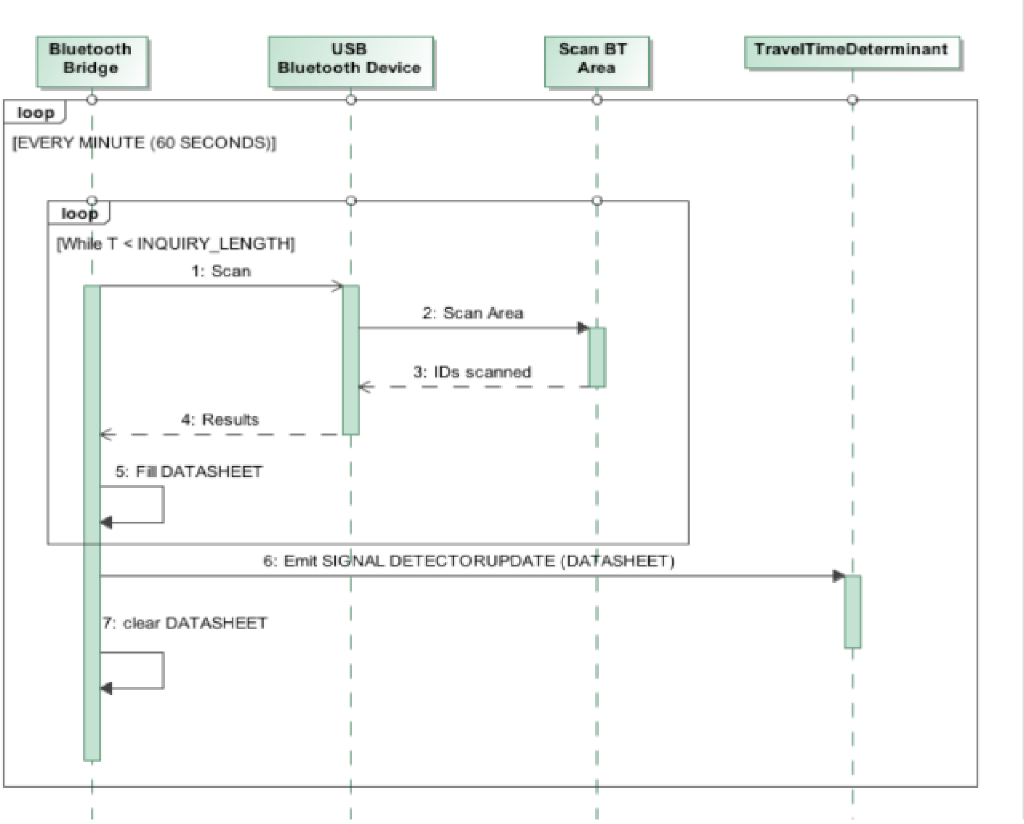

Figure 3: Sequence diagram of the Bluetooth detection

The physical architecture of the system consists of two mini-PC´s (Advantech ARK 1388) that connect to internet by means of an UMTS router. Through the UMTS routers, the data sheet with Bluetooth id´s can be send to the central server where the travel time determinant and route objects are calculating the information. In the figure below, the physical architecture of the system is given (see figure 4: Physical architecture of the Bluetooth detection).

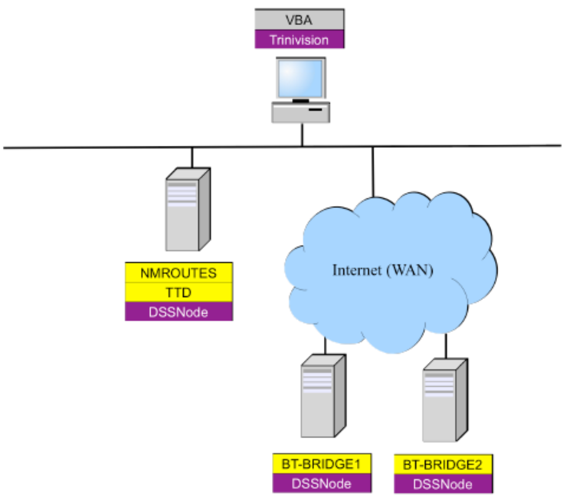

Figure 4: Physical architecture of the Bluetooth detection

The DSS datapool middleware is being used to exchange information between the detectors and the traffic management objects. The DSS messages are compressed to reduce the amount of data being send through the UMTS routers.

Description of the test environment

Travel time is an important source of information for dynamic traffic management applications. Most of the highways are equipped with loop detectors, which are expensive to install and maintain. The same goes for license plate recognition systems that use cameras to measure travel time on local roads and in cities. An emerging alternative for measuring travel time is the Bluetooth technology.

The tests with the Bluetooth detectors have been held on the road E313, between Geel-Oost and Antwerpen-Oost, in collaboration with Verkeerscentrum Vlaanderen for a period of 5 weeks. The results are compared against the license plate recognition system (ALPR) that is installed along the route. The ALPR is used as a reference to the Bluetooth detection system (see figure 5: Bluetooth test environment).

Figure 5: Bluetooth test environment

<u>Obtained results</u>

The tests of the Bluetooth detection system show the following results:

- The error on the average travel time decreases when there is more congestion. At free-flow the percentage error lies between 6% and 9%, at congestion between 2% and 5% and at heavy congestion between 1.5% and 4%.
- The finer the measurement grid, the better the average travel time will be. With very small trajects, the travel time will get worse because the increasing relative influence on the accuracy of time and place determination.
- With free flow the travel time seems to be overestimated, with heavy congestion the smaller trajects under estimate the travel time slightly

The results for Task 1.4 show that the system performs sufficiently well when there is congestion. Especially the situation of congestion is of interest and relevant to be accurate. The detection area of the Bluetooth detectors is about 100 meters, larger than the detection area of the camera´s used in the ALPR system (about 20 meters). This makes the uncertainty in accurate measurement of the Bluetooth device larger then with the ALPR system. On the other hand, the ALPR system itself is not error free compared to the real travel time. Studies have been done to compare GPS data (floating car data) with Bluetooth data and the results have very little deviation.

An improvement of the Bluetooth detection system and a next step would be a finer measurement grid of the Bluetooth detectors and to use Bluetooth detectors with a smaller detection radius.

2.2 WP2 Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation

2.2.1 Summary of WP 2

The main objective of WP2 is to develop novel algorithms for creating predictive analytics models that will operate in the decentralised environment of REDUCTION. The proposed prediction models will enable the generation of knowledge for supporting driver-behaviour adaptation in order to educate drivers about ways of energy-efficient driving. Therefore, this work package has also the objective of developing distributed data mining algorithms that will be designed to run on-board and exchange computation and data with other vehicles and with the centralised infrastructure.

2.2.2 Work package objectives for the current reporting period

In reporting period 1 the first objective to be fulfilled has been the defining of software architecture of the methods to be used in the basic and advanced prediction models.

In reporting period 2 the methods developed within the first year of the project have been extended in order to allow predictive models to run throughout the decentralised system of REDUCTION. The aim is to develop novel data mining algorithms to address the challenging nature of required decentralisation. The models to be developed under Task 2.3 will present adaptation to new concepts in the data, such as differences incurred due to changes in traffic conditions or road conditions. This option will allow REDUCTION to timely adapt the information generated by its models and offer accurate knowledge that can be utilised for driver-behaviour adaptation.

The advanced models of Task 2.3 will also be built upon the needs defined by the use cases in Task 5.1.

A second objective was to develop algorithms for motion/trajectory prediction based on the theory of Markov chains. This task 2.4 addressed the issue of prediction in a completely localised manner with minimal information exchange, instead of performing analysis of voluminous data at centralised “warehouses”. The aim of the developed algorithms is their use by vehicles in forwarding information towards its destination to reduce anticipated delay.

The results obtained in Tasks 2.3 and 2.4 have been integrated in the prototypes developed under Tasks 4.2 / 4.3.

2.2.3 Progress towards the objectives and tasks completed

Corrections after 1st Technical Review

In the 1st quarter effort has been made on updating and resubmitting the Deliverables 2.1 Report with data flow analysis & system architecture and 2.2 Report on basic predictive analytics models.

Concerning Deliverable 2.1 the evaluation of state-of-art technologies has been written and additional input has been added to requirements specifications. Additional justification has been made for approach to eco-driving and data security issues. Explanation of on-line feedback to drivers has been extended.

The main functionalities have been categorised as follows:

- Eco-Routing, Eco-Driving and Distributed Data Mining. The requirements related to these systems were collected from REDUCTION partners.
- Based on the collected requirements, the basic and optional elements of the predictive analytics models were analysed and the system architecture was proposed. Next, a scenario was described to explain how the system interacts with users, such as on-line feedback to drivers, justify heuristic approach to eco-driving and data security issues.
- An alternative approach which uses estimation models was proposed to estimate fuel consumption and CO2 emission in the case when CANBus data was not assessable. This discussion was incorporated in risk assessment section.

For Deliverable 2.2 the evaluation of state-of-art technologies has been written. The methodology for identifying ITS problem categories and driver behaviour feedback has been extended. A summary table has been written to clarify project approach.

The following main results have been obtained:

Several ITS (Intelligent Transportation Systems) tasks with impact on fuel consumption were identified and ranked according to their impact on fuel economy. After detailed evaluations of ITS tasks, Eco-Routing, Eco-Driving and Traffic Management were found as the tasks having highest impact on fuel. A time series classification method was presented for Eco-Driving, that classifies driving behaviour related actions/parameters and history/records. Personalised travel time prediction was described as a method to predict eco-routes. This method uses a matrix factorization technique which, on the basis of driver's data from his previous historical trips, infers accurate predictions for the travel time and usage of desired future trips. Finally, distributed data mining in vehicle-to-vehicle scenario was described as a method that can help in predicting traffic congestion and hence in avoiding it in prior. Extensive experimental evaluations showed the efficiency and attractiveness of the proposed methodologies.

T2.3 Advanced predictive analytics models

The above-mentioned task includes advancements in the domains Eco-Driving and Distributed Data Mining. The objectives targeted by this task can be summarised as follows:

Distributed Data Mining

- Development of decentralised algorithms for V2V/V2I decision-making
- Development of efficient local predictive models which learn from intravehicular data
- Development of broadcasting algorithms for sharing local predictive models with neighbouring peers/vehicles

Experiments to validate the gained benefits in terms of improved prediction accuracy and reduced communication time

Eco-Driving

- Processing of GPS trajectory data into driving behaviours
- Analysis of driving behaviour data and detection of driving patterns
- Identification of fuel-inefficient driving patterns
- Empirical evidences over real-life GPS data

Progress towards Distributed Data Mining

In this reporting period, a distributed classification approach was developed, which takes into account the scale free nature of ad-hoc networks, especially P2P networks. This approach is based on the idea that motivates the propagation of classification model beyond the direct neighbours, with continuous reduction in model size at each transitive step.

A local model was learned using Reduced-SVM, at each peer. In a next step, this model was exchanged with the peers in the network using the idea of transitive reduction. This way, the approach helped not well connected peers to receive local models of other, better connected peers, in order to enhance the local models of the not well connected peers, and thus to substantially improve classification accuracy over the entire P2P network. Since uncontrolled transitive propagation of classification models can increase the communication cost (leading eventually to flooding the network), this approach worked in a controlled way by first using 'light weight' models generated by Reduced-SVM, and then performing transitive reduction, that kept the communication cost low and improved the classification accuracy at a weak peer, which represents the vast majority of peers in real world P2P networks.

The experimental evaluation showed that transitive classification improves the classification performance compared to several existing baseline methods and how it considers the trade-off between communication cost and prediction accuracy.

Progress towards Eco-Driving

The first part of the work on eco-driving included the development of a novel method to classify long time series composed of local patterns occurring in an unordered fashion and by varying frequencies. The principle relies on detecting local polynomial patterns, which are extracted in a sliding window approach, hence fitting one polynomial to each sliding window segment.

A technique was proposed to fit sliding window content which has a linear run-time complexity. Local polynomial approximations were computed in a sliding window approach for each normalised segment under the sliding window. The computed polynomial coefficients are converted to symbolic forms (i.e. literal words) via an equivolume discretization procedure. Thresholds for the distribution of the values of each coefficient were determined to split the coefficient's histogram into equal regions and each region was assigned an alphabet symbol.

In a second step all the polynomial coefficients were transformed into characters by locating them within the threshold values of the histogram and assigning the region symbol. The final literal representation of a polynomial was a word composed of the concatenation of each coefficient's character, in the order of the coefficient's monomial degrees. Once the bags of words were computed then a histogram is populated with the frequencies of each word in a time series.

A linear time technique was presented to compute the polynomial approximation of a sliding window segment, while the overall method has a run time complexity, which is linear in terms of the series points. The classification accuracy of the nearest neighbour method utilizing the histogram rows that the method computed was compared against the performance of three baselines.

The method won all the experiments, most of them with a statistically significant margin. Furthermore, empirical results demonstrated that the method has a practically feasible running time performance, comparable even to the fastest methods which require a single scan over the time series.

The second part of the task focused on eco-driving is detecting fuel inefficient patterns from driving behaviour data. High frequency GPS recordings were converted to velocity plots by computing the distance between two successive latitude and longitude measurements. The mining of local patterns in the velocity plot was conducted using the bag of patterns algorithm, where the local patterns were stored as columns in a frequency histogram. In order to detect which of the extracted local patterns were more influential with respect to fuel consumption, the consumption of velocity plots was estimated. The VT-Micro estimation model was utilised for fuel estimation based on instantaneous velocity and acceleration.

The search for most influential patterns was carried via greedy forward search over the space of histogram columns, i.e. over local driving patterns (see figure 6: The top 6 most influential driving patterns). Experiments on driving behaviour plots of the Infati dataset were conducted by selecting velocity plots from the most frequently travelled map segment. The top influential local patterns with respect to describing fuel consumption were the sudden accelerations and decelerations. The presented study completed the purpose of experimentally analysing driving behaviours from driving data in the context of Eco-driving. The analysis empirically validated the existing intuition that sudden accelerations and decelerations were the main reason for inefficient fuel consumption.

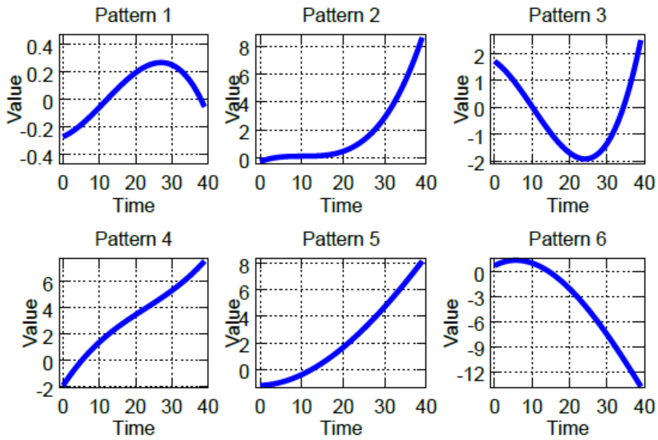

Figure 6: The top 6 most influential driving patterns

T2.4 Vehicle motion prediction algorithms

The goal of this task is to describe the new algorithm developed for the study of the trajectory forecasting problem in vehicular environments. Here are the main objectives of this task:

Evaluation of the current state-of-the-art trajectory predictor;

Exploitation of the resource-rich environment of a vehicle (unlimited power, significant processing power) to build rich summaries of the roaming history of vehicles that subsequently provides more accurate predictions.

Development of a new “coarse-grained” motion predictor, which

- Is localised, and thus it is distributed.

- Is fully parameterised presenting different trade-offs in efficiency vs. prediction accuracy.

Evaluation of the developed predictor against the state-of-the-art algorithm

One of the key components of emerging and next generation wireless networks is the integration of fixed and/or mobile relays to, inter alia, increase capacity, lessen edge-cell starvation, and permit an energy-efficient operation of the network. If mobile nodes are allowed to perform mechanical relaying, i.e., store and carry the information before forwarding it to another relay node or base station (BS), a plethora of different, novel resource-utilization schemes can be explored to increase network performance. At the heart of such relaying methods lies an efficient trajectory prediction algorithm. Here, the issue of transforming the motion prediction problem into a discrete sequence prediction problem was investigated, so as to apply algorithms coming from the compression literature.

Moreover, a new localised trajectory prediction algorithm based on the type of Markov predictors was developed and evaluated against the state-of-the-art. The novel motion prediction algorithm was named the Rich Dictionary Markov Predictor (RDM). The simple observation that the vehicular environment is a resource rich environment, a trade-off between storage and computational overhead was considered in order to increase the prediction accuracy.

Prediction accuracy is an important requirement that vehicular ad hoc networks need to possess, because it enables them to provide more than an acceptable connectivity concerning the overall QoS. RDM supersededin prediction accuracy the state of the art Markov predictor, namely Active LeZi (ALZ). RDM was able to provide online predictions. It is fast, accurate and fully parameterised presenting different trade-offs in efficiency vs. prediction accuracy.

Risk Assessment

The proposed methodologies were implemented and are functional. There were no deviations from the objectives described in the DOW and the time line. For Distributed Data Mining, data was generated synthetically, while for Eco-Driving the GPS data was already acquired.

Conclusions and future work

This deliverable focused on reporting the progress accomplished by the REDUCTION project in the contexts of distributed data mining and ecological driving. The main drawback of the study was the type of real data used for the experimentation. Whereas there exists a plethora of mobility data that concern mobile trajectories over road networks, these datasets have not segmented the roads based on the mobility profiles of the vehicles and the number of lanes of these roads. Such fine-grained datasets are almost impossible to be found or created. In the context of REDUCTION, efforts need to be made to produce such datasets, even though it is a very difficult task due to the need to have close cooperation with transportation authorities of countries, and the privacy issues involved in processing accurate mobility profiles of vehicles.

2.3 WP3 Data Management for Environment Aware Routing and Geo-Locational Analysis Application

2.3.1 Summary of WP 3

The objective of WP3 is to design and develop a series of software prototype that can convert vehicle-related data, primarily GPS data but also Controller Area Network (CAN) bus data. A main objective of

WP3 is to convert the GPS and CAN bus data to metrics that capture the environmental impact, e.g., the fuel consumption on a route or the estimated CO2 emission. To fulfil the objectives WP3 will make both advance the state-of-the-art within eco-routing and implement a series of prototypes that can handle very large volumes of GPS and CAN data from different types of vehicles. These prototypes must also efficiently compute the multi-modal eco-routes, i.e., where different means of transportation is used, e.g., a combination of taxi, bus, and trains. Work package objectives for the current reporting period

2.3.1 Work package objectives for the current reporting period

In WP 3 the consortium has set its focus in the 2nd year of the project on the development of advanced eco-routing methods using both point-based and trip-based data. A setting is envisioned where a possibly very large set of vehicle streams massive volumes of data to a central system. Task 3.3 aims at developing runtime efficient, high-performance data structures and data-mining algorithms for computing eco-routes in such a setting. Compared to Task 3.2 the focus is on the scalability and the performance of both data structures and algorithms. This task invents and prototypes data structures that can bulk updated in incremental fashion. Due to the massive data volumes and high update rates, efficient usage of memory is called for. Particular challenges include how to identify and eliminate redundant of outdated data. Extensive experimental studies are necessary in this case.

During the 2nd year a number of agreements have been made with data suppliers to provide the REDUCTION project with very large volumes of CAN bus data. This will enable the proposed new advanced eco-routing algorithms to be compared to ground-truth, i.e., the actual fuel consumption reported from the vehicles via the CAN bus. Progress towards the objectives and tasks completed

2.3.1 Progress towards the objectives and tasks completed

Corrections after 1st Technical Review

At the beginning of the 2nd reporting period work has been done on Deliverable 3.1 Report covering requirements specification, data-flow analysis & system architecture, which had to be revised. Vehicle types have been clarified and the use cases have been presented in more detail.

The table 2 below shows the requirements for the use cases:

Table 2: Requirements for the use cases

Requirement	Use Case
Load/update basic map	Load Basic Map
Load/update specialized map	Load Specialized Map
Load GNSS Measurements in Batch	Load GNSS Data
Load GNSS Measurement in Real-Time	Load GNSS Data
Load CANBus Data in Batch	Load CANBus Data
Load CANBus Data in Real-Time	Load CANBus Data
Load Passenger Requests	Load Passenger Requests
Load Tour Related Data	Load Tours
Convert GNSS Measurements to GHG Emission	Build Eco-Map
Combine GNSS Measurements and CANBus data	Build Eco-Map
Annotate Existing Map Technology with Eco Routes	Build Eco-Map
Estimate GHG Emission for a Single Trip	Evaluate Single Trip
Compare and Contrast GHG Emission for a Single Trip	Evaluate Single Trip
Estimate GHG emission for a set of Trips	Evaluate Fleet Trips
Compare and Contrast GHG Emission for a Set of Trips	Evaluate Fleet Trips
Evolution of of Eco-Routes	Update Basic Map

Also for Deliverable 3.2 Report on eco-routing computation techniques additional work has been done on:

- Clarification of timescale for future work on lifting a spatial network using laser scan data
- Completion of variables list that influence vehicular environmental impact
- Providing a more detailed range of driving behaviours evaluated in instantaneous models

<u>Main results obtained</u>

For the Deliverable/Task 3.2 Report on eco-routing computation techniques additional work has been done. This is mainly on the on the following topics.

- Clarification of timescale for future work on lifting a spatial network using laser scan data, i.e., more advanced lifting of an existing 2D map to 3D.

- Completion of variables list that influence vehicular environmental impact. This is part of the Eco-mark benchmark for comparing 11 existing approaches to convert GPS data to fuel estimations.

- Providing a more detailed range of driving behaviours evaluated in instantaneous models. Again this is related to the Eco-mark benchmark

Overall, AAU has in this task studied existing fuel computation models and compared them. In order to do so AAU needed to build more infrastructure which included generation of an accurate 3D spatial network by combining a 2D road network with 3D-LiDAR (laser scan data) data. The availability of slope information affected the fuel computation model's respective accuracies. AAU also computed a special graph for modelling a spatial network that records information about road intersections and road segments, and measures the length of each road segment, the travel time required to traverse the road segment, and fuel consumption or GHG emission on the road segment. The classical Dijkstra's algorithm, which is originally used for searching the shortest routes and the fastest routes, is adapted to conduct the basic eco-routing tasks.

Progress towards Task 3.3: Advanced eco-routing methods

To support eco-routing, the main challenge is to assign accurate eco-weights to edges. With eco-weights, existing routing algorithms, such as Dijkstra's algorithm, can be applied to compute eco-routing. To provide accurate eco-weights, we distinguish between "hot" edges and "cold" edges when assigning eco-weights. Hot edges are covered by enough GPS records, while cold edges are not covered by any GPS records.

First, based on a huge amount of historical GPS records, methods that are able to assign time-dependent and uncertain eco-weights for hot edges are proposed. The obtained eco-weights capture the typical traffic behaviour of hot edges, such as periodic traffic variations.

Second, as the real time GPS data stream in, a method that is able to update the eco weights on hot edges is proposed (highlighted in II below). The obtained eco-weights consider the most recent data and are able to adapt to unusual traffic situations.

Third, a method is proposed to assign a time-dependent eco-weight to each cold edge. Cold edges are less likely to have much traffic and traffic variation, or the vehicles in the GPS data set do not cover the edges. The problem has been modelled as a regression problem and solved by minimizing a judiciously designed objective function that takes into account the structural similarities between hot and cold edges.

All proposed methods are tested on a massive GPS data set collected from Denmark, which suggests that the proposed methods are effective, efficient, and scalable up to country level road networks.

The following techniques have been invented and implemented for Task 3.3:

1. **Assigning time-dependent uncertain eco-weights to hot edges.**
Histogram-based techniques are proposed that are able to assign a time-dependent uncertain eco weight to each hot edge in a road network based on a collection of historical GPS data.

- An Eco-Road Network is proposed as a foundation for enabling eco-routing.
- Compact, time-dependent histograms are proposed to represent the time-dependent, uncertain eco-weights for hot edges in a compact way.
- Accurate and efficient GHG emission estimation on the Eco Road Network is proposed.
- Extensive experiments are conducted to illustrate the efficiency and accuracy of the proposed methods.

2. **Updating eco-weights for hot edges based on real time GPS data.**

Real time GPS data collected from different hot edges are modelled as a collection of correlated time series. A novel spatio-temporal hidden Markov model (STHMM) is proposed to model the correlation among these time series, and thus is able to update the eco weights for hot edges.

- A general framework is proposed that is capable of modelling the traffic behaviour of a road network and thereby enables routing services that optimize different travel-related costs.
- A spatio-temporal hidden Markov model is formalized to model the traffic behaviour of a road network.
- Learning algorithms are proposed to obtain individual state sets for all road segments and to

determine the parameters needed to configure an STHMM.

- Comprehensive experiments are conducted to elicit the design properties of the proposed framework and algorithms.

3. **Annotating cold edges with time-dependent eco-weights**.

Techniques that take into account the structural similarities between cold and hot edges are proposed to annotate cold edges with time-dependent eco-weights.

- A novel problem, road network weight annotation, is formalized which aims to assign time-dependent eco-weights to both cold and hot edges.
- A general framework for assigning time varying trip cost based weights to the edges of the road network is presented, along with supportive models, including a directed, weighted graph model capable of capturing time-varying edge weights and a trip cost model based on time varying edge weights.
- Two novel and judiciously designed objective functions are proposed to contend with the data sparsity. A weighted PageRank-based objective function aims to measure the variance of weights on road segments with similar traffic flows, and a second objective function aims to measure the weight difference on road segments that are directionally adjacent.
- Comprehensive empirical evaluations with real data sets are conducted to elicit pertinent design properties of the proposed framework.

Current investigations are ongoing concerning which of the advanced eco-routing techniques should be included in the prototypes. A requirement for including an advanced technique is that the response time can be made very short. To enable very short response times new data structures for handling both point and trip (trajectory) data is needed.

2.4 WP4 System Design and Integration

2.4.1 Summary of WP 4

The main objective of WP4 is to have a real-time publish-subscribe distributed middleware with a generic functionality. Components may subscribe for information, unsubscribe, publish information, and notify that they are interested in some kind of information. The Event Handler receives all these events through an interface, and can also notify components when the information is of relevance for them. The publish-subscribe communication mechanism will support an asynchronous (non-blocking), many-to-many communication between components in the network.

2.4.2 Work package objectives for the current reporting period

The main objective of WP 4 is the development of an advanced prototype for a distributed middleware with a generic functionality.

Firstly, a rapid prototype was implemented to provide an initial insight in the results delivered by WP 1-3. The initial prototype is used as an initial user interface for one user evaluation in WP 5. This prototype is based largely on the currently available products of the consortium industrial partners, namely on a Dynamic Subscribe System data pool. This prototype is functional enough to allow for all critical operations of work properly in a multi-modal transportation scenario.

In a second step, the advanced prototype building on the field cases in WP 5 is developed and aims at implementing a final pre-market-ready system, which can be accessed and used by end-users after a short introduction. The system supports tracking mechanisms and vehicle ad hoc communications. The advanced prototype will be used in Tasks 5.5 /5.6 /5.7 for both end user adoption and evaluation.

2.4.3 Progress towards the objectives and tasks completed

Corrections after first and second Technical Review

In quarter 1 work focused on revising deliverable D4.1 Report on initial requirements specification & conceptual framework. Additional contextual detail on requirements specification has been produced on: expansion of design specification; on & off-line feedback for eco-driving and safe driving; justification for lack of public user input; revision of software architecture diagram.

Progress towards Task 4.2 Rapid prototype

The primary focus of Task 4.2 is on describing the software architecture of the software stacks which will be utilised in the first phase of the field trials conducted in WP 5.

The architectural description follows a modular fashion. All field studies (FlexDenmark, TrainOSE and Nikosia) utilised specialised software stacks, which implement the methodologies tailored for the focus of analysis. Naturally, the software stacks of each field trial comply with the technical requirements imposed by the underlying infrastructure of the field trial companies and interact with the support systems of the respective provided services. The specific software architecture to be used in all the field trials (FlexDenmark, TrainOSE, Nikosia and Trinité) is covered in depth in deliverable 2.4. Inter-modular communication and interaction through modules was carried through web-service technologies and was described posterior to the individual pilot software architecture.

FlexDanmark Field Trial: Eco-routing functionality

The eco-routing functionality was used to find the most fuel-efficient routes between two points. There were multiple goals of using eco-routes including the following:

- Estimate the fuel consumptions of the existing routes used,
- Evaluate the potential for saving fuel if routes are optimised for minimal fuel consumption instead of fastest travel time,
- Estimate the total fuel consumption for all trips made by a fleet of vehicles.

