REDUCTION
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Deliverable D 7.4 Third periodic report

Jan/2015

D 7.4 Third periodic report

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1.0	Oct/2014	Initial version
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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: 30/10/2014

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 third year of the project (01/09/2013 – 31/08/2014). 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 third 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 and energy consumption 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 and is updated on a regular basis.

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 7.4

Deliverable 7.4 aims at monitoring the progress of tasks and work done in all work packages during the 3rd year of the project. The deliverable also aims at monitoring the expenditure of person months and budget resources during the 3rd 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).

The constant evaluation of risks 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 address them once more during the last year of project life time.

Table 1: Objectives of Deliverable 7.4

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

During the 3rd year of the project life time the focus is based on Task 1.4 (Intelligent V2V and V2I Communication). A further objective is to understand the functionalities of WP1 and integrate these in WP4.

2.1.3 Progress towards the objectives and tasks completed

WP1 for the last year of the project, Task T1.4, focused on closing the investigation of Bluetooth tracing, i.e., two Bluetooth detectors were installed at the beginning and the end of a route. Then, the average travel time could be calculated if the Bluetooth IDs match at the beginning point and the end point of the route. T1.4 also aimed at creating a cooperating scheme, e.g., the communication of Bluetooth detectors with the in-car system or smart phones to give more traffic information or instructions. For their communication, Bluetooth detectors can communicate with Bluetooth devices anywhere within 200 metres. Each Bluetooth device has a worldwide unique address (MAC address); this address is detectable. Approximately 20 to 30 percent of road users can be detected by using the Bluetooth detector, so that the system can receive guaranteed, accurate travel information. The work principle of the Bluetooth detectors is that the system receives a list of detections with Bluetooth MAC address for each measurement point every minute. Then, the system tries to match the MAC address at two measurement points. Once a match is found, travel time for the road user can be calculated.

In this period design, development, testing and reporting had taken place concerning the AccessPoint software object that allows the signing-in and signing-out for individual vehicles. Also the BuildingBlock software object that represents an area and needs to keep track of all vehicles in its area was part of this V2I communication. The StreetWise App, the smartphone App that is the in-car device for individual vehicle information was part of this work, as well as the SmartNode development for detection of Bluetooth devices in vehicles was part of the V2I work being done. These devices and software communication objects are necessary to provide vehicular information like travel time, velocity, CO2 emission and fuel consumption to be accessible by the software architecture developed in WP4.

2.1.4 Deliverables in WP 1 during the 3rd Reporting Period

Deliverable 1.4.2: Test report with communication between the Bluetooth detectors and the in-car systems or smart phones

This deliverable describes the results of the Bluetooth detection system and calculated travel times, compared to the ALPR system. The major finding was that the Bluetooth-based detection system performed reasonably well, especially when there was heavy congestion.

The Bluetooth detection system was developed to detect Bluetooth devices in-car systems or smartphones. A Bluetooth device that sends out his unique ID (MAC-address), can be used to detect the same car passing the first and second detection point, this way, the travel time can be calculated for a route between two or more points. Having accurate travel time is an important part of REDUCTION project, especially in areas where conventional loop detection systems or camera ALPR (Automatic Licence Plate Recognition) systems are not available or too expensive. Together with CO2 emission and fuel consumption, the most eco-friendly rout can be selected.

Traffic congestions are linked to a higher rate of CO2 emission. In order to detect congestions, the real time measurements of travel time could be used to compare to the average travel time on a given road.

When the travel time increased and exceeded the threshold for that road, the TrafficLink system took measures (e.g. rerouting) to reduce CO2 emission in the area.

The test results of the updated BlueTracking system were compared to a quantitative measurement by observing and counting during the field trial.

The big advantage of the SmartNode system as compared to the BlueTracking system is the communication between the SmartNodes. The Smart Nodes can be placed everywhere and only the first (gateway) SmartNode requires an Internet connection. But when the distance between the SmartNodes was greater than 200 metres, the connection was lost and no data is received. The MAC addresses detected by the SmarNodes were not correct and not stable. On the other hand, the updated BlueTracking system worked better and detected all correct MAC addresses in the environment. The test results showed that the BlueTracking system gives a good travel time compared to the real travel time manually measured.

Risk Assessment

By developing a new Bluetooth detection system, there is a risk that the hardware or software is not ready in time. In this case, the company that developed the SmartNodes delivered the system in time, however it didn't work properly. The system wasn't ready for the test, and an alternative plan had to be set up. Due to this reason, there was a delay in D1.4.2.

The alternative plan was to update the previous BlueTracking system and set up the test with this system. The BlueTracking tests and results were as expected and planned. The travel time that this system can provide is well suited for the TrafficLink Management system and integrated easily into the DSS middleware.

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

The objective of WP2 in the year 3 is to develop advanced analytic methods (T2.3) for ecological driving and distributed cooperative optimisation of lane change behaviour on motorways, and more importantly to report empirical evaluations of these methods in terms of potential fuel savings and reduction in energy consumption and GHG emissions.

In terms of Eco-driving, the objectives are:

- to develop methods to determine the impact of driving behaviours on energy consumption and extract fuel efficient driving tips.
- to filter out global factors which affect energy consumption but are not directly related to driving behaviours.
- to detect inefficient driving patterns from the driving data and illustrate the reduction in energy consumption if such driving styles are avoided.
- to determine optimal driving policies which empirically demonstrate potential energy savings.

As an application of distributed data mining algorithms in VANETS, the objective is to develop methods for distributed cooperative optimisation of driving manoeuvres. The first step is to analyse existing state-of-the-art cooperative lane change models and perform an extensive empirical evaluation of these models with common lane change behaviours of drivers on motorways. For this purpose, traffic simulations utilising V2V communication were developed to evaluate distributed cooperative lane change models, based on cumulative travel times, fuel consumption, braking and CO2 emissions

2.2.3 Progress towards the objectives and tasks completed

In the current reporting period, for ecological driving under task T2.3, inefficient driving patterns were identified from driving data in the form of GPS time series. Particularly, driving behaviour data from trains of TrainOSE Greece was analysed with respect to energy consumption. A clustering technique was developed to group similar behaviours along a particular railway segment. For each of these behaviour clusters, impact on energy and GHG emissions was visualised. Optimal driving policies resulting in minimum energy consumption were found using a novel non-convex optimisation algorithm. Also the fuel and energy savings were illustrated empirically and visually. Chapter 3 of deliverable D2.3.2 describes the details of these methods. Secondly, state-of-the-art cooperative lane change models were analysed as a first step to design distributed cooperative optimisation of lane change manoeuvres. Traffic simulations were developed using standard simulators (SUMO, OMNeT++) incorporating V2V communication using DSRC protocols. The presented lane change models were evaluated for fuel efficiency, travel times, overall braking, and number of lane changes as a measure of driving discomfort. Chapter 4 of deliverable D2.3.2 describes the details of these methods.

Details concerning Task 2.3: Advanced prediction 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:

Eco-Driving

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

Distributed Data Mining

1. Development of decentralised algorithms for V2V/V2I decision-making
2. Development of efficient local predictive models which learn from inter-vehicular data
3. Development of broadcasting algorithms for sharing local predictive models with neighbouring peers/vehicles
4. Experiments to validate the gained benefits in terms of improved prediction accuracy and reduced communication cost

<u>Eco-Driving</u>

In terms of ecological driving the considered problem was the analysis of eco-friendliness in train driving (Chapter 3 of D2.3.2). A series of train driving records was collected from the TrainOSE field trial. The trains for which the data were collected have electric engines and the target variable of the analysis is energy consumption (KWh).

In the first step, global factors resulting in high train energy consumption but not directly related to driving styles were identified, for example day/hour/week of travel, railway segment and direction etc. Histogram visualizations of impact of these global factors on energy consumption were presented. From these visualizations, it could be concluded that the differences in terms of fuel consumption within the recorded data were not due to any recorded global factor. Such a finding is indicative for the goal of this WP because it hints that the differences are mainly due to varying driving styles. Section 3.3 of D2.3.2 describes the details of these findings.

In the second step, methods to identify and localize inefficient driving patterns were devised. For this purpose, the railway segment was chosen which exhibited the highest variance in terms of measured energy consumption, reflecting considerable differences between driving behaviours in that segment. To understand the impact of driving styles on energy consumption, the velocity series of the chosen segment were divided into clusters of similar behaviours, using K-Means clustering algorithm. The clusters made the distinction between fuel economical behaviours and fuel inefficient styles, very obvious.

Finally, optimal driving policies for train drivers of TrainOSE were identified by finding the answer to the question: "While driving between arbitrary departure and arrival station, what is the best velocity/speed a train driver should have at every distance point (e.g. at each kilometre stone)?" Particularly, the proposed method mines through all the velocity series and the instantaneous energy series, in order to compute the best driving policy, i.e. the series that has the minimum energy consumption. For this purpose, a non-convex optimisation method named Simulated Annealing was used. Details of this method are presented in section 3.5 of D2.3.2.

Distributed Data Mining

For the second part of task T2.3, cooperative lane change models were analysed to design distributed cooperative optimisation of driving manoeuvres in VANETS. Specifically, the effect of coordination among communicating vehicles was analysed during lane change manoeuvres, on the traffic flow management. The approach of analysis was different in the sense that it focused on the cumulative effects of lane changing manoeuvres such as overall traffic delays, braking, fuel/CO2 emissions and the number of lane changes.

To develop a distributed cooperative lane change assistant for connected vehicles and evaluate state-of-the-art, the cooperative lane change model MOBIL (Minimising Overall Braking Induced by Lane Changes), was evaluated with respect to the common driver behaviours during lane changing manoeuvres on motorways as studied by German Aerospace Centre DLR. MOBIL is a cooperative lane change model for microscopic car-following models and allows lane changes only if they increase the sum of accelerations of all the involved vehicles i.e. the current vehicle and its old and new followers. On the other hand, common lane changing behaviours of drivers on multi-lane freeways reflect their response to neighbouring vehicles in the vicinity in the manoeuvres of passing and overtaking slow leaders or giving lanes to faster followers. Details of these models are presented in section 4.3 of D2.3.2

Empirical evaluations of these models were performed by developing traffic simulations using standard simulators (SUMO, OMNeT++) incorporating V2V communication using DSRC protocols. Evaluation metrics included average delay, total braking, number of lane changes, fuel consumption, CO2 emissions, average time of driving at preferred speed, the effect of different levels of cooperation and performance analysis with a percentage of vehicles using MOBIL and the others exhibiting common lane change behaviour.

Major Findings

In terms of ecological driving, the optimal driving policy discovered using the novel methods improved the energy consumption of the best (minimum) recorded series by up to 31%. In case an average driver would follow the suggested optimal (yet realistic) velocity policy, the overall consumption could potentially be reduced to approximately 50%.

For distributed cooperative lane change models, it was identified that MOBIL keeps its promise of reducing overall braking in the European type asymmetric traffic. It lets vehicles drive at their desired speeds for a larger time of their travel duration, in comparison to vehicles exhibiting usual cooperative speed gain behaviour. But this performance lift comes at the cost of making large number of frequent lane changes and burning much more fuel with CO2 emissions. However, while exhibiting common lane change behaviours, drivers only react to the local situation when it occurs. It was concluded that both approaches do not plan ahead or are unable to predict the upcoming traffic situation. This insight provided the project with a basis to develop a distributed and cooperative trajectory based lane change optimisation method.

2.2.4 Deliverables in WP 2 during the 3rd Reporting Period

Deliverable 2.3.1: Progress report on advanced predictive analytic models

This deliverable focuses on reporting the progress accomplished by the REDUCTION project in the contexts of distributed data mining and ecological driving. The scope of the deliverable lies within the Task 2.3 of the second work package, which is responsible for developing state-of-art methodologies. In the light of the objectives, the presented deliverable appropriately answers all the obligations with respect to both the problems of distributed data mining and ecological driving.

Regarding distributed data mining, the development and application of decentralised statistical prediction model on a P2P communication topology was reported. Local models were developed using state-of-art nonlinear classification model and the results of the statistical learning process were broad-casted to the neighbourhood. The share of intelligence contributes significantly to the improvement of local classification accuracy. In addition, the communication costs were kept to feasible levels due to the utilization of compact learning models for broadcasting. Empirical results demonstrated the validity of the results, by demonstrating the efficiency of the decentralised model and its superiority in terms of communication time compared to selected baselines.

Ecological driving was detailed. The detection of inefficient patterns from the fuel consumption perspective was carried by mining the velocity plots of the GPS recordings of vehicles. Local patterns were mined through state-of-art techniques and represented as histograms of symbolic polynomials. Identification of local driving patterns which mostly influence fuel consumption was conducted by utilising fuel estimation models. The patterns which best approximate the estimated fuel consumption were found via a greedy forward search technique. Finally, experiments over the real-life GPS data of the Infati dataset were conducted. The top-most influential driving patterns were found to be sudden accelerations and deceleration, therefore the study empirically proves the hypothesis via the mining of behavioural data.

The progress in detecting ecological driving patterns was achieved by mining trajectory data. Similarly, distributed algorithms were proposed to tackle the decentralisation of local statistical inference.

Furthermore, the project achieved advances **beyond the state-of-the-art** in the fields of eco-driving and distributed data mining. While current eco-driving methods operate on instantaneous data frames of real-time CANBUS signals, REDUCTION developed a more general approach. The proposed method operates off-line using only GPS data trajectories, which are cheaper and more widely present. Moreover, the state-of-the-art data mining methods for V2V networks were further improved with additional reductions in the sizes of the statistical models and the communication cost, by preserving the prediction accuracy.

Risk Assessment

Both sets of methodologies, regarding distributed data mining and Eco-Driving are already implemented and functional. There are no deviations from the objectives of DoW and the time-frames. The synthetic data for the distributed data mining is already generated, while data related to eco-driving is possessed and is expected to be enriched by CTL use-case. Therefore, no deviations are expected in terms of data availability as well.

Deliverable 2.3.2: Report on advanced predictive analytics models

This deliverable presents the progress achieved within the third year of the REDUCTION project, with respect to eco-driving and cooperative vehicle routing. In terms of eco-driving, train driving data which were collected from the TrainOSE field trial of the project (Work Package 5) have been analysed. The aim of the proposed methodologies was to localize inefficient driving behaviours and compare groups of efficient vs inefficient driving styles. An analysis of the potential savings in electrical energy has been conducted, in case the inefficient groups of behaviours would follow the examples of the efficient styles. It could be demonstrated that approximately 10.3 KWh/kilometre of energy could be saved by adapting the driving behaviours. Speaking in green terms, the avoided GHG emission is 2.16 CO_2 kg/kilometre. In addition, a method that computes the theoretically optimal driving policy from a set of recorded driving data was introduced. The procedure involved concatenating optimal segments of driving data and applying a non-convex optimisation method that searches the best concatenation of driving patterns from different drivers, resulting in the minimum energy consumption. It could be shown that in case drivers would follow the theoretically driving optimal policy, then 45-56% of the consumed energy can potentially be saved.

To develop methods of distributed cooperative optimisation of driving manoeuvres, the effect of coordination among communicating vehicles during lane change manoeuvres, on the traffic flow management was analysed. This approach of analysis was different in the sense that the focus was based on the cumulative effects of lane changing manoeuvres such as overall traffic delays, braking, fuel/CO_2 emissions and the number of lane changes. Particularly, in this exploratory study the cooperative lane change model MOBIL with respect to common lane change behaviours of drivers was evaluated. It can be concluded that both approaches do not plan ahead or are unable to predict the road situation in the next 500 metres or 1 kilometre. The findings of this analysis are used in current work on developing a distributed cooperative lane change assistant (DCLCA). Therefore, V2V communication is used in a bit larger road neighbourhood so that vehicles can coordinate to search for their optimal trajectories ahead in time, in such way that optimises the objective function.

<u>Risk Assessment</u>

The progress achieved in the scope of Work Package 2 within the three years of the REDUCTION project has accomplished all the objectives set by the Description of Work. The methodological contributions regarding the predictive analytics models have been reported in the previous Deliverables D2.2 and D2.3.1.

The objectives on personalised travel time (D2.2) have been addressed by proposing a method that learns a latent representation of the sparse 'vehicles-vs-road segments' matrix. The efficiency of the dimensionality reduction in reconstructing the travel time cells of the matrix was empirically demonstrated using the Infati GPS data. In addition, D2.2 proposed finding the eco-driving behaviour using ground-truth CANBUS data. Under the lack of CANBUS data, this problem (in D2.3.1) has been addressed by mining GPS data and estimating the fuel consumption through approximate models that use instantaneous velocity and acceleration. In terms of analysing ecological driving behaviours, the objectives have been fully addressed in D2.3.1 and D2.3.2, where concrete methods and empirical evaluations were conducted for identifying inefficient driving styles and suggesting optimal behaviours. In addition, the distributed vehicle routing problem was addressed (in D2.2, D2.3.1 and D2.3.2) by developing distributed decision-making algorithms and extending the work in terms of cooperative lane-changing manoeuvres.

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 software prototype that can convert vehicle-related data, primarily GPS data, to metrics that capture environmental impact. The prototype must handle very large volumes of data from different types of vehicles and must efficiently compute the multi-modal eco-routes in both real-time and offline modes. In addition, the prototype must be able to report on the temporal evolution of eco-routes, e.g., due to a variety of changes in the transportation infrastructure and its use. The work package will

a) define the interfaces for how vehicles communicate with the server side and with each other,

b) invent and prototype techniques for computing eco-routes,

c) invent and prototype techniques for the validation of eco-routes,

d) design and prototype high-performance data structures and algorithms for the handling of very large volumes of streaming data from the vehicles, and

e) invent and prototype efficient, off-line data mining algorithms capable of monitoring and reporting on the temporal evolution of eco-routes.

2.3.2 Work package objectives for the current reporting period

In WP 3 the consortium sets its focus in the 3rd year of the project on consolidating the techniques developed during the 1st and 2nd year of the project into a unified, final prototype system (Task 3.4). In detail the objective is to design and develop a software prototype that can convert vehicle related data, primarily GPS data, to metrics that capture environmental impact. The prototype must handle very large volumes of data from different types of vehicles and must efficiently compute the multi-modal eco-routes in both real-time and offline modes. In addition, the prototype must be able to report on the temporal evolution of eco-routes, e.g., due to a variety of changes in the transportation infrastructure and its use.

2.3.3 Progress towards the objectives and tasks completed

In this period design, development, testing and reporting have taken place concerning the software objects that play a significant role in the eco-routing part of the Network Management architecture. The Measure object that was being developed in this context takes care of activating measures on actuators like VMS panels, to enable rerouting advices to drivers. Also the Measure Collection object was being developed to activate Measures, based on the actual condition of the road and the vehicular information.

Task 3.4: Prototype Consolidation

Considerable effort on Task 3.4 Prototype Consolidation has been carried out by performing the following actions:

- Further data cleansing in ETL process has been needed due to new types of "dirty data". This is an ongoing task that is quite time consuming. The goal of the data cleansing is to be able to use more and more of the GNSS and CAN bus data received from a wide range of vehicles. Web-interface is constantly being improved and made public available (see http://daisy.aau.dk/its, http://daisy.aau.dk/its/spqdemo, and http://daisy.aau.dk/its/sheaf)

- Tuning for being able to use pgRouting for finding the fastest, shortest, and most-fuel efficient routes. The routing functionality runs directly in the PostgreSQL DBMS. This makes the prototype both more flexible and robust.

- Extension of data warehouse to include several of the fuel and GHG estimates done by other partners in the project.

- Overall major effort is tuning for making the implementation run fast enough to be useful in interactive sessions. This is an ongoing process necessary due to increasing data sizes.

- Extended data warehouse to be able to include electrical vehicle data

- Added support for compression of GNSS trajectory routes and corresponding temporal data.

The following results were developed and implemented for Task 3.4:

1. EcoMark 2.0 is an extension of EcoMark developed in D3.2. It proposed a general framework for assigning eco-weights, so as to enable eco-routing, using GPS trajectories, actual fuel consumption

data, and six instantaneous and five aggregated models that estimate vehicular environmental impact as vehicles traverse road segments.

The application of EcoMark 2.0 indicated that the instantaneous model EMIT and the aggregated model SIDRA-Running are suitable for assigning eco-weights under different circumstances. In contrast, other instantaneous models should not be used for assigning eco-weights, and other aggregated models can be used for assigning eco-weights only under certain circumstances.

2. Stochastic Skyline route planning is a general eco-routing strategy, and it was developed on top of the time-dependent, uncertain eco-weights that were reported in D3.4. This eco-routing strategy takes into account multiple travel costs (i.e., travel distance, travel time, and travel environmental impact), time-dependency (e.g., traffic patterns in peak hours vs. off-peak hours), and uncertainty in the context of driving behaviours (e.g., moderate driving vs. aggressive driving).

   Given a source-destination pair and a trip starting time, the proposal is able to return a set of pareto-optimal eco-routes that consider all travel costs of interest and addresses the challenges due to the time-dependency and driving behaviour uncertainty.

3. A personalised eco-routing strategy was developed on top of the time-dependent, uncertain eco-weights reported in D3.4 as well. Unlike the previously discussed general eco-routing strategy, this strategy takes into account driving behaviours of different drivers. Further, it considers individual driver's preferences at different times. For example, the same driver may take a time-efficient route during peak hours, but may prefer a fuel-efficient route during a weekend trip.

   Such driving preferences were analysed and learned automatically from a driver's past behaviours. Given a source-destination pair, a trip starting time, and a unique driver identification, a single route that best fits the driver's preference at this moment is returned.

4. EcoSky, a prototype system that consolidates techniques developed in Tasks 3.2 to 3.4, was designed. Specifically, EcoSky annotates edges of a road network with time dependent and uncertain eco-weights using GPS data and that provides different types of eco-routing.

Task 3.5: Final versions of prototypes

Nicosia Simulation Study

CTL in cooperation with the University of Texas at Austin Network Modelling Center – external to REDUCTION – developed a new version of the VISTA Dynamic Traffic Assignment software through the introduction of a generalised cost function instead of the original traveling cost that included only travel time and fuel consumption. The cost function is called the E-GC (energy-based generalised cost) for brevity. The E-GC function (equation 1) contains a linear combination of toll costs, travel time costs and energy consumption costs for the proportion of demand in the system that maintains energy-saving objectives in addition to travel time saving objectives. Consider the following functional form:

Equation 1: The E-GC Function

$$GC_E = \alpha_t t + \tau + \alpha_\epsilon \epsilon$$

In the above expression, $\alpha_t, \alpha_\epsilon$ are the time factor and energy consumption factor, respectively. These factors assign a monetary value to the metrics of time and energy consumption and indicate their share in the generalised cost of travel where $t, \tau,$ and ϵ are the actual magnitudes of travel time, tolls and energy consumption over a trip. For eco-routed vehicles in the system, the values of the energy consumption factor was higher compared to the travel time factor indicating higher expected trip costs associated with energy and environmental impacts as opposed to travel times. A multi-class vehicle fleet based approach where the eco-routed vehicles are a constituent class were used in the study.

The function defined in equation 2, based on work by Gardner et al.[2], was used in this study to compute energy consumption based on average link speed. This model was chosen because it based on link speed, which is readily available from DTA model results. The model is consistent with the results of MOVES.

Equation 2: Energy Consumption

$$E\left(kW\frac{h}{mi}\right) = 14.58\ s^{-0.6253}$$

where E is energy consumption and s is average link speed in mph.

This change in the VISTA DTA made it a remarkably more flexible software to handle multiple classes of vehicles. The previous version of VISTA as implemented under REDUCTION required the sequential running of the model first allocating the users who utilize travel time as their travel cost and then allocating the fuel consumption conscious users. Now this is accomplished seamlessly using the generalised cost function. The software was also modified to allow for an easier allocation of the demand – by allocating a certain percentage to fuel conscious drivers and the remaining to the travel time conscious drivers.

The main results obtained were: 1) The network has benefited as a whole (reduction in fuel consumption and travel time) – albeit by a small percentage ranging from 2 to 3% - by changing the drivers from travel-time conscious to fuel-consumption conscious in both transport networks tested, the greater Nicosia region and the Austin, Texas downtown network; 2) These results indicated a solution that moves closer to a system optimal solution – where drivers are forced to follow specific routes in an optimal manner to minimise the total travel cost and/or fuel consumption of the network; 3) The two networks showed that they move towards convergence from iteration to iteration indicating that the two-objective model developed potentially moves to a local Dynamic User

[2] Gardner, L. M., Duell, M., Waller, S.T. 2013. A framework for evaluating the role of electric vehicles in transportation network infrastructure under travel demand variability. Transportation Research Part A, Vol. 49, pp. 76-90.

equilibrium. This result is a motivation for further analysis and testing of other transport networks to develop a more robust set of tests to indicate whether indeed this is true or not.

2.3.4 Deliverables in WP 3 during the 3rd Reporting Period

Deliverable 3.4: Prototype of advanced high-performance eco-route methods

Reduction in GHG emissions from road transportation calls for effective eco-routing, and road network graphs where all edges are annotated with accurate weights that capture environmental costs, e.g., fuel usage or GHG emissions, are needed for eco-routing. However, such weights are not always readily available for a road network.

Deliverable D3.4 describes advanced eco-routing techniques developed and implemented to solve task "T3.3 Advanced Eco-Routing Methods of WP3". In this deliverable, techniques to derive eco-weights for a road network have been studied and proposed. With the eco-weights, existing route algorithms can be employed to compute eco-routes for any given source-destination pairs. In particular, it has been studied (1) how to assign time-dependent, uncertain eco-weights to road segments that are covered by sufficient GPS records; (2) how to update uncertain eco-weights as real-time GPS data streams in; (3) how to assign time-dependent eco-weights to road segments that are uncovered or insufficiently covered by GPS records.

The proposed methods were evaluated using a large GPS data set collected in Denmark. The experimental results indicated that these new methods are effective, efficient, and scalable up to country-level road networks. This suggests that the objectives of D3.4, which includes (1) to develop efficient eco-routing algorithms, (2) to develop scalable eco-routing algorithms, and (3) to conduct extensive experimental evaluations, have been fully achieved. Further, the proposed methods have been partially used as part of a prototype system developed by AAU and AU.

All objectives of the deliverable were fully met. Deliverable D3.4 has significantly improved state-of-the-art approaches. First, the **state-of-the-art approaches** are only able to assign deterministic eco-weights, while D3.4 describes a method that is able to assign uncertain eco-weights, which provides much detailed information on GHG emissions; Second, the state-of-the-art approaches are unable to update eco-weights, while D3.4 provides a method that is able to update eco-weights as real-time GPS data streams in; Third, the state-of-the-art approaches are only able to assign eco-weights on road segments covered by sufficient amount of GPS records, while D3.4 offers a method that is able to assign eco-weights to road segments that are uncovered by GPS records. Risk Assessment

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 to record the real fuel consumption on some road segments has been obtained. Additional experiments to compare the fuel consumption estimated by existing models to the fuel recorded by the small amount of CANBus data have been conducted. 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.

Deliverable 3.5: Final versions of prototypes

Reduction of GHG emissions from road transportation can be achieved by effective and efficient eco-routing techniques, where road segments are annotated with eco-weights that accurately quantify environmental impact, e.g., fuel consumption or GHG emissions, as vehicles travel on the road segments.

Deliverable D3.5 describes consolidations and improvements of techniques and prototypes developed in Tasks T3.2 "Basic eco-routing methods" and T3.3 "Advanced eco-routing methods". Several techniques were developed in Tasks T3.2 and T3.3: (1) Road grades that are important for assigning accurate eco-weights were obtained; (2) the utility of vehicular environmental impact models to assigning eco-weights was assessed; (3) given a source and destination pair and a trip starting time, basic eco-routes on a road network where eco-weights are deterministic values and are assigned by the vehicular environmental impact models and GPS trajectories were computed; (4) time-dependent and uncertain eco-weights to road segments in a road network that are covered by a significant number of GPS trajectories were assigned; (5) eco-weights to road segments that are not covered by GPS trajectories using the eco-weights obtained from (4) were annotated; (6) a method for estimating near-future eco-weights as real-time GPS data streams into the system was developed.

In Task T3.4, techniques (2) and (3), based on technique (4), were improved and consolidated all techniques developed in Tasks T3.2 to T3.4 into a prototype system. Specifically, as reported in this deliverable D3.5, the technical improvements include: (a) Assessing the utility of vehicular environmental impact models to assigning eco-weights by actual fuel consumption data; (b) developing a skyline routing method that takes into account travel distance, travel time, and vehicular environmental impact; (c) developing a personalised routing method that recommends a route that best fits a specific driver's driving preferences.

The proposed techniques were evaluated using a large GPS data set collected in Denmark. The experimental results indicated that these new methods are effective, efficient, and scalable up to country-level road networks. This suggests that all the tasks in work package WP3 are completed and all the objectives of deliverables D3.2, D3.4, and D3.5 have been achieved. Deliverable D3.5 has significantly improved the state-of-the-art approaches. The state-of-the-art systems primarily work on a road network that is annotated with time-homogeneous and deterministic weights and do not support personalized routing. D3.5 describes a system that annotates a road network with time-dependent and uncertain eco-weights that are determined primarily based on GPS data and that offers different types of eco-routing based on eco-weights, i.e., basic eco-routing, skyline eco-routing, and personalized eco-routing.

Risk Assessment

The main risk in the work package lies in the difficulty of obtaining actual fuel consumption data on the majority of road segments in Denmark. This may influence the accuracy of eco-weights that quantify the environmental impact as vehicles travel on-road segments, and thus affects the proposed eco-routing techniques.

To compensate for this deficiency, a small amount of data from CAN bus devices that are installed on vehicles have been obtained. The data cover the actual fuel consumption as vehicles travel through some road segments. On the basis of the CAN bus data, EcoMark 2.0 included experiments and found that vehicular environmental impact models are suitable for assigning eco-weights to road segments when GPS trajectories are available. Further, a technique that annotates eco-weights on road segments that are not covered by GPS trajectories using the eco-weights on the road segments that are assigned by vehicular environmental impact models and GPS trajectories has been proposed. All these results allow providing a solid foundation for computing eco-routes for travellers.

Hence, although actual fuel consumption data is not available on all road segments in Denmark, the techniques developed in D3.2, D3.4, and D3.5 have considered and addressed this deficiency. Thus, the accuracy of the proposed eco-routing techniques was enabled even when lacking actual fuel consumption data on the majority of road segments in Denmark.

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

During the 3rd year of the project life time Tasks 4.2, 4.3 and 4.4 are in the main focus.

Requirements on software level for the envisaged final software product are to be collected and the software architecture is to be defined. The software architecture is to be based on the principles of i) publish-subscribe, and ii) distributed middleware. Such architecture provides higher levels of abstraction, hiding the complexity of dealing with a variety of platforms, networks and low-level process communications. Application developers may concentrate only on the current requirements of the software to be developed, and use lower-level services provided by the middleware when necessary.

From feedback of the end users the advanced prototype is supposed to be extended to serve as a near-market-ready end user product. Emphasis is laid on the self-explainable fact.

2.4.3 Progress towards the objectives and tasks completed

Task 4.2: Rapid prototype

The primary focus of Task 4.2 was 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 Nicosia) 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, Nicosia 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 2. Here the shortest, the fastest, and the most fuel-efficient) routes between two points in the Greater Copenhagen, Denmark area are shown. A significant difference between these routes can be seen.

Table 2: 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 1 below:

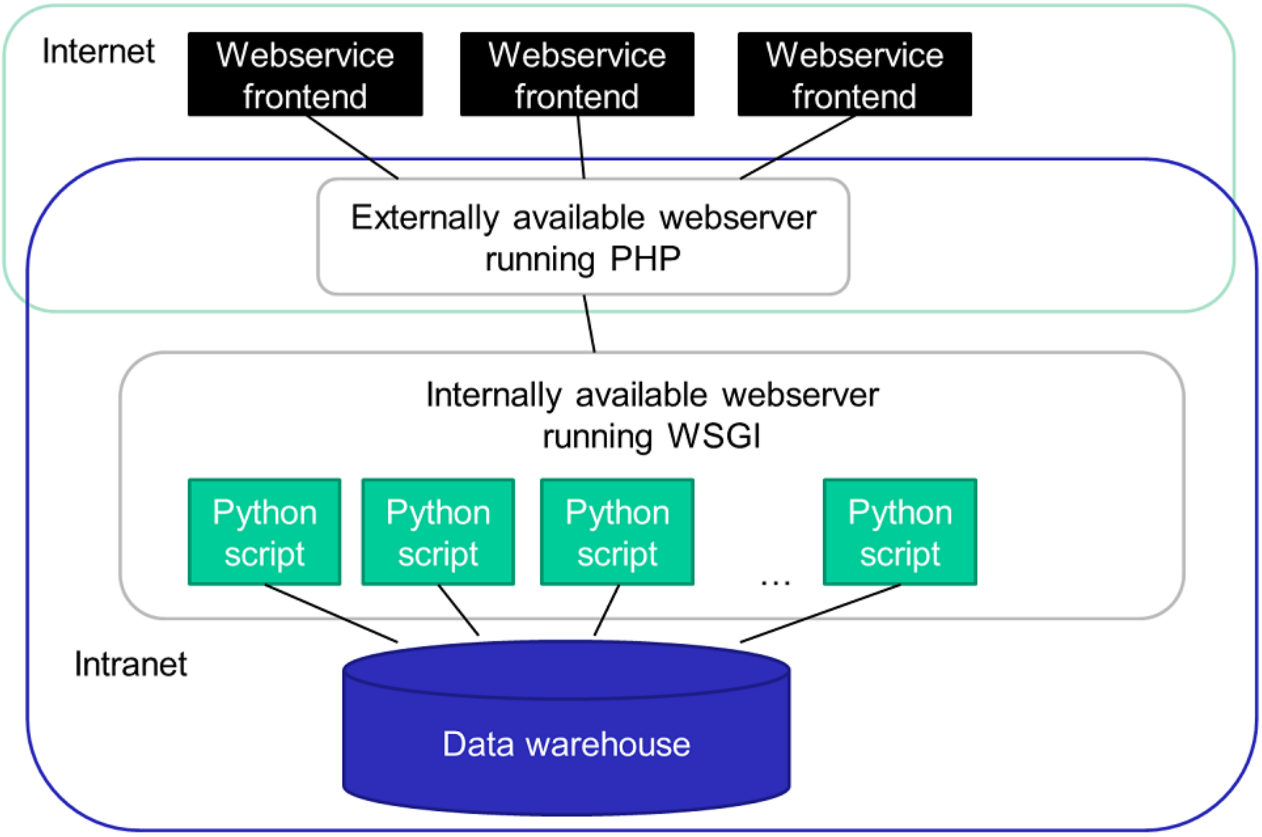

Figure 1: Overview of implementation

There is a subsystem running on the public internet. The clients access 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 1 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 1, 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 1, 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 1.

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 2. 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

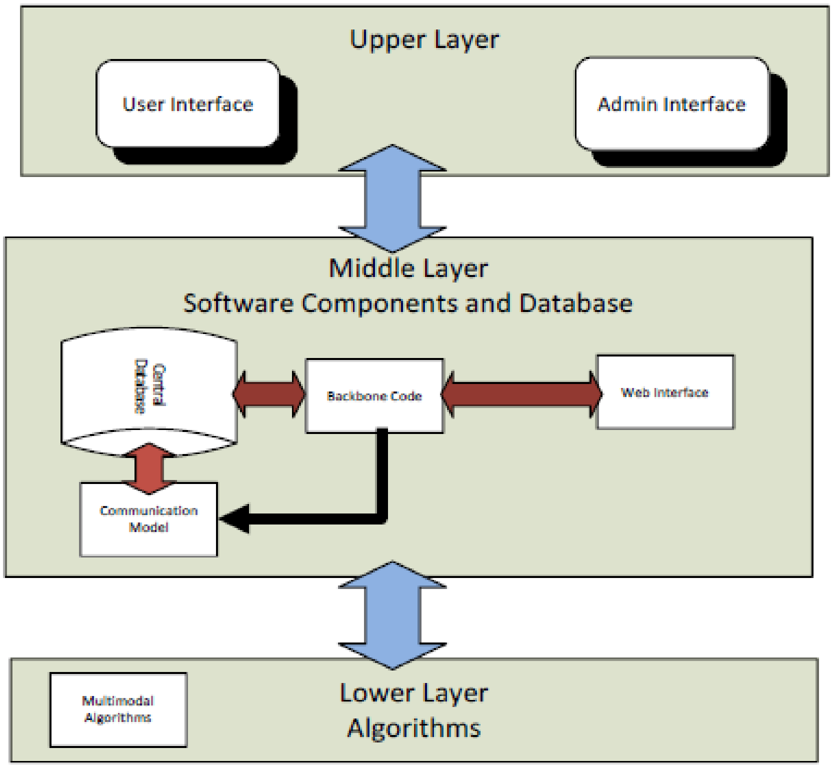

Figure 2: Architectural Layers of TrainOSE's Pilot Software

Nicosia Field Trial: Eco-driving methodologies

The Nicosia field trial focused on exploring aspects of Eco-Driving methodologies described in Work Package 2. 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.

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 3.

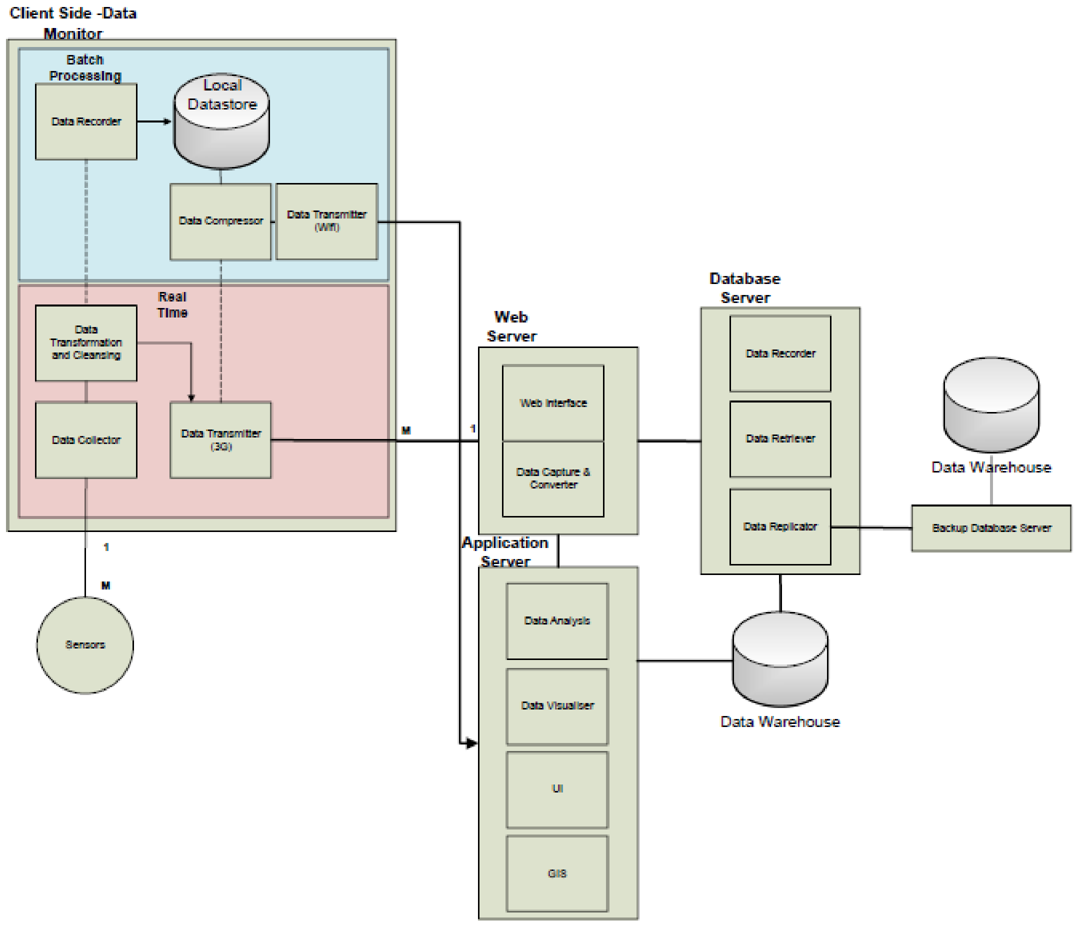

Figure 3: Nicosia Fleet Field Trial System Architecture

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

1. Demonstrate the Delphi Delco Electronics GMBH (DDE) Vehicle to Vehicle and Vehicle to Infrastructure (V2V/V2I) device capabilities – this field test was decided not be done in Nicosia as it was deemed not feasible due to the problems encountered with the V2X OBU devices.