The core functionality of the software developed for the first FlexDanmark field trial is illustrated in table 3. Here the shortest, the fastest, and the most fuel-efficient routes between two points in the Greater Copenhagen area are shown. A significant difference between these routes can be seen

Table 3: Details about the shortest, fastest, and most fuel-efficient routes

Jagtvej to Smedeland	Time	Distance	Fuel
Fuel-Efficient	0:22:33	13.90 km	1.48l
Fastest	0:18:05	22.41 km	2.41l
Shortest	0:20:54	13.33 km	1.50l

The implementation of the architecture is illustrated in Figure 7 below:

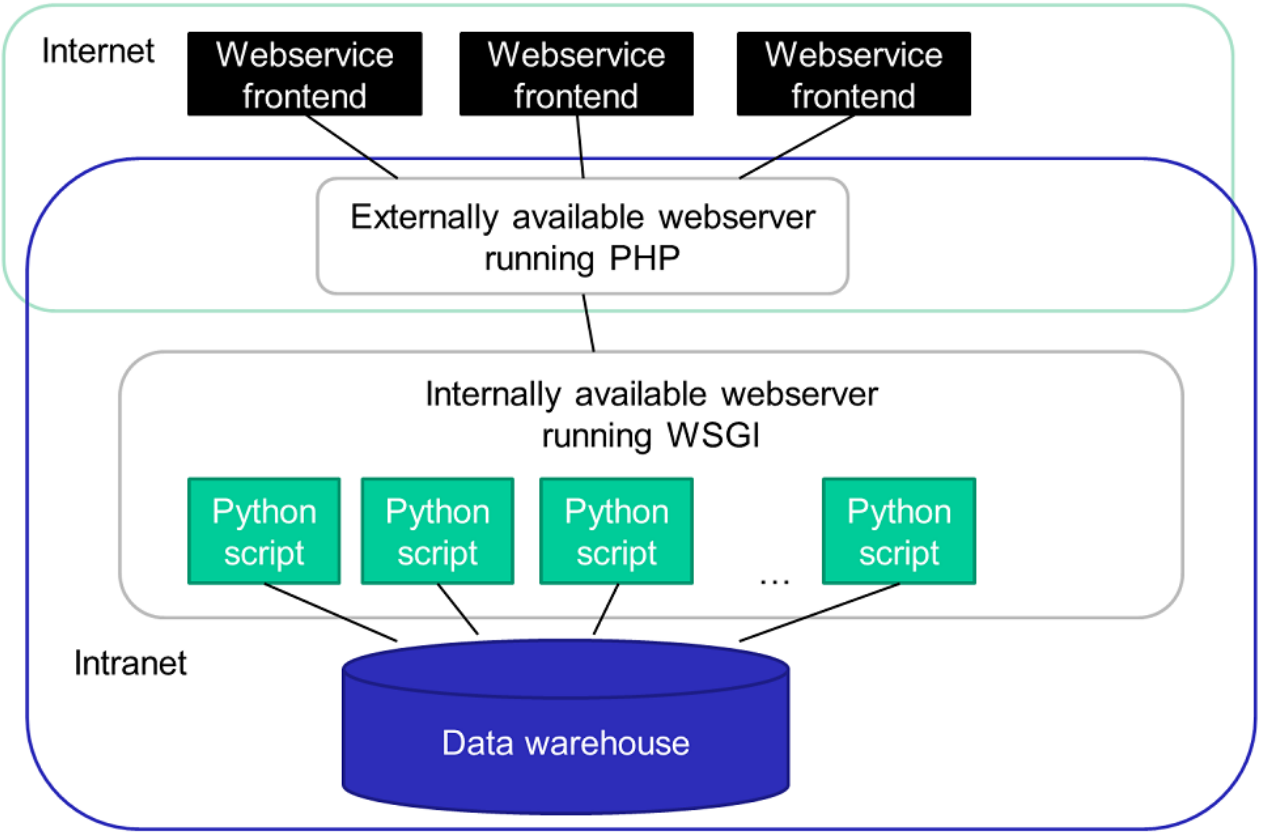

Figure 7: Overview of implementation

There is a subsystem running on the public internet. The client accesses the services provided by using a standard web browser such as Firefox, Internet Explorer, or Google Chrome. Each of the services is displayed as black boxes in Figure 7 and labelled 'Webservice frontend'. These services were implemented using HTML, JavaScript, and CSS and runs on most browsers including the mobile browsers on the Android and Apple iOS platforms.

In Figure 7, each web-service front-end looks isolated. In the implementation, there is a larger overlap in particular the JavaScript and CSS code used for these services.

The web-service front-ends communicate with a web server running Apache with the PHP programming language extension enabled. The PHP programming language was used to be able to forward HTTP request from the internet to the internal service situated behind a firewall. The size of the PHP code was kept to a minimum and works only as a glue layer. PHP was chosen due to it being a very popular scripting language that is available on most platforms.

The blue rectangle labelled 'Intranet' contains the software component that runs behind the firewall. Another Apache web server with WSGI functionality enabled acts as interface between the external Apache web server and the functionality were implemented on top of the data warehouse.

WSGI was used because it enables the execution of Python scripts. On the server-side all programs were implemented using the Python programming language and it is therefore to be able to centrally execute these programs. In Figure 7, each Python program is shown as a green rectangle labelled 'Python script'. There was a very large degree of reuse between the Python programs that is not directly visible from Figure 7.

TrainOSE Field Trial: Multimodal eco-routing aspects

Architecture for multimodal application should include various components that can support further evolution of the product. The structure of the architecture which supports the functionalities offered in the TrainOSE field trial follows a polylithic fashion (many layers), as described in figure 8. Three main layers encapsulate the services of the software stack as described below:

1. Upper Layer: The User Interface and the Administrator interface

2. Middle Layer: The backbone, data and Communication components

3. Lower Layer: The implementation of multi-modal eco-routing algorithms

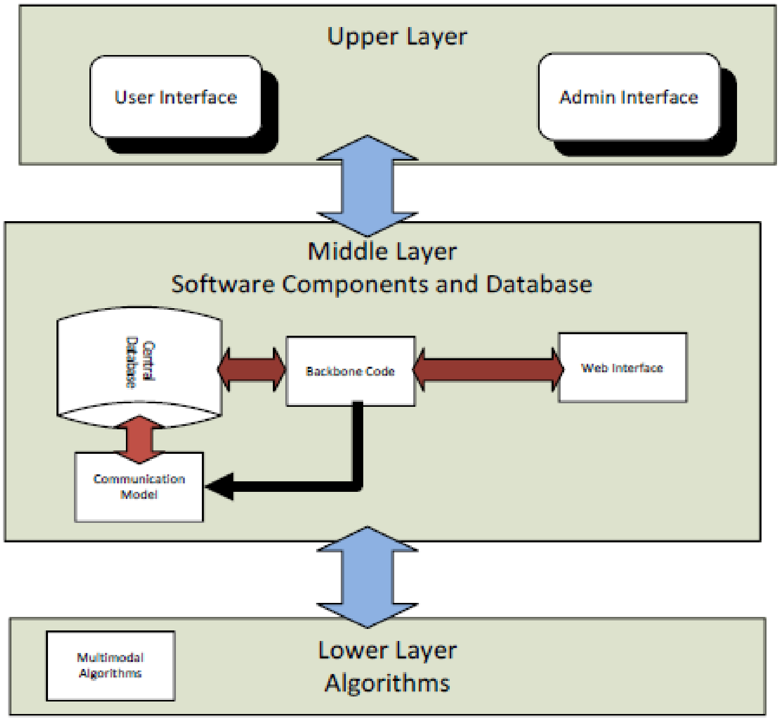

Figure 8: Architectural Layers of TrainOSE's Pilot Software

Nicosia Fleet Field Trial: Eco-driving methodologies with the use of V2I and V2V hardware and software

The Nicosia fleet field trial is main focus is on the utilization of the DDE V2X OBU V2I and V2V devices to develop efficient eco-driving methodologies through a field test using the OSEL bus fleet and the CPO delivery fleet.2I. In this field trial the test bed was the OSEL bus fleet, while the data collected from the route attributes was intended to provide analytical means for eco-driving and peer-to-peer data mining, while testing the performance of the V2X OBU devices.

The architecture of the OSEL Bus Field trial system was based on the paradigm of client server realised in four layers, namely: data capture layer that was realised by a number of clients, application layer, database layer and web interface as an additional layer. A detailed pictorial description of the architecture used to conduct the Nicosia field trial is shown in figure 9.

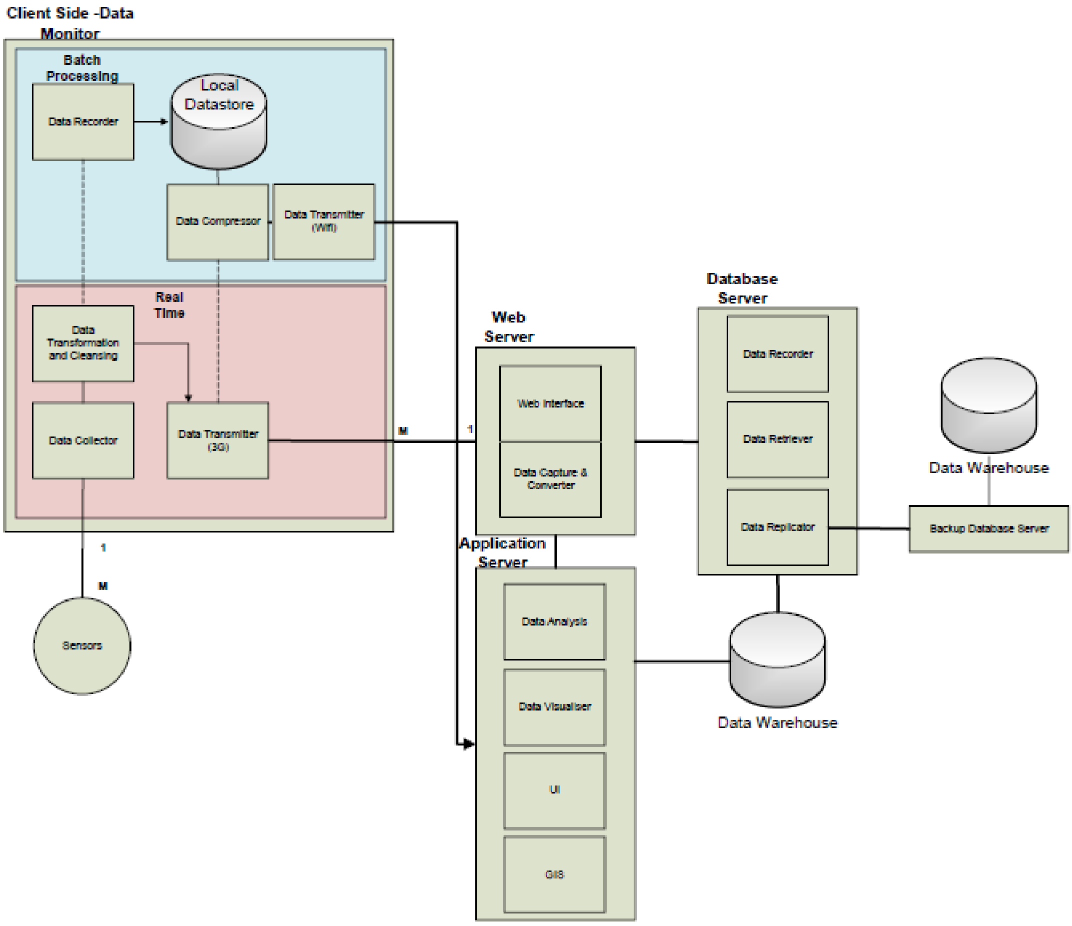

Figure 9: Nicosia Fleet Field Trial Architecture

For the Nicosia Fleet Field Trial the following aspects have been explored:

1. Distributed Data Mining
2. Simulation Software for Distributed Data Mining
3. Architectural Characteristics of P2P Data Mining
4. P2P Network Topology for DDM
5. Data distribution
6. Mapping P2P Data Mining architecture for the field trial
7. P2P Data Mining scenario for the field trial

These aspects have been described in detail in deliverable D4.2.

Trinite Field Trial: Eco-routing services for individual users

Trinite offered a new field trial in the scope of REDUCTION aiming at eco-routing services for individual users. The final outcome of the field trial was a functional iPhone application targeting individual users, which computes the best eco-route for travelling between two destinations.

A platform named "Digital Road Guide" processed the historic and real time information gathered by the App. This way even more information can be combined in order to give the best route advice. This advice can be delivered to the in-car app or to neighbouring networks.

In order to contribute to the goals of optimising driving behaviour, and eco-routing the REDUCTION App was designed to stimulate users to reduce CO2 emission. The Field test contained the following phases:

- **Phase 1**: Register and collect data in central database using in the in-car App for CO2 calculation
- **Phase 2**: Calibrate the CO2 emission data with actual fuel consumption.
- **Phase 3**: Using collected data, as input for the Digital Road Guide to give route advise to users

The REDUCTION app on IPhone main purpose is to reduce CO2 emission. This is done by two ways:

- Optimising driving behaviour, Eco-driving
- Personalised Eco-routing

In Figure 10 the eco-routing application developed by Trinite for the iPhone mobile device is named "REDUCTION" and consists of four main parts:

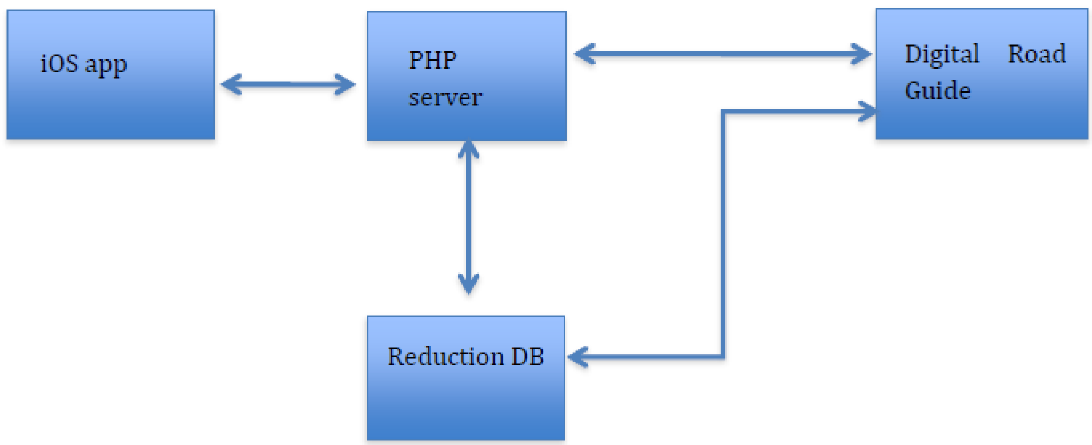

Figure 10 Structure of the IPhone Application

1) **Xcode project, iOS app**: App designed to use in-car to collect data and inform the user.

2) **REDUCTION database**: Database to store all information. Used for analytics and route advice

3) **PHP server**: Data collecting point where all REDUCTION app information is gathered.

4) **Digital Road Guide**: All gathered information is send to the Digital Road Guide to calculate the

route information.

Future work

In the future several points can be examined to improve and extend the system.

- Increase number of users
- Integrating with other systems (weather forecast, CO2 measurement etc.)
- Tuning app using historical data
- Multi model integration
- Extending the App with the functionality to enter mileage and refuel information

Considerable progress has also been made in describing the architecture of the V2V/V2I communication capabilities.

Progress towards Task 4.3.1 Advanced prototype

In this task the primary focus is describing the advances in the prototype as described in the previous deliverable (D4.2). The software architecture and communication protocols to be are elaborated more extensively, which can be used for the field trials of Work Package 5.

Flex Danmark field trial

The following main issues were addressed in the second field trial for the FlexDanmark:

- Multi-modal using busses and mini-busses/taxis/trains will be covered in details.
- Using a set of trips allowed covering a larger geographical area; the second field trial looked at one year of trips from FlexDanmark covering all of Denmark. A number of minor technical changes that will not be covered in this deliverable.

The multi-modal routing was clearly the biggest challenge for the second FlexDanmark field trial. However, the challenge with finding train/bus networks and the fuel consumption was non-trivial. The multi-modal routing therefore had focus on the route from the city of Aalborg to the city of Frederikshavn (both larger cities in Northern Jutland Denmark). The Aalborg-Frederikshavn route has been picked of the following reasons:

- It is a route that often is used.
- It is serviced by train, buses, speedy-buses, and taxis.
- There is a clear different on the travel-time train compared to taxi and bus.

Changing Modality

The major new item explored in the second FlexDanmark field trial was the multi-modality, which was not supported in the software prototype developed. In this prototype the fundamental data structure used for computing travel-time and eco-routes was a directed graph. Graphs are very well-supported data structures in the software used and graphs can be very efficient to use. For these reasons the second field trial reused the graphs as the underlying fundamental data structure. However, the graph data structure had to be annotated with additional information.

Future Work

The multi-modal scheduling was the main new issue explored in the second field trial. There was a number of challenges that needed to be addressed. These were the following.

1. Penalty for changing modality?
2. How many times can a passenger change modality on a trip?
3. From which modality are switches allowed?
   3.1 Taxi→ train → taxi? Makes sense
   3.2 Taxi→ bus → taxi? Probably does not make sense!
4. How can the bus/train schedule be taking into consideration?
   4.1 This will be handled in a simple way in the field trial to avoid having to integrate with the complete train/bus schedule systems.

Experiences from the daily use of trip based data collected continuously

The following were the main experiences and lessons learned from the field trial:

- Better and more precise driving times
- Less discussions with drivers who disagree with the estimated driving time, more objective
- Able to make an ecological calculation of our GHG emissions and fuel consumption
- In the future reducing GHG-emission based on better routes
- Generally good experiences when it comes to drivers and companies

TrainOSE field trial

In the second field trial – Phase 2, tasks from first field trial completed while few other tasks initiated from scratch as well.

Old Tasks:

Web application for multimodal traveling in Greek Territory completed in terms of development effort. However, Data enrichment process continued during second field trial and remains ongoing for the near future. Few promoting actions took place in order to give web application more publicity.

New Tasks:

A new multimodal transportation service initiated during second field trial. Service name was TRAIN-TAXI and it combines train and taxis for the same trip. Every train passenger heading to the city of Thessaloniki could use taxi to reach his/her final destination but not in the traditional way. Taxis trips combine more than one customer in more efficient ways(less KM's). In order to achieve this behaviour, TRAIN-TAXI service, used routing algorithms for route formation.

Energy consumption study for electrified locomotives: Early observations over energy consumption showed that there was an underlying factor that affects heavily energy consumption. Study was initiated in cooperation with another project partner and produced interesting results due to locomotives' driving behaviour. Extensive analysis over energy consumption metrics revealed that the main factor for these variations in energy consumption was the driving behaviour. The next step was the design –via genetic algorithms - of optimal driving paths in order to reach the lowest possible levels of energy consumption.

Construction of ECO-Driving manual: Results of the above mentioned study used in order to write a "good behaviour" driving manual. ECO-Driving manual was about the way, locomotive drivers should drive locomotives in an ECO-way without lowering trips quality (travel time, delays etc.).

Nikosia field trial

The Nicosia fleet field trial architecture is described in D4.3. Since the fleet field trial has not started yet, the Costas Papaellinas Organisation (CPO) (in addition to the OSEL bus company) is incorporated here as well. It describes the addition of a company that operates a fleet of 120 vehicles. For completeness the architecture is repeated in this section as well.

The main objectives of the Cyprus fleet field trial were:

> 1. Demonstrate the capability of the DDE V2X OBU devices to: Phase 1 - a) Read, store in local memory CANbus data and send them to a server via a 3G wireless communication system, Phase 2 - b) Perform Vehicle to Vehicle communications (V2V),
>
> 2. Develop fuel reduction driving profiles for the bus and delivery fleet using REDUCTION technologies: Phase 1 - a) Analyse the fuel consumption driving pattern and develop fuel-consumption driving profiles, b) Develop a bus drivers' and/or delivery fleet drivers' eco-routing guide to reduce fuel consumption, Phase 2 - c) Validate the drivers' eco-guide via a fleet field trial in Nicosia, Cyprus.

The Nicosia fleet field architecture is depicted in Figure 9, which applies to both the DDE and IST/CPO technologies. The Nicosia fleet field trial is expected to provide the following into the overall REDUCTION prototype is terms of fleet management systems:

Task 4.3.1/4.1 Test the feasibility and performance of the DDE V2X OBU devices to read, store and send wirelessly data to a server and/or other vehicles:

Task 4.3.1/4.1.1 Test the feasibility and performance in gathering CANbus data from the OSEL Citaro buses, storing them locally and sending them wirelessly to a server using the DDE V2X OBU devices. This task was delayed due to the inability of the V2X OBU device to read the data from the wiring system. At the end of August, 2013, DDE managed to develop a custom made connector to read the data from the FMS port of the Citaro buses. This task is expected to be completed during the third year of the project.

Task 4.3.1/4.1.2 Evaluate the capability of V2X OBU devices to send and receive data between vehicles (e.g. buses). This task was delayed due to the inability of the device to connect and read the data from the Citaro buses during year 2. Similarly, this task is expected to be completed during the third yar of the project.

Task 4.3.1/4.2 Development of fuel-efficient driving profiles using CANbus data (GNSS, fuel consumption).

Task 4.3.1/4.2.1 Develop Fuel-Efficient driving profiles for the OSEL bus fleet. This task could not be accomplished as planned during Year 2 since the V2X OBU devices were not installed by the end of Year 2. This task is expected to be completed during year 3 with the aid of UHI.

Task 4.3.1./4.2.2 Develop Fuel-Efficient Driving Guidelines for the CPO delivery fleet. This task could not be accomplished as planned during Year 2 since the CPO fleet operator was only recruited to the project in July, 2013. Similarly, this task is expected to be completed during year 3 with the collaboration of UHI and IST.

The schedule for the completion of Tasks 4.3.1/4.1 and 4.3.1/4.2 during year 3 is described in the section related to WP5.

Trinite field trial

The Field trial revealed some Technical problems:

- Power consumption of the App, by constant communication by sending the GPS location.
- User unfriendly way of selecting routes destinations.
- A lot of data is being stored that needs to be computed.

To resolve the drawbacks the design of the App was extended in order to solve the problems. Besides the technical problems the field test showed that there is a need to inform the driver more active, not only by showing the different routes, but also advising the driver actively about the area he is driving in and what possibility's the area has to offer in order to drive a more Eco-friendly, faster or more economical route.

<u>REDUCTION App second implementation</u>

The second implementation of the REDUCTION App integrated the App in a middleware services that will act as enablers of decentralised algorithms and applications faced with the difficult task of sharing real-time streams of UTF mission-critical critical data and information over intermittently connected vehicular networks. Following REDUCTION's decentralised computing approach, this middleware platform service components were distributed on vehicles to tackle the real-time data movement needs of the overlaid analysis algorithms and applications. In addition, the platform has included a back-end server for the benefit of the UTF's access to real-time fleet data as well as for longer-term data analysis and reporting.

The Area Traffic Manager used the real-time information to calculate the most economic and Eco-friendly route. Since the Area Traffic Manager also communicated with neighbouring Digital Road

Authorities, passing route information that could be shared in order to optimise the network.

Future Work

In order to improve the REDUCTION App the integration of information for electric cars will be explored:

- Overview of electric charging points
- Availability of charging points
- Making reservations for charging points
- Route information based on electric charging points.

Risk Assessment

- The field trials involving FlexDanmark, Nicosia and TrainOSE do not show any deviations from the plan. The respective software stacks are being implemented, which means that the functionality is present in accordance with the DoW.
- The Trinité field trial also doesn't show any deviations from the plan. Trinité detected draw backs on the initial architecture like excessive power consumption, user-unfriendly way of operating the App and the large amount of data to be handled and stored and made the necessary modifications to the architecture to overcome the problems.
- The interface description has been added to connect different functionalities between the modules of the work packages. Differences in interpretation on the interface description between the different partners could constitute a certain risk for future implementation and thus needs to be monitored carefully.
- The Nicosia field trial delay is expected to be fully covered and completed by the spring of 2014, within the boundaries of the REDUCTION project. (see table 4).

Table 4: Overview of risks within the field trials

Risk no.	**Description**	**Impact**	**Strategy**
1.	Problem with power consumption Trinité field trial	Low	Modification in architecture. Adapted in the current version.
2.	Time Schedule Trinité	Medium	Focus on the necessary functionalities of the architecture.
3.	Interface connection between modules	Medium	Monitoring. Tuning of interaction in case interpretation differences.
4.	Nicosia field trial	Medium	Complete the field trial during fall 2014

2.5 WP5 Case Studies for assessing Energy-Efficiency and CO2 REDUCTION

2.5.1 Summary of WP 5

The goal of this task is to twofold; firstly, to confirm that the architecture of the REDUCTION system is generic enough to encompass diverse "application" scenarios, and secondly, to provide useful input to the partners for any omissions concerning the operational part of the system, that might have got unnoticed, or to develop more advanced features for the system. Therefore, the existence of several field trials is mandatory, multimodal and traditional as well.

2.5.2 Work package objectives for the current reporting period

The objectives of the second reporting period include phase 1 of the field trials conducted by the partners BEK, TrainOSE and CTL.

T5.2: Phase 1 Field trial for BEK (AAU, BEK)

In the first trial of BEK, the main focus is to validate the eco-routes. The validation part must examine if the environmental indicates lead to trips that are practical to use.

To make these validations it may be necessary to collect additional traffic-related information that currently is not part of the existing operational systems.

T5.3: Phase 1: Field trial for TrainOSE (UTh, TrainOSE)

The first field trial by TrainOSE aims at demonstrating the appropriateness of the system in multimodal scenarios that involves transport of passengers in Greece. The goal will be accomplished through an integrated approach that links train routes between major cities, with buses (owned by TrainOSE) to service local destinations, and vans to serve destinations within a major city (e.g., Thessaloniki). Instead of having the clients to pre-decide the exact transportation medium, a multi-modal transportation provider (TrainOSE in this case) will perform a dynamic plan.

The partners will gain experience in multimodal transportation and will reconsider (if necessary) the system's design principles and operations. The outcome of this field trial is to identify the critical factors in the design of an efficient multi-modal transportation system.

T5.4: Phase 1: Field trial for CTL (UTh, CTL)

The main two objectives of the Cyprus CTL field trial are:

1. Develop and implement a transport simulator to produce estimates of traffic flow and environmental conditions to determine the impact of eco-prone travellers on the transport network conditions.

2. Install the DDE V2X OBU devices on one or more fleets and a) evaluate its capabilities to read, store and support Vehicle to Infrastructure (V2I) and Vehicle to Vehicle Communications (V2V), b) develop environmentally efficient driving profiles and test them in a real operational environment using one or more vehicle fleets.

2.5.3 Progress towards the objectives and tasks completed

Corrections after 1st Technical Review

In quarter 1 partners have worked on resubmitting Deliverable 5.1 Report on collecting requirements & specification.

An overview table of the use cases and the contents of the trials has been added (see table 5 below).

Table 5: Use cases and contents of the trials

Field Trails	Focus
BeKTra/FlexDanmark	• Main vehicle type: Person cars (taxis and minibuses) • Main focus: Eco-routes • Routes: Flexible (where passengers are)
CTL	• Main vehicle type: Buses • Main focus: Driving behavior • Routes: Fixed routes
TrainOSE	• Main vehicle type: Trains/Buses • Main focus: Multimodal public transportation • Routes: Fixed routes

The technical solution provided in the project can be used anywhere that there is a digital map and GNSS/CANbus data available. However, the actual fuel consumption savings may be different from region to region. The actual savings will properly partly depend on cultural impact, e.g., how easy it is to educate drivers in following the speed limit and accelerate/break reasonably. Since the project only have GNSS/CANbus available for Denmark it is not possible to quantify how big the cultural impact is.

Additional input has been added to the impact of cultural variation between case studies and EC countries.

The individual field trials do study the geographical variations that exist within the EC countries. Their variations are outlined below:

- TrainOSE covers the city of Athens, Greece which is much larger than the city Aalborg, Denmark. As an example, Athens has a underground metro system whereas public transportation in Aalborg is mainly by buses.

- The TrainOSE field trials take places in Greece where there are larger mountains. The BeKTra/FlexDanmark field trials take place in Denmark that if fairly flat compared to Greece. Similarly, the CTL field trial is taking place in Nicosia that is also fairly flat.
- The BeKTra/FlexDanmark field trial covers rural areas in Denmark whereas the CTL field trials are cover the suburban/urban region of Nicosia, Cyprus. As a consequence congestions is a minor problem for parts of the BeKTra/FlexDanmark field trials whereas it is a major problem for parts of the CTL field trial.
- The BeKTra/FlexDanmark takes places in Northern Europe and therefore must take icy roads into considerations. This is not necessary for the CTL and the TrainOSE field trials.

These variations have to be taken into considerations when generalising the conclusions from the individual field trials.

Also the field trials in general have been described more precisely.

Progress towards initial requirements collection

Task 5.2: Phase 1 Field Trial for BEK

The main purpose of the FlexDanmark field is to use the results from WP3 "Data Management for Environment Aware Routing and Geo-Locational Analysis Application" to address the following business goals (from Delivery 3.1). In particular, the following business goals from D3.1 are pursued:

- Reduction of the GHG emissions from vehicles used in flex-traffic.
- Establishing environmental profiles of vehicle types.
- Estimation of GHG emissions based on GNSS measurements.
- Estimation of the GHG emissions of a single vehicle.

In addition, the case study should provide feedback to WP4 "System Design and Integration" and should validate the detailed functionality for computing eco-routes as done in WP3.

<u>Nature of the trial</u>

The field trial is conducted based on real-world GNSS and CANBus data. The data is loaded into a software prototype that is based on the design from WP3 (mainly D3.1). Two set of trips are being evaluated:

First, a small set of canonical trips taken from the northern part of Denmark where both large quantities of GNSS and CANBus data is available. This small set of trips is examined in details to evaluate the trustworthiness of the GNSS and CANBus data foundation.

Second, a large set of trips from Region North Denmark for the month November 2012. This set of trips is used to examine what the differences are in pricing and fuel consumption if trips are optimised for the fastest route or alternatively for the most fuel-efficient route.

For the set of canonical trips the start and end points of the trips are plotted into web site that is a front-end to the software prototype built. The web site can visualize the shortest, fastest, and most fuel-efficient route.

For each trip in the set of trips from Region North Denmark the duration, the length, and the estimated fuel-consumption is added when optimising for fastest trips and when optimization for most fuel-efficient trips.

The first field trial has been conducted as a number of iterations where mistakes and errors from the previous iteration have been corrected and the results of the new iterations have been discussed.

The participants in the first field trial at FlexDanmark are FlexDanmark and AAU.

Description of the input

The data foundation or the input to the first field trial is the following:

- A travel-time map created as described in WP3.
- An eco-map created as described in WP3.
- Two sets of real-world passenger requests provided by FlexDanmark (explained above).

Use Scenario

The area (Region North Denmark) that is used in the field trial is picked because there are alternative routes that are interesting to explore. In addition, the scenarios are in areas where both high-frequency GNSS and CANBus is available.

Use Cases from D3.1

In Deliverable 3.1 (D3.1) a number of use cases are listed. In this section the implementation status of each use case is shortly explained:

- Load GNSS data

Fully implemented. GNSS data is automatically downloaded each night and added to the existing set of GNSS data. Approximately 1.8 million rows from ~3.000 vehicles are loaded every work day. In weekends these numbers are approximately half. The data warehouse can be updated in approximately 3 hours on a work day.

GNSS data has been available to the project since its start. Therefore the cleaning of GNSS data in the ETL process is considered stable and well understood.

The operator is warned when no data is present.

- Load CANBus data

Fully implemented. As for GNSS data, CANBus data is downloaded each night and added. There is approximately 0.5 million rows from ~100 vehicles for workdays and a third in weekends.

The cleaning of the CANBus data major has required a major effort (in the ETL process) CANBus data first got available to the project during the Autumn of 2012 and understanding the details of cleaning the CANBus data is still ongoing.

The operator is warned when no data is present.

- Update Basic Map (both a new map and update to existing)

Fully implemented. Both a NAVTEQ map and an OSM map are supported. Multiple versions of the OSM are used.