2. Demonstrate a fuel efficiency and/or emissions reduction through a driver bus – OSEL bus company – and delivery fleet monitoring system – CPO delivery company – using the REDUCTION technologies:

   2.1 Read, store and send to a server CANbus data

   2.2 Analyse the driving pattern of fleet drivers (bus and delivery)

   2.3 Develop a fleet drivers' eco-guide to reduce fuel consumption and emissions

   2.4 Validate the drivers' eco-guide at a field trial.

These aspects have been described in detail in deliverable D4.3.

Trinité Field Trial

The Trinité field trial in the scope of REDUCTION was aiming at eco-routing services for individual users. The Trinité field trial was based on TrafficLink's Digital Road Authority and the streetwise App advanced prototype.

The Digital Road Authority was designed from the vision to improve the service to the drivers if all parties (marketing, government and the travellers) combine and tune their travel (information) and intentions. Not so long ago the routing and informing of drivers was primarily a task of the government. This situation changed drastically when navigation systems and apps also advised and informed the drivers. The introduction of these systems/apps has the great advantage that the service to an individual traveller greatly increases. An unfortunate disadvantage to the introduction of these systems/apps was the lack of synergy between all advices.

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, time based demand distribution, truck time window optimal assignment and real time optimal routing.

A platform named "Digital Road Authority" 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 CO_2 emission.

Figure 4 shows the layered architecture of the Digital Road Authority.

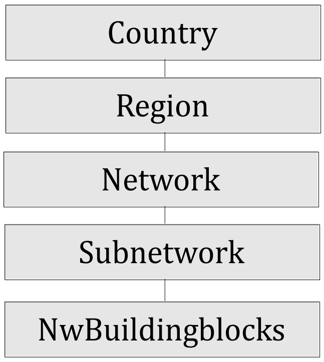

Figure 4: Layered architecture Digital Road Authority

The streetwise app can be used as a Traffic Measure. Controlling the Traffic Measure could be done from all layers in the network structure from the Digital Road Authority. The effect of the Traffic Measure to the App depends on the purpose it serves.

The streetwise app purposes were: Reduction of CO2 emission by optimising driving behaviour, Eco-driving and personalised Eco-routing, time based demand distribution, truck time window optimal assignment and real time optimal routing.

Figure 5 shows the communication architecture developed by Trinité for the mobile device named “Streetwise” and consists of three main parts:

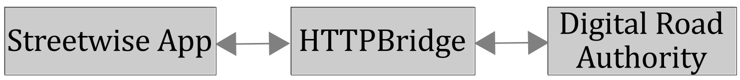

Figure 5: App communication architecture

1. Streetwise app: App designed to use in-car to collect data and inform the user.

2. HTTPBridge: Communication device used to send and receive information between the Streetwise App and there Digital Road Authority.

3. Digital Road Authority: All gathered information is send to the Digital Road Guide to calculate the route information. The outcome is used as a so called Traffic Measure to the App.

<u>Future Work</u>

In the future several points can be examined to improve and extend the system based on the feedback of the end user. This will become part of the market ready product where the time based demand distribution; truck time window optimal assignment and real time optimal routing also play a role.

Task 4.3: Advanced prototype

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

FlexDanmark field trial

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

- Multi-modal using busses and mini-busses/taxis/busses/trains were covered in details.
- Using a set of trips allowed covering a much 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 not covered in the 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.

<u>Changing Modality</u>

The major new item explored in the second FlexDanmark field trial was the multi-modality, which was not supported in the first 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.

<u>Challenges Second Field Trial</u>

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

1 Penalty for changing modality? It was here decided to use a minute penalty per modality change because this reflects the real-world well, where a passenger is typically escorted by an aid when changing modality.

2 How many times can a passenger change modality on a trip? No fixed limit where initially set but if a trip has too many modality changes the operators in warned. In practice, there were never more than two modality changes, e.g. taxi to train and train to taxi.

3 From which modality are switches allowed?

3.1 Taxi→ train → taxi? This clearly makes sense because trains typically can be used for long parts of the journey. In practice, this modality change was used quite often for longer trips.

3.2 Taxi→ bus → taxi? This probably does not make sense because only a bus routes are very long in Denmark. In practice, this modality change where used a few times mostly where express busses are available.

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 can be archived with GNSS data.
- Less discussions with drivers who disagree with the estimated driving time, more objective
- Able to make more accurate calculation of the GHG emissions and fuel consumption using CANBus data.
- In the future reducing GHG-emission based on better routes
- Generally good experiences when it comes to drivers and companies

TrainOSE field trial

The second field trial for TRAINOSE was quite fruitful. Web application came to its completeness. Application was debugged successfully for various problems and enriched with data for entire Greek Territory. All rail stations and main intercity stations included. However, the process is ongoing and data updating takes place every day. Following figure presents web application's home page (figure 6).

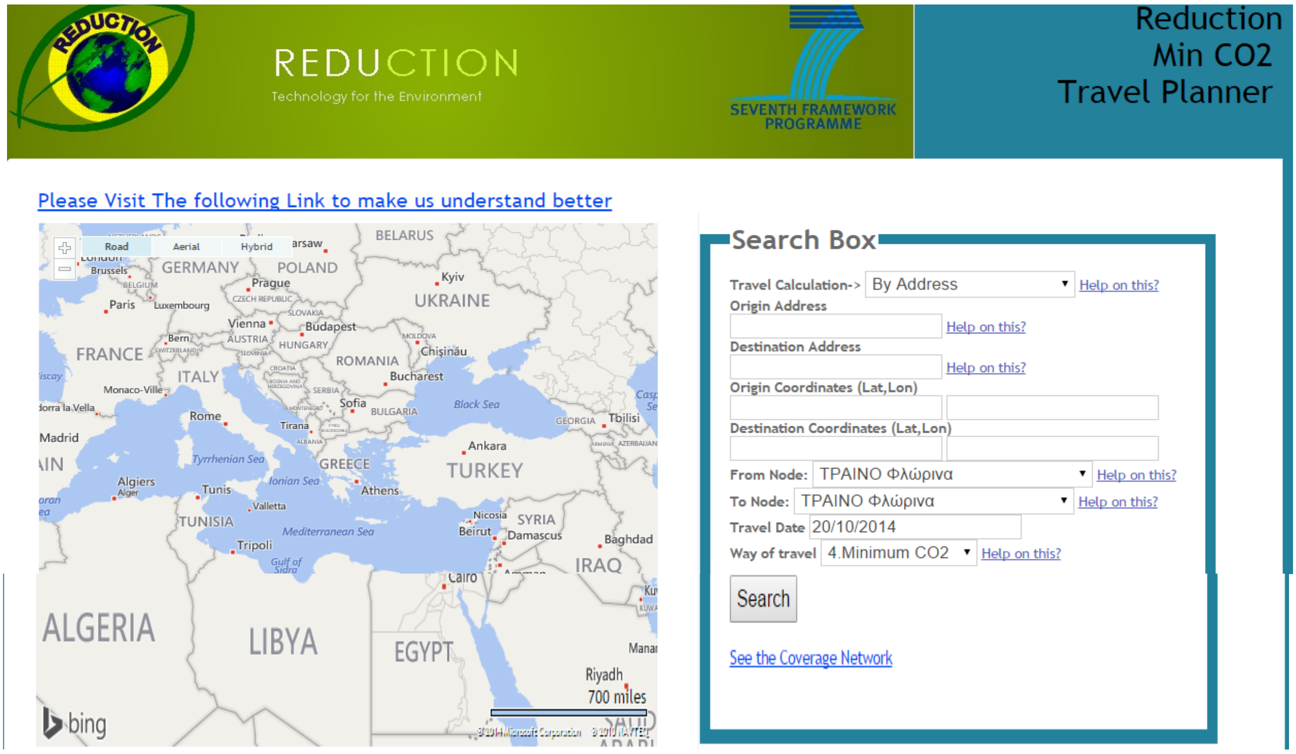

Figure 6: Multimodal Traveling Web Application for Greece

In order to enforce web application usage, TrainOSE, uploaded its entire rail network and trains schedule to Google Maps. This action was quite successful and very promising in terms of multimodal traveling in Greece. Following figure presents TrainOSE trips on google maps (figure 7).

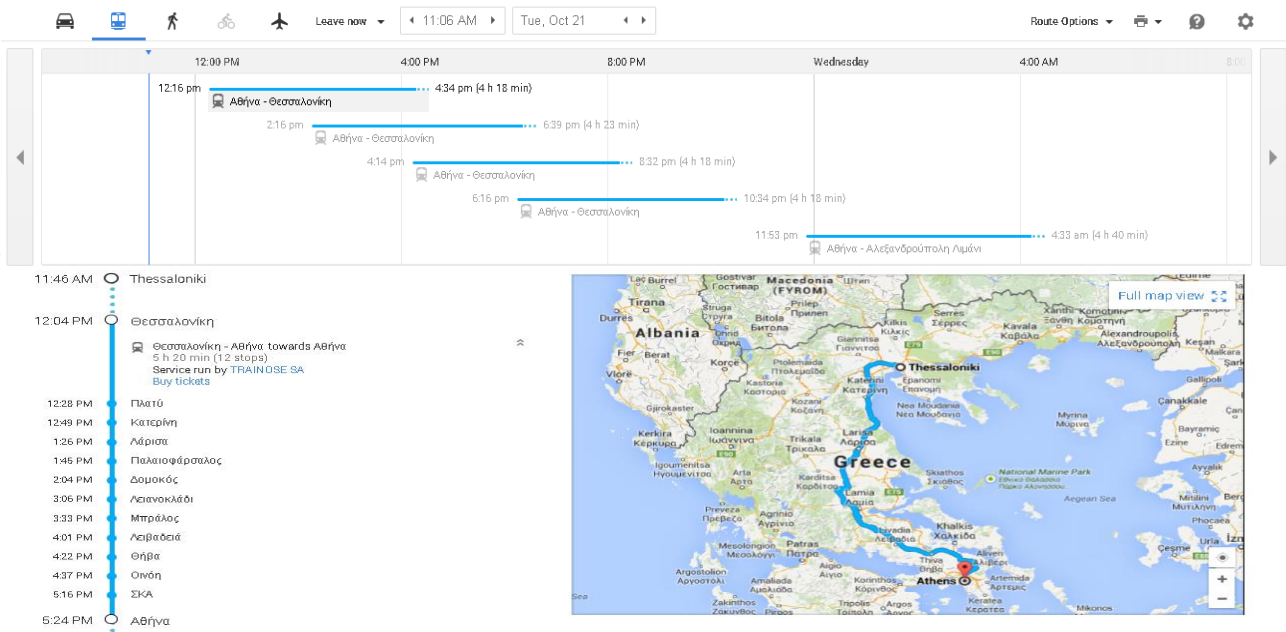

Figure 7: Greek railways on Google Maps

Additionally, TrainOSE, conducted a user survey to get users perception for multimodal trips. Results were quite interesting and presented in short as follows.

- Users' accept the idea of Multimodal ECO driving.
- Users' majority are willing to afford small transfer delays close to 0-10 minutes for more ECO traveling.
- Users' majority are will to afford small additional cost close to 0-10% for more ECO traveling.
- Users' majority are will to afford small additional travel close to 0-10% for more ECO traveling.
- Users' Perception is that ECO Multimodal Traveling can fit Medium – Long trip distances.

Another goal for field trial during the second phase was to promote a unique service related to multimodal traveling by using trains and taxis. Service initiated for the city of Thessaloniki and it was (is) successful. Every traveller who travels to the city of Thessaloniki can use combined train and taxi ride. The innovation behind this service lies to the fact that this service uses “dial-a-ride” routing algorithms in order to optimize (reduce) more that 50% in comparison to original point-to-point taxi rides. Following figure presents Train-Taxi Service (figure 8).

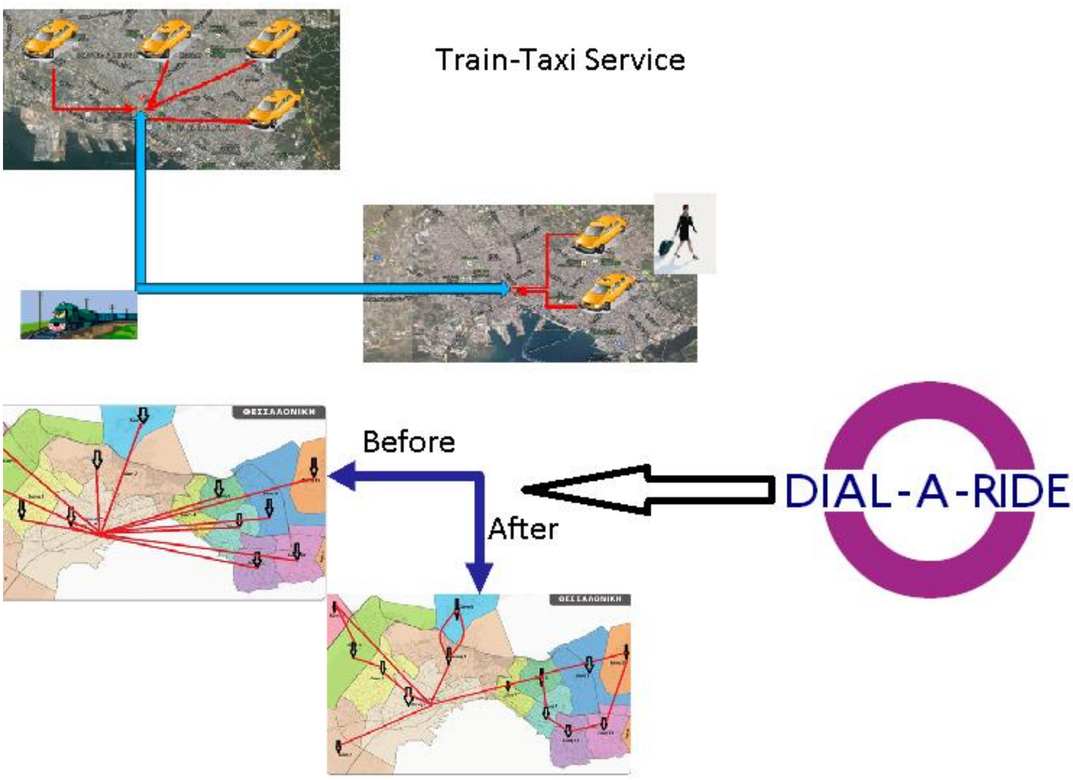

Figure 8: Train-Taxi service

The last accomplished goal in this field trial was a study over the energy consumption for electrified locomotives due to variations in locomotives' driving behaviour. Study took in account hundreds of measurements related to locomotives' energy consumption. Interesting results for driving patterns were revealed after extensive analysis. The final outcome from this study was the ECO-driving manual (figure 9). ECO-driving manual describes in details what is the best (optimal) driving behaviour in order to achieve less energy consumption. Eco-driving manual – through 5 pilots –proved its value when locomotive drivers obey to proposed eco-friendly driving behaviour.

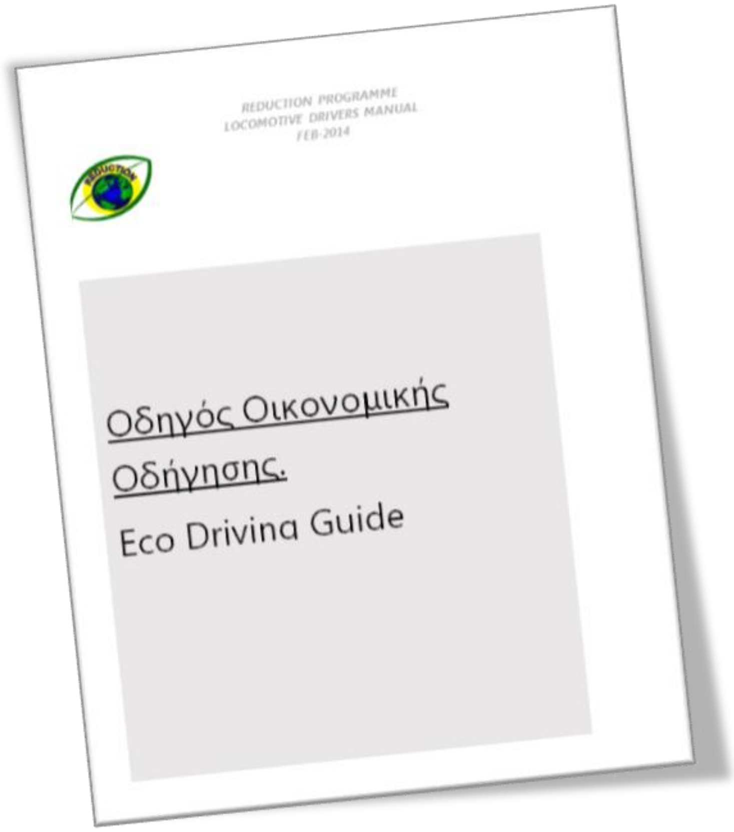

Figure 9: Eco-Driving manual for Trainose's electrified locomotives

Future Work

- Data enrichment process for the multimodal web application.
- Making the driving manual part of locomotive drivers formal education.

Nicosia 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 field trial were:

- Demonstrate the Delphi Delco Electronics GMBH (DDE) Vehicle to Vehicle and Vehicle to Infrastructure (V2V/V2I) device capabilities – this field test was decided not be done in Nicosia as it was deemed not feasible due to the problems encountered with the V2X OBU devices.

- Demonstrate a fuel efficiency and/or emissions reduction through a driver bus – OSEL bus company - and delivery fleet monitoring system – CPO delivery company – using the REDUCTION technologies:
  - Read, store and send to a server CANbus data
  - Analyse the driving pattern of fleet drivers (bus and delivery)
  - Develop a fleet drivers' eco-guide to reduce fuel consumption and emissions
  - Validate the drivers' eco-guide at a field trial.

Based on the changes to organisation of the field trial and the involvement of Cyprus Papaellinas Organisation (CPO) as reported in Deliverable 5.2, the Cyprus fleet field trial was expected to be carried out on two different fleet types:

1 The Nicosia OSEL bus driver behaviour field trial was designed to test the capabilities of the DELPHI V2X OBU devices in retrieving CANbus fuel consumption, GHG emissions and GPS vehicle location and speed data, storing them on its solid state disk and disseminating this data remotely to a server for post processing. The bus field trial was conditional on the ability of the V2X OBU devices to read the Citaro Mercedes-Benz CANbus data. Updated status:

   a. A preliminary test that was conducted in March 2013 was not successful in reading the CITARO bus CANbus data.

   b. A second test conducted in late August 2013 was successful and was determined that the V2X OBU could read the data from the Citaro FMS port.

   c. A new software was developed and installed on the V2X OBU.

   d. Various tests were conducted on one bus with the V2X OBU installed. Also various tests were conducted in the lab by CTL. The V2X OBU device could not operate properly under the environment of the Citaro bus as the device was found to stall without having the ability to store data – in some cases some data were stored but nothing significant. The main potential problems that were identified are: the V2X OBU could not handle the high temperatures found in Cyprus; The V2X OBU stalled when the voltage dropped below 11v. Various different configurations were attempted without any resolution. The main changes involved the use of a battery to ensure power supply for a few hours and a protective relay to ensure a voltage of 12v. Finally, DDE managed to redesign the device housing and changed the software, which resulted in a smooth operation of one device for a period of five days – and continuously since then as of the writing of this report.

e. The successful test at the end of August 2014 encouraged DDE and CTL to continue the OSEL bus field trial during fall 2014 and spring 2015, independent from REDUCTION. (The REDUCITON project officially ended at the 31st of August 2014.

2 The Cyprus IST/CPO fleet field trial involved a total of 68 delivery vehicles. The first part of the trial involved the development of fuel efficient driving profiles using the IST/CPO GNSS and fuel consumption data. Data were retrieved for four months from September to December, 2013. CTL retrieved the data from IST and map-matched them to a GIS-link shape file. These data were then sent to UHI for analysis to identify fuel efficient or non-efficient driving patterns. UHI delivered the first analysis which is included in deliverable D5.3 based on the four month long data. The architecture for the IST-CPO remained the same as the previous year.

CTL and IST in cooperation with UHI decided to complete the second part of the IST/CPO field trial during fall 2014 and spring 2015 to examine the impact of the proposed driving profiles of fuel consumption.

Trinité field trial

The Field trial delivered the following improvements based on the results of the field tests:

The Digital Road Authority design and development has been based on a distributed layered architecture using the DSS middleware.

The App in a middleware services that acted as enablers of decentralised algorithms and applications faced with the difficult task of sharing real-time streams of UTF mission-critical data and information over intermittently connected vehicular networks. Following REDUCTION's decentralised computing approach, this middleware platform service components have been distributed on vehicles to tackle the real-time data movement needs of the overlaid analysis algorithms and applications. In addition, the platform 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 Digital Road Authority used the real-time information to calculate the most economic and Eco-friendly route. Since the Digital Road Authority also communicated with neighbouring Digital Road Authorities, passing route information that could be shared in order to optimise the network.

Information to App or devices was only shared when the area was matching.

Bluetooth tracking could be used to determine travel time and travel behaviour for origin destination patterns.

The standards DVM Exchange and DatexII could be used to communicate with external devices or management systems and were extended with the information fields needed for REDUCTION.

An installation and test was done for the Digital Road Authority. It had the configuration for the Amsterdam environment with as top layer the city of Amsterdam with Subnetworks and NetworkBuildingblocks.

A manual was delivered and an instruction was given to qualify for testing and evaluating the system.

A new design was made for the App in order to meet the user feedback. The new user interface will be part of the market ready software product and part of the installation in October 2014.

For the field trials Trinité established contact with the city of Amsterdam in order to use their extensive CO2 sniffer network. Amsterdam has been measuring CO2 and particulate values over a long period of time on the selected route (Jan van Galenstraat). The access to both actual and historic data was of great use to measure the effect of the field trial.

Task 4.4: Market-ready software product

Feedback from the end users made it possible to extend the prototype to a market-ready software product.

The end user offered the possibility to deliver the following products purposes:

- time based demand distribution,
- truck time window optimal assignment,
- real-time optimal routing.

Using the Digital Road Authority combined with the three product purposes a market-ready product is now available.

Using DatexII and DVM Exchange enables the possibility to include eco-routing and optimise driving behaviour.

2.4.4 Deliverables in WP 4 during the 3rd Reporting Period

Deliverable 4.3.2: Report on second pilot (to be used for field study 2)

Conclusions for the FlexDanmark field trial

The field trial of FlexDanmark expanded its architecture and geographical areas, based on the results of the first field study. Multi-modality was covered in detail and a larger set of trips, covering larger areas was targeted. The experiments have shown that it is complex to work with CANbus data and that implementation of equipment to monitor the vehicles is not simple. The first field trials have also shown that valuable data could be gained from observing vehicles in operation. The experience of this round was used to expand the number of vehicles and scope of the study in the next trial. The FlexDanmark field trial provides travellers serviced by FlexDanmark to select a route based on travel time, fuel consumption or emissions for taxis only or for multi-modal trips (taxi plus train, taxi plus bus/minibus).

Conclusions for the TrainOSE field trial

TrainOSE for the last phase of the second trial fulfilled the following goals:

1. Finished multimodal web application. However, Data enrichment process is ongoing.

2. Made a survey over the customers in order to get their perceptions over multimodal trip using trains as well.

3. Collected measurements for energy consumption of the electrified locomotives for the route part Domokos-Thessaloniki.

4. Made an initial statistical analysis over these measurements in order to see if there is a basis for improvement.

5. Cooperated with University of Hildesheim for the production of good driving patterns.

6. Prepared a good behaviour driving manual.

7. Put on test the driving manual for five trials and proved that the driving manual when applied gives better results for energy consumption.

8. Presented the driving manual to the locomotive drivers' union.

9. Moved to the next phase, which is to make drivers' manual part of locomotive drivers' formal education.

Conclusions for the Nicosia field trial

The Nicosia field trial was comprised of two parts: 1) The first part involved the utilization of two different fleets to test REDUCTION technologies as: a) Evaluate the performance of the DDE V2X OBU devices and develop a set of efficient fuel consumption driving guidelines, b) Develop efficient driving guidelines for the CPO delivery fleet (up to 68 vehicles); and 2) The second part involved the monitoring and reporting of the effect of the efficient driving guidelines developed for both fleets. The following were accomplished until the end of August, 2014 for each of the two fleets: *OSEL bus fleet trial:* The DDE V2X OBU devices exhibited substantial malfunctions that prohibited the collection of data as planned. These malfunctions included shutting down due to voltage drop, high temperature and inability to send data via the 3G wireless system. DDE managed to solve the hardware and software problems by the end of August 2014 and submitted to CTL one redesigned V2x OBU device which operated flawlessly for four days between the 26th and the 31st of August, 2014 – subsequently DDE redesigned two more units during September, 2104 which were installed on the OSEL buses and continued to work flawlessly until the day of this report. During these four days at the end of August 2014, the DDE device recorded CANbus data, stored them on he local memory and sent them to the CTL server thus achieving the hardware/software part of the filed trial. CTL and DDE agreed to continue and complete the field trial by mid-Spring 2015 beyond the official deadline of REDUCTION of August, 2014: Complete the hardware/software testing, develop efficient fuel driving patterns and then monitor/report the impact of the proposed driving patterns on fuel consumption.

CPO delivery fleet field trial: The IST/CPO Nicosia field trial was completed for the first part – the analysis of the driving pattern; which focused on higher speeds at the main freeway sections and sudden acceleration patterns throughout the Nicosia arterial network. In order to complete the trial CTL and UHI will propose these driving patterns to IST/CPO in September 2014 and then monitor/report the impact of the proposed driving patterns on fuel consumption by mid-Spring 2015 beyond the official deadline of REDUCTION of August, 2014. It is expected that the developed methodology – if it is proven to be successful - will be embedded into the existing fleet management system of IST on behalf of CPO.

Conclusions for the Trinité field trial

The first field trial of Trinité showed some drawbacks on the REDUCTION App. The constant communication caused a significant amount of power consumption, selected routes were not user friendly and a lot of data needed to be stored and computed. By adding the Area Traffic Manager to the architecture and in combination with the Digital Road Authority, vehicles could sign in and sign out when they are entering or leaving the area. This architectural change solved the drawbacks from the first field trial and was developed to be used in the second field trial. Also the interface description between the multi modal eco routing, eco driving, prediction and V2V communication system was being defined. This interface description could be implemented to integrate the information of CO_2 emission, fuel consumption, location, speed and travel time into the DSS-Datapool architecture and Traffic Management System of Trinité Automation, TrafficLink. TrafficLink could be used to take active measures on the traffic flow of highways, provincial and urban roads, to reduce the CO_2 emission in the designated areas.

The ATM was installed in the Amsterdam Traffic Control-room. A manual was delivered to the traffic manager and an instruction was given.

For the field trials Trinité established contact with the city of Amsterdam in order to use their extensive CO2 sniffer network. Amsterdam has been measuring CO2 and particulate values over a long period of time on the selected route (Jan van Galenstraat). The access to both actual and historic data was of great use to measure the effect of the field trial.

Future Work

In the future meetings will be established with some major transport enterprises in order to find users for the product.

Usage of the standards DatexII and DVMExchange offers the possibility to communicate on regional level, where network management systems inter-operate to address common traffic challenges. These systems are commonly built, owned and managed by different parties.

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. Some less important functionalities of the architecture are postponed to a second release.

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 OSEL bus field trial could not be completed until August 2014 due to the V2X OBU malfunctions. However, at the end of August, 2014 DDE managed to redesign one V2X OBU unit which was then installed at one bus and worked flawlessly for the final five days of August 2014. The device was able to continuously collect CANbus data, store them in the internal memory and send them to the CTL server via a 3G wireless network. The steps to complete the OSEL bus field trial beyond the August 31st 2014 official REDUCTION deadline are outlined in Table 3.

The IST-CPO fleet field trial was completed for the first part – the analysis of the driving patterns and the development of efficient fuel consumption. In order to complete the second part of the CPO fleet field trial the following steps will be undertaken as outlined in Table 3, outside of REDUCTION.

Table 3: 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.
4.1	Nicosia OSEL field fleet trial	Medium Medium Medium Low Low Low Low Low	30/9/14 – DDE will redesign 4 additional V2X OBU devices; it is noted that not all devices may be reconfigurable. The field trial will continue with the functioning devices. 18/10/14 – CTL will install the newly redesigned devices on four additional OSEL buses. The redesigned devices may malfunction. If none ready then CTL will wait for DDE to fix them for up to three more months. Schedule will be adjusted accordingly in case the devices are not ready by the end of September. 20/12/14 – CTL will gather CANbus data from the devices. Any malfunctions cannot be foreseen now due to previous experience. 19/1/15 – CTL will map-match the data and send them to UHI for analysis. If the devices function properly then the map-matching poses low risk. 14/2/15 – UHI/CTL will produce the fuel consumption driving profiles. Subject to the availability of data this procedure has been matured by the UHI and poses low risk. 21/2/15 – CTL will submit to OSEL the fuel consumption driving guidelines after consultation with UHI. 21/2 - 21/3/15 – CTL will gather/analyse the data from the devices in cooperation with DDE and UHI. 31/3/15 – CTL will issue the Final Report on the OSEL bus field trial in cooperation with DDE and UHI.
4.2	Nicosia IST/CPO fleet field	Low	30/9/2014 - CTL will submit the fuel consumption driving guidelines to IST/CPO.

	trial	Low Low Low	31/12/2014 – IST will reconfigure the fleet management system software parameters to incorporate the proposed parameters (high speed, high acceleration) into the FMS system for automated reporting without distracting the drivers. 19/1 - 14/2/15 – CTL will gather/analyse the data from the devices in cooperation with IST and UHI. 31/3/15 – CTL will issue the Final Report on the IST/CPO fleet field trial in cooperation with IST and UHI.

Deliverable 4.4: Market-ready product

D4.4 describes the market-ready products based on the advanced prototype from D4.3. REDUCTION developed several market-ready products, as each commercial partner has specified their market-ready product(s) for their specific organisation.

Trinité products

The Trinité participation in the REDUCTION project resulted in the products the Digital Road Authority and the Streetwise App.

The Digital Road Authority has been designed from the vision to improve the service to the drivers if all parties (marketing, government and the travellers) combine and tune their travel (information) and intentions. The Streetwise App is a tool to prove the functionalities of the Digital Road Authority.

The Digital Road Authority is based on the real-time publish-subscribe distributed middleware with generic functionalities and capability to communicate with different sources using communication standards and is able to integrate the standardised output from the partners, to be used as structure and can integrate to traditional road side equipment and in car devices. The following functions are covered:

- Eco-routing for an origin destination pair App
- Truck time window optimal assignment App
- Time based demand distribution
- Real time optimal routing

Travel time can be the result of the Bluetooth tracking. The measurement information can also be integrated in the Digital Road Authority.

TrainOSE products

TrainOSE's participation in the REDUCTION project resulted in three ready to market products:

- Multimodal Service of TRAIN-TAXI
- Multimodal Traveling Web Application
- Energy reduction method for electrified locomotives

CTL Product

The participation of CTL in the REDUCTION project resulted in the enhancement of the VISTA Dynamic Traffic Assignment (DTA) Traffic Forecasting System to handled multiple objectives (traffic flow and environmental).

The user of the enhanced VISTA will be able to produce estimates of the traffic flow and environmental conditions and conduct a more comprehensive analysis at the network, subnetwork, path and linked level at the desired time period aggregation level. The current enhanced VISTA model with environmental analysis is at the prototype level. The software and models will go through various testing and enhancements to produce a marked ready software version, which is estimated to be completed during 2015. The implementation of the Vista DTA version for real-time operations would require a direct interface data feed with a traffic monitoring system (GNSS, Bluetooth, other traffic flow detectors) and it would also require undergoing various testing and enhancements.

FlexDanmark product

The participation of FlexDanmark in the REDUCTION project resulted in the design of one product.

GNSS-driving times: These have been implemented in 2 out of 5 regions in Denmark and the remaining 3 regions are expected to follow in late 2014 or in 2015.

ECO-routing, driving behaviour measurements: Regarding driver behaviour the problem has been faced that data of specific drivers cannot be stored because of the protection laws in Denmark. Through a small field trial it was at least possible to show that driving behaviour influences the amount of fuel used. So taxi companies are encouraged to look closely at driving behaviour as method of using less fuel because of financial and ecological interest.

Multi-modality calculations and estimations made in this project will be included in a different project FlexDanmark is running, "The Joint Trip".

FlexDanmark does not introduce products to the market, but makes the product available to the owners.

Delphi product

The participation of Delphi in the REDUCTION project resulted in the design of one product: V2X OBU device with V2V/V2I capabilities of CANbus data. Vehicle integration is foreseen in case the C2C/V2X functionality moves into the direction of a commodity product.

2.5 WP5 Case Studies for assessing Energy-Efficiency and CO_2 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 objective of WP5 for the 3rd year of the project is to run the second phase of the field trials (real and simulated ones) and the completion of the first phase. So the main focus during the 3rd year of the REDUCTION project is on a) Task 5.5 (Second phase field trial for BEK), b) Task 5.6 (Second phase field trial for TrainOSE) and c) Task 5.7 (Second phase field trial for CTL). For a) the main goal is to study the scalability of the proposed solutions. For b) it is important to optimise a multimodal transportation scenario along several dimensions. The main issue for c) is the implementation of the Nicosia Cyprus field trial.

2.5.3 Progress towards the objectives and tasks completed

Task 5.3: Phase 1 – Field trial for TrainOSE

The main objectives of the TrainOSE field-trial for Phase-1 were:

a) The development of a web application for multimodal transportation in Greek Territory,

b) The promotion of the Multi-modal Web-application to TrainOSE's users.

Objective a)

Development of the Multi-modal Web application to TrainOSE's users. The basic idea behind the multimodal web application was to offer multimodal transportation services to users by providing a well-designed web site for traveling with minimum CO2 emissions when it is possible. The basic tasks behind the creation of the multimodal web application during the Phase-1 of the field trial was:

1. Definition of the Data Requirements. The Data Requirements dealt with:

   a. Train Schedules. For train schedules, TrainOSE provided access -through web services - to its train schedule data base.

   b. Bus Schedules. For TrainOSE's bus fleet schedules, TrainOSE provided access through specific web services. The private companies' bus schedules were incorporated into the web application after an extensive search through their web sites.

   c. Train and bus Stops. Train stops were provided by TrainOSE. The private companies' bus stops were incorporated after an extensive search through their web sites.

2. Definition of Data collection Methodology.

The data collection methodology was divided into two parts. The first part was the dynamic one, while the second one is the static one.

- (Dynamic) Train Schedules. For train schedules, TrainOSE provided access through specific web services to its train schedule data base.
- (Part Dynamic part Static) Bus Schedules. The TrainOSE bus fleet data were provided the same way as train schedules. However, bus schedules from other private bus companies were gathered in a purely static way.
- (Part Dynamic part Static) Train and bus Stops. The train stops of TrainOSE were represented in a dynamic way. Bus stops related to private bus companies were gathered after extensive search through their web sites.

3. Definition of Architectural Requirements. The basic architectural elements were:

   a. Multimodal algorithms. Multimodal algorithms were based on Multimodal Shortest Path algorithms. These algorithms were using a modified version of Distance metric. The modified distance metric included $CO2$ emissions metrics in order to provide the shortest route in terms of $CO2$ emissions.

   b. Web Application User Interface. The site provides to users the cheapest (in terms of C02 emissions, money, time) multimodal route for traveling from one point to another in Greece by using train, bus and any other public transportation means. The user enters the website and provides as input: i) the origin and destination pair (address, or place or a transportation node or lat/lon), ii) the metric of traveling based on CO2 emissions, iii) the date and time, and iv) the favourite combination of transportation means. As a result the user gets back the full multimodal path with all transportation means involved in this path, including its carbon footprint via the CO2 metric.

Additionally, TrainOSE provided a flexible multimodal service involving train and taxis. This service can be described as follows: Every train passenger can book a ticket for multimodal transportation consisted of train plus a fleet of taxis having a capacity varying from 4 to 7 persons. This service offers to the user a multimodal path; shared taxi/minivan from his/her origin address to the closest train departure point, train to the train arrival point, and taxi/minivan to the user's destination address. The basic idea was to offer the train passengers an attractive offer – through one ticket and discounted taxi fare – such that they could use shared taxis and minivans in comparison to one-person taxi transportation – and consequently reduce the carbon footprint of each train/taxi passenger, TrainOSE and the country. Additionally, dial a ride algorithms were used in order to improve (decrease) the number of "dead" KMs of taxis and minivans fleet.

Objective b)
The promotion of the Multi-modal Web Application to TrainOSE's users.

The first users' wave came after a small promotion campaign of the Multimodal Web Application. The primary means of the campaign were the use of e-mailing (users who book train tickets online were "forced" to input their email address). Through these emails the users were invited to try the web application. These users provided the company with some preliminary findings that helped to further sketch partially their profiles. A set of the retrieved data are provided below (see figure 10-16).

The following figures provide a description of the users in terms of their relation with eco-multimodal traveling (Log file date: 15 Oct 2013, Number of Users: 103):

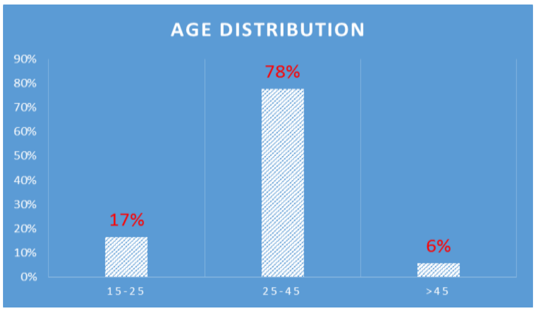

Figure 10: Age Distribution

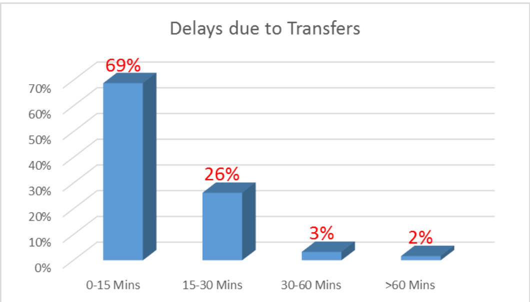

Figure 11: Delays due to Transfers

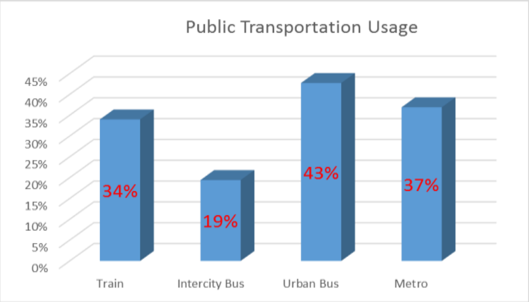

Figure 12: Public Transportation

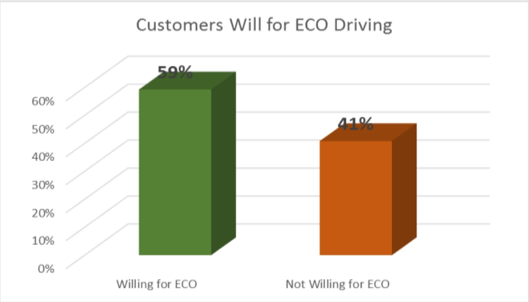

Figure 13: Customers Will for ECO Driving

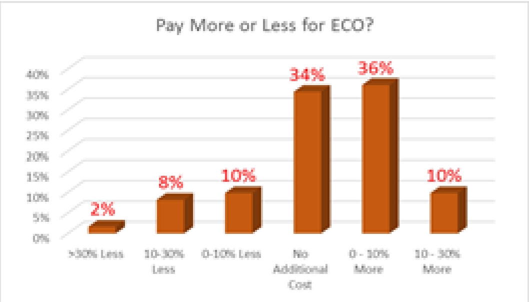

Figure 14: Pay More or Less for ECO?