The OSM map is updated every 2-3 months. Updating the map requires map-matching all GNSS data again. This process can be done over a weekend.

- Update Specialised Map

Fully implemented with a reduced data set. It was expected that the REDUCTION project could get access to the full set of maps with bus and train stops and bus and train routes in all of Denmark. It has proven to be very hard to get access to this data. Instead the main stops and routes for Northern Denmark have been manually created. This set of stops is clearly sufficient to show the reduction in fuel consumption using multi-modal transport. The prototype built in WP3 is generic and can be extended with all stops and routes for all of Denmark when this data becomes available.

- Load Passenger Requests

Fully implemented with blurred exact addresses of passengers of anonymity reasons. Because FlexDanmark is involved in the transportation of the elderly and sick where FlexDanmark's customers live can be considered person-sensitive data. Of this reason a very fine grained zone system of Denmark has been used instead of the actual addresses of the customers (Denmark divided into 13,.000 zones where the travel time in each zone is below 5 minutes). The zones are very fine grained and the impact on the field trials is considered minimal.

- Load Tours

Fully implemented in an offline fashion using a combination of script running outside the data warehouse an Excel spreadsheet. Further studies will determine if a closer integration to the data warehouse solution is needed.

- Modify Basic Costs

Fully implemented using Excel spreadsheet and data extracted from the data warehouse.

- Compute Coverage

Fully implemented for both all four data types, {low-frequent, high-frequent} x {GNSS, GNSS+CANBus}

- Annotate Data

Fully implemented. The map is updated every night when the ETL is updated.

- Build Eco Map

Due to limited access to CAN bus data the development of the eco-map was postponed to the second field trial. In this field trial a complete eco-map of Denmark has been created using the actual fuel consumption from the CAN bus. The REDUCTION project has collected approximately 340 million GNSS+CAN bus measurements. To the best of knowledge this is the largest CAN bus data set available to any EU funded project not involving the can manufacturing OEMs.

- Evaluate Single Trip

Fully implemented and used in the second field trial at FlexDanmark.

- Evaluate Fleet Trips

Fully implemented in offline fashion using scripts running outside the data warehouse and Excel spreadsheet. Further studies will show if a closer integration with the data warehouse solution is needed.

- Business Goals

This section describes if the business goals from D3.1 has been fulfilled in field trail 1 or has been postponed to field trial 2.

- Reduction of the GHG emissions from vehicles used in flex-traffic

The most fuel-efficient routes can be determined.

The fastest routes can be compared are to the most fuel-efficient routes.

From the first field trial the basic building block for evaluating the GHG emissions from vehicles is therefore possible. A more detailed study is needed during the second field trial on how to convert fuel consumption (from CANBus data) to GHG emission numbers.

- Establishing environmental profiles of vehicle types.

Fully implemented for single vehicle type. At the end of first field trial sufficient CANBus data for establishing an environmental profile for mini buses (Mercedes Sprinter).

There is insufficient data for comparing make and models, e.g., compare a VW Passat to a Ford C-Max. During the field trials it has shown to be very difficult to get information on the make and models of the vehicle driving for FlexDanmark. Instead the CAN bus data set has been divided into three sets based on vehicle types. Concretely taxi, minibus, and bus vehicle types are used. This makes it possible to estimate the fuel consumption for an average vehicle, which is sufficient for the purpose in the field trials. We have made informal requests to get access to CANBus data from other sources. Here we have not been successful. Please note that it is impossible on the REDUCTION budget to buy very large quantities of CANBus data. However, we are very satisfied with the actual quantity and geographical spread of the CANBus data that we actually have access to. We are not aware of any other project that has access to nearly the same quantity of CANBus data that is available in the REDUCTION project.

- Estimation of GHG emissions based on GNSS measurements.

Fully implemented using a single instantaneous model from D3.2. However, this will be studied further in the second field trial, if CANBus data cannot be used.

- Estimation of the GHG emissions of a single vehicle.

Fully implemented using the fuel consumption as recorded in the CANBus data.

In conclusion, the basic building block for estimating the fuel-consumption/GHG emission from vehicles is available. However, a more detailed study involving multi-modal transportation is needed in the second field trial.

Obstacles

The obstacles addressed during the first field trials are the following:

- Limited CANBus data available and allowing distribution of data.

Before and during the first field trial a number of visits to transport companies has been made and individual agreements with a number of smaller companies to gain access to CANBus data has been made. It has been necessary to promise that only aggregated results can be used in the field trials and only allowing access to CANBus data for a very limited set of persons.

During the field trials FlexDanmark and AAU have been very active in getting access to CAN bus data. As a result of this effort approximately 340 million GNSS+CAN bus measurements were available are available for the second field trial. The problem of limited CAN bus data can be considered as solved.

- Demonstrate the possibilities with GNSS and CANBus data.

To demonstrate the possibilities when having access to GNSS and CANBus the software design from WP3 has very little focus on presentation of data to the user, i.e., a graphical user-interface (GUI). This has resulted in a number of meetings with companies and organisations with limited outcome. It has therefore been necessary to build a GUI for demonstration purposes. In addition, it has been necessary to make a number of database performance optimizations to the software back-end to make the GUI respond fast to user inputs. The positive effect is that the software prototype now has a nice and responsive GUI (http://daisy.aau.dk/its) and that a very large number of users have tried out this GUI. The negative effect is that the first field trial has had little focus on multi-modal transportation. The business goal "Reduction of the GHG emissions from vehicles used in flex-traffic" has therefore not been sufficiently covered in the first field trial. However, this will be covered in details the second field trial. There is time for this in the second field trial because the efficiency of the final prototype already has been accomplished.

- Diverse set of GNSS and CANBus input formats.

To gain access to GNSS and CANBus data it has not been possible to set any requirements to the data received from the data providers. To deal with this the software prototype has been made very flexible with respect to the input data. This has been realised by using data plugins where a plug-in is made for each data provider. At the time of writing, 11 difference plugins have been created.

- Ensuring anonymity of persons transported.

To avoid that it is possible to deduce which persons are being transported the set of trips are not exactly address to address but between zones. Denmark has been subdivided into approximately 13,000 zones.

Conclusions

In the first field trial large quantities of GNSS and CANBus data has been used to compare the fastest and most fuel-efficient routes. This has been done for both a canonical set of trips and a large set of real-world trips.

The first field trial uses as much GNSS and CANBus data sets then first envisioned and has a more polished graphical user-interface than planned. Further, there has been a considerable effort in performance tuning the data structures and methods to provide the users with a responsive user interface. There has been a huge interest from the public in using the interface with estimated more than 25,000 unique visitors to the web site in December 2012.

The large effort in providing a user-friendly and responsive GUI was planned for the second field trial. However, this was moved forward to accommodate interaction with transport companies and to support a large number of users. The change in schedule has cause that the first field trial has only look at the basic of multi-modal transportation. Multi-modal will have a must larger focus in the second field trial. Thus the same functionality will be provided in the software prototype as described in WP3, however, the order in which the functionality is provided has been changed.

The preliminary results from the first field trials are encouraging; however, a more detailed study of the estimated fuel consumption is needed. One should therefore be careful not over interpreting the results presented here.

Task 5.3 Phase 1: Field trial for TrainOSE

Field trial in phase 1, focused to WEB multimodal transportation application. Development effort focused to the fact that application should be simple and easy to users. The underlying routing algorithms were variations of Time Dependent Shortest Path Algorithm. The most important part of this development was data definition and data integration into application. In order to produce a multimodal transportation application focused on CO2 emissions following data have been collected.

1. Points (or Nodes) of transportation.
    a. Rail Stations
    b. InterCity Bus Stations
    c. Ports

2. Links between nodes. Each link is described by its network features

   a. Distance in KM's

   b. Cost

   c. Vehicle Type for that specific link

   d. CO2 emissions

3. Schedules. Time schedules for each link and each vehicle type defined as well.

<u>Nature of the trial</u>

Trial in Phase 1, focused to offering an internet service for ECO multimodal transportation in Greek Territory. Till now there is no tool for Greek territory to offer reliable and valid multimodal transportation information. The traditional way of traveling in Greece, is by getting information from various sources for available transportation means and their schedules accordingly. The concept of ECO traveling wasn't considered at all. Reduction's multimodal web application filled that gap. Now every Greek citizen or tourist can get combined travel information with the minimum CO2 emissions.
Almost entire Greek territory has been covered. Each city above 10000 inhabitants included. The ultimate goal for web application is to connect all points where some type of transportation mean offers transportation services. In few words, nature of the field trial in Phase 1, was the Web Application and its ECO-multimodal transportation functionalities.

<u>Description of the input</u>

Input for field trial in Phase 1, was the transportation network for Greek Territory. Transportation network described by its nodes, links and schedules and CO2 emissions. Nodes represent transportation points (stations).

Links represent basic arc features such as Travel Time, Vehicle type, distance, energy consumption (oil, electric energy)

Schedules represent transportation means trips schedule (start time, duration etc)

One of the most important features for each trip was CO2 emissions. Three type of CO2 emissions ware calculated for first field trial.

1. CO2 emissions for intercity busses. An extensive search over bus manufactures was conducted in order to define engine types, oil consumption. The average passenger number per trip calculated from data that came from intercity bus companies.

2. CO2 emissions for Diesel locomotives. TrainOSE provided large data sets for oil consumption for diesel locomotives.

3. CO2 emissions for electrified locomotives. TrainOSE provides large data for electric energy consumption. However, CO2 estimation was not so accurate, since electric power company,

didn't provide the exact composition of their energy production mix(oil, coal, natural gas and renewable energy) to define precisely the amount of produced CO2 per KWh.

Description of the output

Outputs from field trial in Phase 1, were twofold.

1. Data for entire transportation Greek network. (transportation nodes, transportation links, schedules etc)

2. Web application output as the result to Web application user interaction. User provide input for: origin/destinations, trip start time, favorite way of travel (ECO, cheapest, fastest etc.). The output is the full trip itinerary where trip information related to transportation mean, travel cost, travel time and CO2 emissions presented in details. Additionally, each trip itinerary contains hyperlinks to transportation web sites, helping this way, users to book seats and buy tickets.

Conclusions

Field trial in Phase 1, was quite productive. TrainOSE prepared software tools for multimodal ECO-Traveling. The underlying work related to

1. UI Design for Web Application,

2. algorithms development ,

3. data collection,

4. web application development ,

5. CO2 estimations,

6. transportation network design and implementation,

was quite successful and fulfilled all goals that have been defined from the project for Phase 1-field trial. Additionally new ideas for more CO2 reduction came up for implementation in Phase 2-field trial.

Obstacles

REDUCTION's web multimodal application proved valuable to travellers in Greek territory since it offers unique travel information. Till now, there is no travel information for combined trips between Intercity Busses and Trains for Greek Territory. During implementation few obstacles rose up.

The main obstacle is the behaviour of Greek syndicate (KTEL) of Intercity Busses. The syndicate has an agreement with the government as the only provider of intercity bus transportation in Greece. They operate soundly competitive to trains for main Greek cities. They can allege that REDUCTION's web application is biased enough to the benefit of TrainOSE, since it promotes trains usage instead of busses. Eventually they can claim TrainOSE to shut down the multimodal web application.

Risks Assessment

The main risk is the degradation of travel information. TrainOSE guaranteed, that travel information related to trains, will be updated all the time. However, travel information related to intercity busses suffers from lack of updating procedures. Each member - local bus companies - of the Greek Syndicate of InterCity busses (KTEL) operates its own web site. There is no unique format on every aspect. The information gathering was made through painful manual procedures. There is no guarantee that TrainOSE can provide the funding for continuous updating of intercity bus scheduling, nor these local bus companies will provide web functionalities for automatic updating procedures.

Task 5.4 Phase 1 UTH Simulated Trial

This simulated trial is an essential part of CTL's field trial aiming at investigating and measuring the impact of V2V communications in the total emissions of CO2, i.e., whether this mode of communication can indeed offer any advantages in reducing CO2. It is widely known and solidly validated, that V2V mode of communication is very successful in terms of achieving driver and vehicle safety. There also studies that have promoted this type of communication for reducing traffic congestion, but there is a significant gap in the literature concerning the impact of V2V on eco-friendliness. Since, CTL's field trial can only deploy a limited number and type (only buses) of vehicles, it was mandatory to complete this field trial with an extensively studied simulated scenario, where we will have the opportunity to experiment with various parameters (across a range of values) affecting the transportation efficiency in terms of CO2 reduction. In what follows, we describe in details the simulation configuration, and give a representative set of plots depicting the obtained results.

Nature of the trial

The study has been developed by using the hybrid simulation framework Veins (Vehicles in Network Simulation), which is the composition of the network simulator OMNET++ and the open source road traffic simulator SUMO. The study is based on simulating an accident in a short distance from the vehicles destination, providing one possible exit. The reason for selecting the vehicles' destinations close to the accident is because it is interesting to quantify the impact of V2V communications on CO2 emissions independently of the travel time. A selection of a very distant (from the accident site) destinations, then it would be apparent that the emitted CO2 from the detouring vehicles would be dominated by the emissions due to the long travel. The measurements have been considered using three possible scenarios:

(A) Enabled IVC (IVC), where the first vehicle that identifies the accident sends a message to the other vehicles after waiting for 15 seconds, and those who receive the message change their route if possible.

(B) Disabled IVC (NIVC), where vehicles with access to the exit, after waiting for 3 minutes change their route. The rest of the vehicles are trapped behind the accident.

(C) All vehicles are blocked (BA), and queued behind the accident.

Experiments take place in a part of the city of Erlangen. The reason for that is there are available maps for that city that are appropriate for our simulation, i.e., not too many options for detouring, and also means for comparison with earlier results that used that map are available. Nevertheless, the location of experimentation is not an essential issue, and it leaves the obtained results unaffected.

Description of the input

The input to the simulation is various values for the independent parameters, and also a map of the city. These inputs are fed into VEINS.

Description of the output

VEINS produces the values of various output (dependent) parameters such channel busy time, number of rebroadcasts, CO2 emission, distance travelled, maximum/minimum speed, maximum/minimum acceleration, packets lost, and so on. In our investigation, we are interested in the total CO2 emission for the EMIT (grams/sec), and the SIDRA-Inst (mL/sec) models, and also the total CO2 emission per meter covered by vehicles.

Conclusions

We examined the impact of Intelligent Transportation Systems (inter vehicle communications) on CO2 emissions. We considered the GHG emissions as a first class citizen in the measurement tasks for transportation scenarios. We conducted a series of simulations using the VEINS simulation framework. We concluded that the IVC method, under a realistic emissions model (i.e., EMIT), outperforms its no-IVC competitor, and even proves to be a better option than that of keeping the vehicle (voluntarily) trapped.

Task 5.4 Phase 1: Field Trial for CTL

The main two objectives of the Cyprus CTL fleet field trial are:

1. Develop and implement a transport simulator to produce estimates of traffic flow and environmental conditions to determine the impact of eco-prone travellers on the transport network conditions.

2. Install the DDE V2X OBU devices on one or more fleets and a) evaluate its capabilities to read, store and support Vehicle to Infrastructure (V2I) and Vehicle to Vehicle Communications (V2V), b) develop environmentally efficient driving profiles and test them in a real operational environment using one or more vehicle fleets.

Task 5.4.1 CTL Nicosia Simulation Study

Main Objectives

1. Enhance the VISTA DTA software to model both eco-prone and travel time-prone drivers.

2. Implement the model in Nicosia, Cyprus and Austin Texas, USA.

The VISTA DTA was employed to produce estimates of traffic flow conditions and fuel consumption at 15-minute time intervals for the two test networks of Nicosia, Cyprus and Austin, Texas by varying the percentage of travellers that are eco-prone (by choosing the least fuel consumption OD paths) and those that are travel-time prone (by choosing the paths with the least travel time). The fuel consumption was estimated using the PAMVEC environmental model, which it was embedded into the VISTA software under REDUCTION. A set of parametric analyses were conducted to estimate the impact of eco-prone drivers on the traffic flow and fuel consumption network conditions.

Brief description of the VISTA DTA software

1) It is an internet/intranet based software that utilizes the PostgreSQL database with GIS capabilities, 2) It requires as input the GIS and roadway geometry characteristics, traffic control data, bus routes and schedules, vehicle class restrictions, any traveller information devices such as Variable Message Signs or in-vehicle navigation devices, and the dynamic Origin-Destination (OD) travel demand matrix, 4) The model requires the estimation of the OD matrix using a combination of techniques (OD surveys, traffic counts, path trajectories via location estimation devices (GPS, wireless roadside vehicle readers)) - the dynamic OD matrix is usually estimated at 15-minute time intervals or less, 3) The model propagates the OD demand using a mesoscopic traffic simulator (Daganzo, 1994) cell transmission model at every few seconds (e.g., 6 seconds or less), where vehicles move in packets from one cell to the next subject to the traffic flow theory laws of density, flow and speed - where the number of vehicles moving is determined by the available capacity of the receiving cell at the specific time step, 4) Each vehicle moves along a time-dependent shortest path (TDSP) that is determined at each iteration, 5) The model converges to a local Dynamic User Equilibrium (DUE) – no user can unilaterally improves his/her travel time (cost) by changing his/her departure or desired arrival time and path within the assignment time interval – each path that has vehicles on it for a specific time interval will eventually have the same travel time (cost) as the other paths for each OD pair – a global DUE is almost impossible to estimate with the current computational performance and mathematical knowledge of DTA.

Progress towards the objectives and tasks completed

Task 5.4.1.1 Develop a framework to evaluate eco-routing strategies using the VISTA DTA

The fuel consumption model of PAMVEC was encoded into the VISTA software to produce fuel consumption estimates. A new procedure was implemented within VISTA to accept the sequential loading of first travel-time prone vehicles and then fuel consumption-prone vehicles. First, the dynamic OD matrix is distributed according to the DUE using the travel time parameter for all vehicles. Then the least fuel consumption path is found per OD pair. The corresponding fuel consumption demand per OD pair is then loaded on to the least fuel consumption path. The model developed is applicable for short term events where it loads the eco-prone demand only on one path assuming that the eco-prone travellers will follow the directions blindly, whereas the travel time–prone travellers will remain on their original routes. A more comprehensive assignment would have been to reassign the eco-prone travellers onto more than one path such that to reduce the risk of oversaturation of only one eco-path. In Phase II (year 3) it is expected that a more universal Dynamic User Equilibrium (DUE) model will be developed using a generalized cost function – which will redistribute both eco-prone and travel-time-prone travellers to more paths for each OD pair.

Task 5.4.1.2 Gathering of the input data for the Nicosia and Austin, Texas networks and input

into VISTA

The GIS data and roadway geometry were obtained from the CYPWD on January, 2013 through the use of the VISUM model that was developed by the CyPWD (2010-2012). The traffic control data (signal timing, roadway directionality restrictions, speed limit, turn prohibitions) were obtained from the previous VISTA implementation model under the Nicosia Integrated Mobility Master Plan study (2010). The bus routes and schedules were obtained from the CyPWD. The data were then input into the VISTA data warehouse. The static OD matrix from the CyPWD VISUM model was also input into the VISTA data warehouse.

In parallel, through cooperation with the Network Modelling Centre (NMC) of the University of Texas at Austin, the corresponding traffic flow, traffic control and infrastructure data were input into the VISTA data warehouse. The NMC participated in this study as an external participant.

Task 5.4.1.3 Implement the enhanced VISTA DTA in Nicosia, Cyprus and Austin, Texas, USA

The proposed new VISTA framework was implemented on two transportation networks: the greater Nicosia (Cyprus) region (58,678 trips during the peak period hour and 25,029 links) and the downtown Austin, TX (62,836 trips during the 2 hour AM peak period and 1,574 links).

The dynamic OD matrix was estimated using the static OD matrix for the AM peak period – obtained from VISUM – and a set of traffic counts that were conducted during the Nicosia Integrated Mobility Master Plan study (2010) that was conducted by the CyPWD. A set of additional traffic counts conducted during 2011 and 2012 were also used to supplement the estimation of the dynamic OD matrix. In parallel, the corresponding OD matrix was estimated for the Austin, Texas network using the static OD matrix from the regional network of the Austin metropolitan area and a set of historical traffic counts.

A set of parametric analyses were conducted by varying the percentage of eco-prone vehicles from 0% and up to where the network exhibited unrealistic results (e.g. oversaturation at the least fuel consumption path). The results were then summarized for all tests conducted for each network in terms of both fuel consumption and travel time.

Task 5.4.1.4 Risk Assessment for the Nicosia Simulation Study

The first phase of the simulation study was delayed due to the unavailability of the data from CYPWD – as the updated VISUM model for Nicosia was made available at the end of January, 2013. However, CTL in cooperation with the team from the University of Texas at Austin (the Network Modelling Centre) managed to complete the first phase of the simulation study by July, 2013, thus covering the few month delay experienced in the beginning of the study.

Task 5.4.3 Conclusions and Future Work

The first phase of the simulation study involved the enhancement of the VISTA DTA software to be able to model both eco-prone and travel time prone travellers for short term events – where eco-prone travellers were assumed to follow the least eco-path per each OD pair. The VISTA software was reconfigured to model fuel-consumption-prone travellers using the environmental model PAMVEC, which was encoded into VISTA. In addition, the software was further enhanced to estimate the least fuel consumption path per OD pair and load the eco-prone OD demand onto this path thus changing the original DUE assignment that assumed that all travellers were travel time-prone. A set of parametric analyses were conducted by changing the percentage of eco-prone travellers from 0% up to a percentage where the least fuel consumption path was becoming oversaturated and the network as a whole was producing unrealistic results. The results of the parametric analysis suggest that system-wide benefits could be observed for low market penetration rates (5 -15%) of eco-prone vehicles – which was constrained by the use of only one least energy path. Similarly, eco-prone vehicles experienced lower fuel consumption for low-market penetration rates of 5 to 15%.

The second phase of the simulation study (year 3) will focus in the development of a more comprehensive multi-objective VISTA DTA model that can be utilized for both short term (non-DUE) and long term (DUE) traveling behaviour. The main components of the new framework under Phase 2 will include a generalized cost function that can capture travel time, fuel consumption and monetary cost and a DUE iterative process.

Task 5.4.2 CTL Cyprus Fleet Field Trial: Phase 1 and 2

<u>The main objectives of the Cyprus fleet field trial are</u>

1. Demonstrate the capability of the DDE V2X OBU devices to: a) Read, store in local memory CANbus data and send them to a server via a 3G wireless communication system, b) perform Vehicle to Vehicle communications (V2V); and
2. Develop fuel reduction driving profiles for the bus and delivery fleet using REDUCTION technologies: a) Analyse the fuel consumption driving pattern and develop fuel-consumption driving profiles, b) develop a bus drivers' and/or delivery fleet drivers' eco-routing guide to reduce fuel consumption, c) validate the drivers' eco-guide via a fleet field trial in Nicosia, Cyprus.

Task 5.4.2.1 Secure the participation of at least one fleet operator

The OSEL bus company of the greater Nicosia region agreed to participate in the Nicosia field trial, subject to the condition that the field trial will not interfere with the bus operators and the installation of the V2X OBU devices will not negate the Mercedes Benz warranty of the Citaro buses. OSEL was selected to participate in REDUCTION since it had a set of uniform buses that would have made the installation of the DDE V2X OBU devices easier as it would not require the development of different software to read the corresponding CANbus data.

Task 5.4.2.2 Secure the cooperation of the Mercedes-Benz in reading the CANbus data from the Citaro buses.

This task could not be accomplished as the REDUCTION consortium could not secure the cooperation of Mercedes-Benz in providing access to the CANbus data. As a remedy, DDE decided to develop a custom made solution to read and decipher the CANbus data from the Citaro buses.

Task 5.4.2.3 Read the Citaro CANbus data via the wiring system or the fleet management port

(FMS)

DDE with the aid of CTL and OSEL conducted a diagnostic test on March, 2013 to try and sniff the data via the wiring system of the Ctaro bus. This test was not successful and it was decided to try and sniff the CANBus data from the FMS port via a custom-made connector. The development of the FMS port connector and the redesign of the V2X OBU software were completed between March and August 2013.

In August, 2013 DDE installed the custom-made connector and managed to read and download the CANbus data on a laptop. It was therefore decided to proceed and redesign the V2X OBU devices to be able to read the CANbus data via the FMS port. The main tasks to be completed during the third year of the project include: 1) Install the five V2X OBU devices on to five OSEL buses and conduct a validation test to see whether they can read, store and send data, and 2) a) collect the CANbus data and develop fuel-efficient driving guidelines, b) validate the proposed driving guidelines through a field test.

Task 5.4.2.4 Recruitment of an alternative company to conduct the fleet field trial

Given that the field trial by March, 2013 did not start, CTL and DDE decided to recruit another fleet operation company in case it became non-feasible to read the data from the Citaro buses. CTL identified the Costas Papaellinas Organization (CPO) fleet operator through their system integrator Istognosis Ltd. (IST) as a candidate replacement for the field study. The CPO had a fleet of homogeneous vehicles and it was about to install its own FMS, that included GNSS and fuel consumption data in addition to other FMS related data. In July, 2013, the IST/CPO fleet operator solution was accepted by the REDUCTION consortium as an alternative to OSEL or as an addition in case DDE managed to read the CANbus data via the FMS port of the Citaro buses – which was accomplished by August, 2013.

The data collection (GNSS and fuel consumption) from the CPO commercial vehicle fleet started in late July, 2013 and is expected to continue until the end of 2013 It is noted that the data from the IST/CPO FMS system are retrieved at 10-second time steps, which will constrain the analysis of the driving profiles. The main tasks to be completed during he third year of the project are: a) Collect the CPO fleet data (GNSS, fuel consumption) from July to December 2013, b) Analyse the data and develop fuel consumption driving guidelines, c) validate the proposed driving guidelines via a field test.

Task 5.2.5.5 Risk Assessment for the Nicosia fleet field trial

The Nicosia OSEL fleet field trial could not be completed as planned during the second year of the project due to the following reasons: 1) The REDUCTION consortium could not provide any assistance in connecting the DDE V2X OBU devices on the Citaro buses. Action taken: DDE suggested to try and "sniff" the CANbus data from the wiring system; 2) DDE with the aid of CTL and the cooperation of OSEL conducted a diagnostic test to try and sniff the CANbus data from the wiring system. Unfortunately, no data could be read via the wiring system. Actions taken: a) DDE and CTL decided to try and find another fleet operator to conduct the test, b) In parallel DDE decided to try and read the CANbus data via the FMS port of the Citaro buses, 3) The REDUCTION consortium accepted CTL's recommendation to recruit the CPO fleet operator as an alternative to OSEL on July, 2013. Since July, 2013 CTL started gathering GNSS and fuel consumption data which were made available by IST, 4)

DDE with the aid of CTL successfully installed a custom made FMS connector to one OSEL bus and collected CANbus data. It was then collectively decided to continue the trial with both fleets for the third year of the project.

Given these changes, the following schedule is expected to be followed during the third year of the project (see table 6):

Table 6: Nicosia Fleet Field Trial Schedule for Year 3

Fleet field study	Risk	Field Trial Schedule for Year 3
OSEL bus fleet field study	Low	1/9/13 – 31/10/13: DDE will prepare the devices and install them on the five OSEL buses. Risk is low as DDE has substantial experience in this type of task.
	Medium	1/11/13 – 31/12/13: Data gathering from the OSEL buses. Risk is medium as the performance of the V2X OBU devices under the operating environment of the OSEL buses in Nicosia is not known. DDE with the aid of CTL will try and resolve any issues related with the devices in case problems are presented during the course of the field trial.
	Medium	15/1/14 – 15/2/14: Data analysis and development of the fuel consumption driving profiles. This task is based on the availability of the data from the devices. Further, the data analysis may not produce any meaningful fuel consumption guidelines. In such case, the trial will stop and the results will be reported. Otherwise, the follow-up study will take place.
	Low	16/2/14 – 1/3/14: fuel consumption driving guidelines will be presented to OSEL – if such are found. If the analysis produces meaningful driving guidelines then this task carries low risk.
	Low	15/5/14 – 15/6/14: data gathering from the CPO fleet and data analysis. The risk for this task is low.
	Low	30/6/14: Final Draft Report on the CPO fleet field trial. Low risk.
	Low	31/8/14: Final deliverable on the CPO field trial. Low risk.
IST/CPO fleet field study	Low	1/9/13-31/12/13: Continue the data gathering from the CPO FMS system. The risk of gathering the data is rather low as it is a mature commercial FMS system.
	Medium	15/1/14-30/4/14: Data analysis and development of fuel consumption driving profiles. The risk is medium since the CTL team is not familiar with the data quality. Therefore, the analysis may take longer than anticipated. The field study will continue beyond the official deadline of REDUCTION if it is found necessary. Further, the data analysis may not produce any meaningful driving guidelines. If this is the case then the CPO fleet field trial will stop and the results will be presented as such.
	Low	1/5/14 -15/5/14: fuel consumption driving guidelines will be presented to CPO. This task carries low risk.
	Low	15/5/14 – 15/6/14: data gathering from the CPO fleet and data analysis. Low risk.
	Low	30/6/14: Final Draft Report on the CPO fleet field trial. Low risk.
	Low	31/8/14: Final deliverable on the CPO field trial. Low risk.

Task 5.2.Trinité Amsterdam Field Trail: Phase-1

Goals of the field trail

The Amsterdam field trail should deliver insight to several points of interest.

- Examine the possibility to minimise the air pollution and keep the route "green" by advising specific routes and departure times to drivers using the ATM (Area Traffic Manager) of the system architecture, described in work package 4 and the smartphone app.
- Examine the possibility of integrating the traffic data and CO2/NOx data from third party companies, in order to compare the baseline situation with the outcome of the field trail.
- Determine the possibility to minimise traffic accidents with bicycle drivers and the contribution to the safety in the environment.
- Determine the possibility to minimise the travel time for transportation companies and the contribution to decrease CO2/NOx emission and fuel consumption.
- Establish a clear and concrete view on how to deploy the system, with all obstacles identified and removed in order to successfully fulfil the pilot with the city of Amsterdam.
- Establish a system that is ready or nearly ready to be used in the pilot, before the field trails of the REDUCTION project finishes.

It is not a main goal of this pilot to be finished within the time constraints of the REDUCTION project itself. We expect the pilot to be operational, even after the REDUCTION project will end. This is because this pilot is strongly related to two other pilots: the IJburg pilot and the ambulances pilot for the city of Amsterdam. These pilots together form one of four "Front Runner" projects ("boegbeeld" projects in Holland).