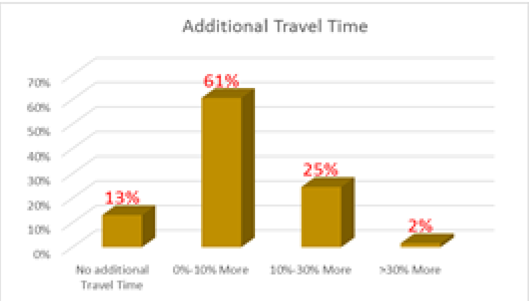

Figure 15: Additional Travel Time

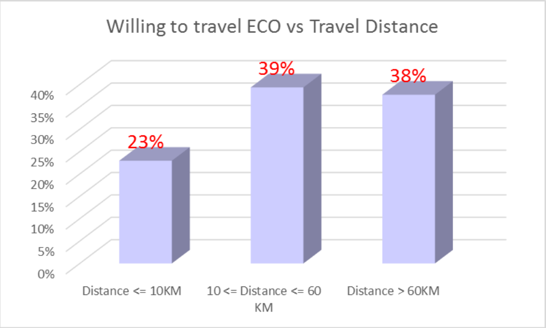

Figure 16: Willing to Travel ECO vs Travel Distance

The main conclusions from the gathered data are:

- Users accept the idea of Multimodal ECO driving.
- Users are willing to afford small transfer delays close to 0-10 min for more ECO traveling.
- Users are willing to afford small additional cost close to 0-10% for more ECO traveling.
- Users are willing to afford small additional travel close to 0-10% for more ECO traveling.
- Users' Perception is that ECO Multimodal Traveling can fit to Medium – Long trip distances.

Task 5.4: Phase 1 – Field trial for CTL

CTL Cyprus Fleet Field Trial: Phase 1 and 2

Main objectives

1. Demonstrate the Delphi Delco Electronics GMBH (DDE) vehicle-to-vehicle and vehicle-to-infrastructure (V2V/V2I) device capabilities

2. Demonstrate a fuel efficiency and/or emissions reduction through a driver bus and delivery fleet monitoring system using the REDUCTION technologies:

- Read, store and send to a server CANbus data
- Analyse the driving pattern of the OSEL bus and CPO fleet driver
- Develop a bus drivers' eco-guide to reduce fuel consumption and emissions
- Validate the drivers' eco-guide at a field trial.

The original fleet trial that would have started in October 2012 has been delayed and started in August 2013 due to:

1) REDUCTION consortium could not reach an agreement with Mercedes-Benz in assisting DDE to read the CANbus data from the Citaro Mercedes-Benz buses operated by OSEL;

2) A diagnostic test conducted on the 6th of March 2013 to read the data by sniffing the data via the wiring system of the OSEL buses was not successful.3) DDE then developed a custom made connector to read the CANBus data through the bus fleet management port. In parallel, it revised the software of the device and a new version was redesigned during summer of 2013. From September 2013 to August 2014 a series of tests were conducted to test the capabilities of the V2X OBU device to read, store and send the CANbus data to a server. Unfortunately the various hardware and software problems of the device could only be resolved by the end of August, 2014 (the official deadline of REDUCTION), see next section for more details on the efforts undertaken to make the device operational. Given this extensive delay, the development of the fuel consumption driving profiles could not be completed in time under the REDUCTION deadline of the 31st of August, 2014. CTL, DDE and UHI agreed to continue and complete the field trial by mid-Spring, 2015 after the official deadline of REDUCTION on their own.

Main changes to the original Nicosia, Cyprus field trial

Given these obstacles, CTL identified one fleet operator company in April 2013 - Cyprus Papaellinas Organisation (CPO) - through their Fleet Management System (FMS) integrator, Istognosis Ltd (IST) that was willing to participate in REDUCTION. CPO was chosen due to the fact that they were getting ready to install their own fleet management system for their fleet that had the capability of extracting CANbus data including GPS location and speed as well as fuel consumption. CTL informed the REDUCTION consortium that this was a potential change in the field trial in the month of May 2013 and provided further assurances at the Volos, Greece meeting on the 9-10th of July 2013. CTL in cooperation with Istognosis Ltd. (IST), the system integrator and operator of the fleet management system for CPO, met with CPO in mid-July and obtained permission to utilize the data that can be collected by the CPO fleet management system to develop fuel efficient driving patterns for their drivers.

Given these changes, the Cyprus fleet field trial was expected to be carried out on two different fleet types:

1) The Nicosia OSEL bus driver behaviour field trial was conducted to test the capabilities of the DELPHI V2X OBU devices in retrieving CANbus fuel consumption, GHG emissions and GPS vehicle location and speed data, storing them on its solid state disk and disseminating this data remotely to a server for post processing. The bus field trial was conditional on the ability of the V2X OBU devices to read the Citaro Mercedes-Benz CANbus data.

- A preliminary test that was conducted in March 2013 was not successful in reading the CITARO bus CANbus data.
- A second test conducted by DDE/CTL in August 2013 determined that it was feasible to read the data from the fleet management port of the Citaro buses. This test involved hooking up to the FMS of the Citaro via a custom made connector – made by DDE – and downloading the data

on a laptop. Therefore, it was decided to continue the test through the OSEL buses and examine the feasibility of obtaining the data either manually at the end of the day or via a 3G connection.

- Subsequently, DDE burned the new software on all five V2X OBU devices which were then installed on five OSEL buses in September, 2013.

2) The Cyprus IST/CPO fleet field trial involved a fleet of up to 68 delivery vehicles from the company CPO with the support of the system integrator IST. The data retrieval from the CPO vehicles started in late July, 2013 and was stored in the IST's server. The data retrieval continued until the end of 2013 and formed the basis for conducting the analysis of the CPO drivers' driving behaviour. It is noted that the data are stored at 10-second time steps due to the limitation of the devices installed in the CPO vehicles.

<u>Obstacles in running the field trial</u>

The Nicosia OSEL bus field trial has been delayed due to the following reasons: OSEL requested that REDUCTION should provide a guarantee that the installation of the DDE devices on the OSEL Citaro Mercedes-Benz buses would not negate the Warranty of the buses. DDE explained that without the cooperation of Mercedes-Benz it would have been difficult if not impossible to be able to read the CANbus data from the Citaro Mercedes-Benz buses. By the end of October 2012 it was decided that such cooperation with Mercedes-Benz is not possible. DDE then informed CTL that there was a possibility that the CANbus data could be read indirectly by "sniffing" them from the bus wiring system. It was therefore agreed to proceed with the test using OSEL buses if OSEL would agree to participate. CTL in November 2013 informed OSEL whether they will participate in the field trial, based on the advice from DDE that the installation and testing of the devices will not be intrusive to their operation. After several discussions, CTL, DDE and OSEL agreed to conduct the "sniffing" diagnostic test in early March, 2013 – the time that all parties were available to do this test.

First OSEL Buses Diagnostic Test at the 6th of March 2013: DDE during this test with the cooperation of OSEL and CTL tried to gather data streams by sniffing data from the bus wiring system. This test was not successful.

Second OSEL Diagnostic Test in late August 2013: The second diagnostic test conducted was successful in reading the data from the FMS of the Citaro bus. It was therefore decided to continue and test the CCU device and examine whether it can read, store the data and send them to the server via a 3G connection under a real environment.

Back-up solution to the OSEL bus field trial, the use of CPO delivery company: Given this setback, in March 2013, CTL and DDE decided that an identification of an alternative fleet to carry out the Nicosia fleet trial as a back-up solution was needed. CTL therefore conducted the following potential participants: 1) Travel Express (an intercity taxi/minivan) company 2) The EMEL Limassol bus company 3) The CPO company - Among others the CPO was selected as the best potential solution since it was ready to install its own fleet management system that included GNSS and fuel data.

IST informed CPO in May 2013 of the desire of CTL to utilize their fleet management system, once installed, for the purposes of REDUCTION and specifically for the development of bus driver profiles using fuel consumption as the main parameter. IST during the months of May, June and July kept on updating CTL on the progress of the installation of the CPO fleet management system. IST also informed CTL in early July that CPO was looking favourably towards a potential cooperation with REDUCTION. Given these assurances, CTL informed the REDUCTION consortium at the Volos, Greece meeting (9-10/7/2013) that an alternative company has been found which could be used for carrying out the fleet field trial regardless of the outcome of the second diagnostic test using the OSEL buses. CTL subsequently met with CPO and IST and received a verbal agreement from CPO at a meeting conducted at the offices of CPO in mid-July, 2013. CTL proceeded to provide final confirmation to DDE that indeed the CPO delivery company as a back-up could be utilised, in case the second diagnostic test using OSEL Citaro Mercedes-Benz buses fails. Since the end of July, 2013, IST started storing the CPO-data from 68 vehicles into its server for analysis by REDUCTION researchers of UHI and CTL.

Given these changes the following tasks have been performed during Year 3 to complete the first phase of the Cyprus OSEL bus fleet field trial: Phase 1 OSEL bus field trial: 1) Developed and installed new V2X OBU software to read, store, and send the data wirelessly to a server via a 3G connection and attached the custom-made FMS port connector; 2) One new redesigned device was installed at one OSEL Citaro bus that successfully read and stored the CANbus data on a laptop computer in August, 2013. 3) The five devices were installed on five OSEL buses for testing during September, 2013; 4) Unfortunately, the devices experienced substantial malfunctions due to high operational temperatures within the compartment where the devices were installed and 3G communication problems – only sporadic data were recorded and the devices were continuously stalling and stopped functioning. DDE with the aid of CTL tried several configurations and eventually at the end of August, 2014 managed to redesign one device that performed flawlessly for a period of five days – and continued to work flawlessly since then - until the 31st of August, 2014 (the official deadline of REDUCTION). Since the official deadline of REDUCTION has been reached, CTL, DDE and UHI decided to complete the field trial beyond the official deadline as outlined in Table 4, which is also repeated here for completeness.

Table 4: Nicosia OSEL bus field trial Phase 2 - schedule beyond REDUCTION

Field Trial	**Risk**	**Schedule**
Nicosia OSEL bus field trial	Medium	30/9/14 – DDE will redesign 4 additional V2X OBU devices; not all devices may be reconfigurable. The field trial will continue with the functioning devices.
	Medium	18/10/14 – CTL will install the newly redesigned devices on four additional OSEL buses. The redesigned devices may malfunction. If none ready then CTL will wait for DDE to fix them for up to three more months. Schedule will be adjusted accordingly in case the devices are not ready by the end of September.
	Medium	20/12/14 – CTL will gather data from the devices. Any malfunctions cannot be foreseen now due to previous experience.
	Low	19/1/15 – CTL will map-match the data and send them to UHI for analysis. If the devices function properly then the

		map-matching poses low risk.
	Low	14/2/15 – UHI/CTL will produce the fuel consumption driving profiles. Subject to the availability of data this procedure has been matured by the UHI and poses low risk.
	Low	21/2/15 – CTL will submit to OSEL the fuel consumption driving guidelines after consultation with UHI.
	Low	21/2 - 21/3/15 – CTL will gather/analyse data from the devices in cooperation with DDE and UHI.
	Low	31/3/15 – CTL will issue the Final Report on the OSEL bus field trial in cooperation with DDE and UHI.

Phase 1 IST/CPO fleet field trial: 1) Retrieved and stored the data from the CPO 68-vehicle fleet; 2) Map-matched the data to a GIS-link shape file; 3) Analysed the data to produce fuel efficient and non-efficient drivers' driving profiles; 6) Developed guidelines (high speed, high acceleration) to CPO management to reduce fuel consumption based on the results of the analysis. The schedule for the second part (Phase 2) of the IST/CPO field trial is outlined below in Table 5:

Table 5: IST/CPO Phase 2 – Schedule to complete the field trial beyond REDUCTION

Field Trial	**Risk**	**Schedule**
Nicosia IST/CPO fleet field trial	Low	30/9/2014 - CTL will submit the fuel consumption driving guidelines to IST/CPO.
	Low	31/12/2014 – IST will reconfigure the fleet management system software parameters to incorporate the proposed parameters (high speed, high acceleration) into the system for automated reporting.
	Low	19/1 - 14/2/15 – CTL will gather/analyse the data from the devices in cooperation with IST and UHI.
	Low	31/3/15 – CTL will issue the Final Report on the IST/CPO fleet field trial in cooperation with IST and UHI.

Field Trials in Phase 2

Task 5.5: Phase 2 – Field trial for BEK

Main objectives

The scalability test must cover the following issues:

- that the new data structures can be updated within the time intervals available,
- that the memory consumption of the data structure scale as expected when real-world data is used (of special interest is if redundant or outdated data is found and eliminated),
- that the data-mining algorithms a capable of finding and reporting on the temporal evolution of eco-routes in an efficient manner on both real-world data set and workload (queries).

Main activities

The main contribution of the second field trial at FlexDanmark was the addition of the multimodal transport support to the prototype developed from WP3 and testing the benefits and drawbacks of multi-modal transport on a very large set of real-world trips. During the field trial there have been a number of challenges (e.g. the bus and train route information was not available). Therefore, a number of bus train routes have been added manually. In addition, detailed information of the fuel consumption and CO2 emissions on bus and trains was not available. Therefore, the fuel consumption was estimated using analytical methods. A study was conducted that compared multi-modal transport to pure taxi transport using 578,907 real-world trips. The study showed that there are significant environmental benefits of using multi-modal transport; e.g. up to an estimated 34.5% reduction in fuel consumption and 27.8% reduction in CO2 emission. The study also showed that there are significant economic benefits of multi-modal transport where the total cost can be reduced by up to 24.5%. However, all these improvements were at the cost of increasing the overall travel time by 50% for FlexDanmark's passengers. The field trial has made a best case assumption that all FlexDanmark's passengers can use public transport such as buses and trains. However, most of the passengers are elderly or disabled. Therefore, the actual environmental and economic improvements were expected to be lower. However, during the field trial all the bus and train routes have not been available to the project. Adding more routes will increase the usage of public transportation, thereby improving the overall multi-modal impact on fuel consumption and GHG emissions.

Task 5.6: Phase 2 – Field trial for TrainOSE

Main objectives

The main objectives of the Phase 2 TrainOSE Field-Trial are:

a. to complete the TrainOSE multimodal web application and to deliver it to the users in a fully operational mode,

b. to improve energy consumption of electric locomotives in the main rail line of Greek Rail Network,

c. to produce guidelines for ECO-Driving behaviour for locomotive drivers.

Main activities

Objective a): To complete the multimodal web application for TrainOSE's users. During Phase 1 the main accomplishments were: Development of the architecture and all basic application elements, including a first prototype. During Phase 2 the web application was completed and became operational. As of September, 2014 the application entered a new phase where continuous data enrichment procedures takes place. The ultimate goal is to incorporate into the web application all intercity bus schedules, all train schedules and all ferry schedules preferably in a dynamic manner – where all bus/train/ferry data are updated under a real-time environment in a robust and timely manner.

Objective b): To improve energy consumption of electric locomotives. TrainOSE took thousands of measurements of locomotives' energy consumption for the main rail line of Domokos-Thessaloniki-Domokos. For each electric locomotive, scheduled to operate the Domokos-Thessaloniki-Domokos line measurements were gathered for 30 consecutive days. These measurements were the main input for the energy consumption study.

Objective c): To construct a TrainOSE ECO-Driving Manual. The ECO-driving manual for locomotive drivers was the final outcome from the energy consumption study. The creation of the driving manual was based on best driving policy findings. The core of this manual is a set of instructions for driving speed, acceleration, and deceleration. The ECO-Driving Manual can be found at Deliverable D5.3-Appendix A.

The Phase-2 of the field trial established the benefits of multi-modal transportation to emissions and fuel reduction. The TrainOSE field trial was implemented along the railway line connecting Athens to Thessaloniki with electric locomotives. The field trial was carried out to achieve the two main objectives: a) To determine the impact of multi-modal trips on fuel consumption and emissions, and b) to determine the impact of the driving patterns of the locomotive drivers on fuel consumption. Under the first objective, a Web application was developed that allows the users to find the (ecological/shortest) trips among cities in Greece. In addition, under the first objective a market-ready product was developed – the "TrenoTaxi", which allows the train passengers to utilize the same train ticket to book a taxi under a taxi-pooling/sharing fashion. Under the second objective, a "good driving policy" manual was developed by analysing field speed data per locomotive driver.

The following table 6 presents a sample of the electric locomotive data that were gathered to develop the "good driving policy" manual:

Table 6: Electric Locomotive Sample Data

DATE/TIME	ODOMETRE	SPEED	CONSUMPTION/KWs
20 Ιαν 2013 10:01:49,4	7190,27	38,30	0
20 Ιαν 2013 10:01:49,5	7190,27	38,35	0
20 Ιαν 2013 10:01:49,6	7190,27	38,41	0
20 Ιαν 2013 10:01:49,8	7190,28	38,52	0
20 Ιαν 2013 10:01:49,8	7190,28	38,52	0
20 Ιαν 2013 10:01:50,0	7190,28	38,62	0
20 Ιαν 2013 10:01:50,3	7190,28	38,78	1
20 Ιαν 2013 10:01:50,5	7190,28	38,88	0
20 Ιαν 2013 10:01:52,7	7190,31	40,03	1
20 Ιαν 2013 10:01:52,9	7190,31	40,13	0
20 Ιαν 2013 10:01:55,1	7190,33	41,27	1
20 Ιαν 2013 10:01:55,3	7190,34	41,38	0
20 Ιαν 2013 10:01:57,4	7190,36	42,47	1
20 Ιαν 2013 10:01:57,6	7190,36	42,57	0
20 Ιαν 2013 10:01:58,5	7190,38	43,04	0
20 Ιαν 2013 10:01:58,6	7190,38	43,09	0
20 Ιαν 2013 10:01:58,6	7190,38	43,09	0

The last column in the above table, defines energy consumption in KWs. The red lines define those points where the locomotive has 1KW consumption. TrainOSE sent all these measurements to the University of Hildesheim (UHI) for further analysis.

The UHI proposed an offline driver behaviour adaptation approach (eco-driving) for trains. An optimal driving behaviour policy was computed using Simulated Annealing optimisation search over a collection of real driving behaviour data (realistic policy).

The Best Driving policy is a combination of the best (more ECO) observed/derived driving patterns based on the method developed by UHI-TrainOSE. It defines in a transparent manner, what is the best driving behaviour for every kilometre along the line DOMOKOS-THESSALONIKI-DOMOKOS.