The Dutch ministry of Infrastructure and Environment, in person of Minister Schultz van Haegen, has issued a government initiative "Better Informed on the road". The goal of this initiative is to improve the service to travellers by stimulating innovative commercial companies and allow them to cooperate closely with local governments and road authorities. Trinité Automation signed in on this initiative with the "Digital Road Authority", a concept in which the Area Traffic Management (ATM) plays a central role. The Digital Road Authority contains the three pilots as mentioned above.

The REDUCTION project and its state-of-the-art technologies, research and consortium meetings have a large and positive contribution to the deployment of the system and the success of the pilots. All three pilots (the green route to the Food Centre, the IJburg pilot and the ambulances pilot) use the same concepts and technologies, only deploy them in a different context and for different goals. Trinité Automation chooses to add the green route pilot (the Amsterdam use-case) to the REDUCTION project for the benefit of all partners, the pilot and the REDUCTION project itself. The other two pilots will not be described within this work package, but do have a close dependency with each other in the deployment of the system and management of the pilots.

The second REDUCTION App field test in Amsterdam will cover 2 roads. The roads are selected in cooperation with the city authority (DIVV) of Amsterdam. The two routes are main routes to the centre of the city.

1. Haarlemmerweg

2. Jan van Galenstraat

The city of Amsterdam is very interested in reducing the air pollution created by the traffic on the two routes. The Reduction App will be used to guide road users trying to minimize the CO2/NOx pollution. The ATM (Area Traffic Manager) provides the information used to guide the road user.

The ATM monitors the performance of the network real time and can communicate through controlling SwitchPoints (AccessPoint are the entry and exit points of a SwitchPoint). Depending on the traffic the ATM can decrease the traffic inflow of a specific route. The ATM can use roadside equipment to regulate the flow but for this test especially the REDUCTION App will be used to advise users to reroute.

Secondly, the smartphone app will be used to communicate the desired arrival time of the transportation company at the Food Centre Amsterdam, to unload their cargo. The smartphone app will send the desired arrival time to the ATM that controls the traffic in the area and the ATM gives advice back to the driver on the optimal departure time. In order to determine the optimal departure time, the system has to be able to determine an optimal schedule for unload cargo, minimising the waiting queues at the entrance of the Food Centre.

<u>Use case</u>

1 User wants to take a drive and enters his desired date and departure time in the agenda of his smartphone. The smartphone will read the agenda and communicates the requested arrival date and time with the ATM. The ATM will give back an optimal departure time.

2 The smartphone app calculates the most eco-friendly route based on the historical data from the database and calculates the AccessPoints that are passed.

3 The user starts driving and the smartphone app calculates if it is crossing an AccessPoint. When crossing a AccessPoint it notifies the ATM and sends its information (speed, acceleration, fuel consumption, CO2 emission and the next AccessPoint to pass)

4 The ATM is monitoring the network of Amsterdam and receives a notification from the smartphone app. With the AccessPoint information from the app it can check if the route passes one of the specified routes and decide to give a rerouting advice. (Push message to the smartphone app)

When the user arrives at his destination all information is stored and the driver will receive a ranking from the “Best driver contest”.

<u>Best REDUCTION driver contest</u>

The best REDUCTION driver contest is a game that can be played by the REDUCTION users. Users can register through the App. Based on the fuel consumption, CO2 emission, acceleration and following up the rerouting advice a REDUCTION ranking list is generated. This list is available on the driver contest web portal.

Rerouting advice: use the preferred route. BONUS: 10 extra REDUCTION points

The goal behind the contest is to stimulate users to carry out the re-routing advice and making Eco-driving attractive.

2.6 WP6 Dissemination, Exploitation, Standards

2.6.1 Summary of WP 6

The results of REDUCTION are made publicly available through peer-reviewed publications, conference presentations, press releases, web pages and brochures. Generated intellectual property is carefully protected, e.g., patent filling. An exploitation and dissemination plan is specified to maximize the outcome and benefit of the project for individual partners. Partners will search for and use existing fleet-management standards used in the EU. Important contributions to these standards are made where applicable.

2.6.2 Work package objectives for the current reporting period

T6.1: Dissemination

This task is led by AU although all partners participate in dissemination activities promoting their own findings and results of ongoing research and development. All participants will make the results available to a wider audience.

Results of the project will be presented at high-level conferences. Along with presenting results at conferences, workshops and publishing in high-quality peer-reviewed journals, results and progress information will also be published on a web-site. This web-site is used by the consortium to plan and discuss activities related to the project. Public engagement will be enhanced through press releases and presentations to interest groups.

T6.2: Exploitation

The task to exploit results achieved in REDUCTION is led by TRI who has an excellent overview of the market and current state-of-the-art. TRI plans to develop a software product especially designed for companies in fleet.

The traffic data is already available and obtainable from an integral data pool (already used by TrafficControl centres in the Netherlands); however, additional data can be a part of it. The new software will be developed in close cooperation with the consortium, whose ideas will be combined with Trinité's knowledge. An exploitation plan will be set up in year 1 and updated according to results delivered in other work packages.

The plan will especially cover activities related to work packages 1, 2, and 3 and its final prototype system as delivered by WP 5. Delphi plans to implement the key achievements of REDUCTION as an integral part of their V-2-X product line. This will then be shown to the major fleet managers in Europe and the system further developed with their input. Delphi also plans to present the results at the end of the project in relevant conferences and fairs.

T6.3: Contribution to standards

This task is coordinated by DDE and involves all participants. The currently available standards will be reviewed to see which are the most suitable to use and build upon. The results will feed into the standards being used in all work packages to be highly interoperable with other fleet-management systems not developed in REDUCTION.

Solutions delivered by REDUCTION will build, wherever possible, upon existing open source / freely available standards. If for any scenario no current standard is sufficient, the most promising one will be extended accordingly. Contributions to standards are expected to arise by making significant extensions of existing standards. These will be communicated with the expert sub-committees of standard issuing organisations (e.g. ISO) and approval of suggested extensions will be sought.

Corrections after 1st Technical Review

During quarter 1 effort has been put into the resubmission of deliverables 6.1.1, 6.2.1 and 6.3.1.

Deliverable 6.1.1 has been updated with contacts established, information resulting from dissemination activities; forthcoming events have also been added to the document.

Deliverable 6.2.1 has been updated with the expected outputs of the project subject to exploitation. Also an overview table containing target groups, potential target groups and how exploitation and project outputs differ between target groups. An evaluation of market situation has been added, which includes differences and similarities between transport modes and how these can be exploited.

Deliverable 6.3.1 has been resubmitted and updated with the goal of SAE standardisation, a summary table of standards; the DVM exchange has been described in more detail; Delphi´s position on common standards in EU/USA.

2.6.3 Progress towards the objectives and tasks completed

Task 6.1 Dissemination

This task is led by the partner AU although all partners participate in dissemination activities promoting their own findings and results of ongoing research and development. All participants will make the results available to a wider audience. Results of the project will be presented at high-level conferences. Along with presenting results at conferences, workshops and publishing in high-quality peer reviewed journals, results and progress information will also be published on a web-site.

This website is used by the consortium to plan and discuss activities related to the project.

Public engagement will be enhanced through press releases and presentations to interest groups.

The task involves dissemination activities of all partners about promoting their findings and results of on-going research and development in the project. This document reports on events and publications where it is possible to make the results of the project available to a public audience.

In particular, the dissemination includes the following means and activities:

- Logo, website and poster of REDUCTION project.
- Events that will be attended by REDUCTION partners, where the partners will disseminate information of REDUCTION project and will also discuss results of REDUCTION project.

  Publications produced by REDUCTION partners that report available results to conferences, workshops, journals, newspapers, etc.
- Formal presentations performed by REDUCTION partners that present available results to international conferences and workshops.

- Participation of external bodies in REDUCTION project that help to raise the public awareness of REDUCTION project.

Project Logo

The project logo (see figure 11) conveys the project's aim, meaning and concept. The logo for REDUCTION project is considered to be unique, distinctive and easy to remember. It displays a clear idea of the value of the project and the understanding of its user market.

Figure 11: REDUCTION Logo

Project Website

The project website was developed before the kick-off meeting, and is updated timely since its launch. The website address is http://www.reduction-project.eu/. The website was developed in English. In particular, the website contains the following features:

- The "Home" page states the title, duration, objectives and expected results of REDUCTION project.
- The "project info" page lists the coordinator and each individual partner of the project. It also presents approach that will be used in the project.
- The "Partners" page displays partners involved in the project.
- The "Downloads" page allows publications of the project to be downloaded.

The "Contact us" page is designed for people who are interested in the project to get contact with the consortium.

The project also has a private online shared workspace. This area allows partners to access to, upload and download documents that are related to the project. This folder includes all documents related to the physical meetings held regularly, all minutes from the physical meetings and telephone meetings, deliverables that have been submitted to the commission, and internal documents that have been circulated among the partners. Login user name and password are provided to each partner.

Project Poster

A project poster has been designed, in order to support the promotion of the project at public events and workshops.

The poster provides a brief glance of the project, but concisely presents the key information of the project. In particular, the poster includes the project name and acronym, project type, program, the project coordinator, the project partners, objectives, approach, description of work and expected results.

The poster is available from the link
http://147.172.223.251/reduction/documents/REDUCTION_Project_Factsheet.pdf.

Dissemination Rational

The outcomes of REDUCTION project are mainly disseminated to public by attending various events, publishing papers and giving presentations in prestigious academic conferences, giving demonstration in conferences and exhibitions, and publishing articles in local media.

Different work packages have different main dissemination targets. For example, the main objective of WP2 is to develop novel machine learning algorithms for creating predictive analytics models for eco-driving. Thus, the main dissemination targets of WP2 are prestigious machine learning conferences and journals, intelligent transportation system industry linkages, and local newspapers and magazines.

The benefits of these dissemination activities are raising the public awareness of REDUCTION project to academic audience (e.g., publishing papers and giving presentations in prestigious academic conferences), industrial audience (e.g., demonstrations in exhibitions), and citizens (e.g., articles in local newspaper and interviews in local TV).

A list of dissemination activities and publications completed during the 2nd reporting period can be found in the table 7 below.

Task 6.2 Exploitation

The main objective of this task in the 2nd reporting period was to further develop an exploitation plan for the project.

The goal of this REDUCTION Exploitation Plan is to activate all partners in seeking opportunities for the exploitation of the project results and to execute and communicate its value proposition. The

REDUCTION consortium has a goal to promote the results of this project to many diverse target groups—including businesses, industries, government and the general public. Aspects of this marketing plan also address the need to enhance REDUCTION's "image" or reputation in the eyes of those same target groups.

The consortium decided to split the deliverable in two parts: a general part about exploitation and a part with individual marketing plans by each commercial partner. The decision was made to activate all partners even more in seeking opportunities for the exploitation of the projects' results and to execute and communicate its value proposition. In this way the consortium wants to realise a good and structured way to the EU market through local knowledge. The five exploitation plans are written in year two and will be further expanded in year three.
In the revision of the second delivery on Exploitation the first year version is completed and expanded with new information. The added information in year two is about understanding the most important target groups and adding motivation to the description, completion of the situational Analysis, a PEST(L)E analysis, new chapter on key advantages and challenges in the SWOT chapter, risk assessment, a chapter about administrative and policy and a general activity plan.

Outputs of REDUCTION

In the table 7 below the exploitable results REDUCTION expects to deliver are set out. Including the target group it expects to reach and the impact is expects.

Table 7: Exploitable results

Exploitable results			
Project output	**Target group**	**Results**	**Expected impact**
Fleet management system - software product especially designed for companies in fleet - key achievements of REDUCTION will be implemented as an integral part of a V-2-V product.	Fleet owners (passenger & freight)	Advanced management services to fleets: - Advise, information & awareness in eco routing - driver education - Speed advise by taking current traffic situation.	Reduction of CO2 emissions & fuel economy

Open architecture of REDUCTION	Companies that own / develop Traffic Management Systems	- Extensibility to groups of fleets ("social" fleets) - Information & awareness about potential improvements of adaptive and decentralised fleet management on returns/running costs	Increase of synergies (& cooperation) between different fleet management solutions
On-board communication and computation devices	(incar) Fleet owners, (passenger & freight), Public transport companies, etc.	Additional services for fleet management	Increasing safety, and reducing accidents
Distributed predictive analytics algorithms	Companies that own / develop Traffic Management Systems (also for incar suppliers)	Predictive travel time and predictive CO2 emission of the ECO routing	The predictive travel time and CO2 emission can be shown on DRIP or send to users via App, Bluetooth or internet
Eco-routing methodologies	Companies that own / develop Traffic Management Systems (also for incar suppliers)	- Advise in eco routes to road user by means of internet or via Bluetooth, smart phone or by traditional roadside equipment like VMS - The schedule of public transportation via VMS or smart phone	More precise eco-routing for the type of a car which users are using by means of smart phone, such as a IPhone app.

Target groups

REDUCTION has mainly Business-2-Business focus. Potentially all automobile industry partners are potential partners. But also ministries, public organisations and public agencies are target groups, because they can encourage a multiplier effect on national policy. In the table 8 below you will find an overview of the target groups.

Table 8: Overview target groups

Overview target groups		
All possible target groups	Groups Used (companies)	Potential future groups (companies)
Private Urban Fleets (such as taxi fleets, shuttles (e.g. school busses) of all modes and their combinations, etc.		X: Partly added names of organisations
Automotive rental - Long term lease: Companies who opt for this service outsource their vehicle fleet needs to a leasing company. - Short term lease: Cars, vans and trucks can be rented to private or professional clients for a relatively short period of time in order to meet their respective transport needs		
International rail/ship/airline companies		X: Partly added names of organisations
Logistics & cargo/freight-transport companies with multi-model fleets		
Public transport organisations		X: Partly added names of organisations
Ministries & public organisation that want to deploy pilot studies based on fleets comprised by individual drivers.		X: Partly added names of organisations
Public agencies: environmental agencies, public health departments, departments of transport		X: Partly added names of organisations

<u>Marketing Strategy</u>

The marketing strategy of REDUCTION will be to execute and communicate its value proposition of offering innovative services and state of the art systems for fleet management whose outcome are environmentally friendly and are produced by a system architecture that is decentralised and extendible in its design.

Additional to distinguish the REDUCTION project in this competitive & saturated market, we have to focus on a message which includes: innovative, future proof, state of the art, available, integral & complete.

Mission

REDUCTION’s main mission is to segment the market of “green” fleets by providing an advanced product to individual sectors (mainly private/public fleets), which are otherwise not properly serviced by existing commercial solutions.

Objective

REDUCTION sets the objective to achieve increase in market penetration over regular milestone periods and to achieve Brand Equity (Brand Awareness) so that REDUCTION’s becomes a household word in all our target groups.

Conclusion

Exploitation of REDUCTION will have a broad perspective and has the goal to reduce CO2 emission by 10%. It focuses on three different means:

1. Eco-routing,
2. Multi-modality
3. Optimal driving behaviour

Because both three means and the variety of target groups are very different, exploitation will differ for each focus-group.

Unlike the wide variety of target groups and results of REDUCTION, the situation of the market is very similar. In EU countries infrastructure issues are becoming more complex. Reasons for this are rapid technology changes, aging infrastructure and climate change. The solutions are more and more found in providing services (focus on ITS/In Car) instead of investing in new infrastructure. REDUCTION adapt to these market changes by offering a future proof and broad based initiative. It also adapts to the fast growing wish for ITS solutions and because of the increasing awareness of the environment, the outcome of a multi modal solution is very interesting. The threats we have to deal with are the increasing competition and associated app builders. We don’t want them to gain the results we are working on now.

Because of the different perception of the content of an Exploitation Plan by the REDUCTION partners and the broad sense of the project, we decided to compose an Exploitation plan by each commercial partner. This resulted in a plan which is more individually based and makes it possible to narrow it down to focus areas for each commercial partner.

Task 6.3 Contribution to Standards

This task is coordinated by and involves all participants. The currently available standards will be reviewed to see which are the most suitable to use and build upon. The results will feed into the standards being used in all work packages to be highly interoperable with other fleet-management systems not developed in REDUCTION. Solutions delivered by REDUCTION will build, wherever possible, upon existing open source / freely available standards. If for any scenario no current standard is sufficient, the most promising one will be extended accordingly. Contributions to standards are expected to arise by making significant extensions of existing standards. These will be communicated with the expert sub-committees of standard issuing organisations (e.g. ISO) and approval of suggested extensions will be sought.

DVM Exchange Standard

Network Management (NM) manages road traffic in a way that takes the network context into account. It contrasts with the more common local measures for traffic management, such as traffic signals, ramp metering, and variable message signs, that have a geographic scope of at most one node in the network or just a short road segment. It is easy to solve congestion at one place by shifting it to some other place. This is what local measures often do and what NM tries to prevent. But NM is not a well-established method of traffic management. It is in the middle of the process of development, a process started in the mid-nineties and which is rather slow, due to a number of reasons, the most important one being the sheer complexity of traffic behaviour in a network, especially dense traffic. The increasing levels of congestion in many densely populated areas in the world urgently need an effective NM, because local traffic management measures are limited in their capabilities for structural reduction of congestion. Speeding up the development process of NM would be welcomed by traffic management authorities at many places in the world.

A key property of the standard is that it defines cooperation between systems in terms of effects on traffic and not in terms of system-specific details. The latter would greatly reduce the general applicability of the standard. On the other hand, especially in case of legacy systems, this property may cause loss of functionality, when certain system-specific interactions between two systems are hard to translate into effects on traffic. To that end, a user defined part has been included in the standard.

Overview of the DVM-Exchange Standard

Usually, connecting traffic management systems is part of an overall plan for a given area, in which many systems have to be made interoperable. The standard is however described from the bilateral point of view: connecting two systems (see figure 12: Two TM systems connected via DVM Exchange). The standard makes a number of assumptions about the two individual systems, and about their relationships:

- An owner
- A management area
- A capability and a responsibility for traffic in its management area

In that area there are no other systems with overlapping responsibilities (case of connecting systems with overlapping responsibilities that share the same management area will be covered by the standard, but is omitted in this article).

The two systems have the following relationships:

They are neighbours: management areas are non-overlapping and share part of their boundary (peer to peer case), or one area falls within the other area (child to parent case);

They share one owner or the two owners know each other and interact;

The two systems have a shared clock;

The two systems are not otherwise connected.

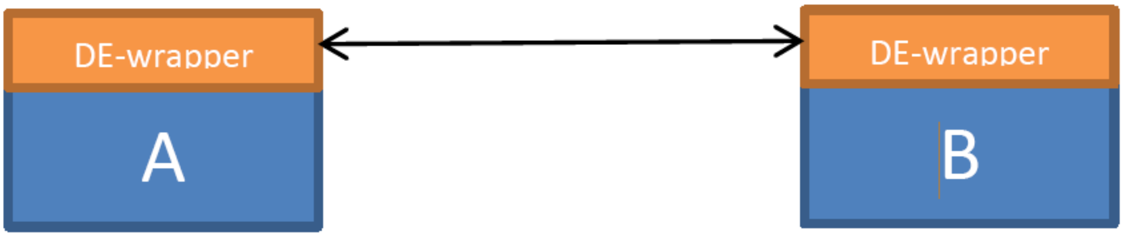

Figure 12: Two TM systems connected via DVM Exchange

Primary Goal of DVM Exchange

In this setting (figure 12), the primary goal of the DVM Exchange is to reduce the amount of interaction between system owners concerning the details of connecting the two systems, especially the IT-technical details. This includes interaction for first realization and for maintenance. The standard offers a framework in which it is easier to make the necessary agreements on the cooperation of the two systems for purposes of traffic management.

Requirements for DVM Exchange

A number of requirements have been formulated, that guide the development of the standard. We mention only the most important requirements:

- Generality and Extensibility: the standard is intended for all types of systems involved in traffic management, for current and for future TM measures. The standard is such that it can be extended with new TM measures, while remaining backwards compatible with earlier versions of the standard.
- Using the standard should not cause any functional loss.
- In order to achieve this, the standard includes a "user defined" part, which guarantees that existing, system-specific connections, that are hard to express in effects on traffic, can still be expressed in the standard.

- The standard supports SLA (Service Level Agreements)-based cooperation between two owners, including those in which one party pays for the services of the other.

Other Standards

Integrating traffic information using the Datex II standard

In REDUCTION, the different partners work on models for eco routing, multi modal eco routing, eco driving, prediction, V2V and V2I devices and communication. The information delivered from these systems is in essence the CO2 emission, fuel consumption, location, speed and travel time on certain segments/routes of the area's that are measured.

The European standard for traffic systems to exchange data is Datex II. The Area Traffic Manager can use through the Datex II exchange, all the information from the partners to calculate an optimised Eco-friendly route.

Description of the Datex II adaption to REDUCTION

The interface description is based on the Datex II definition. There are some information fields needed for this interface, that are not defined in the Datex II standard. For those fields some information records are defined on top of the standard.

For security and authentication the standard VPN connection between two communicating systems is proposed.

There are two messages defined that needs to be exchanged between two communicating systems:

- A data message, containing data values that needs to be exchanged and
- a message reply, indicating the data message has been received successful or not successful.

The essential information that is exchanged within the data message is:

- CO2 emission, fuel consumption, travel time and velocity
- Identifier of the measured trajectory, to relate the same trajectory in two different systems.
- Location, length and geographical form of the trajectory, to allow display on a geographical map.

The data message structure makes it possible to exchange one or more trajectories within one message and for each trajectory one or more measurements.

1939 - Intra-Vehicle communication standard

The J/1939 standard defined by the Society of Automotive Engineers is a recommended practice used for communication among vehicle components. This standard is very commonly in heavy duty vehicles as well as omnibuses in public transportation. Controller Area Network (CAN) is used for the physical layer and data-link layer. The bus-speed is 250kBit/s (defined in J1939/11 and J1939/15, generally used on trucks as well as omnibuses).

FMS – Fleet Management Systems

The FMS-Extension to the SAE J/1939 is based on and fully compliant to the standards J/1939-21 and J/1939-71. The FMS-extension has been created by a group of market-leading heavy-duty manufacturers (IVECO, Daimler Trucks, SCANIA, MAN, and VOLVO) with the purpose in mind to have a common way to communicate with automotive components (ECUs) and the core FMS-component that manages large flees of heavy duty vehicles or public transport vehicles. For the scope of the REDUCTION project only a subset of available data is useful, which is namely the fuel consumption and vehicle motion information (yaw-rate and velocity). The fuel consumption information is carried by the parameter group numbers PGN 64777 (SPN 5053 & SPN 5054) as well as PGN 65257 (SPN 182 & SPN 250) of the J/1939 standard. The FMS-standard extension utilised in the Daimler EvoBus GmbH CITARO omnibus FMS-interface unfortunately does neither support information requesting nor trip fuel information. Also, any information about the data format within the Daimler EvoBus GmbH CITARO omnibus FMS-interface was obtained while researching the SCANIA FMS documentation, due to lack of support and strong resistance of the Daimler Company to provide any information on this matter.

V2X standards

For the V2X area the networks can be divided in the following way (figure 13):

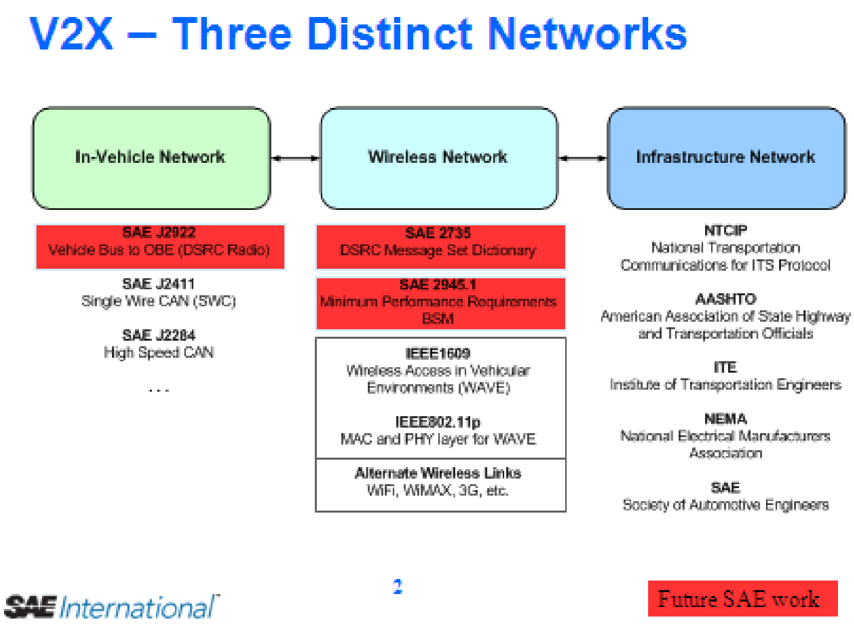

Figure 13: Red marked cells describe DELPHI´s efforts in SAE

Delphi will continually be active in the development of EU and USA standards by participating in committee activities in SAE, ETSI, etc. Due to Delphi's global presence, harmonised standards are desirable that allow common products to deploy world-wide with minimal configuration differences.

Our intent is not to create closed standards, and we support open standards that enable quick adoption on a large scale. A specific example of such a harmonization is the use of SAE's Basic Safety Message (BSM) and the ETSI Cooperative Awareness Message (CAM). The exact format of both messages need not be identical but the essence of content and performance requirements should be compatible.

Conclusion

Network management is hard but also much needed by traffic management authorities around the world. The congestion problem is a huge drain on economic resources. For its development, and for easy, cost-effective deployments of network management, an open interoperability standard is indispensable. The DVM Exchange initiative is an attempt to fill in this need. It reflects what is currently known about NM and it tries to be extensible in a backwards compatible way, for future NM measures and approaches. Key elements in its approach are the Hierarchical Model for recursive decomposition of a network, expressing interoperability in terms of effects on traffic on boundary points between the management areas of the two systems involved. Big challenges in the deployment of the standard will be the adoption of the NM approach on which the standard is based and the way to handle legacy systems. The standard has included the "user defined" field in order to ease this transition.

The REDUCTION Consortium actively disseminated the project results during the second reporting period (see table 7: Dissemination Activities completed in Reporting Period 2, table 9: Dissemination Activities planned for Reporting period 3 and table 9: Peer-Reviewed Publications in Reporting Period 2).

Table 9: Dissemination Activities in Reporting Period 2

Dissemination Activities completed in reporting period		
Nature of activity	**Partner**	**Details**
Paper submitted	University of Hildesheim (UHI)	"Eco-driving Data Analysis By Mining Local Driving Behaviour", Transportation Research Board 2013
Paper submitted	University of Hildesheim (UHI)	"Time-Series Classification Through Histograms of Symbolic Polynomials", ICDM 2013
Paper submitted	University of Hildesheim (UHI)	"Least Model Exchange for Distributed Classification in Peer-to-Peer Networks", European Conference in Data Analysis, ECDA 2013
Paper submitted	University of Hildesheim (UHI)	"Transitive Classification in P2P Networks", INFORMS Journal of Computing

Monitoring	University of Hildesheim (UHI)	Monitoring of the IST R&D Implementation 10/05/2013 Location Brussels, Belgium Survey of EC FP7 Projects' Progress, European Commission
Presentation	University of Thessaly, Hellas (UTH)	Title : "Clustering in Urban Environments: Virtual Forces Applied to Vehicles" Proceedings of the IEEE Workshop on Emerging Vehicular Networks: V2V/V2I and Railroad Communications (ENV), In conjunction with the IEEE International Conference on Communications (ICC), June 9-13, 2013, Budapest, Hungary
Presentation	University of Thessaly, Hellas (UTH)	Title: "Enhanced Spring Clustering in VANETs with Obstruction Considerations", The 77th IEEE Vehicular Technology Conference - Spring (VTC-Spring) June 2-5, 2013, Dresden, Germany
Newspaper article	University of Thessaly (UTH)	Thessaly's local newspaper – ELEFTHERIA Title: Innovative projects by the Department of Computer & Communications Engineering of the University of Thessaly March 17, 2013, Larissa, Greece http://www.inf.uth.gr/~dkatsar/papers/REDUCTION_in_Larisa_local_press.pdf
Presentation	Aarhus University (AU)	Title: "iPark: Identifying Parking Spaces from Trajectories", The 16th International Conference on Extending Database Technology (EDBT) March 18-22, 2013, Genoa, Italy

Presentation	Aarhus University (AU) and Aalborg University(AAU)	Title: "EcoTour: Reducing the environmental footprint of vehicles using eco-routes." The 14th International Conference on Mobile Data Management (MDM) June 3-6, 2013, Milan, Italy
Presentation	Aarhus University (AU)	Title: "Building Accurate 3D Spatial Networks to Enable Next Generation Intelligent Transportation Systems." The 14th International Conference on Mobile Data Management (MDM) June 3-6, 2013, Milan, Italy
Presentation	Aarhus University (AU)	Title: "Travel Cost Inference from Sparse, Spatio-Temporally Correlated Time Series Using Markov Models" The 39th International Conference on Very Large Data Bases (VLDB). August 26-30, 2013, Riva del Garda, Trento, Italy
Academic visit	Aarhus University (AU)	An academic visit to Renmin University. 29 June -9 July, 2013 Beijing, China
Company meeting	Aalborg University (AAU)	Discussion on Intelligent Transport Systems Case Study; Discussion of usage of combination of GPS and CANBus data in the REDUCTION project. Board meeting of Transport Industriens Innovations Network (National Danish network on transportation in general). 2012.09.21 Copenhagen, Denmark
Meeting	Aalborg University (AAU)	GPS and CANBus Data, Case Study 2012.09.27, Aarhus, Denmark Purpose: Possibilities with GPS/CANBus data for larger municipalities and consultancy companies in Denmark.

Company meeting	Aalborg University (AAU)	Analysis of GPS and CANBus data (in Danish) 2012.10.02, Møldrup, Denmark Purpose: Presentation of possibilities with GPS/CANBus data for bus company and GPS/CANBus supplier.
Company meeting	Aalborg University (AAU)	Analysis of GPS and CANBus data (in Danish) 2012.10.19, Viborg, Denmark Purpose: Presentation of possibilities with GPS/CANBus data for bus company and GPS/CANBus supplier.
Company meeting	Aalborg University (AAU)	Daisy Innovation Case Studies 2012.11.15, Aalborg, Denmark Purpose: Presentation of GPS/CANBus possibilities and first public demo of web-site for software prototype. Region North Denmark, municipalities, number of companies.
Conference presentation	Aalborg University (AAU)	GPS data for Analysing Congestion (in Danish) 2012.12.05, Nyborg, Denmark Purpose: Presentation of software prototype and the usage for estimating traffic congestion on a large Danish conference for road usage.
Company meeting	Aalborg University (AAU)	Shortest, Fastest and most “Green” Routes 2012.12.10, Aalborg, Denmark Purpose: Meeting with Aalborg Municipality about possibilities with GPS and CANBus data.
Funding meeting	Aalborg University (AAU)	Presentation: ITS Case Studies and Ideas 2013.01.25 Aalborg, Denmark Purpose: Meeting with Danish Transport and Logistics (DTL) and Transport Industriens Innovationsnetwork on possibilities for collaboration and future funding.