This resulting method aided TrainOSE to discover hidden patterns related to the locomotive drivers behaviour.

The following figure 17 presents in a graphical representation the best driving policy for the DOMOKOS-THESSALONIKI-DOMOKOS rail line:

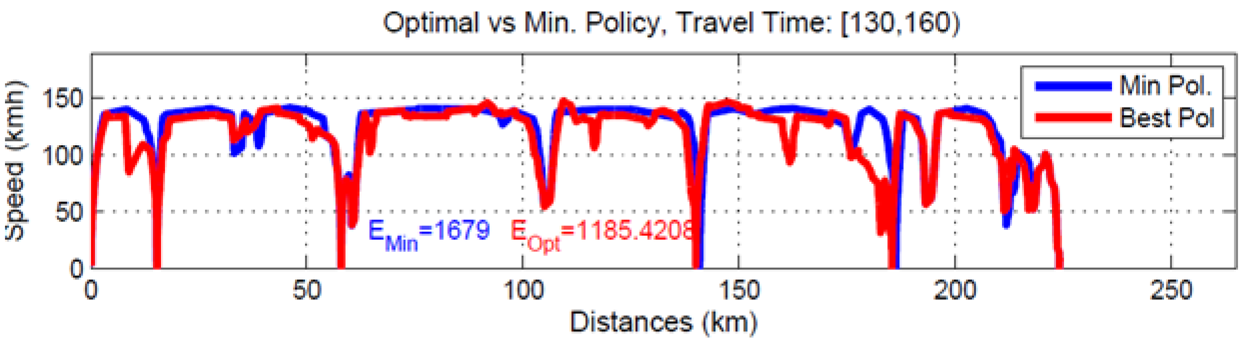

Figure 17: Presentation of best Driving Policy for the DOMOKOS-THESSALONIKI-DOMOKOS rail line

The best driving policy instructions as incorporated into the ECO-Driving Manual is provided below in figure 18:

Action #	Action Description
1	Acceleration FROM:0 Km TO:3 Km to SPEED:125
2	ROLL FROM:3 Km TO:14 Km to SPEED:120
3	Deceleration FROM:14 Km TO:15 Km to SPEED:1
4	Acceleration FROM:15 Km TO:17 Km to SPEED:126
5	ROLL FROM:17 Km TO:56 Km to SPEED:123

6	Deceleration FROM:56 Km TO:58 Km to SPEED:2
7	Acceleration FROM:58 Km TO:62 Km to SPEED:125
8	ROLL FROM:62 Km TO:101 Km to SPEED:126
9	Deceleration FROM:101 Km TO:105 Km to SPEED:49
10	Acceleration FROM:105 Km TO:107 Km to SPEED:126
11	ROLL FROM:107 Km TO:137 Km to SPEED:125
12	Deceleration FROM:137 Km TO:141 Km to SPEED:3
13	Acceleration FROM:141 Km TO:142 Km to SPEED:125
14	ROLL FROM:142 Km TO:183 Km to SPEED:125
15	Deceleration FROM:183 Km TO:185 Km to SPEED:37
16	Acceleration FROM:185 Km TO:186 Km to SPEED:62
17	Deceleration FROM:186 Km TO:186 Km to SPEED:0
18	Acceleration FROM:186 Km TO:189 Km to SPEED:121
19	Deceleration FROM:189 Km TO:192 Km to SPEED:100
20	Deceleration FROM:192 Km TO:194 Km to SPEED:55
21	Acceleration FROM:194 Km TO:195 Km to SPEED:125
22	ROLL FROM:195 Km TO:209 Km to SPEED:126
23	Deceleration FROM:209 Km TO:211 Km to SPEED:50
24	Acceleration FROM:211 Km TO:215 Km to SPEED:107
25	ROLL FROM:215 Km TO:217 Km to SPEED:91
26	Deceleration FROM:217 Km TO:218 Km to SPEED:56
27	ROLL FROM:218 Km TO:219 Km to SPEED:56
28	Acceleration FROM:219 Km TO:221 Km to SPEED:95

29	ROLL FROM:221 Km TO:222 Km to SPEED:80
30	Deceleration FROM:222 Km TO:224 Km to SPEED:3

Figure 18: Best Driving Policy Instruction

Empirical findings showed that, if the locomotive drivers follow the recommended optimal policy, then an energy saving of up to 50% is a realistic upper bound potential.

Task 5.7: Phase 2 – Field trial for CTL

The main contribution of the second field trial by CTL was to develop solutions for mounting the communications hardware to buses and retrieving data relevant to vehicle operation, and also testing the effectiveness of the developed communications protocols. The second phase of the trial established hardware and communication protocol functionality, and also data extraction procedures from moving vehicles. An implementation of the Geonetworking protocol was done in the context of the trial. Also, an investigation of the problems related to mounting the hardware in buses was done, and solutions were developed, unfortunately not able to fully circumvent the problems by the official deadline of REDUCTION. Testing of protocols functionality (Geonetworking) was eventually took place and the effectiveness and efficiency of the implementation was confirmed with a video-streaming application.

In parallel, CTL developed a new two-objective (fuel consumption, travel time) DTA simulation model using a generalized cost function to analyse the impact of eco-prone vehicles (fuel consumption) on traffic flow conditions. The new model was implemented successfully on the Nicosia, Cyprus and the Austin, Texas transport networks and demonstrated its effectiveness in analysing the impact of various types of travellers on traffic flow and fuel consumption conditions.

Nicosia Simulation Study

Main objectives

The main objective of the Nicosia simulation study was to develop a DTA model that will capture both fuel consumption-prone travellers and travel time-prone travellers. This model could then be used to evaluate the impact of such eco-prone travellers on traffic flow conditions. In the Nicosia simulation study the VISTA software was modified to capture this two-objective DTA model and was also applied for comparative purposes to the Austin, Texas transport network.

Main activities

The main innovation implemented in Phase 2 was the introduction of the energy-based generalised cost (E-GC) function. The E-GC function (equation 3) contains a linear combination of toll costs, travel time costs and energy consumption costs for the proportion of demand in the system that maintains energy-saving objectives in addition to travel time saving objectives.

Equation 3: A monetary value to the metrics of time and energy consumption

$$GC_E = \alpha_t t + \tau + \alpha_\varepsilon \epsilon$$

In the above expression, α_t, α_e are the time factor and energy consumption factor, respectively. These factors assign a monetary value to the metrics of time and energy consumption and indicate their share in the generalised cost of travel where the actual magnitudes of travel time are tolls and energy consumption over a trip. A multi-class vehicle fleet based approach where the eco-routed vehicles are a constituent class was used in the study.

The function defined in equation 4, based on work by Gardner et al., was used in this study to compute energy consumption based on average link speed. This model was chosen because it is based on link speed, which is readily available from DTA model results. The model is consistent with the results of MOVES, the US EPA environmental analysis model.

Equation 4: Where E is energy consumption and s is average link speed in mph

$$E\left(kW\frac{h}{mi}\right) = 14.58\ s^{-0.6253}$$

The modified DTA model consists of updating link-based energy tolls at each iteration based on the equations described in the previous section. If the model reaches convergence then a DUE solution is found for each vehicle class - In general this is not guaranteed for DTA models with multiple classes depending on their specific travel costs and the way they choose their paths.

Two networks were considered in the numerical experiments. The downtown Austin TX network (3,109 OD pairs, 1,574 links and 62,836 trips during the AM 2-hour peak period) represents a sub-area of the regional planning model maintained by the Capital Area Metropolitan Planning Organisation (CAMPO).

The developed Nicosia model (26,443 OD pairs, 25,029 links and 58,678 trips during the AM peak hour) was based on the corresponding regional planning model - designed by the Cyprus Public Works Department (CyPWD). Even though both considered networks have a comparable number of trips, Nicosia covers a larger geographic area, and the topology allows that more alternative routes are present in comparison to the Austin network that is smaller and it has a grid structure.

Table 5 presents the transport network system performance metrics for different fractions of eco-routing travellers, once the system is nearing convergence (a set of 20 iterations were used for each network). For the Nicosia network results are presented only up to a 40% penetration level, beyond which the convergence after 20 iterations was not sufficient to permit meaningful comparisons (additional iterations need to be used to reach convergence). The Austin network converged to a near 2% convergence gap while the Nicosia network converged to less than 7% gap. The slower convergence rate in the larger network was probably a consequence of the availability of longer alternative paths which remain relatively uncongested. The results presented in table 7 suggest that the indirect use of speed as part of the objective function (given its direct relationship with energy consumption) may be leading to a solution that is closer to the system-optimum assignment. Such solutions are characterised by a minimization of overall system costs at the expense of some travellers accepting paths which do not minimise their individual travel times (or travel costs).

These results are encouraging, as they suggest that policies and strategies oriented towards minimising energy consumption may actually lead to improved system performance for both eco-prone drivers and travel time-prone drivers (table 7). As it is observed, when all users – at 0% eco-prone market penetration - utilised travel time as their path-choice cost they create a more congested system, whereas if some of them and/or all of them use fuel consumption as their path-choice cost the transport network is benefited.

Table 7: System performance metrics for different fractions of eco-prone travellers

	Austin, TX, USA						Nicosia, Cyprus					
% eco-prone	Total Energy (KWh)	%	Total Travel Time (h)	%	Total Distance Travelled (veh-km)	%	Total Energy (KWh)	%	Total Travel Time (h)	%	Total Distance Travelled (veh-km)	%
0	160358	0.00	3678	0.00	166969	0.00	549058	0.00	14813	0.00	377114	0.00
5	159832	0.33	3664	0.38	166731	0.14	546567	0.45	14581	1.56	376808	0.08
10	159641	0.45	3649	0.81	166824	0.09	545406	0.67	14491	2.17	377567	-0.12
20	159353	0.63	3642	0.98	166472	0.30	543965	0.93	14567	1.66	375437	0.44
40	158296	1.29	3628	1.38	166013	0.57	542775	1.14	14512	2.04	373478	0.96
50	157970	1.49	3614	1.74	165735	0.74	--		--		--	
70	157203	1.97	3597	2.21	165246	1.03	--		--		--	
100	156479	2.42	3604	2.03	164263	1.62	--		--		--	

Conclusions and Future Work

This report discusses the methodology used to model the network-level impact of eco-routing strategies that minimise energy consumption. The modelling approach is appropriate to assess the long-term effects of an increasing number environmentally conscious travellers, by finding dynamic user equilibrium (DUE) conditions in a system with different driver types. This new model upgrades the methodology developed during the first two years which is applicable only for short terms events – where travellers do not have information about changes in the travel paths of other travellers; in the third year the model was expanded to reach DUE solutions - travellers have full information on the traffic flow conditions.

The concept of generalised cost was used to model the preferences of eco-prone drivers, for which a time varying energy toll was defined. Such cost represents the energy consumption on the link based on the corresponding speed, which in turns depends on the prevalent traffic conditions. Methodological modifications to the VISTA DTA software package were implemented in order to appropriately update such costs during the search for equilibrium conditions.

Numerical experiments suggest that the hybrid system converges towards a DUE, and that system-level reductions in energy consumptions were possible at a moderate level between 2 to 3%. Further, results suggested that implementing eco-routing strategies based on minimising energy consumption may actually improve the overall system performance, by reaching an equilibrium state closer to a system-optimal assignment – it was noted here that this equilibrium state differs from the one where all travellers use travel time as their path-choice cost. Such results assume that some drivers are willing to face longer travel times than others.

The future work will concentrate on creating a more comprehensive DTA DUE model for various classes of users, while trying to improve the computational performance of the software which now is rather cumbersome, requiring 1-2 days per scenario:

- Incorporation of other classes of vehicles such as diesel, hybrid, electric and fuel-cell or other category. For example, it is expected that if all vehicles are electric then the final solution will be closer to the 0% eco-prone market penetration leading to a higher system-wide travel time. In this implementation all vehicles have been considered the same, with the same use of gasoline,
- Incorporation of a user category that its path-choice cost is GHG emissions,
- Incorporation of user groups that have a mixed path-choice cost such as fuel consumption and travel time,
- Develop a more comprehensive generalised cost function to cover some or all of the user groups mentioned above,
- Develop an interface between the VISTA traffic simulator to various environmental models,
- Improve the computational performance of the DTA model,
- Develop a real-time traffic simulator to estimate and predict the near future traffic flow and environmental performance measures.

Nicosia OSEL Field Study

Main objectives

The Nicosia OSEL bus field trial's main objectives (see D5.1 and D5.2 for the DDE technology and the tests conducted for the first two years) are to test the capabilities of the V2X OBU devices developed by DDE as an on-board vehicle device:

1. to read and store locally GNSS, fuel consumption and GHG data from the CANbus of OSEL Citaro Mercedes-Benz buses,
2. send the data via V2I using 3G wireless communication to a server, and
3. to develop efficient fuel consumption guidelines for bus drivers.

Main activities

During the first two years DDE and CTL endured a set of institutional issues that made the field trial to be more cumbersome than initially designed. Specifically, during the first year it was found out that it was not possible to get any cooperation from Mercedes-Benz to provide the capability of the devices to communicate with the OSEL Citaro CANbus. Therefore, a custom made solution was devised by DDE with the help of CTL and OSEL – the DDE/CTL team assured OSEL that the DDE devices and the installation does not interfere with the operation of the buses and it does not cause any interference to the drivers. This solution included the development of a connector to the Citaro Fleet Management System (FMS) and the development of software to read the CANbus data through the FMS, which had to be “flashed” on the V2X OBU. The third year of the project DDE and CTL focused on designing several configurations of the V2X OBU devices to connect and operate flawlessly within the OSEL buses. The various tests and configurations that were tried during the OSEL field trial are outlined below.

Sniff the CANbus data from the OSEL Citaro bus using the FMS port: The main outcome of the various efforts that were undertaken during the first phase of the project was to manage to read the CANbus data of the Citaro bus using a custom-made port connector via the fleet management system port (see D5.2). In addition, DDE revised the software and flashed it on the V2X OBU device, which was then installed on the OSEL bus for testing. During the third year most effort was consumed to make the V2X OBU device to operate properly under a real operational environment. In summary, the following efforts were made to make the V2X OBU operational:

- Voltage drop problem - A battery was installed to ensure that the V2X OBU device can still operate in case the power supply is disconnected. During several trials it was found that the device demonstrated voltage drop; the device was not functioning at all when the voltage dropped below 11volts. Initially an on-board 7Ah lead acid battery was installed and then a more powerful one was installed of 25 Ah. In addition, a power relay was installed to keep the device operating at a constant 12 volt.

- 3G connectivity problem – The device stopped functioning when the 3G connection was lost. CTL changed the wireless company from MTN to CYTA, which has a more robust cellular network.

- Temperature potential problem – the device was extremely hot each time the CTL team tried to retrieve it from the bus. DDE redesigned the V2X OBU housing and installed a fan by the end of August, 2014.

- Software problems – These problems related to the inability of the device to keep functioning when the 3G was lost and when the voltage dropped. DDE produced a new version of the V2X OBU software and flashed it on one device by the end of August, 2014.

- Preliminary encouraging result in late August and early September, 2014 – DDE and CTL conducted several two-hour tests using an OSEL bus based on the redesigned V2X OBU device. The new design showed that the unit did not malfunction during the two-hour operation and the data were sent for analysis. In addition, the temperature was kept below 50 Celsius as a result of the new design (new housing and the addition of a cooling fan).

Conclusions and Future Work

The OSEL bus field trial was substantially delayed due to malfunctions of the V2X OBU during the first part of the trial. DDE managed to resolve these malfunctions and resulted in a partial completion of the field trial by the end of August, 2014. Mainly one redesigned device was shown to successfully read, store and disseminate CANbus data to a server via a 3G wireless connection. The completion of the field trial will continue beyond REDUCTION as it was outlined in Table 4 above.

Istognosis (IST) - Costas Papaellinas Organisation (CPO) Fleet Field Study

The main objective of this report was to develop driving profiles for the drivers of the CPO delivery company in Cyprus that operates a fleet of 120 vehicles. Istognosis Ltd., the system integrator of CPO installed and operates the Fleet Management System of the CPO fleet through covering 68 vehicles of the entire fleet. The FMS systems includes a device that connects to the OBD port of each vehicle and a 3G GPS antenna and reads, stores and sends CANbus data to a server on a real-time basis. IST provided to CTL six months of GNSS data for up to 68 vehicles (only these vehicles had installed the FMS system) that were then map-matched to the GIS of Nicosia, Cyprus which was provided by the CyPWD. The map-matched data were also linked to the associated roadway links as defined by the corresponding regional transport model of Nicosia that was developed by CyPWD. UHI then conducted the analysis based on the GNSS map-matched link-based data and developed guidelines based on vehicle speed and acceleration.

The methodology developed by UHI included the following steps: 1) Estimation of the vehicle speed and acceleration/deceleration using the location of a vehicle based on two consecutive time-stamps of GPS data; 2) Input the data into the VT-micro environmental simulator to produce estimates of fuel consumption and GHG emissions; 3) Mining the top inefficient fuel patterns; 4) Clustering the top fuel inefficient patterns (see figures 19, 20, 21). The velocity figure (figure 21) indicates drivers who abuse the speed limit of 100 km/hr (maximum in Cyprus). The maximum acceleration pattern captures drivers both on the freeway and the arterials who tend to have a heavy foot on the petal and they unnecessarily accelerate much more than necessary thus increasing fuel consumption. This study is limited due to the 10-sec time step that the GNSS data were recorded, whereas a one-sec time step would have provided a more detailed analysis of the driving pattern - more accurate acceleration and speed patterns. Any change to the time step was found to be non-feasible as the FMS system installed in the CPO vehicles did not provide any flexibility to change the manufacturer's parameters.