Funding meeting	Aalborg University (AAU)	Presentation: An ITS Platform and its Application 2013.01.28, Aalborg, Denmark Purpose: Meeting within the Danish InfinIT network for collaboration and joint funding.
Funding meeting	Aalborg University (AAU)	Title : Road Pricing Prototype 2013.04.02, Copenhagen, Denmark Purpose: Discussion with Danish Ministry of Transport about using GPS for road pricing and reusing parts of software prototype built in REDUCTION project.
Funding meeting	Aalborg University (AAU)	Road Pricing 2013.05.03, Aalborg, Denmark Purpose: Discussion with the Congestion Commission (Danish Ministry of Transport) about using GPS for road pricing and reusing parts of software prototype built in REDUCTION project.
Conference presentation	Aalborg University (AAU)	ITS and Fuel Consumption (in Danish) 2013.05.22, Copenhagen, Denmark Purpose: Presentation of possibilities with GPS/CANBus data and fuel reduction at larger Danish event. Many organisations and companies.
Company meeting	Aalborg University (AAU)	ITS Case Studies and Ideas (in Danish) 2013.06.11, Aalborg, Denmark Purpose: Follow-up meeting with DTL about collaboration and joint funding of projects.
Company meeting	Aalborg University (AAU)	GPS/CANBus Data Ideas (in Danish) 2013.07.01, Vamdrup, Denmark Presentation of possibilities with GPS/CANBus data and fuel with 5 Danish transport companies (small and medium size companies).

Company meeting	Aalborg University (AAU)	Path-based Travel-Time 2013.07.02, Aalborg, Denmark Purpose: Presentation of using trip data instead of point data with large Danish consultancy company.
Company meeting	Aalborg University (AAU)	Intelligent Transport Systems Case Study 2012.11.13, Stockholm, Sweden Purpose: Discussion of usage of GPS/CANBus data in the optimising Taxi planning and paying for CO2 reduction. Board meeting of SUTI
Prototype launch	Aalborg University (AAU)	2012.11.15, Released first version of prototype built in REDUCTION with travel-time and congestion URL http://daisy.aau.dk/its
Prototype update	Aalborg University (AAU)	2013.03.15 Updated prototype with fastest, shortest and most fuel-efficient routes http://daisy.aau.dk/its
Prototype launch	Aalborg University (AAU)	2013.06.30 Launch of advanced, high-performance prototype using both trip and point data http://daisy.aau.dk/its/spqdemo

Presentations	Aalborg University (AAU)	2012.12.16 – 2013.01.13 Topics: Researchers Map Congestion Problems (in Danish) Researchers find: Ringvejen in Silkeborg is Congested (in Danish) Obbekærvej is a statistical joke (in Danish) Smart Usage of GPS Data Reveals Traffic Jams (in Danish) How GPS data used to find congestion in traffic. Less Traffic on Minor Roads- More on Strandøre (in Danish) Taxis and Mini Busses Reveals Traffic Jams in Kolding (in Danish) http://vbn.aau.dk/da/clippings/forskere-kortlaeggertrafikpropper(ca6b046f-f478-4ac9-a21d-b8d0c979f705).html
Technical paper	Trinite (TRI)	A technical paper for ITS World Congress 2013, Tokyo: "An app to contribute on CO2 emission reduction."
Meeting	Flexdanmark (BEK)	Title: GPS Data, Case Study 2012.12.09, Aalborg, Denmark Purpose: Use of GPS driving time estimations in Denmark for public transport.
Meeting with supplier	Flexdanmark (BEK)	Topic: Use of GPS and CANBus data (in Danish) 2012.12.19, Gøteborg, Sweden Purpose: Presentation of possibilities with GPS/CANBus data for taxi planers.

Networking	CTL	CTL presented the REDUCTION concept to Cyprus Papaellinas Organisation and requested their participation to REDUCTION. CPO accepted the invitation and is now a participant to the Nicosia Fleet field trial. CTL contacted the developers of the COPERT 4 environmental analysis software, at Thessaloniki, Greece and requested their collaboration in using their model for the Nicosia simulation field trial. The COPERT 4 group accepted our invitation. In parallel, we informed Mr. M. Lambrinos of the Cyprus Public Works Department that we plan to combine VISTA and COPERT 4 to extract fuel consumption and air quality for the Nicosia VISTA model developed under REDUCTION
Conference paper	CTL	"A Dynamic Traffic Assignment Framework to Assess the Short-Term Network-Level Impacts of Eco-Routing Strategies," Accepted for presentation and publication at the CD ROM proceedings of the 93rd Annual Meeting of the Transportation Research Board, January 2014, Washington D.C.
Poster presentation	CTL	“Implementing the VISTA DTA for Environmental Analysis in Nicosia, Cyprus under the REDUCTION European Commission sponsored project,” New Jersey Department of Transportation Annual Research Showcase, West Windsor, NJ, USA, 2013/10/23.
Press release and presentation	CTL	“Implementing REDUCTION technologies for environmental analysis in Nicosia using OSEL buses and CPO company delivery vehicles,” Cyprus Public Works Department, December, 2013

Table 10: Dissemination activities planned for Reporting Period 3

Dissemination Activities planned for next reporting period		
Nature of activity	**Partner**	**Details**
Conference	University of Thessaly (UTH)	IEEE Intelligent Vehicles Symposium June 8 - 11, 2014 Michigan, USA http://www.ieeeiv.net/

Table 11: Peer-Reviewed Publications in Reporting Period 2

Title	Authors	Journal/Series	Publisher	Place of Publication	Year	Relevant pages	Permanent Identifier	Open Access Y/N	If yes, as of when?	If no, please provide explanation
Supervised Dimensionality Reduction Via Nonlinear Target Estimation	Partner 1 UHI Josif Grabocka, Lucas Drumond, Lars Schmidt-Thieme	Lecture Notes in Computer Science (Book 8057)	Springer	Berlin Heidelberg	2013	177-183	10.1007/978-3-642-40131-2_15	Y	July 2013	N/A
Detecting Influential Spreaders in Complex, Dynamic Networks	Partner 2 UTH Pavlos Basaras, Dimitrios Katsaros, Leandros Tassiulas	IEEE Computer magazine, Special issue on Cybersecurity	IEEE	IEEE Magazine, Volos, Greece	2013	All	10.1109/MC.2013.75	N	N/A	Also, self-archived by the authors in their Web page
Enhanced Spring Clustering in VANETs with Obstruction Considerations	Partner 2 UTH Leandros Maglaras, Dimitrios Katsaros	Proceedings of the 77th IEEE Vehicular Technology Conference - Spring (VTC-Spring)	IEEE	Dresden, Germany, June 2-5, 2013	2013	All	Not yet available, but when it will be published in IEEEXplore	N	N/A	Also, self-archived by the authors in their Web page

Clustering in Urban Environments: Virtual Forces Applied to Vehicles	Partner 2 UTH Leandros Maglaras, Dimitrios Katsaros	Proceedings of the 77th IEEE Vehicular Technology Conference - Spring (VTC-Spring)	IEEE	Dresden, Germany, June 2-5, 2013	2013	All	Not yet available, but when it will be published in IEEEXplore	N	N/A	Also, self-archived by the authors in their Web page
Travel Cost Inference from Sparse, Spatio-Temporally Correlated Time Series Using Markov Models	Partner 4 AU Bin Yang, Chenjuan Guo, Christian S. Jensen	PVLDB	VLDB Endowment		2013	12 pages		N		Accepted, not yet published
Building Accurate 3D Spatial Networks to Enable Next Generation Intelligent Transportation Systems	Partner 4 AU Manohar Kaul, Bin Yang, Christian S. Jensen	MDM	IEEE		2013	12 pages		N		Published

Using Incomplete Information for Complete Weight Annotation of Road Networks	Partner 4 AU Bin Yang, Manohar Kaul, Christain S. Jensen	TKDE	IEEE		Unknown, accepted in May 2013	14 pages		N		Accepted, not yet published
EcoTour: Reducing the Environmental Footprint of Vehicles Using Eco-Routes	Partner 4 AU Ove Andersen, Christian S. Jensen, Kristian Torp, Bin Yang	MDM	IEEE		2013	3 pages		N		Published
iPark: Identifying Parking Spaces from Trajectories.	Bin Yang, Nicolas Fantini, Christian S. Jensen	EDBT	ACM		2013	705-708		Y	March 2013	Published
Finding Shortest Paths on Terrains by Killing Two Birds with One	Partner 4 AU Manohar Kaul, Raymond Chi-Wing Wong, Bin	VLDB	VLDB Endowment		2014	12 pages		N		Accepted, not yet published

Stone	Yang and Christian S. Jensen									
Efficient Classification of Long Time Series	Partner 1 Josif Grabocka, Erind Bedalli, Lars Schmidt-Thieme	Proceedings of ICT Innovations 2012, Springer, Advances in Intelligent Systems and Computing	Springer	Ohrid, Macedonia	May 2013	Volume 207, pages 47-57	http://link.springer.com/chapter/10.1007%2F978-3-642-37169-1_5	Y		
Trajectories for Novel and Detailed Traffic Information	Partner 4 Benjamin B. Krogh, Ove Andersen, and Kristian Torp	ACM SIGSPATIAL Workshop IWGS		Los Angeles, USA	2012		ISSN 1903-1092			
Fastest Versus most Fuel-Efficient Route (in Danish)	Partner 4 Ove Andersen, Benjamin B. Krogh Harry Lahrmann, and Kristian Torp	Trafik Dage		Aalborg, Denmark	2013		ISSN 1903-1092			
A Dynamic Traffic Assignment Framework to Assess the Short-	Partner 9 Jafari, R.Shah, Natalia Ruiz-	CD ROM of the 93rd Annual Meeting of the Transportation	Transportation Research Board	Washington D.C.	2014	TBD	TBD	Y	Jan 2014	N/A

Term Network-Level Impacts of Eco-Routing Strategies,"	Juri, K. C. Mouskos	Research Board, January 2014, Washington D.C.								

2.7 WP7 Project management

2.7.1 Summary of WP 7

This WP will ensure the effectual and timely achievement of goals within the project in the most cost-effective manner. The central objectives are:

- To ensure the effective planning and coordination of work, tasks and outcomes of the individual work packages, including the timely submission of deliverables
- To provide the necessary structures and support to facilitate project management, decision-making, quality management and accountability
- The administration and financial management of the project, including the periodic and final reports to the EU Commission
- To guarantee a continuous flow of information and efficient decisions-making processes within the consortium
- Communications management with external groups and with the EU Commission

WP Leaders also play an important role in technical management preparing the periodic activity reports and finalising deliverables, but the person month allocation for this work is allowed for in the respective work packages.

2.7.2 Work package objectives for the current reporting period

Work package 7 focuses on the coordination and effective planning of tasks and outcomes in the individual work packages. A major goal of the activities undertaken in this work package is the timely submission of deliverables and milestones and the efficient communication within the consortium and with the European Commission. The objectives of work package 7 for this reporting period included the maintaining of communication structures within the consortium through the groupware platform, the REDUCTION website and the establishment of quarterly General Assembly meetings in order to facilitate information flow for project tasks among partners. Internal reporting structures on a quarterly basis as well as the timely submission of deliverables/ milestones have been accomplished.

2.7.3 Project management activities during the current reporting period

- Establish and implement management structures to facilitate planning and coordination of project activities and quality management
- Monitor all contractual, financial and administrative issues
- Ensure effective communication within the consortium and with the Commission and other external stakeholders

Consortium tasks and achievements

The project coordination office established effective internal reporting structures to facilitate project controlling by eliciting quarterly reports on activities from all partners and communication infrastructure to support regular exchange between partners and work packages.

Communication among partners has been facilitated through the creation of a project groupware platform offering the possibility to exchange project documentation and to follow the progress within the project.

The coordination team has hosted monthly teleconference consortium meetings to assess progress.

An internal review process was organised for the completion of the deliverables due on months 18 and 24. Therefore, a check list was created to be filled in by the reviewing partner. Contents of the check list are for example: Executive Summary, Introduction, Conclusion, List of Figures, List of Tables, Glossary and so on.

The quality management handbook including project governance structures and agreements among partners was updated and made available to all partners.

The project coordinator has also maintained regular contact with the External Advisory Board to update them regarding project events and progress.

Deliverables due in Reporting Period 2

D 7.3 Second periodic report (Month 24 + 60 days). Status: delivered

Problems which have occurred and how they were solved or envisaged solutions

Not applicable.

Changes in the consortium

There were no major changes to the consortium in the current reporting period.

List of project meetings, dates and venues

The table 12 below gives an overview of the major project meetings held in Reporting Period 2. Agendas, meeting minutes, participant lists and presentations can be found in the password-protected groupware platform under http://147.172.223.242/bscw/.

Table 12 Overview of Project Coordination Meetings RP2

Overview of Project Coordination Meetings RP2	
1st Technical Review Meeting, Brussels, Belgium	04 -05/10/2012
General Assembly + Steering Committee Meeting, Berlin, Germany	15 – 16/01/2013
External Advisory Board Meeting, Berlin, Germany	17/01/2013
General Assembly + Steering Committee Meeting, Amsterdam, Netherlands	16 – 17/04/2013
General Assembly + Steering Committee Meeting, Volos, Greece	9 – 10/07/2013

In addition, several informal work package meetings and teleconferences have been held to facilitate the communication concerning tasks / deliverables /milestones.

I. General Assembly + Steering Committee Meeting and External Advisory Board Meeting, Berlin, Germany - 15 – 17/01/2013

This meeting has mainly focused on the development of the field trials in WP 5. Here is an overview of work on tasks involved in conducting the field trial of Nicosia:

Task 1. Inform OSEL and the Ministry of Communications and Works of the REDUCTION Nicosia Bus Operations field study and secure their participation in the project

A preliminary meeting between DDE, CTL and OSEL needs to take place in order to finalize what data are feasible to be collected and for OSEL to understand all the issues:

OSEL allocates one bus at a maintenance yard together with a driver and a technician for DDE to install their devices.

DDE will do its tests to figure out what data can be extracted and to demonstrate to OSEL that the device will not interfere with the bus operation.

Task 2.

DDE will develop the software to interface the V2V/V2I devices with the OSEL buses and the computing/storage devices that are going to be installed in the buses.

Task 3.

Development of software to store and analyse data by REDUCTION partners

Task 4.

Installation and testing of REDUCTION hardware and software in the OSEL buses

Task 5.

Conduct the REDUCTION Nicosia Bus Driver Behaviour Field Trial

Task 6.

Nicosia Bus Driver Behaviour Field Trial Final Report:

- Analysis of the Driving behaviour and its impact on fuel consumption and GHG
- Report on the performance of the hardware and software installed on the buses
- Evaluation summary from the case study partners

Steering Committee Meeting

Topic 1: Revise the deliverables' internal submission and reviewing procedure

The reviewers' concerns were summarised and new deliverable template structure agreed.

Partners agree to prepare a table of reviewers' concerns versus our solutions, in light of next year's review.

Topic 2: Cooperation with Relevant Projects

Cooperation with the projects ICT-Emissions and eCompass is likely.

Topic 3: Schedule Next Plenary Meetings

Amsterdam 16-17 April 2013

Volos 9-10 July 2013

Topic 4: Discuss on the feasibility of holding the next EC Review Meeting in Greece, September-October 2013

Commission is more likely to prefer holding the Review Meetings in Brussels.

Topic 5: Discuss the possibility of signing "Form C"-s electronically starting 2013

An amendment to the GA must be made for this and this makes more sense if REDUCTION had two upcoming Periodic Reports in the not so near future.

Conclusions

The field trials are ongoing and everything is going according to plan.

A new deliverable template has been created to fit the reviewers' concerns.

Cooperation with other projects should be enhanced during the next period.

The next Review Meeting will be held in Brussels.

II. General Assembly + Steering Committee Meeting, Amsterdam, Netherlands - 16 – 17/04/2013

Intensively discussed during this meeting have been the following themes:

1. **WP 2 Distributed Data Mining for P2P Networks**

Task 2.3 Advanced Prediction Models (UHI): Algorithms for decentralised V2V, V2I networks

Targeted Application in Task 5.4/5.7 in Nikosia Use-Case.

The presented method is under review in Informs Journal of Computing (Khan et al. 2013)

Main proposed principle

- Share the findings (model), not the original data
- Motivation:
  - Communication bandwidth is prohibited for large data transfer
- Claim:
  - Accuracy is not deteriorated

Idea in a nutshell

- Learn Local Model (i.e. compute SVM SV)
- Send the model to neighbours
- (simultaneously) Receive models from neighbours
- Combine models (add received support vectors to local data)
- Relearn a **reduced** local model (RSVM)

Conclusion

- Sharing intelligence boosts local classification
- Sharing reduced findings boosts communication costs without significant penalization of

accuracy

Open issues

- Concrete application to REDUCTION use-case
    - Bottleneck 1: Number of cars few
    - Bottleneck 2: What are the measured parameters? What is the local model?
- Alternative remedy:
    - Simulation environments (a standard in the field of P2P research)

2. WP 3 Data Management for Environment Aware Routing and Geo-Locational Analysis Application

Purpose of Trips Tool

Show performance of new trip indexing schema: Input D3.4 M24 and/or D3.5 M36

Easy evaluation of trips:

- Average travel time
- Average fuel-consumption
- 85% quantile

Easy extraction of trips:

- Filtering conditions (time-of-day, week day, month, year)
- For further analysis
- Comparison to point data

Traffic Research Group at AAU is beta testers:

- Have provided a lot of nice feedback (fixed misunderstandings)
- Ideas and problems could have realised
- To increase the general usability
- Good to have something very concrete to collaborate on

Summary

Getting a better and better understanding of fuel-economy:

- There is still a number of issues that we cannot explain
- Weather, wind, weight, make, model is outside our control

- Fuel consumption properly not as accurate as travel-time

Slowly integrating from trip and point data:

- Trip data is much harder to handle
- Based on new indexing schema
- The benefit of trips are added accuracy
- Both travel-time and fuel consumption (GHG emission)
- Working on the presentation

Map Issues

- Are not better than the underlying map foundation

Overall conclusion

- The method used in the Nicosia Use- Case trial has been intensively discussed:
- In WP 3 it is essential to get a better understanding of fuel-economy.

III. General Assembly + Steering Committee Meeting, Volos, Greece- 9 – 10/07/2013

In this consortium meeting the following main topics have been discussed:

Topic 1: DDE device status

- Project does not expect DDE device to be used for extracting interpretable CANBus data
- Steering committee asks Lali (DDE, Leader of WP-1) to have a fall back plan for evaluations if Cyprus field trial does not work.
- Finalising the device should be put to Highest Priority.

Topic 2: **Month 24 (31/08/2013) Deliverables Status**

- Partners agreed to complete deliverables by 31st July, 2013, for internal review.
- For D6.2.2, all industry partners have to provide input (activity plan) to Daniele (TRI) until 23rd July, 2013.

Topic 3: Schedule Next Plenary Meetings

- Review Prep Meeting 30th Oct 2013
- Review Meeting 31st Oct, 2013 (Every partner's PI must attend)
- Participants agreed for next plenary meeting on Fri, 1st Nov, 2013.

Topic 4: Meetings for 3rd Year

- Consortium agreed to hold 3 Meetings for 3rd Year
- January 2014, Berlin
- April 2014, Cyprus
- July 2014, Copenhagen
- January 2014, 2nd Advisory Board Meeting in Berlin
- Dates for the 3rd year's plenary meetings will be finalised in up-coming Telco meeting.

Conclusion

The highest priority at the moment is finalising the DDE device.

Partners have agreed to complete the deliverables until 31st of July.

Next plenary meetings have been scheduled.

Impact of possible deviations from the planned milestones and deliverables, if any

None

Project planning and status

See Gantt Chart

Any changes to the legal status of any of the beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs;

There were no changes in the legal status of any beneficiaries in the current reporting period.

Development of the Project website, if applicable

The project website http://www.reduction-project.eu was launched in Month 1 of the project and provides the project's primary means of communication with the scientific community, other interested stakeholders and the public. The website provides information on the project's objectives and progress and is updated regularly to feature current and upcoming events. Publications are also regularly updated on the website

Coordination activities and coordination

In addition to the project meetings outlined above, the project partners maintained regular contact via telephone and ad-hoc WP meetings or informal meetings at scientific conferences. As part of the project's communication strategy, a project mailing list reduction-announcement@ismll.de was set up for communication within the project.

The password-protected groupware platform, in particular the interactive forum has also proved very effective in fostering good communication channels between project partners and work packages.

Cooperation with other projects / programs

REDUCTION has extended collaboration ties with related ICT projects which primarily focus on reducing the GHG emission.

The REDUCTION project coordinator participated in a workshop among related EU FP7 projects organised in Vienna, Austria on October 24, 2012 from 10:30 – 17:00. The aim of the workshop was to share experience, to discuss and work together on the following topics:

- Usability of traffic information systems
- Future challenges and directions in ICT-based navigation and transport systems
- Requirements and environmentally awareness in travel contexts.
- Possibilities for reducing environmental impact of personal transportation
- Platform architectures
- A common book publication

The related EU FP7 project representatives attending the meeting are included in the following table 13:

Table 13: Participating Projects in the workshop at the 24.10.2012 in Vienna

Participant	Project	Website
Christos Zaroliagis	ECOMPASS	http://www.ecompass-project.eu
Josif Grabocka	REDUCTION	http://www.reduction-project.eu
Lars Schmidt-Thieme	REDUCTION	http://www.reduction-project.eu
Martin Litzenberger	CARBOTRAF	http://carbotraf.com
Zissis Samaras	ICT-EMISSIONS	http://www.ecostand-project.eu/ecostand/links/ict-emissions
Marcel Meeuwissen	SUNSET	www.sunset-project.eu
Johann Schrammel	PEACOX	www.project-peacox.eu
Sebastian Prost	PEACOX	www.project-peacox.eu
Mariella Hager	PEACOX	www.project-peacox.eu

REDUCTION presented the project and the achievements conducted so far to the participants of the other projects. The experts shared opinions on various strategies to tackle the reduction of GHG and fuel consumption. The proposed approaches were diverse, ranging from eco-routing, eco-driving, fuel consumption modelling of vehicles, up to providing incentives for ecological behaviours.

In order to share technical and strategic know-hows two related projects for presenting their achievements have been invited, namely the ICT-Emissions (http://www.ict-emissions.eu/) and the eCompass (http://www.ecompass-project.eu/) projects. The meeting with presentations took place during the plenary meeting held on July 10, 2013 in Volos, Greece.

The invited representatives were:

10:00 - 10:45: Dr. Leonidas Ntziachristos, Project ICT-Emissions

10:45 - 11:30: Dr. Damianos Gavalas, Project eCompass

Dr. Leonidas Ntziachristos, representing ICT-Emissions, introduced the achievements of the project. The ICT-Emissions methodologies rely on a micro level assessment of ICT measures. Particularly, the audience discussed the opportunity to incorporate such measures for deducing macro-level emissions, for the sake of eco-routing algorithms.

The progress of the eCompass project, on the other hand, was presented by Dr. Damianos Gavalas in the Volos plenary meeting of REDUCTION, 10/07/2013. eCompas focuses on ecological routing of multi-modal transportations, with a particular aim on route planning optimization. REDUCTION partners benefited from the offered perspective on vehicle routing algorithms and discussed comparisons with our own methodologies.

In addition, REDUCTION participated in the ECOSTAND project initiative, which strives to create an internationally agreed methodology for assessing the impact of ICT initiatives and their GHG emission efficiency. The feedback has been submitted and the REDUCTION stand on the future research directions of the ICT community has been presented.

External Advisory Board

Members of the External Advisory Board (EAB) are:

- Svend Tofting (North Denmark Region
- Agnes Voisard (Freie Universität Berlin)
- Andrea Tomatis (Hitachi)

Reasons for selecting the above mentioned persons to join the REDUCTION EAB:

1. Svend Tofting (North Denmark Region)

   Mr. Tofting is a public authority and an ITS expert affiliated with the NorthJylland region of Denmark. He holds a Master of Science degree from the Technical University of Denmark. Since 1989, Svend Toftings is the editor of the Danish Vejtidsskrift, a popular traffic research magazine. In 2007 he was the Congress Director for the European ITS Congress. He is a Supervisory Board member of ERTICO ITS Europe, a premier network of ITS services stakeholders for Europe. Given his long expertise with traffic research and public authorities, Mr. Tofting will provide precious assistance in particular on policy and administrative issues.

2. Agnes Voisard (Freie Universität Berlin)

   Agnès Voisard received her Ph.D. degree in computer science from the University of Paris at Orsay(Paris XI) and INRIA(French Institut National Recherche en Informatique et en Automatique) in 1992. During the academic year 1991-92 she was a research assistant in the database group of the Conservatoire National des Arts et Métiers (CNAM) in Paris. In 1992-93 she was an INRIA postdoctoral fellow at Ludwig-Maximilian Universität in Munich. In 1993, she was appointed Assistant Professor of Computer Science at the Free University of Berlin, where she obtained her "Habilitation" in 1999. Between January and May 2001, she was system architect at

Kivera, Inc. (Oakland, California), a start-up designing navigation systems.

She is now head of the department Location-based Services at the Fraunhofer Institut for Systems and Software Engineering (ISST) in Berlin as well as adjunct faculty (since July 2004 "Außerplanmässige Professorin" in German) at the Free University of Berlin, Institute of Computer Science. Her areas of expertise include geographic information systems, location-based services, event notification systems, and interoperability in information systems. She has participated in several program committees, was general chair of the 5th International Symposium on Spatial Databases (SSD'97) and was program co-chair of the international ACM GIS conference in 2002.

With Philippe Rigaux and Michel Scholl, she co-authored the book Spatial Databases - with Application to GIS, published by Morgan Kaufmann in 2001. With Jochen Schiller she co-edited the book Location-based Services, Morgan Kaufmann (2004).

Agnes Voisard's scientific background matches thus well scientific topics that are central to the project, e.g., routing, eco-routing, geographical data management. In addition, she bridges the gap between academia and applied research, e.g., through her affiliations with FUB and Frauenhofer. Therefore she is well positioned to advise the project.

3. Andrea Tomatis (Hitachi)

Andrea Tomatis finished his Ph.D. program in December 2008 at the Politecnico di Torino under the guidance of Prof. Fabio Dovis. He acquired experience during the Ph.D. and during the period spent as a research scholar at Network Research Lab (UCLA) working on vehicular networks and data dissemination. Dr. Tomatis has extensive research experience. The work over the past years has ranged from navigation/localization to data dissemination problems.

Currently he is working in the Cooperative Systems field as Research Engineer at the HITACHI Europe SAS Information and Communication Laboratory in Sophia Antipolis.

Dr. Tomatis provides important advising into the REDUCTION project because of his expertise in terms of communication protocols in vehicular networks, which is instrumental for Work Package 1 of the REDUCTION project. In addition, Andrea Tomatis blends together experience from an academic background with considerable industrial research.

The **first EAB of the REDUCTION project** was held in Berlin, 17/01/2013, in collocation with the plenary meeting of the project.

Mr. Andrea Tomatis could not participate to the External Advisory Board due to a cancelled flight.

Both present members of the EAB expressed their positive impressions on the achievements of the REDUCTION project during its first year.

Mr. Tofting recognised the importance of deploying state-of-art inter-vehicular communication devices (by DDE) in order to share local traffic intelligence (by UTH, UHI). He also expressed positive impressions in the study of the multi-modality impacts (by TrainOSE) over the reduction of emissions. Following similar positive tones, Agnes Voisard welcomed the progress made towards exploring geo-spatial information and traffic trajectories with the aim of reducing travel time and costs (by FlexDenmark, AU, AAU, UHI).

In addition, Prof. Agnes Voisard, stated (citing explicitly):

"The REDUCTION project is certainly a big step towards a real exploitation of multi-dimensional traffic trajectories in order to reduce not only travel time but - as a consequence - cost and impact on the environment. The work presented by the participants during the advisory board meeting convinced me that this can be achieved and that they are on the right path”.

Minutes of the meeting 17th of January 2013 in Berlin:

Overall Impressions

Both EAB members Mr. Sven Tofting and Mrs. Agnes Voisard expressed their positive opinions and impressions from REDUCTION. More specifically:

- Sven Tofting appreciated the emphasis on the analysis of driving behaviors (by UHI, CTL, TRI) as a driving factor towards improving fuel economy.
- Mr. Tofting recognised the importance of deploying state-of-art inter-vehicular communication devices (by DDE) in order to share local traffic intelligence (by UTH, UHI). He also expressed positive impressions in the study of the multi-modality impacts (by TrainOSE) over the reduction of emissions.
- Agnes Voisard welcomed the progress made towards exploring geo-spatial information and traffic trajectories with the aim of reducing travel time and costs (by FlexDenmark, AU, AAU, UHI).

Comments and Suggestions

Sven Tofting underscored the individual aspect of the driving style, therefore he emphasised that good driving should not be exported as a template. The eco-friendliness progress of a particular driving style should be judged as an incremental progress within the same driver.

Mr. Tofting stressed the importance of measuring the driving behaviours within the same road in order to eliminate external factor's impact.

Sven Tofting expressed the possibility that alternative communication devices could be deployed and questioned the direct impact that the utilization of such devices can contribute over driver behaviour adaptation.

He directed to the closed EU-funded project MobiNet, as related work in sustainable mobility.

Agnes Voisard underlined the openness of data as an important factor and the necessity of using unified map standards like the OpenStreetMap.

Mrs. Voisard additionally expressed the concern of creating a common software package unifying the work package contributions.

Sven Tofting raised the importance of devising a market-ready profile for the outcomes of the project, such that the findings and the technologies evolved could be used after the project has ended.

Mr. Tofting provided the example of merging the products into a joint portable smart-phone which directs drivers in an eco-friendly manner. Such service should act pro-actively to the user instead of remaining idle waiting for continuous feedback. He stressed that optimal systems should be dynamic and able to guess user preferences with minimal input.