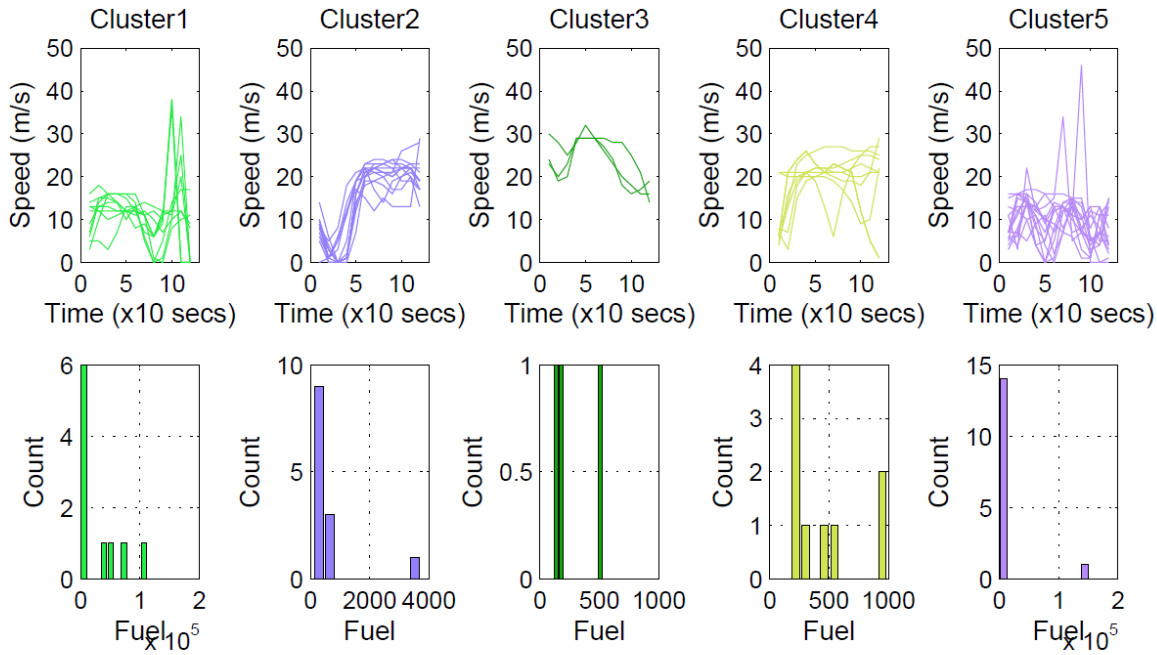

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Figure 19: Clusters within top-50 fuel inefficient patterns

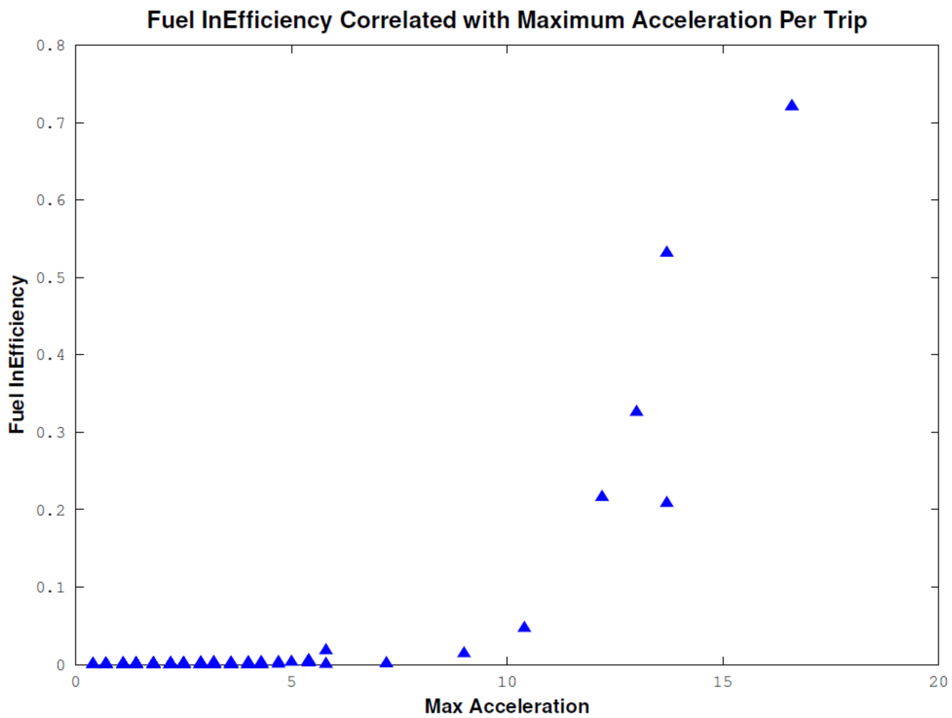

Figure 20: Correlation of Max. Acceleration with Fuel

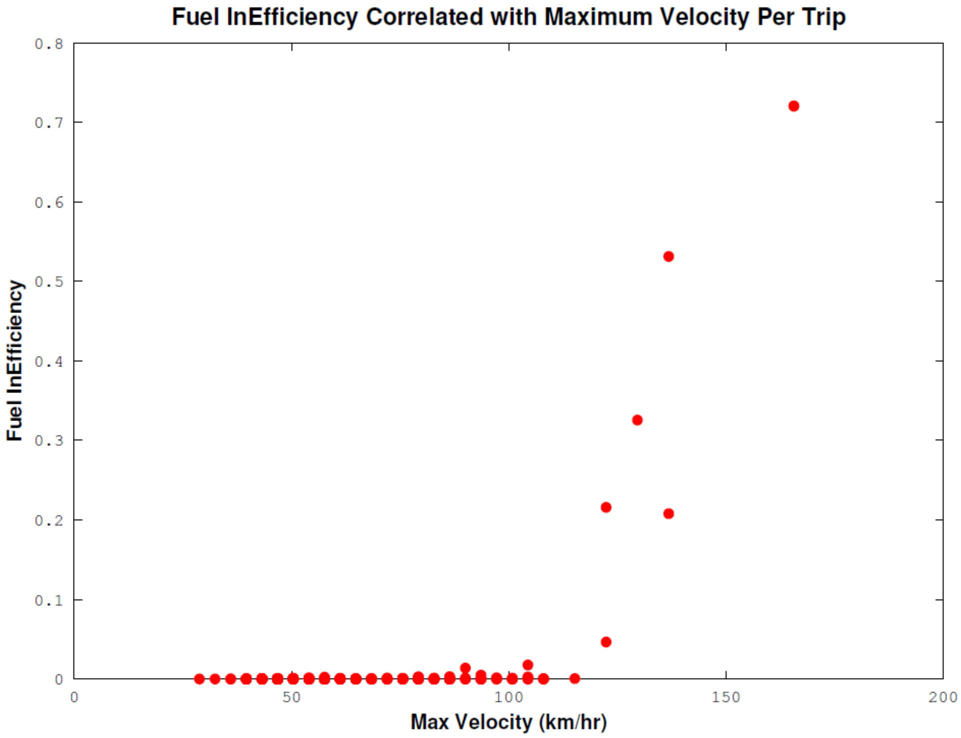

Figure 21: Correlation of Max Velocity with Fuel

<u>Conclusions and Future Work</u>

The main results of the analysis were the identification of driving patterns that were deemed inefficient based on a comparative analysis of the overall driving patterns. These inefficient patterns were identified using the maximum acceleration and maximum velocity versus the corresponding fuel consumption. This concluded the first part of the study which involved the identification of inefficient driving pattern of certain drivers due to acceleration and speed.

The second part will be undertaken during September and October, 2014. CTL and UHI will inform Istognosis Ltd. of the results of the analysis and present the driving patterns that were deemed inefficient. Then CTL and Istognosis will provide a set of guidelines to CPO to present the drivers of their fleet in early September. Then the "after" phase will follow for about 6 weeks. The vehicle data will be reported and analyses on a weekly basis to see whether the drivers are following these guidelines and whether the CPO fleet as a whole and each driver individually have reduced their fuel consumption. The "after" data period will be concluded by the end of October, 2014 and the final results will be ready by the end of November, 2014.

Obstacles in running the field trial: 1) This trial started late in the project (mid-July 2013) and the data were delivered to CTL mid-January, 2014; 2) The data cleaning and map-matching process proved to be more cumbersome than expected as a semi-manual approach had to be followed, which resulted in a mid-June delivery of the clean map-matched data to UHI. UHI then completed the analysis of the data by the end of July, 2014.

2.5.4 Deliverables in WP 5 during the 3rd Reporting Period

Deliverable 5.3: Report on collective evaluation from field-trials in Phase 2

This deliverable documents the methods and results obtained during the second phase of the field trials. It describes multimodal support to the prototype developed by FlexDanmark, the benefits of multi-modal transportation and of efficient driving to fuel consumption reduction in TrainOSE's trial, and the efforts for evaluating hardware and communications protocols as well as mining of vehicle data in the trial run by CTL. Additionally, it describes the steps done by Trinite's trials and the simulated trials by CTL and UTH (see figure 22).

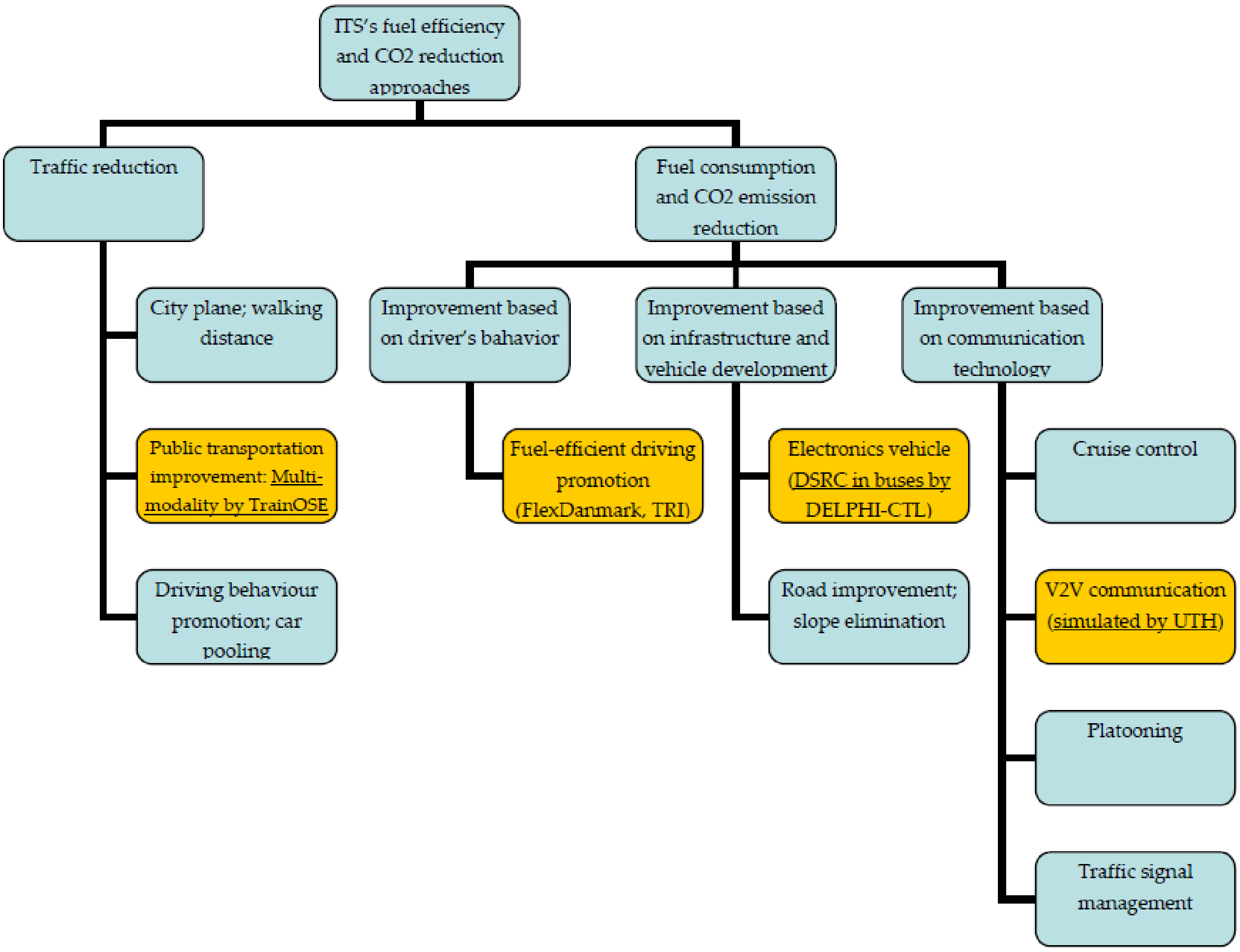

Figure 22: Approaches for ITS fuel efficiency and CO2 emission reduction

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

Task 6.1: Dissemination

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

Next to standard communication activities like developing a logo and a website, the REDUCTION partners participate intensively in various events to broadcast technologies developed and implemented during the project.

Task 6.2: Exploitation

Exploitation of REDUCTION in the past three years and in the future has a broad perspective, because both the three means of the project and the variety of target groups are very different. This is mainly the reason that the consortium decided to compose an Exploitation plan that is split in two parts as outlined in D6.2.3, chapter 10 “Policy and Administrative Issues”. One part is the general marketing plan and the other part is an exploitation plan made by each commercial partner. Due to this decision, the plans resulted in more individually based plans which make it possible to narrow it down to focus areas for each commercial partner.

Unlike the wide variety of target groups and results of REDUCTION, the situation of the market is very similar in participating EU countries. E.g. infrastructure issues are becoming more complex, because of rapid changes in technology, aging infrastructure and climate change issues. 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 to deal with are the increasing competition and associated app builders.

The plans that are carried out and the future plans all address to strengthen the REDUCTION approach and to promote the project outcomes for the promotion and future exploitation of the REDUCTION results towards direct access user services and to the commercialization of these services as well as of the technological products.

Task 6.3: Contribution to standards

This task is coordinated by and involves all participants. The currently available standards are 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 are to be build, wherever possible, upon existing open source/freely available standards. As far as the latter goal is concerned, contributions to standards have arisen by making extensions to existing standards (i.e., Geonetworking protocol) or developing new solutions (i.e., pCoCe protocol).

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 participated in dissemination activities promoting their own findings and results of ongoing research and development.

Within the three years of the project, most results have been available to the public in the form of publications. A significant number of presentations and discussions are carried in the three years, which allows the project to be more aware to the public. Furthermore, some external bodies, e.g., international media, are also involved to discuss the utility of the REDUCTION project. This raises the public awareness of the objectives and the focuses of the REDUCTION project. Meanwhile, the REDUCTION partners have published several papers in prestigious conferences and journals. One paper won the best paper award in MDM 2013, and one paper won the best demo award in MDM 2013. This makes the awareness of the REDUCTION related academic contributions to researchers in related fields.

The task involved dissemination activities of all partners about promoting their findings and results of on-going research and development in the project. In table 12 "Dissemination Activities" events and publications in the area "Public participation and awareness" are listed to make the results of the project available to a public audience.

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

- Logo, website and poster of REDUCTION project.
- Events attended by REDUCTION partners, where the partners disseminated information of REDUCTION project and discussed results of REDUCTION project.
- Publications produced by REDUCTION partners that reported available results to conferences,

workshops, journals, newspapers, etc.

- Formal presentations performed by REDUCTION partners that presented available results to international conferences and workshops.

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

Project Website

The project website was developed before the kick-off meeting, and is updated on a regular basis 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 was designed for people who are interested in the project to get contact

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.

The poster was e.g. distributed as follows:

- The poster was placed on the site of Trinite in 2011

- ACM SIGSPATIAL conference 2012 and 2013

- MDM 2013 conference (in A4 format)
- At the national Danish conference TrafikDage in 2012 and 2013

- in conferences such as Informatik 2013
- fairs such as in Cebit 2014
- Cyprus Public Works Department
- OSEL bus company
- Costas Papaellinas Organisation Istognosis Ltd.
- Conferences such as EDBT 2012, ICDE 2014, SIGMOD 2014

Task 6.2 Exploitation

The main objective of this task in the 3rd reporting period was to further develop an exploitation plan for REDUCTION, but also start attempting exploitation activities (as outlined in D6.2.3, chapter 10 "Policy and Administrative Issues". 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 were written in year two and completed in the third year with risk assessment, strategic choices and recent and future exploitation activities.

Moreover, as outlined in D6.2.3 the commercial partners delivered input to Deliverables concerning the market analysis, where necessary.

<u>Outputs of REDUCTION</u>

In the tables below the exploitable results REDUCTION delivered so fare are set out. The results are divided in two separate tables: One for the commercial partners (table 8) and one for the academic partners (table 9). Including the target group it expects to reach and the impact is expects.

Table 8: Exploitable results by commercial partners

Exploitable results for commercial partners					
Partner	**Project output**	**Target group**	**Results**	**Expected impact**	**IP**

TRI	Digital Road Authority: Traffic Management Congestion based Smartphone App (Streetwise) Traffic Management congestion based Truck delivery Smartphone Eco-routing App. Traffic Management system with Pollution parameters implemented as an integral part of the product.	Government related target groups (Ministry, cities, provinces); Fleet owners (passenger & freight); Educators; Individual travellers	Advanced management services to Traffic Control Centres, fleets and travellers: - Advise, information & awareness in eco routing - Driver education - Speed advice by taking current traffic situation.	Reduction of CO2 emissions & fuel economy, Awareness of pollution status	Own ed by TRI
CTL	Network-wide environmental analysis using the VISTA Dynamic Traffic Assignment (DTA) simulator.	Ministries of Transport, Public Agencies, Travel information providers, Travellers, researchers, educators	A prototype DTA model embedded into the VISTA software to produce estimates of fuel consumption using a generalised cost function.	Estimation of fuel consumption/cost function. Using various user groups	IP own ed by CTL
DDE	My-fl device with V2V/V2I capabilities of CANbus data	(in-car) Fleet owners, (passenger & freight), Public transport companies, Automotive industry	Additional services for fleet management companies	Increasing safety, and reducing accidents, state of the art product	IP own ed by DDE
TrainO SE	Eco-routing methodologies	Companies that own / develop Traffic Management Systems (also for in car suppliers)	- Advise in eco routes to road user by means of internet or via Bluetooth, smartphone or by traditional roadside equipment like VMS - The schedule of public transportation via VMS or smart	More precise eco-routing for the type of a car which users are using by means of smart phone, such as a IPhone app.	

			phone		
CTL	Eco-Driving techniques	- Fleet owners in both public and private sectors - Municipalities and policy makers	- Detect ecologically inefficient driving behaviours - Cluster / Group drivers based on their GHG footprint	More economically feasible eco-driving from GPS and vehicle CANbus trajectory data	

Table 9: Results by academic partners

Org.	REDUCTION Products	(Potential) Customers Worldwide	Market Ready Products	Availability
UHI	Eco-driving behaviour models	Travellers, Fleet operators	Web-based Eco-driving Assistant	Open Source
UTH	Integrated microscopic traffic and communications simulator	Ministry of transport, Environment, Labor; Public Agencies; Fleet operators; Major Cities; Researchers; Travellers; Traveller information providers; Educators.	Integrated Simulator	Open Source
AU + AAU +	Modal Eco-routing; Intermodal eco-routing with continuously updated GNSS and CAN bus data	Ministry of Transport, Public Agencies; Fleet operators; Travel information providers; Travellers; Researchers; Educators.	Web-based large scale modal/intermodal eco-routing with GNSS and CANbus data	Open Source
AU	EcoMark, a framework for assigning eco-weights to road networks, and a prototype of eco-routing	Ministry of Transport, Public Agencies; Fleet operators; Travel information providers; Researchers; Educators.	EcoMark (http://daisy.aau.dk/its/)	Available for public use. Generally, the code will be shared with other scientists for research purposes
CTL	1. A new DTA software that uses a generalised cost function capturing tolls, fuel	Ministries of Transport, Public Agencies, Travel information providers, Travellers, researchers, educators	Large-scale simulation of eco-routing based on multiple classes	Proprietary software co-owned by various partners.

	consumption and travel time 2. Hands on experience on FMS hardware and software for buses and light vehicles	Fleet management companies either public or private, Research institutions, Travellers, educators	of users Hardware and software to support FMS; Modeling of energy consumption driving behaviour using GNSS and CANbus data	Software available to research institutions on a case by case basis. The driving behaviour model developed by UHI for the Nicosia field study is open source.

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 10 below an overview of the target groups can be found.

Table 10: 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.		
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		
Logistics & cargo/freight-transport companies with multi-modal fleets		

Public transport organisations
Ministries & public organisation that want to deploy pilot studies based on fleets comprised by individual drivers.
Public agencies: Environmental agencies, public health departments, departments of transport

Marketing Strategy

The marketing strategy of REDUCTION is to execute and communicate its value proposition of offering innovative services for fleet transport management and traveller information whose outcome are environmentally friendly and are produced by a system architecture that is decentralised and extendible in its design.
Additionally, to distinguish the REDUCTION project in this competitive & saturated market, the consortium is focusing on a message, which includes: Innovative, state of the art, future proof, 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/freight fleets), which are otherwise not properly, complete and integrated serviced by existing commercial solutions. In parallel, to promote the results of REDUCTION to public agencies and policy makers through a robust product that can estimate accurately the carbon footprint of each traveller and commercial vehicle.

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 becomes a household word in all the target groups.

Strategic Choices

Based on the conclusions that have been drawn in the confrontation analysis, the consortium is able to appoint strategic choices. These choices are used to set up an activity plan:

- Use the involvement of the Government and its push for climate changes issues to exploit the results of REDUCTION.
- Use REDUCTIONS' integrated solutions and broad sense as an USP and link it to its innovative image.
- Use the presence of commercial partners to exploit and disseminate about REDUCTION.
- Setup joint ventures and search for partnerships.
- Search for integration possibilities and exchange of information/solutions.
- Use other EU projects to communicate about the results and integrate the solutions.

The activityplan is set up and implemented by all (commercial) partners and carried out as much as possible during the duration of the project.