Sven Tofting expressed that further future business scenarios should be developed for the multi-modal integrated transportation systems.

He additionally expressed the necessity to optimize the traffic load by sharing empty seats inside vehicles, in parallel to legislative, route optimization and technological steps.

The **second EAB of the REDUCTION project** was held in Berlin, 22/01/2014, in collocation with the plenary meeting of the project.

Mr. Andrea Tomatis could not participate to the External Advisory Board due to personal reasons.

Minutes of the meeting 22nd of January 2014 in Berlin:

Overall Impressions

Mr. Tofting and Mrs. Voisard shared various views about technical and vision-related aspects of the REDUCTION project (a detailed report found below). Overall, the EAB members declared to be highly satisfied with the progress achieved by the project. In particular, Mrs. Voisard stated that the project has made considerable progress compared to Year 1.

Meeting Report

Agnes Voisard emphasised the importance of exploitation aspects and she stressed that further actions could be taken to unify the contributions under a unified scope.

Svend Tofting was interested in the novelty aspect of the communication protocols implemented in WP1. He pointed out the need to clarify the added V2V contribution compared to V2I protocols.

The driving behaviour analysis has large potential to achieve impacts on markets like driving school, said Mrs. Voisard. She raised the concern that the research community, in general, has a lot to do in terms of elaborating driving adaptation methods.

On the other hand, Mr. Tofting clarified that the driving behaviours should be educated in a dynamic and personalised fashion. Therefore, a driver should compete against his/her personal track of records, instead of directly comparing to a perfect driver. An individual scale of eco-driving improvement, instead of global progress is required, because every driver has a different learning curve.

Agnes Voisard emphasised the potential of exploring the multi-modality and inter-modality aspects. She stated that various technical difficulties might be related with multi-modality methods.

Svend Tofting brought an example from Norway, where sharing seats was introduced as a promotion tool for reducing GHG emissions. The GHG reduction was printed on the bill, in order to boost green publicity.

Another example of Berlin taxis was mentioned by Mrs. Voisard. Passengers are asked to choose between fast and expensive routes and longer/cheaper routes.

Regarding the field trials and driver education, Mr. Svend Tofting indicated the importance of directly talking to the drivers in order to explain the system and the procedures.

Furthermore, Mr. Tofting brought into attention the Mobinet project that informs the drivers about adapting their velocities before green lights.

Svend Tofting was interested to hear how the Delphi on-board unit could be generally applied to other types of vehicles. He stated that a larger number of vehicles should be used for testing the on-board device. Otherwise, a test on a small sample of buses only shows a technological test, rather than a large scale CO2 reduction test.

Mr. Tofting also headlined that V2V protocols are challenging because they require powerful signal transmissions.

Finally, Svend Tofting proposed to hold a closing session meeting with the EAB members, in order to discuss the learned lessons and look for follow up ideas and projects.

3. Deliverables and milestones tables

3.1 Deliverables

An overview of the REDUCTION project Deliverables are given in table 1$. The status of each Deliverable is indicated.

Table 14: Deliverables

Del. no.	Deliverable name	Version	WP no.	Lead beneficiary	Nature	Dissemination level	Delivery date from Annex I	Actual / Forecast delivery date	Status	Contractual Yes/No	Comments
D7.1	Project website and fact-sheet	1	7	1. UHI	R	PU	30.09.2011	Month 1	Done	Yes	
D1.1	Report on the design and architecture of onboard technology and wireless communication technology	1	1	2. UTH	R	PU	29.02.2012	Month 6	Done	Yes	
D3.1	Report covering requirements specification, data-flow analysis and the	1	3	3. AAU	R	PU	29.02.2012	Month 6	Done	Yes	

	system architecture										
D1.2	Report on advances in the development of onboard technology	1	1	5. DDE	R	RE	31.08.2012	Month 12	Done	Yes	
D1.3	Report on Packet Scheduling/Routing algorithms	1	1	2. UTH	R	PU	31.08.2012	Month 12	Done	Yes	
D2.1	Report with data flow analysis and system architecture	1	2	6. TRI	R	PU	31.08.2012	Month 12	Done	Yes	
D2.2	Report on basic predictive analytics models	1	2	1. UHI	R	PU	31.08.2012	Month 12	Done	Yes	
D3.2	Report on eco-routing computation techniques	1	3	4. AU	R	PU	31.08.2012	Month 12	Done	Yes	
D3.3	Prototype basic eco route prediction	1	3	3. AAU	P	PU	31.08.2012	Month 12	Done	Yes	
D4.1	Report on initial requirements specification and conceptual	1	4	6. TRI	R	PU	31.08.2012	Month 12	Done	Yes	

	framework										
D5.1	Report on collecting requirements and specification	1	5	3. AAU	R	PU	31.08.2012	Month 12	Done	Yes	
D6.1.1	First report on Dissemination	1	6	4. AU	R	PU	31.08.2012	Month 12	Done	Yes	
D6.2.1	First report on Exploitation	1	6	4. AU	R	PU	31.08.2012	Month 12	Done	Yes	
D6.3.1	First report on Contributions to Standards	1	6	5. DDE	R	PU	31.08.2012	Month 12	Done	Yes	
D7.2	First periodic report	1	7	1. UHI	R	PU	31.08.2012 + 60 days	Month 12 + 60 days	Done	Yes	
D 1.4.1	Test report with communication between the Bluetooth detectors and the in-car system or smart phones	1	1	6. TRi	R	PU	31.08.2013	Month 24	Done	Yes	
D 2.3.1	Progress report	1	2	1. UHI	R	PU	31.08.2013	Month 24	Done	Yes	

	on advanced predictive analytics models										
D 2.4	Report with localised motion prediction algorithms in vehicular environments	1	2	2. UTH	R	PU	30.04.2013	Month 20	Done	Yes	
D 3.4	Prototype of advanced high performance eco-route methods	1	3	4. AU	P	PU	31.08.2013	Month 24	Done	Yes	
D 4.2	Report on first pilot (to be used for field study 1)	1	4	6. TRI	R	PU	28.02.2013	Month 18	Done	Yes	
D 4.3.1	Report on	1	4	6. TRI	R	PU	31.08.2013	Month 24	Done	Yes	

	second pilot (to be used for field study 2)										
D 5.2	Report on collective evaluation from field-trials in Phase 1	1	5	2. UTH	R	PU	28.02.2013	Month 18	Done	Yes	
D 6.1.2	Second report on Dissemination	1	6	4. AU	R	PU	31.08.2013	Month 24	Done	Yes	
D 6.2.2	Second report on Exploitation	1	6	6. TRI	R	PU	31.08.2013	Month 24	Done	Yes	
D 6.3.2	Second report on Contributions to Standards	1	6	5. DDE	R	PU	31.08.2013	Month 24	Done	Yes	
D 7.3	Second periodic report	1	7	1. UHI	R	PU	31.08.2013 + 60 days	Month 24 + 60 days	Done	Yes	

3.2 Milestones

An overview of the REDUCTION project Milestones are given in table 1%. The delivery date of each Milestone is given. All Milestones have already been reached.

Table 15 Milestones

Milestone no.	Milestone name	Work package no	Lead beneficiary	Delivery date from Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
MS1	Requirements Collection and Initial Framework	WP 1, WP 2, WP 3, WP 4	6. TRI	Month 12	Yes	Month 12	
MS2	Field Trials for Phase 1	WP 5	2. UTH	Month 18	Yes	Month 18	
MS3	Monitoring Project Progress	WP 1, WP 2, WP 3, WP 4	1. UHI	Month 24	Yes	Month 24	

4. Explanation of the use of the resources and financial statements

The financial statements have to be provided within the Forms C for each beneficiary (if Special Clause 10 applies to your Grant Agreement, a separate financial statement is provided for each third party as well) together with a summary financial report which consolidates the claimed Community contribution of all the beneficiaries in an aggregate form, based on the information provided in Form C (Annex VI of the Grant Agreement) by each beneficiary.

The "Explanation of use of resources" requested in the Grant Agreement for personnel costs, subcontracting, any major costs (ex: purchase of important equipment, travel costs, large consumable items) and indirect costs, have now to be done within the Forms (user guides are accessible within the Participant Portal)[2].

When applicable, certificates on financial statements shall be submitted by the concerned beneficiaries according to Article II.4.4 of the Grant Agreement.

Besides the electronic submission, Forms C as well as certificates (if applicable), have to be signed and sent in parallel by post.

An overview of the project progress is given in table 16: Grant Chart. An overview of the human and financial resources of the REDUCTION project over the reporting period 2 as well as the total life time is given in the figures and tables below (order as specified below):

Table 17: Total PM Expenditure for Year 2 (planned vs actual)

Figure 14: Person months per partner (year 2, in %)

Figure 15: Resources per WP (actual and planned, year 2)

Table 18: Total PM Expenditure for Years 1 + 2 (planned vs actual)

[2] In the past, the explanation of use of resources requested in the Grant Agreement was done within a table in this section. The merge of this table within the Forms C was a measure of simplification aimed at avoiding duplication and/or potential discrepancies between the data provided in the table 'Explanation of use of resources' and the data provided in the Forms C.

Table 16: Gantt Chart

No	Name	Lead	Start Month	End Month	Year 1	Year 2	Year 3
1	**Onboard Technology and Wireless Communication**	**DDE**	**1**	**30**			
1.1	Design and Architecture	UTH	1	6			
1.2	Onboard Technology	DDE	1	12			
1.3	VANET Packet Scheduling/Routing and Information Dissemination	UTH	7	12			
1.4	Intelligent V2V and V2I Communication	TRI	13	30			
2	**Prediction Models for "Energy-Efficient Driving" and Driver-Behaviour Adaption / Predictive Analytics**		**3**	**36**			
2.1	Requirement specification and Software architecture	TRI	3	12			
2.2	Basic prediction models	UHI	7	12			
2.3	Advanced prediction models	UHI	13	36			
2.4	Vehicle Motion Prediction Algorithms	UtH	18	24			
3	**Data Management for Environment Aware Routing and Geo-Locational Analysis Application**		**1**	**36**			
3.1	Requirement specification and Software	AAU, BEK	1	6			
3.2	Basic eco-routing methods	AAU, AU	3	12			
3.3	Advanced eco-routing methods	AU	13	24			
3.4	Prototype Consolidation	AAU, AU	25	36			
4	**System Design & Integration**		**2**	**36**			
4.1	Requirement specification and Software architecture	TRI	2	12			
4.2	Basic prototype	TRI	13	18			
4.3	Advanced prototype	TRI	17	36			
4.4	Market-ready software product	TRI	30	36			
5	**Case Studies for assessing Energy-Efficiency and CO2 Reduction**		**1**	**32**			
5.1	Initial requirements collection	UTH, AAU	1	12			
5.2	Phase 1: Field trial for BEK	AAU, BEK	14	18			
5.3	Phase 1: Field trial for TrainOSE	UTH, TrainOSE	14	18			
5.4	Phase 1: Field trial for CTL	UTH, CTL	14	18			
5.5	Phase 2: Field trial for BEK	AAU, BEK	26	32			
5.6	Phase 2: Field trial for TrainOSE	UTH, TrainOSE	26	32			
5.7	Phase 2: Field trial for CTL	UTH, CTL	26	32			
6	**Dissemination, Exploitation, Standards**		**1**	**36**			
6.1	Dissemination	AU	1	36			
6.2	Exploitation	TRI	4	36			
6.3	Contribution to standards	DDE	1	36			
7	**Project management**		**1**	**36**			
7.1	Project Coordination	UHI	1	36			
7.2	Progress Monitoring and Quality Management	UHI	1	36			
7.3	Meetings and Liaison	UHI	1	36			
7.4	Risk Management	UHI	1	36			

Table 17: Total PM Expenditure for Year 2 (planned vs actual)

Person Months per WP and per Partner													
			TOTALS	1 - UNI HILDESHEIM	1a - LUH (EU Office	2 - UTH	3 - AAU	4 - AU	5 - DDE	6 - TRI	7 - BEK	8 - TRAINOSE	9 - CTL
WP1	**Onboard Technology and Wireless Communication**	**Actual PM current total:**	**25,02**	1,50	0,00	4,10	1,68	6,00	10,24	1,16	0,00	0,00	0,34
		Planned PM total duration:	**20,90**	1,00	0,00	4,00	4,00	3,00	3,60	3,00	1,00	1,00	0,30
WP2	**Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation**	**Actual PM current total:**	**10,71**	7,50	0,00	0,00	0,00	0,00	0,00	2,86	0,00	0,00	0,35
		Planned PM total duration:	**7,70**	5,00	0,00	0,32	0,00	1,00	0,00	1,00	0,00	0,00	0,38
WP3	**Data Management for Environment Aware Routing and Geo-Locational Analysis Application**	**Actual PM current total:**	**37,68**	1,00	0,00	1,20	13,48	21,00	0,00	0,64	0,00	0,00	0,36
		Planned PM total duration:	**22,81**	1,00	0,00	1,36	5,65	9,50	2,00	1,00	1,00	1,00	0,30
WP4	**System Design & Integration**	**Actual PM current total:**	**20,78**	0,50	0,00	4,83	5,70	4,00	0,00	5,35	0,00	0,00	0,40
		Planned PM total duration:	**16,31**	1,00	0,00	7,00	1,91	1,00	2,00	3,00	0,00	0,00	0,40
WP5	**Case Studies for assessing Energy-Efficiency and CO2 Reduction**	**Actual PM current total:**	**40,35**	1,50	0,00	6,94	9,82	2,00	0,00	6,58	3,98	5,61	3,92
		Planned PM total duration:	**27,71**	1,00	0,00	1,71	5,00	2,00	3,00	3,00	5,00	3,00	4,00
WP6	**Dissemination, Exploitation, Standards**	**Actual PM current total:**	**7,56**	1,00	0,00	0,00	0,58	2,00	1,45	1,90	0,00	0,28	0,35
		Planned PM total duration:	**12,15**	0,00	1,00	1,00	1,75	2,00	3,00	2,00	0,00	1,00	0,40
WP7	**Project management**	**Actual PM current total:**	**6,87**	2,00	3,23	0,42	1,12	0,00	0,00	0,10	0,00	0,00	0,00
		Planned PM total duration:	**3,30**	0,00	3,00	0,00	0,00	0,00	0,00	0,30	0,00	0,00	0,00
TOTAL PERSON MONTHS		**Actual total:**	**148,96**	**15,00**	**3,23**	**17,49**	**32,38**	**35,00**	**11,69**	**18,59**	**3,98**	**5,89**	**5,71**
		Planned total:	**110,88**	**9,00**	**4,00**	**15,39**	**18,31**	**18,50**	**13,60**	**13,30**	**7,00**	**6,00**	**5,78**
		% Expended	**134,34%**	**166,67%**	**80,75%**	**113,65%**	**176,84%**	**189,19%**	**85,96%**	**139,77%**	**56,86%**	**98,17%**	**98,72%**

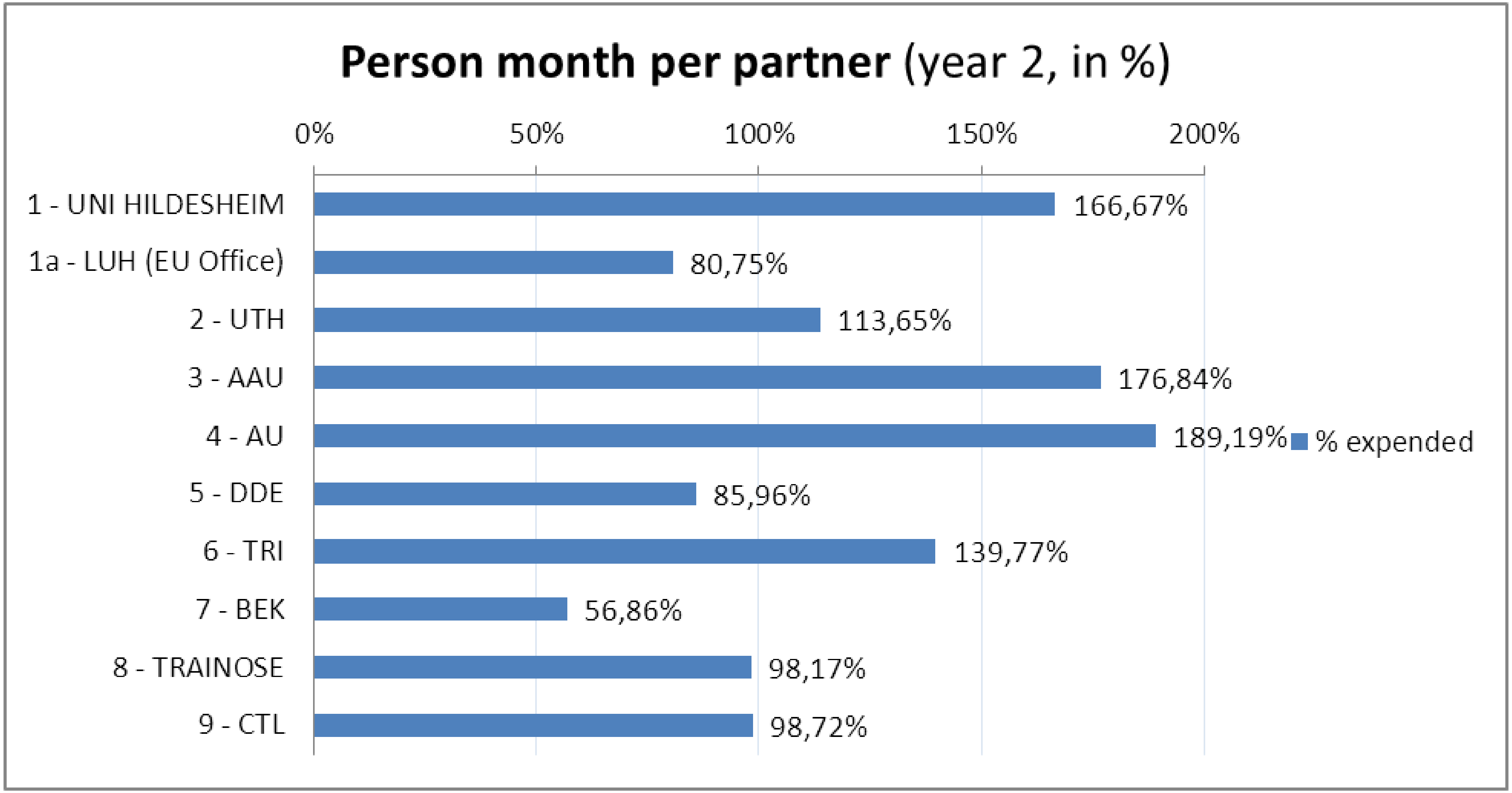

Figure 14: Person months per partner (year 2, in %)

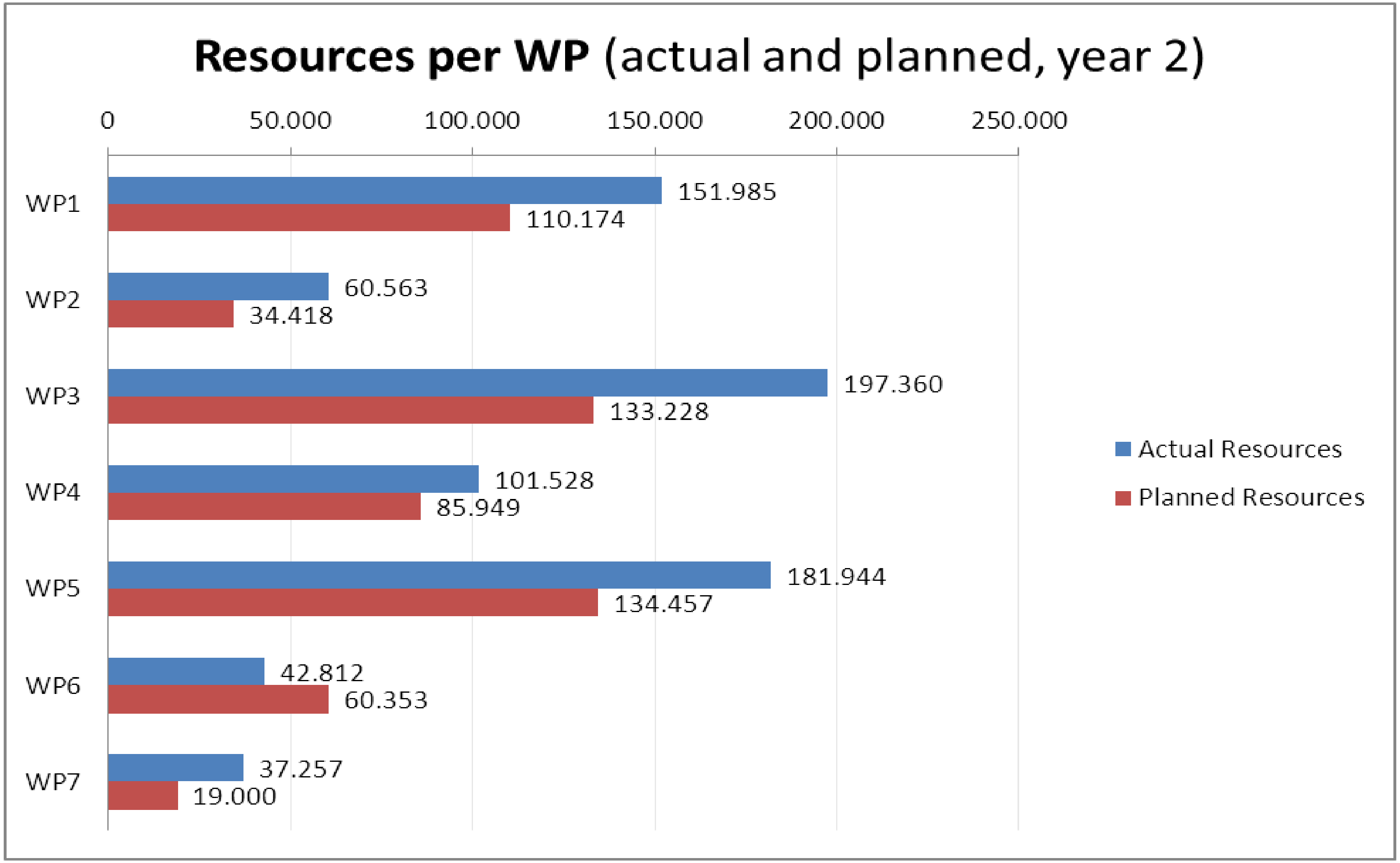

Figure 15: Resources per WP (actual and planned, year 2)

Table 18: Total PM Expenditure for Years 1 + 2 (planned vs actual)

Person Months per WP and per Partner													
			TOTALS	1 - UNI HILDESHEIM	1a - LUH (EU Office	2 - UTH	3 - AAU	4 - AU	5 - DDE	6 - TRI	7 - BEK	8 - TRAINOSE	9 - CTL
WP1	**Onboard Technology and Wireless Communication**	**Actual PM current total:**	**64,67**	4,50	0,00	19,17	1,68	9,00	27,84	1,82	0,00	0,00	0,66
		Planned PM total duration:	**60,59**	3,00	0,00	19,07	4,00	6,00	22,60	3,30	1,00	1,00	0,62
WP2	**Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation**	**Actual PM current total:**	**40,82**	27,50	0,00	2,68	0,00	6,00	0,00	3,97	0,00	0,00	0,67
		Planned PM total duration:	**32,70**	19,00	0,00	3,00	0,00	7,00	0,00	3,00	0,00	0,00	0,70
WP3	**Data Management for Environment Aware Routing and Geo-Locational Analysis Application**	**Actual PM current total:**	**83,12**	4,00	0,00	4,48	25,13	41,50	0,00	1,45	5,88	0,00	0,68
		Planned PM total duration:	**60,91**	2,00	0,00	4,64	17,65	28,50	2,00	1,50	3,00	1,00	0,62
WP4	**System Design & Integration**	**Actual PM current total:**	**52,84**	4,50	0,00	6,91	5,79	6,00	0,00	28,94	0,00	0,00	0,70
		Planned PM total duration:	**41,78**	2,00	0,00	9,08	2,00	3,00	2,00	23,00	0,00	0,00	0,70
WP5	**Case Studies for assessing Energy-Efficiency and CO2 Reduction**	**Actual PM current total:**	**55,47**	4,50	0,00	8,65	10,17	5,00	0,00	6,58	3,98	10,89	5,70
		Planned PM total duration:	**44,84**	3,00	0,00	3,71	5,35	5,00	3,00	3,00	7,00	9,00	5,78
WP6	**Dissemination, Exploitation, Standards**	**Actual PM current total:**	**14,21**	3,00	0,00	0,00	0,83	3,00	3,65	2,80	0,00	0,28	0,65
		Planned PM total duration:	**18,90**	2,00	1,00	1,00	2,00	3,00	5,20	3,00	0,00	1,00	0,70
WP7	**Project management**	**Actual PM current total:**	**10,06**	2,00	5,03	1,42	1,14	0,00	0,00	0,47	0,00	0,00	0,00
		Planned PM total duration:	**6,62**	0,00	5,00	1,00	0,02	0,00	0,00	0,60	0,00	0,00	0,00
TOTAL PERSON MONTHS		**Actual total:**	**321,18**	**50,00**	**5,03**	**43,31**	**44,74**	**70,50**	**31,49**	**46,03**	**9,86**	**11,17**	**9,05**
		Planned total:	**266,34**	**31,00**	**6,00**	**41,50**	**31,02**	**52,50**	**34,80**	**37,40**	**11,00**	**12,00**	**9,12**
		% Expended	**120,59%**	**161,29%**	**83,83%**	**104,36%**	**144,23%**	**134,29%**	**90,49%**	**123,07%**	**89,64%**	**93,08%**	**99,19%**

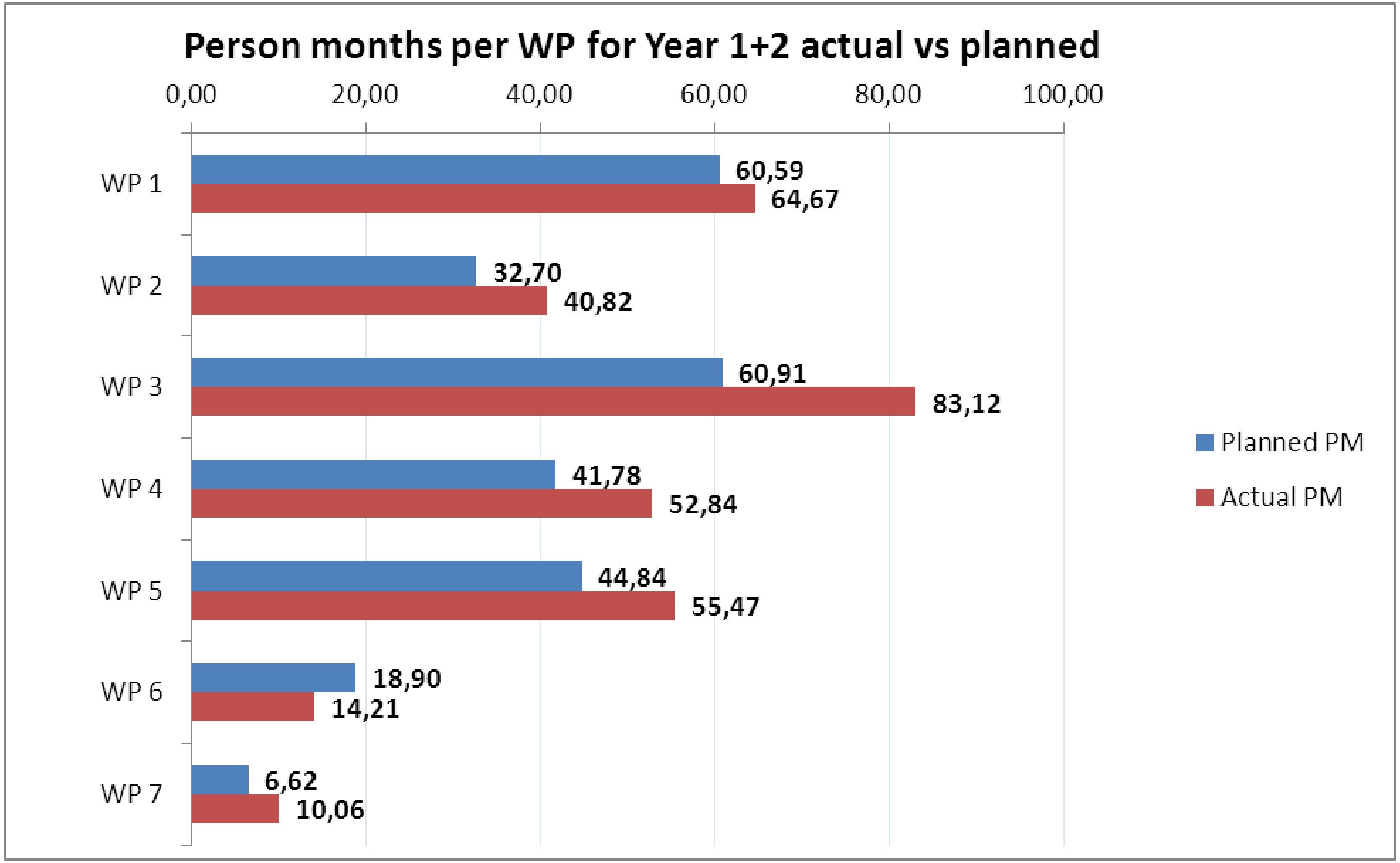

Figure 16: Person months per WP for Year 1+2 actual vs planned

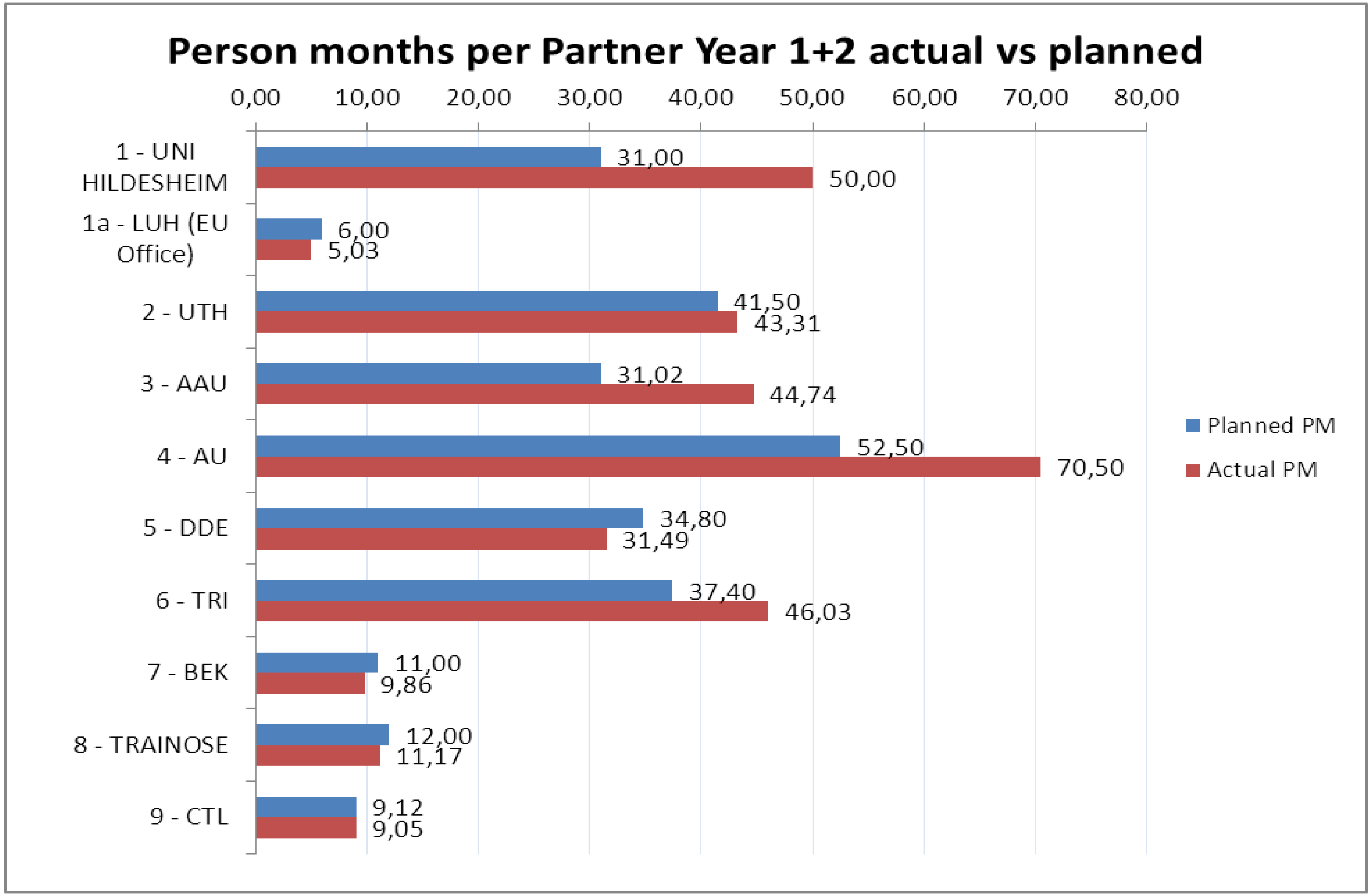

Figure 17: Person months per Partner Year 1+2 actual vs planned

Table 19: Resources actually used vs planned per WP for Years 1+2

Resources per WP and per Partner for Years 1 + 2													
			TOTALS	1 - UNI HILDESHEIM	1a - LUH (EU Office	2 - UTH	3 - AAU	4 - AU	5 - DDE	6 - TRI	7 - BEK	8 - TRAINOSE	9 - CTL
WP1	**Onboard Technology and Wireless Communication**	**Actual Resources current total:**	**362.282,00**	24.750,00	0,00	50.177,00	11.906,00	37.791,00	219.633,00	12.734,00	0,00	0,00	5.291,00
		Planned Resources total duration:	**325.286,00**	16.502,00	0,00	49.223,00	25.000,00	30.113,00	173.644,00	16.500,00	5.893,00	3.300,00	5.111,00
WP2	**Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation**	**Actual Resources current total:**	**199.748,00**	119.317,00	0,00	9.000,00	0,00	51.098,00	0,00	14.984,00	0,00	0,00	5.349,00
		Planned Resources total duration:	**146.528,00**	82.814,00	0,00	12.000,00	0,00	38.303,00	0,00	8.000,00	0,00	0,00	5.411,00
WP3	**Data Management for Environment Aware Routing and Geo-Locational Analysis Application**	**Actual Resources current total:**	**444.042,00**	20.642,00	0,00	17.280,00	100.969,00	255.756,00	0,00	8.601,00	35.359,00	0,00	5.435,00
		Planned Resources total duration:	**339.413,00**	11.328,00	0,00	18.387,00	79.300,00	181.919,00	13.446,00	10.500,00	15.893,00	3.300,00	5.340,00
WP4	**System Design & Integration**	**Actual Resources current total:**	**305.444,00**	23.487,00	0,00	28.682,00	42.830,00	25.510,00	0,00	179.413,00	0,00	0,00	5.522,00
		Planned Resources total duration:	**262.425,00**	13.818,00	0,00	45.507,00	15.497,00	13.635,00	13.446,00	155.000,00	0,00	0,00	5.522,00
WP5	**Case Studies for assessing Energy-Efficiency and CO2 Reduction**	**Actual Resources current total:**	**253.043,00**	22.773,00	0,00	38.245,00	43.975,00	32.680,00	0,00	35.517,00	15.732,00	31.945,00	32.176,00
		Planned Resources total duration:	**218.732,00**	15.181,00	0,00	14.492,00	23.472,00	32.680,00	20.169,00	14.000,00	40.000,00	26.500,00	32.238,00
WP6	**Dissemination, Exploitation, Standards**	**Actual Resources current total:**	**61.583,00**	13.422,00	0,00	0,00	5.353,00	13.809,00	10.085,00	12.295,00	0,00	1.731,00	4.888,00
		Planned Resources total duration:	**79.648,00**	9.100,00	4.000,00	0,00	10.869,00	13.809,00	20.170,00	13.500,00	0,00	3.300,00	4.900,00
WP7	**Project management**	**Actual Resources current total:**	**50.701,00**	8.507,00	23.337,00	4.775,00	7.104,00	0,00	0,00	6.978,00	0,00	0,00	0,00
		Planned Resources total duration:	**34.204,00**	0,00	23.200,00	2.880,00	124,00	0,00	0,00	8.000,00	0,00	0,00	0,00
TOTAL RESOURCES		**Actual total (Year 1 + 2):**	**1.676.843,00**	**232.898,00**	**23.337,00**	**148.159,00**	**212.137,00**	**416.644,00**	**229.718,00**	**270.522,00**	**51.091,00**	**33.676,00**	**58.661,00**
		Planned total (Year 1 +2):	**1.406.236,00**	**148.743,00**	**27.200,00**	**142.489,00**	**154.262,00**	**310.459,00**	**240.875,00**	**225.500,00**	**61.786,00**	**36.400,00**	**58.522,00**
		% Expended	**119,24%**	**156,58%**	**85,80%**	**103,98%**	**137,52%**	**134,20%**	**95,37%**	**119,97%**	**82,69%**	**92,52%**	**100,24%**

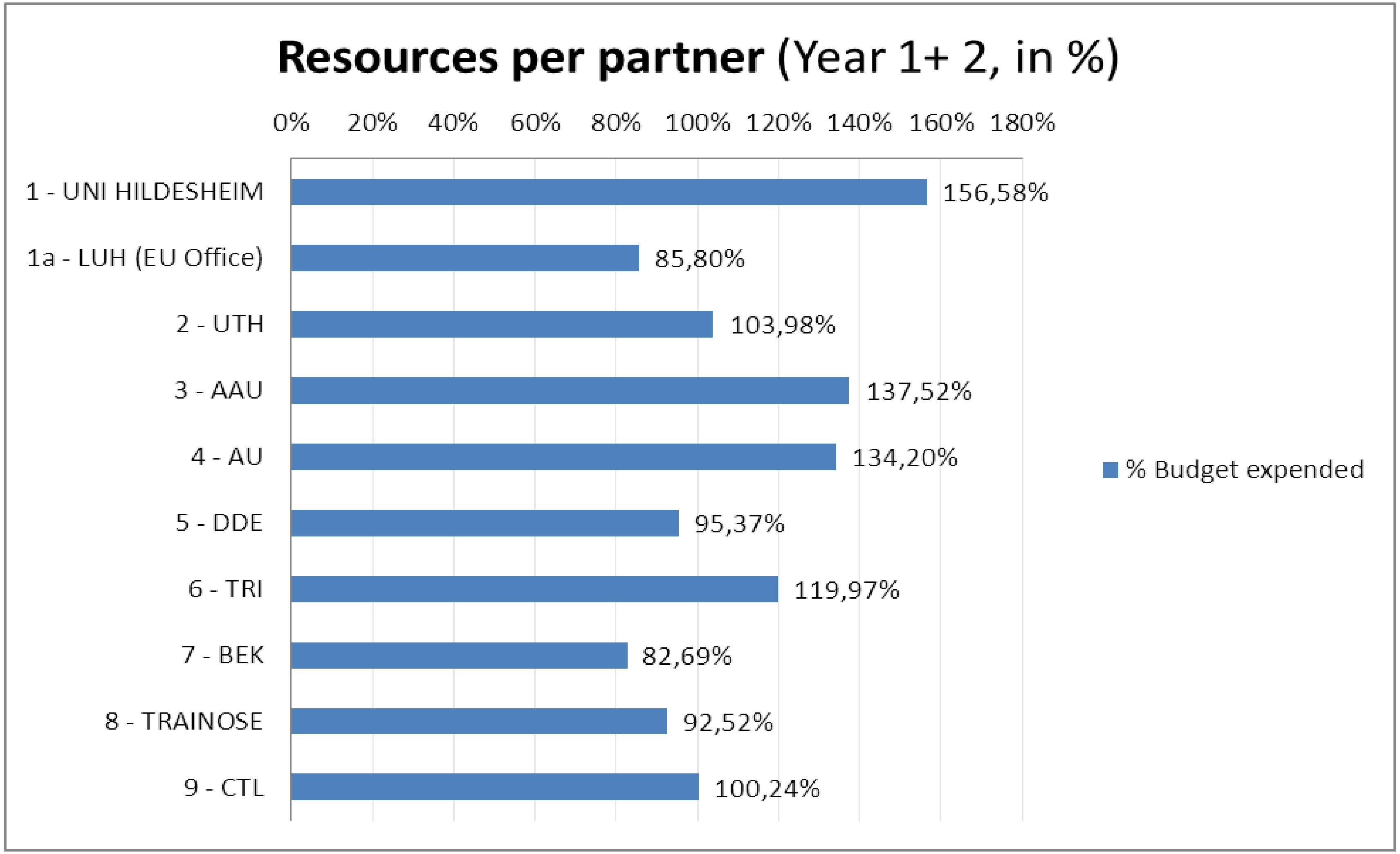

Figure 18: Resources per partner (Year 1+2, in %)

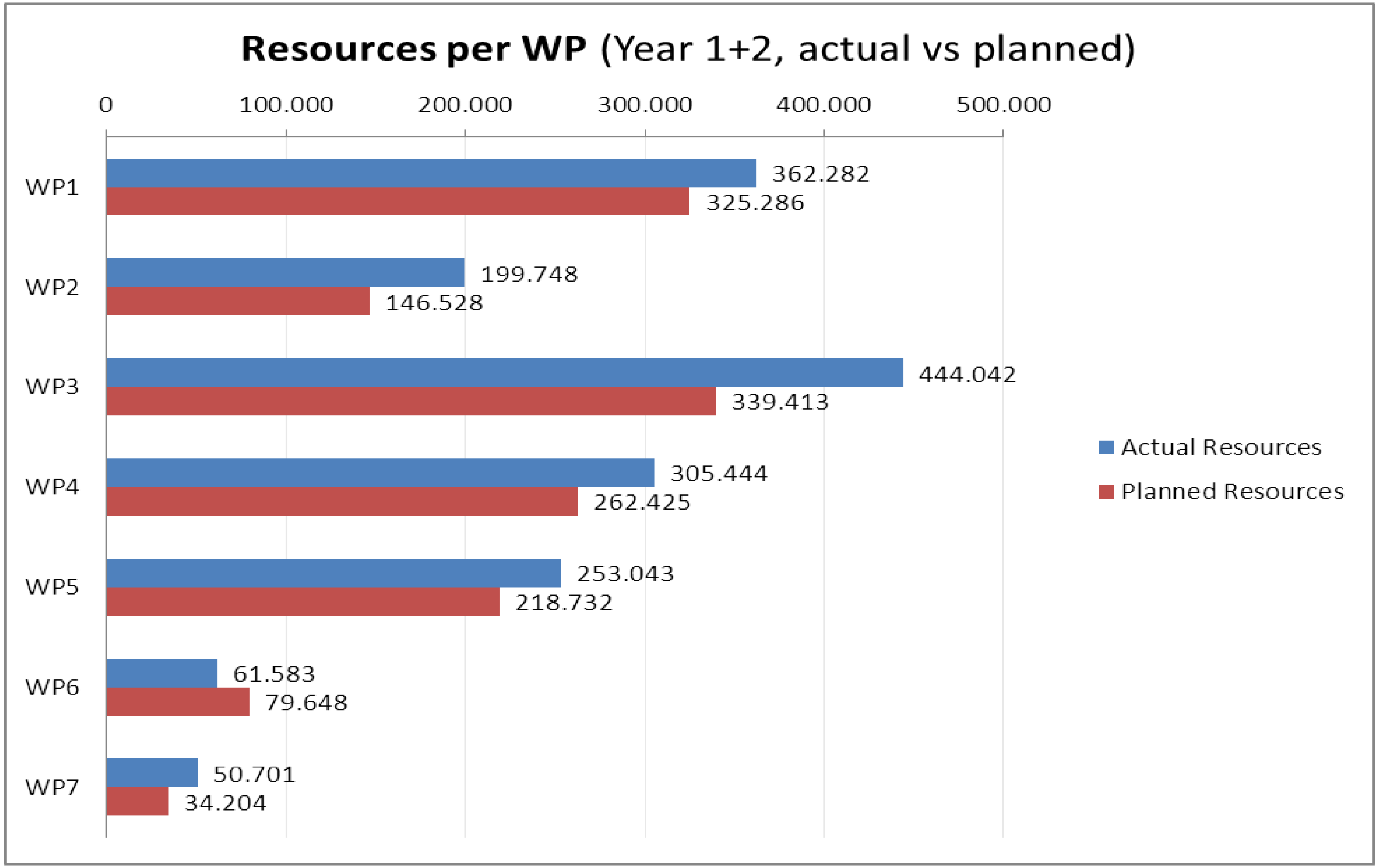

Figure 19: Resources per WP (Year 1+2, actual vs planned)

Table 20: Resources actually used vs planned per WP for Year 2

Resources per WP and per Partner for Year 2													
			TOTALS	1 - UNI HILDESHEIM	1a - LUH (EU Office	2 - UTH	3 - AAU	4 - AU	5 - DDE	6 - TRI	7 - BEK	8 - TRAINOSE	9 - CTL
WP1	**Onboard Technology and Wireless Communication**	**Actual Resources current total:**	**151.985,00**	9.538,00	0,00	19.954,00	11.906,00	15.355,00	82.932,00	9.820,00	0,00	0,00	2.480,00
		Planned Resources total duration:	**110.174,00**	6.360,00	0,00	19.000,00	25.000,00	7.677,00	27.644,00	13.000,00	5.893,00	3.300,00	2.300,00
WP2	**Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation**	**Actual Resources current total:**	**60.563,00**	34.887,00	0,00	0,00	0,00	15.355,00	0,00	7.783,00	0,00	0,00	2.538,00
		Planned Resources total duration:	**34.418,00**	23.258,00	0,00	3.000,00	0,00	2.560,00	0,00	3.000,00	0,00	0,00	2.600,00
WP3	**Data Management for Environment Aware Routing and Geo-Locational Analysis Application**	**Actual Resources current total:**	**197.360,00**	6.668,00	0,00	9.393,00	43.986,00	129.837,00	0,00	4.881,00	0,00	0,00	2.595,00
		Planned Resources total duration:	**133.228,00**	6.670,00	0,00	10.500,00	20.500,00	64.919,00	13.446,00	5.500,00	5.893,00	3.300,00	2.500,00
WP4	**System Design & Integration**	**Actual Resources current total:**	**101.528,00**	4.541,00	0,00	21.175,00	40.999,00	15.833,00	0,00	16.183,00	0,00	0,00	2.797,00
		Planned Resources total duration:	**85.949,00**	9.082,00	0,00	38.000,00	13.666,00	3.958,00	13.446,00	5.000,00	0,00	0,00	2.797,00
WP5	**Case Studies for assessing Energy-Efficiency and CO2 Reduction**	**Actual Resources current total:**	**181.944,00**	8.795,00	0,00	28.645,00	40.903,00	15.833,00	0,00	35.517,00	15.732,00	14.481,00	22.038,00
		Planned Resources total duration:	**134.457,00**	5.863,00	0,00	4.092,00	20.400,00	15.833,00	20.169,00	14.000,00	25.000,00	7.000,00	22.100,00
WP6	**Dissemination, Exploitation, Standards**	**Actual Resources current total:**	**42.812,00**	4.254,00	0,00	0,00	2.758,00	13.809,00	10.085,00	7.983,00	0,00	1.731,00	2.192,00
		Planned Resources total duration:	**60.353,00**	0,00	4.000,00	0,00	8.274,00	13.809,00	20.170,00	8.500,00	0,00	3.300,00	2.300,00
WP7	**Project management**	**Actual Resources current total:**	**37.257,00**	8.507,00	15.896,00	1.895,00	6.980,00	0,00	0,00	3.979,00	0,00	0,00	0,00
		Planned Resources total duration:	**19.000,00**	0,00	15.000,00	0,00	0,00	0,00	0,00	4.000,00	0,00	0,00	0,00
TOTAL RESOURCES		**Actual total:**	**773.449,00**	**77.190,00**	**15.896,00**	**81.062,00**	**147.532,00**	**206.022,00**	**93.017,00**	**86.146,00**	**15.732,00**	**16.212,00**	**34.640,00**
		Planned total:	**577.579,00**	**51.233,00**	**19.000,00**	**74.592,00**	**87.840,00**	**108.756,00**	**94.875,00**	**53.000,00**	**36.786,00**	**16.900,00**	**34.597,00**
		% Expended	**133,91%**	**150,66%**	**83,66%**	**108,67%**	**167,96%**	**189,44%**	**98,04%**	**162,54%**	**42,77%**	**95,93%**	**100,12%**

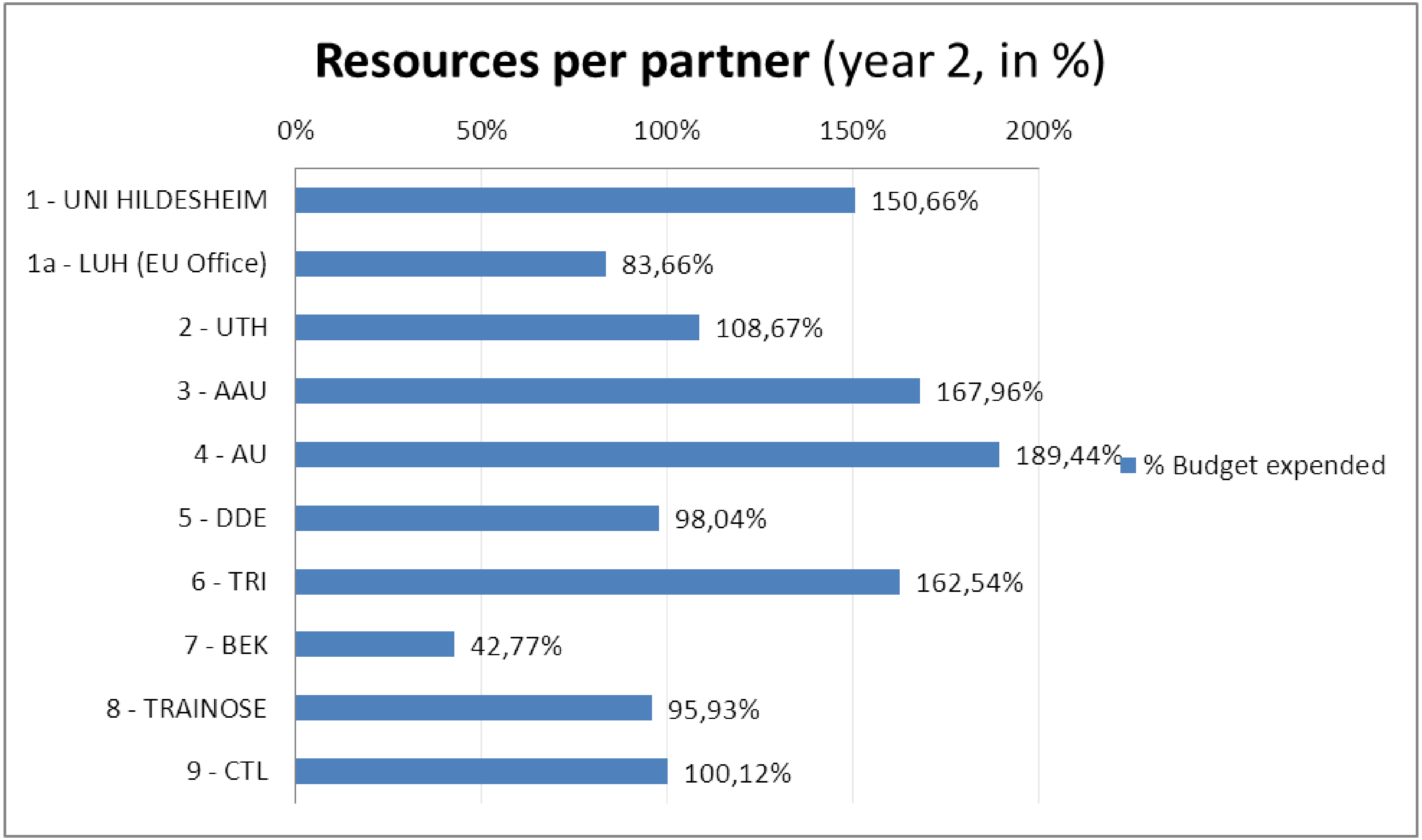

Figure 20: Resources per partner (year 2, in %)

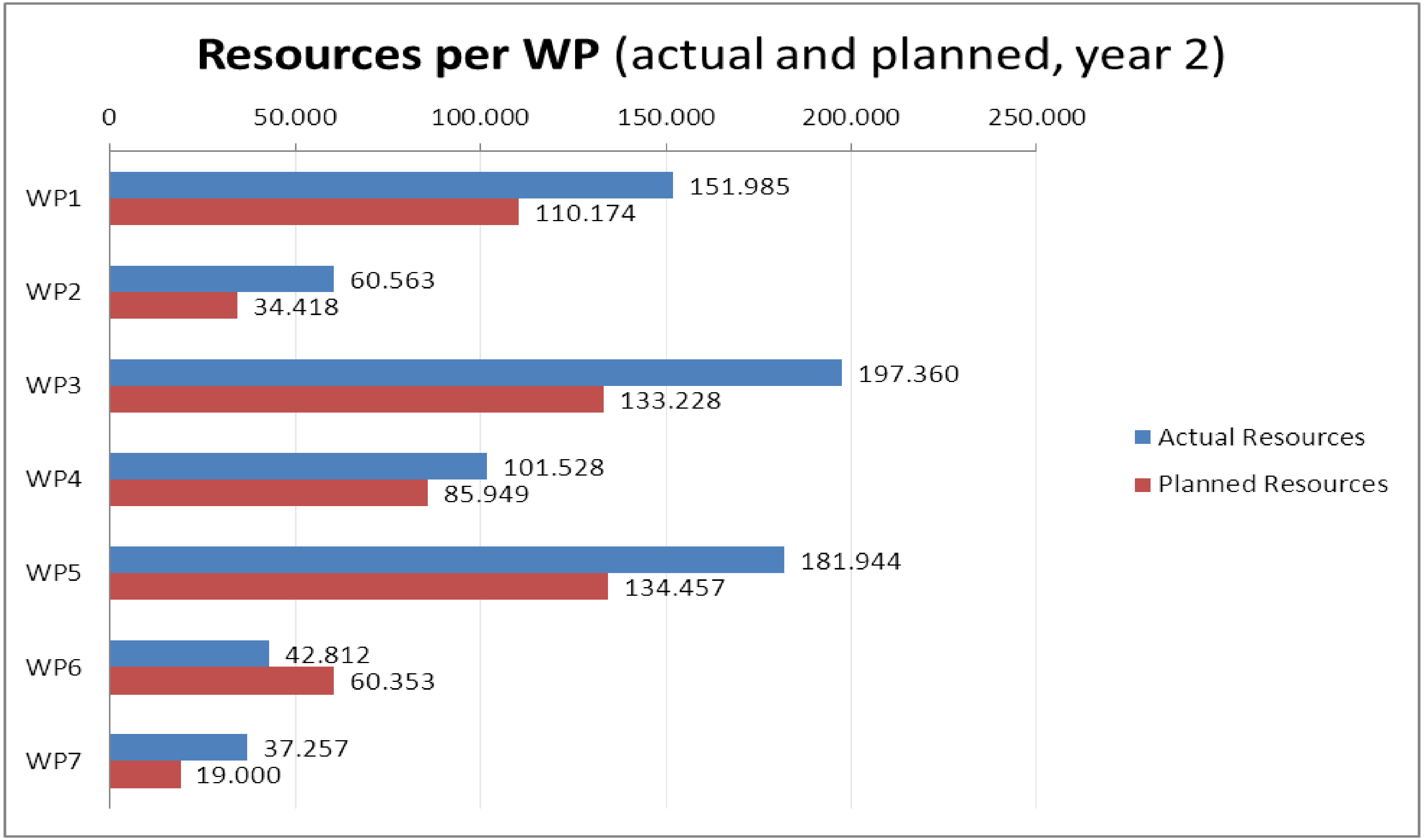

Figure 21: Resources per WP (actual and planned, year 2)

Explanations of deviations of PM and resources

1. Deviations of PM

a. Partner 1 – UHI

The over-commitment of UHI, in terms of spent PMs compared to the planned ones, is incurred from the additive efforts to meet qualitative research within the scope of WP2. The research addressed the primary objectives of the DOW for the areas of ecological driving and cooperative vehicle routing. The primary spending was dedicated to Tasks 2.2 and T2.3 of WP2.

b. Partner 2 – UTH

No significant deviation

c. Partner 3 – AAU

AAU has spent more PM than actually planned in WP 3 and WP 5. In WP 3 the handling of high-frequent GNSS data could not reuse or extend the existing approach as planned (further information is given below, deviation of resources). Moreover, AAU put very large effort into getting access to CAN bus data. This required a lot more visits to companies to explain why they should provide the REDUCTION project with CAN bus data (and GNSS data). After many rounds of discussion with companies AAU got very successful in getting access to CAN bus data.

d. Partner 4 – AU

AU has spent their total budget and total PM within the first two years to promote the project as fast as possible. AU did this with the awareness that they would cover extra costs at the end of the project by means of institutional resources. Extra resources were already made available during the second year of the project, and further costs were covered during the third year in order to extend the prototype to include the newest scientific advances achieved in the project. Notably, support for stochastic skyline route planning and for personalised eco-routing have been invented, prototyped in isolation, studied empirically, and integrated into the consolidated prototype. This way, AU has succeeded in including most of the research advances into our consolidated prototype. In addition, AU has been able to obtain ground-truth fuel consumption data from vehicles. This has allowed us to include a ground truth into the EcoMark benchmark for vehicular environmental impact models, thus addressing a shortcoming of the first EcoMark benchmark.

e. Partner 5 – DDE

No significant deviation

f. Partner 6 – TRI

Budgeted hours had to be specified before the start of the project. To do this, assumptions must be made about the needed hours. The first year of REDUCTION proceeded very slowly. Trinite received information by the partners bit to bit, which was required for links with the DSS software.

In the second year of REDUCTION one of the employees left the company and his knowledge had to be transferred to another employee. For this, more time was needed and more people had to fill the resulting knowledge gap. This is the reason why more time was spent on REDUCTION than was budgeted during the second year.

g. Partner 7 – BEK

No significant deviation

h. Partner 8 – TrainOSE

No significant deviation

i. Partner 9 – CTL

No significant deviation

2. Deviation of Resources

Most person months resources have been spent during Reporting Period 2 on WP 3 and 5.

a. WP1

Work within WP 1 has been carried out in a different time frame. In WP 1 most of the work to be done by project end has already been completed.

b. WP2

Deviations within this WP were mainly caused by the development of the communication stack. It could not be finished due to additional feature requests (for hardware and software capabilities) from the project partners. Also a suitable CAN-subsystem to fit REDUCTION project needed to be contemplated.

Due to the unforeseen requirement of a new communication protocol the start of the F.O.T. was again delayed. Further development of the management feature in the stack was discontinued as it will neither improve performance of the current on-board unit nor introduce any usable feature. The communication standard utilised by heavy-duty vehicles proved to be a major interruption due to the fact that a special parser is needed to make any sense of the received CAN-data.

c. WP3

In WP 3 the main difficulty lies in obtaining real fuel consumption data on the majority of road segments in Denmark, in order to evaluate the accuracy of the proposed eco-routing techniques. To compensate for this deficiency, the REDUCTION partners have put considerable effort in obtaining a small amount of CANBus data to record the real fuel consumption on some road segments. They have also conducted additional experiments to compare the fuel consumption estimated by existing models to the fuel recorded by the small amount of CANBus data. This caused a significant increase of resources within the first 2 years of the project.

Moreover, the handling of high-frequent GNSS data could not reuse or extend the existing approach as planned. The existing solutions (e.g., MON-tree, PARINET, and Suffix arrays/trees) are too time consuming both query and to modify (insert/update/delete) and take up too much disk space. Instead of the existing disk-based approach a new main-memory based approach has been design, implemented, and tested on country size digital maps with millions of trajectories. The new approach is called an SP tree (SP = strict path tree). This approach uses orders of magnitude less space and is orders of magnitude faster than the existing approaches. In addition, the new approach allows for faster modifications. The SP approach is central to the scalable and fast prototype developed in the project.

d. WP4

The difference in resources and PM within WP 4 is mainly caused by a change in personnel at TRI. Knowledge had to be transferred to a new employee which was very time consuming.

e. WP5

Within WP 5 AAU put a very large effort into getting access to CAN bus data. This required a lot more visits to companies to explain why they should provide the REDUCTION project with CAN bus data (and GNSS data). After many rounds of discussion with companies AAU got very successful in getting access to CAN bus data. Unfortunately, the CAN bus data had been very "dirty" and required a significant effort to clean the data in the ETL process. At the end of the project AAU will have more than 340 million measurements with CAN bus data covering all of Denmark. AAU is not aware of any project (where car manufactures are not part of the project) that have access to anywhere near this size of CAN bus data. The data size has enabled AAU to make very accurate estimations of the fuel savings and greenhouse gas emission reductions.

Moreover. in WP 5 considerable more person months and resources were needed than planned due to some delays in the schedule of the field trials. Whereas the first phase of the field trials run by Bektra/FlexDanmark, TrainOSE and UTH ended as initially planned and agreed some delays caused by the Cyprus Public Works Department resulted in subsequent delays in the timely completion of the first phase of CTL's field trial. That resulted in a delay in the evaluation of the efficacy of DELPHI's hardware, but this is not considered a major problem, since it has been extensively tested by the company in other setting. The most significant problem will be the delay in the collection of data for driver behaviour. As far, as the impact of V2V communications on CO_2 emissions, which was another goal for this field study, again it is not considered severe, because UTH's simulated field trial covered that point at a significant degree. During the evolution of the project a fourth field trial – run by Trinite Automation was needed to investigate the traffic control centre's perspective.

f. WP6

The majority of resources needed in WP 6 will be used in the 3rd year of the project, when the results of the project are clear and can be therefore better disseminated and exploited.

g. WP7

More resources had to be spent on WP7 than actually planned. This difference was mainly caused by the high effort of preparing the interim reports and the review meetings. Moreover, extra resources had to be spent on responding to the comments and demands of the reviewers.

Use of resources

To compensate the additional work needed in the work packages 3 and 5, additional person month resources that were meant for WP 1 or WP 6 have been used in WP 3 and 5. This does not have a negative influence on the progress in WP 1 and 6. In WP 1 most of the work to be done by project end has already been completed. The majority of resources needed in WP 6 will be used in the 3rd year of the project, when the results of the project are clear and can be therefore better disseminated and exploited.

The partner DDE has requested in agreement with the Project Officer a shift of 4 PM from WP 6 to WP 1 in order to continue work on the on-board equipment. The total amount of PM in WP1 was 24, adding those from WP6 would total to 28 PM. Subtracting the already spent 17.6 leaves 10.4 PM (6.4 from WP1 and 4PM from WP6). DDE has converted PMs to material-cost, to cover for the hardware built for the Nicosia field trial. The DDE-share is 12.844 EUR, which can be expressed as 1.68 PMs. This money has been shifted to the category RTD /Other costs to cover hardware costs.

Financial statements – Form C and Summary financial report

Form C financial statements are being submitted for all partners in NEF.

Signed versions of all Form C statements will be submitted to the Commission by courier in parallel to the submission of the current report.

Table 21: Total Budget Expenditure for Year 2 (Months 13 – 24)

		Total Budget acc. DOW				RP1 Reported				RP2 Reported				TOTAL Expended Year 1 + 2				TOTAL incl. Adjustments and Receipts	% Budget expended in Year 2	% Budget expended in Year 1+2
	Categories	RTD	MGT	OTHER	TOTAL	RTD	MGT	OTHER	TOTAL	RTD	MGT	OTHER	TOTAL	RTD	MGT	OTHER	TOTAL			
Partner 1 UHI	TOTAL ELIGIBLE COSTS	479.384 €	91.100 €	0 €	**570.484 €**	232.323,00 €	14.668,00 €	0,00 €	**246.992,00 €**	103.403,20	20.417,60	0,00	**123.820,80**	335.726 €	35.086 €	0 €	**370.812 €**	370.812 €	**21,70%**	**65,00%**
	EU CONTRIBUTION	359.538 €	91.100 €	0 €	**450.638 €**	174.242,00 €	14.668,00 €	0,00 €	**188.910,00 €**	77.552,40	20.417,60	0,00	**97.970,00**	251.794 €	35.086 €	0 €	**286.880 €**	286.880 €	**21,74%**	**63,66%**
Third Party LUH	TOTAL ELIGIBLE COSTS	0 €	78.754 €	0 €	**78.754 €**	0,00 €	11.905,00 €	0,00 €	**11.905,00 €**	0,00	25.433,60	0,00	**25.433,60**	0 €	37.339 €	0 €	**37.339 €**	37.339 €	**32,30%**	**47,41%**
	EU CONTRIBUTION	0 €	78.754 €	0 €	**78.754 €**	0,00 €	11.905,00 €	0,00 €	**11.905,00 €**	0,00	25.433,60	0,00	**25.433,60**	0 €	37.339 €	0 €	**37.339 €**	37.339 €	**32,30%**	**47,41%**
Partner 2 UTH	TOTAL ELIGIBLE COSTS	403.200 €	23.100 €	0 €	**426.300 €**	102.747,00 €	4.608,00 €	0,00 €	**107.355,00 €**	126.664,00	3.032,00	0,00	**129.696,00**	229.411 €	7.640 €	0 €	**237.051 €**	237.051 €	**30,42%**	**55,61%**
	EU CONTRIBUTION	302.400 €	23.100 €	0 €	**325.500 €**	77.060,00 €	4.608,00 €	0,00 €	**81.668,00 €**	94.998,00	3.032,00	0,00	**98.030,00**	172.058 €	7.640 €	0 €	**179.698 €**	179.698 €	**30,12%**	**55,21%**
Partner 3 AAU	TOTAL ELIGIBLE COSTS	571.360 €	27.580 €	0 €	**598.940 €**	103.169,00 €	198,00 €	0,00 €	**103.368,00 €**	224.889,33	11.167,28	0,00	**236.056,61**	328.058 €	11.365 €	0 €	**339.424 €**	339.424 €	**39,41%**	**56,67%**
	EU CONTRIBUTION	428.520 €	27.580 €	0 €	**456.100 €**	77.376,00 €	198,00 €	0,00 €	**77.574,00 €**	168.667,00	11.167,28	0,00	**179.834,28**	246.043 €	11.365 €	0 €	**257.408 €**	257.408 €	**39,43%**	**56,44%**
Partner 4 AU	TOTAL ELIGIBLE COSTS	599.360 €	2.500 €	0 €	**601.860 €**	336.998,00 €	0,00 €	0,00 €	**336.998,00 €**	330.353,22	0,00	0,00	**330.353,22**	667.351 €	0 €	0 €	**667.351 €**	667.351 €	**54,89%**	**110,88%**
	EU CONTRIBUTION	449.520 €	2.500 €	0 €	**452.020 €**	252.748,00 €	0,00 €	0,00 €	**252.748,00 €**	247.764,91	0,00	0,00	**247.764,91**	500.513 €	0 €	0 €	**500.513 €**	500.513 €	**54,81%**	**110,73%**
Partner 5 DDE	TOTAL ELIGIBLE COSTS	607.505 €	0 €	0 €	**607.505 €**	234.436,00 €	0,00 €	0,00 €	**234.436,00 €**	178.688,00	0,00	0,00	**178.688,00**	413.124 €	0 €	0 €	**413.124 €**	413.124 €	**29,41%**	**68,00%**
	EU CONTRIBUTION	303.753 €	0 €	0 €	**303.753 €**	117.218,00 €	0,00 €	0,00 €	**117.218,00 €**	89.344,00	0,00	0,00	**89.344,00**	206.562 €	0 €	0 €	**206.562 €**	206.562 €	**29,41%**	**68,00%**
Partner 6 TRI	TOTAL ELIGIBLE COSTS	598.400 €	27.900 €	0 €	**626.300 €**	215.313,00 €	3.485,00 €	0,00 €	**218.799,00 €**	99.853,73	2.759,72	0,00	**102.613,45**	315.167 €	6.245 €	0 €	**321.411 €**	321.411 €	**16,38%**	**51,32%**
	EU CONTRIBUTION	448.800 €	27.900 €	0 €	**476.700 €**	161.484,00 €	3.485,00 €	0,00 €	**164.969,00 €**	74.890,30	2.759,72	0,00	**77.650,02**	236.374 €	6.245 €	0 €	**242.619 €**	242.619 €	**16,29%**	**50,90%**
Partner 7 BEK	TOTAL ELIGIBLE COSTS	199.200 €	0 €	0 €	**199.200 €**	35.359,00 €	0,00 €	0,00 €	**35.359,00 €**	25.171,39	0,00	0,00	**25.171,39**	60.530 €	0 €	0 €	**60.530 €**	60.530 €	**12,64%**	**30,39%**
	EU CONTRIBUTION	149.400 €	0 €	0 €	**149.400 €**	26.519,00 €	0,00 €	0,00 €	**26.519,00 €**	18.878,54	0,00	0,00	**18.878,54**	45.398 €	0 €	0 €	**45.398 €**	45.398 €	**12,64%**	**30,39%**
Partner 8 TRAINOSE	TOTAL ELIGIBLE COSTS	121.500 €	0 €	0 €	**121.500 €**	17.464,00 €	0,00 €	0,00 €	**17.464,00 €**	16.210,62	0,00	0,00	**16.210,62**	33.675 €	0 €	0 €	**33.675 €**	33.675 €	**13,34%**	**27,72%**
	EU CONTRIBUTION	60.750 €	0 €	0 €	**60.750 €**	8.732,00 €	0,00 €	0,00 €	**8.732,00 €**	8.105,31	0,00	0,00	**8.105,31**	16.837 €	0 €	0 €	**16.837 €**	16.837 €	**13,34%**	**27,72%**
Partner 9 CTL	TOTAL ELIGIBLE COSTS	142.400 €	0 €	0 €	**142.400 €**	38.430,00 €	0,00 €	0,00 €	**38.430,00 €**	55.426,08	0,00	0,00	**55.426,08**	93.856 €	0 €	0 €	**93.856 €**	93.856 €	**38,92%**	**65,91%**
	EU CONTRIBUTION	106.800 €	0 €	0 €	**106.800 €**	28.822,00 €	0,00 €	0,00 €	**28.822,00 €**	41.569,56	0,00	0,00	**41.569,56**	70.392 €	0 €	0 €	**70.392 €**	70.392 €	**38,92%**	**65,91%**
TOTAL	**TOTAL ELIGIBLE COSTS**	3.722.309 €	250.934 €	0 €	**3.973.243 €**	1.316.239,00 €	34.864,00 €	0,00 €	**1.351.106,00 €**	**1.089.022,86**	**62.810,20**	**0,00**	**1.151.833,06**	2.476.899 €	97.674 €	0 €	**2.574.573 €**	**2.574.573 €**	**28,99%**	**62,99%**
	EU CONTRIBUTION	2.609.481 €	250.934 €	0 €	**2.860.414 €**	924.201,00 €	34.864,00 €	0,00 €	**959.065,00 €**	**772.095,15**	**62.810,20**	**0,00**	**834.905,35**	1.745.971 €	97.674 €	0 €	**1.843.645 €**	**1.843.645 €**	**29,19%**	**62,72%**

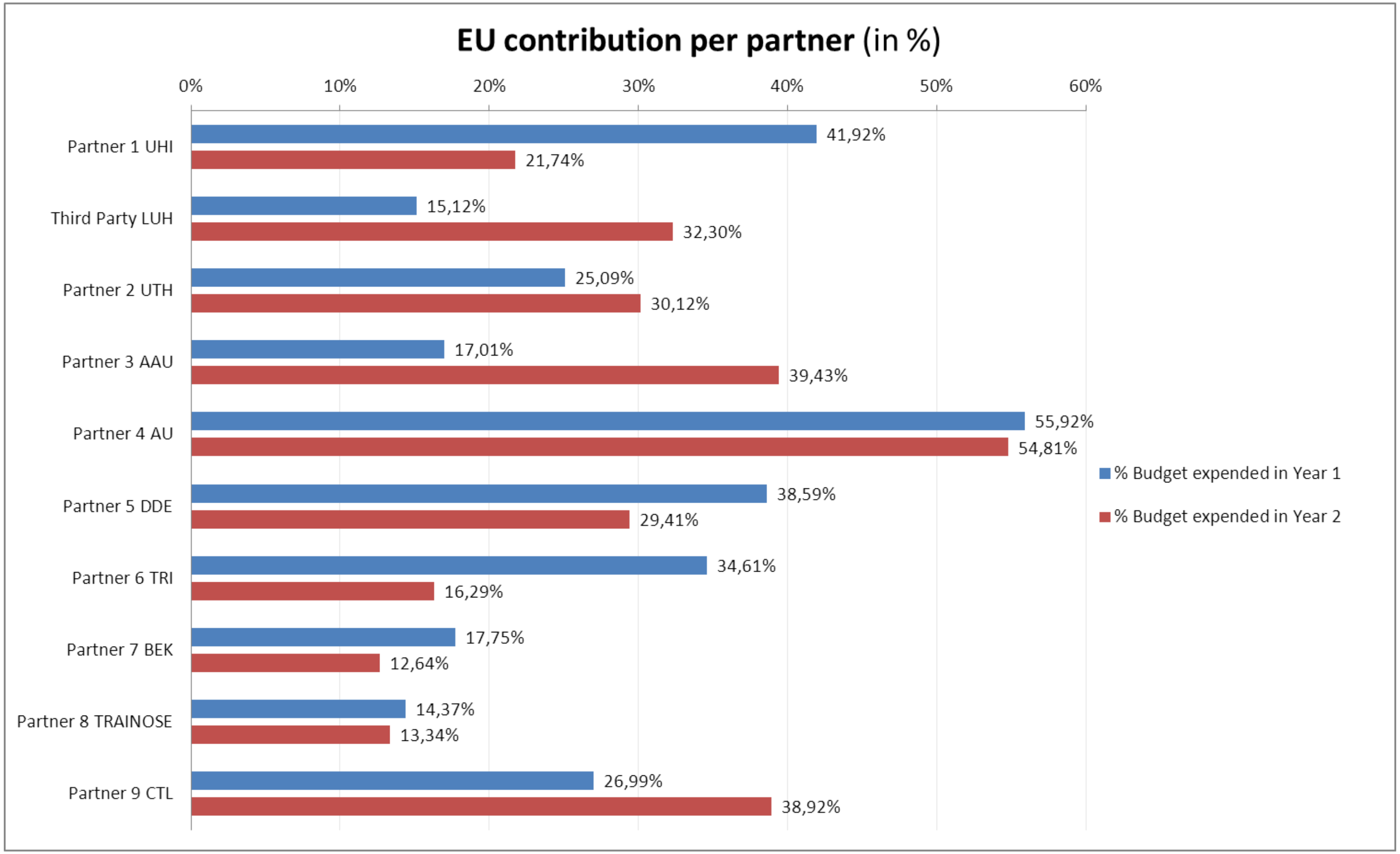

Figure 22: EU contribution per partner (in %)

5. Certificates on the Financial Statements

Table 22: Certificates on the Financial Statements

Beneficiary	Organisation short name	Certificate on the financial statements provided? yes / no	Any useful comment, in particular if a certificate is not provided
1	UHI	No	EC contribution under threshold, no CFS required
1a	LUH	No	EC contribution under threshold, no CFS required
2	UTH	No	EC contribution under threshold, no CFS required
3	AAU	No	EC contribution under threshold, no CFS required
4	AU	No	CFS required / to be uploaded in NEF
5	DDE	No	EC contribution under threshold, no CFS required
6	TRI	No	EC contribution under threshold, no CFS required
7	BEK	No	EC contribution under threshold, no CFS required
8	TRAINOSE	No	EC contribution under threshold, no CFS required
9	CTL	No	EC contribution under threshold, no CFS required

6. Risk assessment

6.1 WP 1 Onboard Technology and Wireless Communication

Task 1.4 Intelligent V2V and V2I Communication

The Bluetooth tests and results from these tests are as expected and planned. The travel times that this system can provide are well suited for the TrafficLink management system and integrate easily into the DSS middleware.

A moderate risk in the Bluetooth tests is the high percentage of errors at free flow. The error on the average travel time decreases when there is more congestion. At free-flow the percentage error lies between 6 and 9%, at congestion between 2 and 5% and at heavy congestion between 1.5 and 4%.

The finer the measurement grid, the better the average travel time will be. With very small trajectory, the travel time will get worse because the increasing relative influence on the accuracy of time and place determination.

With free flow the travel time seems to be overestimated, with heavy congestion the smaller targets under estimate the travel time slightly.

An improvement of the Bluetooth detection system and a next step would be with a finer measurement grid of blue tooth detectors and to use Bluetooth detectors with a smaller detection radius.

The real time travel time delivered by the Bluetooth detection system can be used as input for the traffic management system TrafficLink, in order to reduce CO2 emission and fuel consumption by taking the appropriate measures (e.g. rerouting when congestion occurs).

For a good “quality of service” in in respect to different C2C services a critical mass of C2C enabled vehicles must be reached. The needed take-rate of such an option needs to be high in order to draw a positive value proposition to the end customer.

Another risk is the investment in the necessary infrastructure of a V2X system. Beside of the components embedded to the car, for realizing a C2C system only, the much wider and more comprehensive V2X system needs a lot of infrastructure components. Financing such network and necessary return of invest is still open, although research projects result in positive business cases.

As well the timeline with regards to a working infrastructure for a V2X system is open and may not be in line with the provision of the vehicle embedded components.

6.2 WP2 Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation

Task 2.3 Advanced prediction models and Task 2.4 Vehicle motion prediction algorithms

Both sets of methodologies, regarding Distributed Data Mining and Eco-Driving are already implemented and functional. There are no current (or expected) deviations from the objectives of DOW and the time-frames. The synthetic data for the distributed data mining is already generated, while data related eco-driving is possessed and is expected to be enriched by CTL use-case.

The lack of CANBUS data for the WP2 use-case is already addressed by proposing methods that operate using GPS data. The GPS data are more widely available than CANBUS messages, because vehicles already possess devices that record logs of their position across travels. As a consequence of the large distribution of GPS data and their abundance, the price of GPS data (both acquisition/recording) are comparably low. In addition, the method proposed in Deliverable 2.3.1 can mines local driving behaviours from GPS traces. Therefore, no deviations are expected in terms of data availability as well.

Large scale experiments on V2V scenario will not be possible because of the limited number of buses in the Nikosia field study and the limited instances of the onboard devices produced by Delphi in the scope of WP1. However, the project plans to mitigate this situation by (i) conducting proof-of-concept experiments in the Nikosia buses, and (ii) running large scale experiments on simulated environments in order to test both advantages and limitations of distributed statistical models. The accuracy of the distributed statistical models can be tested and assessed by the results of the simulations, therefore no objective or time deviations are expected for the methods proposed by WP2.

6.3 WP3 Data Management for Environment Aware Routing and Geo-Locational Analysis Application

Task 3.3 Advanced eco-routing methods

The main risk in the work package lies in the difficulty of obtaining real fuel consumption data on the majority of road segments in Denmark, in order to evaluate the accuracy of the proposed techniques. To compensate for this deficiency, a small amount of CANBus data has been obtained to record the real fuel consumption on some road segments. Additional experiments have also been conducted to compare the fuel consumption estimated by existing models to the fuel recorded by the small amount of CANBus data. The conclusion is that it is possible to use GPS data on fuel estimation models to estimate fuel consumption.

Since the proposed algorithms and methods are designed purely based on raw GPS trajectories, they can be employed independently of CANBus data. Thus, the problem of lacking real fuel consumption data in conducting the research is reduced to a low level.

6.4 WP4 System Design and Integration

Task 4.2 Basic prototype and Task 4.3 Advanced prototype

The field trials involving FlexDenmark, Nicosia and TrainOSE do not forecast deviations from the plan. The respective software stacks are being implemented, which means that the functionality is present in accordance with the description of work.

The Trinité field trail also doesn't forecast any deviations from the plan. Trinité detected draw backs on the initial architecture like excessive power consumption, user unfriendly way of operating the App and the large amount of data to be handled and stored and made the necessary modifications to the architecture to overcome the problems. The interface description has been added to connect different functionalities between the modules of the work packages. Interpretation differences on the interface description between the different partners could constitute a certain risk for future implementation and thus needs to be monitored seriously.

The delay experienced in the Nicosia field trial is expected to be fully covered and completed by the Spring of 2014, within the boundaries of the REDUCTION project.

6.5 WP5 Case Studies for assessing Energy-Efficiency and CO2 Reduction

Tasks 5.2, 5.3, 5.4 Phase 1 of Field Trials for BEK, TrainOSE, CTL

Following the best practices, REDUCTION has designed three field trials. One is run by TrainOSE to develop, test and enhance multimodal services in Greece by combining train services, with taxi and bus services. The other field trial run by Bektra/FlexDanmark deploys a large taxi fleet in order to develop techniques for the reduction of the GHG emissions from vehicles, establishing environmental profiles of vehicle types, and also estimate GHG emissions based on GNSS measurements. Finally, the third field trial run by CTL (and its complementary simulation-based trial run by UTH), aims at collecting real data for drive behaviour analysis, for hardware and communications/networking protocols testing.

For the Bektra/FlexDanmark, there are no risks associated with the second phase, and all those risks and open issues described in D3.1, D3.3 and D5.1 are appropriately addressed. Similarly, the simulated field trial by UTH recognised no issues that will affect the execution of the second phase of the trial.

As far as the TrainOSE's trial is concerned, in phase II the multimodal scenarios have been finalised and these scenarios have been offered to the customers. The finalization process depends on two main actions. The first one is the implementation of a native multimodal algorithm, enhanced, in terms of time windows usage. The second one is the precision enhancement over various cost metrics. For the first action the risk on non-completion is low since it depends on the time needed, internally, on algorithms development. Given the fact of previous experience in development process, the risk for uncompleted multimodal algorithms has been considered as very low. For the second one, concerning various metrics, risk comes as result of the possibility of low metrics accuracy. For train lines, cost metrics can be defined in a precise way. The precise oil consumption per KM per Locomotive and the electric power consumption are well known. Tickets price is well known. This can be achieved due to unlimited access to all company internal resources (human and information). However, a problematic situation can arise in case of non-accurate information for KTEL buses. Right now this information came through an extensive search over web sites. Most of these sites are not well formatted in terms of information organisation and the updating process isn't established in a standard way. In the second phase, the precision for all trip features such as oil consumption, tickets pricing and average number of customers per bus line has to be upgraded. It is possible not to be in position to get precise information about these metrics from KTEL private entities. KTEL private entities might deny this information due to:

- Privacy misconception. They could think that these statistics can be used against them form other transportation companies.
- Competition misconception. They could think that there is not profit for them, to establish synergies with trains, since most of their lines apply to same customer pool.

Based on the above mentioned reasoning, the risk to not accomplish the task of enhancing the accuracy for cost metrics (for all transportation means and for all lines) can be considered as medium.
Finally, the CTL's field trial due to the delays caused by external "actors" is the most vulnerable part of REDUCTION. To avoid any future problems, the consortium has taken specific actions concerning the monitoring of activities and designed a very detailed plan of actions so as to guaranteed day-by-day progress of the field trial.

6.6 WP 6 Dissemination, Exploitation, Standards

Task 6.2 Exploitation

1) The first risk of the Exploitation of REDUCTION is about actively participating in the project by all partners. All partners have different perceptions of what Exploitation contains and it is hard to compose a uniform plan, also because of policy and cultural differences. An Exploitation Plan is something, which has to be composed together, and it forms the base of the success of a project. For the roll out of the results of the project it is essential that all partners are aware of, contribute to and actively participate in making and realise a complete and realistic plan. This must also include future activities. To stimulate and prove that participation is in interest of all partners, there must be an integrated control measure in project management of the project. This control measure must focus on cooperation between both commercial and non-commercial partners. There is no such thing as exploitation without new partnerships and joint ventures. The value of the project, in both commercial and dissemination activities must be made clear to all partners.

2) The second risk is about the distinctiveness of the results of the project. Technology is developing very fast. Many suppliers are developing similar products. It will be very difficult to distinguish from other providers. Why should individuals use the REDUCTION app? The REDUCTION consortium must clarify and explain why REDUCTION is different and better than other suppliers. They need to create a distinctive and integrated concept to exploit and communicate about the projects results.

3) The third risk is that the project is carried out only in the European countries of the participating partners. Business cases and tests will be executed and implemented in these 5 countries. There is only little information about initiatives in other EU countries and the focus will be only on the selected countries. The risk is that Exploitation will stagnate after tests or will not be carried out to other EU countries. Due to successful implementation of –and communication about the REDUCTION use cases, it should be easy to get any cross border interest.

4) The fourth and last risk is about the ambitiousness and very broad sense of the project. We cannot include all possible areas of exploitation. Why should the commercial sector adopt /sell our products and why should public authorities be interested? We have to narrow it down to a more realistic and comfortable plan. If the projects results can be integrated in a high-level traffic concept and if the standardization is well organised, it would be simple to exploit to a lot of different target groups and areas.

Task 6.3 Contribution to standards

All the partners that are involved in the standardization activity within this project evaluate the risk of deviation from the description of work as none. The standardization, as described above, is an activity that is well within the time frame as that stated in the description of work.

Moreover, the partners also plan to carry this work further for the last year of the project and bring it to a conclusion.

6.7 WP 7 Project Management

A moderate risk identified by the consortium during the first year of the project was the timely submission of the 1st Periodic Report as at the end of the reporting period the consortium also needs to submit 12 deliverables and prepare for the technical review with the European Commission. The work load on the consortium is therefore very high.

The consortium has taken up two-weekly telephone conferences during the period of preparation of the deliverables in order to facilitate quick exchange of information among the partners. This has proven especially useful when preparing the EC Periodic Report 2 for the submission the reviewers.

Setting the date of the technical review at the end of the 60 day preparation period of the EC Periodic Report 2, has also proven to be a good practice allowing a timely submission of the report to reviewers.

A moderate risk identified during the 2nd year of the project is the delay of the Form C submission due to parallel preparation of Certificates on the Financial Statements by the partners reaching the 375.000 € threshold. To minimize this risk, the coordination team has decided to start preparation of the Certificate on the Financial Statements together with the partners in case before the end of the reporting period and to provide an info sheet on this issue as well as close assistance.

7. Conclusion

In the second year of the project the coordination team has enhanced the monitoring and communication structures within the consortium.

Controlling of budget and Person Months resources has been carried out. The tables with overviews of resources planned vs actual have been integrated in the EC Periodic Report 2.

Quarterly reports been further on carried out to monitor the progress of the scientific work and to serve as background for writing the EC periodic report.

Deliverables and milestones have been achieved mostly at the deadline set in Annex I; when delays in the delivery have occurred, the Project Officer has been informed.

A detailed risk assessment for each work package has been written and included in EC Periodic Report.

Steering Committee meetings have been organised on a quarterly basis in order to facilitate scientific progress and communication within the consortium. The topics discussed per meeting have been included in this report.

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REDUCTION has achieved good progress for the 2nd reporting period. The methodologies and algorithms for eco-routing have been further developed and prototypes have been implemented. Field trials have been successfully carried out and particular progress has been done in GeoNetworking protocol, Bluetooth detection system, novel techniques for computing advanced real-time and static eco-weights.

8. Glossary

AASHTO	American Association of State Highway and Transportation Officials
ALPR	Automatic License-plate Recognition
ALZ	Active LeZi
ATM	Area Traffic Manager
BS	Base station
BSM	Basic Safety Message
CAM	Cooperative Awareness Message
CAN	Controller Area Network
CANBus	Controller Area Network Bus
CCU	Communication and Control Unit
CPO	Costas Papaellinas Organisation
CSS	Cascading Style Sheets
CTM	Cell Transmission Model
DATEX II	Standard for information exchange between traffic management centre
DE	Digital Enlightenment (company)
DDM	Distributed Data Management
DIVV	Dienst Infrastructuur Verkeer en Vervoer
DRT	Demand responsive transport
DSS	Datapool Script Support
DTA	Dynamic Traffic Assignment
DUE	Dynamic User Equilibrium
DVM	Dynamisch Verkeersmanagement
ECU	Engine control unit

EMEL	Limassol Buses and Bus Routes
EMIT	Emissions Inventory Tool
ETL-Prozess	Etract, Transform, Load
ETSI	European Telecommunications Standards Institute
Euro-FOT	European Field Operational Test
FMS	Fleet Management System
GHG	Greenhouse Gas
GNSS	Global Navigation Satellite System
GIS	Geographic Information System
GPS	Global Positioning System
GUI	Graphical User-Interface
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organisation for Standardization
IST	Istognosis Ltd.
ITE	Institute of Transportation Engineers
ITS	Intelligent Transport Systems
IVC	Inter-Vehicle Communications
MAC	Media-Access-Control-Address
MCW-PWD	Ministry of Communication and Works Public Works Department
MyFI	name for wireless routers that act as mobile Wi-Fi hotspots
MP	Motor Power
NEMA	National Electrical Manufacturers Association

NM	Network Management
NMS	Network Management System
NTCIP	National Transportation Communications for IST Protocol
OBC	On Board Computing
OD	Origin-Destination
OSEL	public transport service Nicosia
OSM	Open Street Map
PGN	Parameter Group Numbers
PHP	Hypertext Preprocessor
P2P	Peer-two-Peer
QoS	Quality of Service
RDM	Rich Dictionary Markov Predictor
SVM	Supported Vector Machine
SAE	Society of Automotive
SIDRA-Inst	SIDRA INTERSECTION-Software
SLA	Service Level Agreement
SME	Small and Medium-sised Enterprises
SPN	Suspect Parameter Number
SQL	Structured Query Language
SSD	Solid-State-Drive
STHMM	Spatio-temporal Hidden Markove Model
SUMO	Simulation of Urban Mobility
SVM	Support Vector Machines
TDSP	Time-dependent Shortest Path
TM	Traffic Management

TMS	Traffic Management System
TrainOSE	Hellenic Railways Organisation
TRAIN-TAXI	combination of transportation between a train and taxi for passengers who travel to Thessaloniki
UMTS	Universal Mobile Telecommunications System
UTF	Unicode Transformation Format
UTH	Department of Electrical and Computer Engineering
VEINS	Vehicles in Network Simulation
VISTA	Visual Interactive System for Transport Algorithms
VISUM	Verkehr In Städten – Simulationsmodell (Traffic in cities - simulation model)
VMS	Variable Message Sign
VPN	Virtual Private Network
VSU	Vehicle Sensors Units
VT-Micro	Virginia Tech microscopic emission model
V2I	Among Vehicles and The Centralised Infrastructure
V2V	Between Vehicles
V2X	Vehicle to Infrastructure
WAVE	Wireless Access in Vehicular Environments
WSGI	Web Server Gateway Interface
XML	Extensible Markup Language