Conclusion

Exploitation of REDUCTION has 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 all three means and the variety of target groups are very different, exploitation differs 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 profound in providing services (focus on ITS/In Car) instead of investing in new infrastructure. REDUCTION is adaptable 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 REDUCTION outcome of a multi modal solution is very interesting.

Because of the different perception of the content of an Exploitation Plan by the REDUCTION partners and the broad sense of the project, it was 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

REDUCTION was based entirely on the DSRC layered architecture, and Deliverable 6.3 is highlighting the specific areas where REDUCTION partners have focused their efforts on improving these standards, and which standards REDUCTION has used 'as is'.

The conclusion of the Deliverable is given as follows:

Network management (NM) 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. Making use of a standard for Network management was required for REDUCTION. Stepping out of vendor specific definitions led to interoperability. Vehicles utilize a variety of wireless technologies to communicate with other devices. REDUCTION focused on one specific technology, Dedicated Short-Range Communication (DSRC). The word “Dedicated” in DSRC refers to the fact that the U.S. Federal Communications Commission has allocated 75MHz of licensed spectrum in the 5.9 GHz band for DSRC communication. This spectrum is divided into several channels. The term “Short Range” in DSRC is meant to convey that the communication takes place over hundreds of metres, a shorter distance than cellular and WiMax services typically support. DSRC was designed to support a variety of applications based on vehicular communication. It can be used for many other applications beyond safety applications. Most of these involve communication to and from RSUs. REDUCTION was based entirely on the DSRC layered architecture, and it was highlighted which are the specific areas where REDUCTION partners have focused their efforts in improving these standards, and which standards REDUCTION has used ‘as is’. The geonetworking protocol layer is a network layer protocol that provides packet routing in an ad hoc network. It makes use of geographical position information for packet transport. GeoNetworking supports the communication among individual ITS stations as well as the distribution of packets in geographical areas. GeoNetworking can be executed over different ITS access technologies for short-range wireless technologies. In the context of REDUCTION, UTH developed its own fully-compliant with ETSI version of GeoNetworking making where needed slight improvements. Actually, this implementation is a significant contribution since there are not any other fully-compliant implementations available publicly. Finally, in the context of REDUCTION the inefficiencies of standard multi-hop routing protocols were recognised, and a more efficient one was developed, but only evaluated via simulations. Trinite, DELPHI and UTH will continue their efforts and involvement in the standardization procedures after project lifetime, but it should be made clear that such efforts cannot “commit” within a three-year period. These are time-consuming processes that evolve over many rounds of consultation and discussion.

A summary of the exploitation and extensions to standards by REDUCTION is presented in the following table 11.

Table 11: Exploitation and extensions to standards

Standard	WP	Field trial	REDUCTION contribution	Specific contribution	Status
IEEE 802.11p	WP1, WP5	CTL	X	N/A	Used
IEEE 1609.3	WP1, WP5	CTL	X	N/A	Used
ETSI TS 102 636-4-1	WP1, WP5	CTL	√	Extension to Geonetworking: a) cross-layering, b) refrain from continuous retransmission when not needed	A) Geonetworking implementation: Ready - Used B) Extensions to Geonetworking and evaluation of their efficiency: Ready – Used
SAE J2945	WP1, WP5	CTL	X	N/A	Used
SAE J2735	WP1, WP5	CTL	X	N/A	Used
IETF RFC3626 (OLSR) protocol	WP1, WP5	CTL	√	Extensions to OLSR using complex network theory	A) OLSR used B) pCoCe protocol: Ready (evaluated by simulations)
Bluetooth	WP4, WP5	TRI	X	N/A	Used
DATEX II	WP1	CTL	X	N/A	Not used
DVM Exchange	WP4, WP5	TRI	√	Initial definition of the standard	Not ready

2.6.4 Dissemination Activities in the 3rd reporting period

The REDUCTION Consortium actively disseminated the project results during the third reporting period (see table 12: Dissemination Activities in Reporting Period 3, table 13: Peer-Reviewed Publications in Reporting Period and table 14: Dissemination activities planned after the end of the project).

Table 12: Dissemination Activities in Reporting Period 3

PRESENTATIONS	
Presentation Title	REDUCTION
REDUCTION Partner	University of Hildesheim
Event Title	EC FP7 ICT Call 7 & 8 Conversation Workshop
Date and Year	30 April 2014
Location	Brussels, Belgium
Presentation Purpose	Present the Achievements of the REDUCTION project to related projects and interested audiences within the FP7 community

PRESENTATIONS	
Presentation Title	REDUCTION
REDUCTION Partner	University of Hildesheim
Event Title	Booth at CEBIT 2014
Date and Year	10-14 march 2014
Location	Hannover, Germany
Presentation Purpose	CEBIT is the world's biggest annual fair of IT products and solutions. The REDUCTION project had a dedicated booth in the R&D hall of the fair. The booth was especially visited by the mayor of Hildesheim Mr. Ingo Meyer and the Lower Saxony's Minister of Economy Mr. Olaf Lies. In addition, the project was included in a guided-tour of the R&D hall, titled "IT solutions for safe and economic transportations". About 10-15 business representatives visited our tour and listened to the presentation of the project.

PRESENTATIONS	
Presentation Title	REDUCTION
REDUCTION Partner	University of Hildesheim
Event Title	Informatik 2013 conference
Date and Year	16-20 September 2013
Location	Koblenz Germany
Presentation Purpose	REDUCTION project was presented at the 36th German Conference on Artificial Intelligence (KI 2013) conference, from 16-20 September 2013, in Koblenz Germany. KI conference traditionally brings together academic and industrial researchers from all areas of AI. KI 2013 was colocated with INFORMATIK'13 which is considered the biggest IT conference of Germany. Several ITS researchers attended the REDUCTION presentation and participated in the discussion session.

PRESENTATIONS	
Presentation Title	Enabling time-dependent uncertain eco-weights for road networks
REDUCTION Partner	Aarhus University
Event Title	First International ACM Workshop on Managing and Mining Enriched Geo-Spatial Data
Date and Year	27 June 2014
Location	Snowbird, USA
Presentation Purpose	Present REDUCTION results to audiences who show intensive interests to eco-routing

PRESENTATIONS	
Presentation Title	Multi-cost optimal route planning under time-varying uncertainty
REDUCTION Partner	Aarhus University
Event Title	30th IEEE International Conference on Data Engineering
Date and Year	April 1, 2014
Location	Chicago, USA
Presentation Purpose	Present REDUCTION results to audiences who show intensive interests to skyline route computation

PRESENTATIONS	
Presentation Title	Multimodality and eco-routing
REDUCTION Partner	FlexDanmark
Event Title	Joint trips
Date and Year	25 September 2013
Location	Gothenburg
Presentation Purpose	To discuss multimodality and eco-routing with our Swedish colleagues from Vesttrafik

PRESENTATIONS	
Presentation Title	Multimodality
REDUCTION Partner	FlexDanmark
Event Title	N/A
Date and Year	5 December 2013
Location	Aalborg, Denmark
Presentation Purpose	To discuss methods for multimodality in connection with a new project

PRESENTATIONS	
Presentation Title	Driving times and eco-routing
REDUCTION Partner	FlexDanmark
Event Title	SUTI meeting
Date and Year	14 January 2014
Location	Malmø
Presentation Purpose	To discuss driving times in connection with links between systems

PRESENTATIONS	
Presentation Title	Eco-routing and driving times
REDUCTION Partner	FlexDanmark
Event Title	ITtrans
Date and Year	18 February 2014
Location	Karlsruhe, Germany
Presentation Purpose	To present the way FlexDanmark operates with GPS driving times etc.

PRESENTATIONS	
Presentation Title	DVM wordt een gecoördineerde co-creatie tussen privaat en publiek
REDUCTION Partner	Trinité
Event Title	Nationaal Verkeerskunde Congres
Date and Year	6 of November 2013
Location	Den Bosch
Presentation Purpose	Managers and decision makers in Traffic (mainly government related). Target group is always looking for new trends and possibilities in three focus points in traffic: safety, traffic flow and livability. With livability Reduction of CO2 is a big issue. Talking about the future of TrafficManagement.

PRESENTATIONS	
Presentation Title	Digital Road Authority
REDUCTION Partner	Trinité
Event Title	Verkeer & Mobiliteit (Mobility Exhibition)
Date and Year	30st of November 2013
Location	Houten, The Netherlands
Presentation Purpose	Talking about the future possibilities of TrafficManagement.

PRESENTATIONS	
Presentation Title	Digital Road Authority
REDUCTION Partner	Trinité
Event Title	Verkeer & Mobiliteit Belgium (Mobility Exhibition)
Date and Year	5 & 6 of February 2014
Location	Brussels, Belgium
Presentation Purpose	Talking about the future possibilities of TrafficManagement.

PRESENTATIONS	
Presentation Title	Digital Road Authority
REDUCTION Partner	Trinité
Event Title	Intertraffic Amsterdam (international Mobility Exhibition)
Date and Year	25-28 of March 2014
Location	Amsterdam, The Netherlands
Presentation Purpose	Talking about the future possibilities of TrafficManagement.

PRESENTATIONS	
Presentation Title	Ambition 2016 program: the Digital Road Authority Creating synergy between the information and intentions of public parties, private parties and traveller
REDUCTION Partner	Trinité
Event Title	ITS Helsinki
Date and Year	16-19 June 2014
Location	Helsinki, Finland
Presentation Purpose	Talking about the future possibilities of TrafficManagement.

PRESENTATIONS	
Presentation Title	Exploiting Vehicular Communications for Reducing CO_2 Emissions in Urban environments
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Event Title	2nd International Conference on Connected Vehicles and Expo (ICCVE)
Date and Year	December 2-6, 2013
Location	Las Vegas, Nevada, USA
Presentation Purpose	To describe an algorithm for CO_2 reduction using V2V communications among vehicles.
PRESENTATIONS	
Presentation Title	Enabling ITS Real World Experimentation in NITOS Future Internet facility
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Event Title	11th IEEE/IFIP Annual Conference on Wireless On-demand Network Systems and Services (WONS)
Date and Year	April 2-4, 2014
Location	Obergurgl, Austria
Presentation Purpose	Describe UTH's implementation and evaluation of the GeoNetworking protocol running over UTH's wireless testbed.

PRESENTATIONS	
Presentation Title	A Social-based Approach for Message Dissemination in Vehicular Ad Hoc Networks
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Event Title	6th International Conference on Ad Hoc Networks
Date and Year	August 18-19, 2014
Location	Rhodes island, Greece
Presentation Purpose	To describe a new protocol for network-wide message dissemination over VANET's which beats the established standard protocol Optimised Link State Routing Protocol (RFC 3626) [https://www.ietf.org/rfc/rfc3626.txt]

PRESENTATIONS	
Presentation Title	Dynamic Traffic Assignment Framework to Assess Short-Term Network-Level Impacts of Eco-Routing Strategies
REDUCTION Partner	CTL Cyprus Transport Logistics Ltd.
Event Title	2014 Transportation Research Board Annual Meeting
Date and Year	12-16/01/2014
Location	Washington DC, USA
Presentation Purpose	How to model energy consumption within the framework of a Dynamic Traffic Assignment model. The TRB participants related to DTA and environmental modeling were the main target audience as TRB attracts participants from all disciplines in the area of transport.

PRESENTATIONS	
Presentation Title	Implementing the VISTA DTA for Environmental Analysis in Nicosia, Cyprus under the REDUCTION European Commission FP7 sponsored project
REDUCTION Partner	CTL Cyprus Transport Logistics Ltd.
Event Title	NJDOT Showcase
Date and Year	October 23, 2013
Location	Mercer Conference Center, West Windsor, NJ
Presentation Purpose	How to model energy consumption within the framework of a Dynamic Traffic Assignment model. The NJDOT participants include University researchers, NJDOT engineers and planners, transport consultants
PRESENTATIONS	
Presentation Title	Estimating Travel-Times using GPS Data
REDUCTION Partner	Aalborg University (AAU)
Event Title	Company meeting
Date and Year	2013.07.11
Location	Aalborg, Denmark
Presentation Purpose	Presentation of calculating travel-time using GNSS for public company (Movia).

PRESENTATIONS	
Presentation Title	Path-based Travel-Time
REDUCTION Partner	Aalborg University (AAU)
Event Title	Company meeting
Date and Year	2013.08.12
Location	Pandrup, Denmark
Presentation Purpose	Presentation of calculating travel-time using high-frequent GNSS data.

PRESENTATIONS	
Presentation Title	The Daisy Research Group
REDUCTION Partner	Aalborg University (AAU)
Event Title	Company meeting
Date and Year	2013.10.23
Location	Aalborg, Denmark
Presentation Purpose	Presentation of research group and REDUCTION project for Japanese company visiting Aalborg.

PRESENTATIONS	
Presentation Title	A Spatio-temporal Data Warehouse
REDUCTION Partner	Aalborg University (AAU)
Event Title	Lecture at Open Education
Date and Year	2013.12.06
Location	Aalborg, Denmark
Presentation Purpose	Presentation of WP3 prototype.

PRESENTATIONS	
Presentation Title	ITS Research @ DAISY
REDUCTION Partner	Aalborg University (AAU)
Event Title	Public IT meeting
Date and Year	2013.12.16
Location	Aalborg, Denmark
Presentation Purpose	Presentation of ITS research and REDUCTION project at public meeting.

PRESENTATIONS	
Presentation Title	GPS for Interactive Traffic Analysis
REDUCTION Partner	Aalborg University (AAU)

Event Title	Public IT meeting
Date and Year	2014.01.15
Location	Copenhagen, Denmark
Presentation Purpose	Presentation of REDUCTION research.

PRESENTATIONS	
Presentation Title	Traffic Analysis based on GPS Data (in Danish)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Public IT meeting
Date and Year	2014.02.04
Location	Aalborg, Denmark
Presentation Purpose	Presentation of REDUCTION research.

PRESENTATIONS	
Presentation Title	Big Traffic Data in Practice (partly in Danish)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Public IT meeting
Date and Year	2014.02.05
Location	Aalborg, Denmark
Presentation Purpose	Presentation of REDUCTION research.

PRESENTATIONS	
Presentation Title	Good usage of GPS and CAN bus Data for Traffic Analysis
REDUCTION Partner	Aalborg University (AAU)
Event Title	Public IT meeting
Date and Year	2014.02.19
Location	Copenhagen, Denmark
Presentation Purpose	Presentation of REDUCTION research.

PRESENTATIONS	
Presentation Title	The Traffic in Aarhus/Skejby Area (in Danish)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Public IT meeting
Date and Year	2014.03.17
Location	Aarhus, Denmark
Presentation	Presentation of REDUCTION research.

Purpose	

PRESENTATIONS	
Presentation Title	ITS using GPS and CAN bus Data
REDUCTION Partner	Aalborg University (AAU)
Event Title	Company meeting
Date and Year	2014.05.22
Location	Copenhagen, Denmark
Presentation Purpose	Presentation of REDUCTION research for ITS company.

PRESENTATIONS	
Presentation Title	Usage-based Insurance
REDUCTION Partner	Aalborg University (AAU)
Event Title	Company meeting
Date and Year	2014.05.22
Location	Copenhagen, Denmark
Presentation Purpose	Presentation of REDUCTION research for insurance company.

PRESENTATIONS	
Presentation Title	GPS and CAN bus Data for ITS and Smart Cities
REDUCTION Partner	Aalborg University (AAU)
Event Title	Company meeting
Date and Year	2014.06.04
Location	Aalborg, Denmark
Presentation Purpose	Presentation of REDUCTION research for Japanese company.

PRESENTATIONS	
Presentation Title	Big Traffic Data in Practice (partly in Danish)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Virtual and real meeting
Date and Year	2014.06.13
Location	Aalborg, Denmark
Presentation Purpose	Presentation of REDUCTION research for ITS interest organisation.

Established Contacts

Established Contacts	Smart Cities of Barcelona, Jakarta, etc
By which dissemination	Smart City Event and different presentations held in cooperation with Amsterdam Smart City
REDUCTION Partner	Trinite

Established Contacts	
Established Contacts	Xiaojing Wang (Founder and Director, China National ITS Center)
By which dissemination	During ICCVE 2013 in Las Vegas, USA
REDUCTION Partner	UTH

Established Contacts	
Established Contacts	Universidad Estatal de Milagro, Ecuador; City of Quito, Ecuador; City of Guayaquil, Ecuador NJDOT traffic operations – Mr. Dennis Motiani, Assistant Commissioner, Transportation Systems Management
By which dissemination	Presentation of the capabilities of the VISTA software including eco-routing strategies
REDUCTION Partner	CTL Cyprus Transport Logistics Ltd.

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	Inform Norden
REDUCTION Partner	FlexDanmark
Event Title	Inform Norden
Date and Year	11-13 September 2013
Location	Helsinki, Finland
Event Purpose	To inform about new trends in DRT and inform about driving times
Event Description	A conference
Event results	N/A
Event URL	http://www.informnorden.com/wp-content/uploads/2013/06/InformNorden_Program-FINAL.pdf

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	TOEF
REDUCTION Partner	FlexDanmark
Event Title	Public transport seminar
Date and Year	8 October 2013
Location	Korsør, Denmark

Event Purpose	To speak about multimodality, driving times and eco-routing
Event Description	A yearly seminar for all relevant public transport stakeholders
Event results	N/A
Event URL	N/A

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	Not a formal organisation
REDUCTION Partner	FlexDanmark
Event Title	European DRT
Date and Year	21 May 2014
Location	Copenhagen, Denmark
Event Purpose	To inform about new trends in DRT and inform about driving times
Event Description	A conference
Event results	N/A
Event URL	N/A

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	BNR (Business News Radio)
REDUCTION Partner	Trinité
Event Title	Radio interview about Digital Road Authority
Date and Year	14th of May 2014
Location	Amsterdam, The Netherlands
Event Purpose	Amsterdam Smart City arranged a radio interview on BNR. Because of the innovative projects of the Digital Road Authority. Focus on use cases including Jan van Galenstraat (which is a reduction of CO2 use case)
Event Description	15 minute radio interview about different aspects of Digital Road Authority
Event results	A lot of reactions and invitations to talk about the subject
Event URL	N/A

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	Thessaloniki’s local TV: “EURO Channel”
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Event Title	Weekly TV infotainment show: “Agenda” with Polina Petkaki
Date and Year	May 11th, 2014
Location	Thessaloniki, Hellas
Event Purpose	Talk about Intelligent Transportation Systems (Vehicle clustering/platooning)
Event Description	Dissemination of the REDUCTION project

Event results	Present academic research to a broad, non-technical audience and disseminate EU funding efforts
Event URL	http://eurotileorasi.eu/eurotv/index.php/web-tv-euro/arxeio-ekpompon/psyxagogikes-arxeio/agenda-euro-tileorasi/youtubegallery.html?videoid=hvyld0sCuUM (after 01:01:04)

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	Atv.dk (Akademiet for de Tekniske Videnskaber)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Big Data – bigger potential
Date and Year	2013.11.08
Location	Denmark
Event Purpose	Using GPS/CAN bus for Big Data
Event Description	
Event results	
Event URL	http://vbn.aau.dk/en/clippings/big-data--bigger-potential(92217adc-b0ca-41ad-bfb5-94366b732c61).html

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	Atv.dk (Akademiet for de Tekniske Videnskaber)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Big Data – bigger potentialMød seniorforsker Ravi Kumar fra Google ved ATV's big data-seminar (in Danish)
Date and Year	2014.01.09
Location	Denmark
Event Purpose	Using GPS/CAN bus for Big Data
Event Description	
Event results	
Event URL	http://vbn.aau.dk/en/clippings/moed-seniorforsker-ravi-kumar-fra-google-ved-atvs-big-dataseminar(ea671e90-8109-4038-82f0-4e0891be268f).html

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	(Ritzaus Bureau) (Newspaq / Radio Charlie) (Newspaq / Skaga FM)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Many IT jobs in ITS (in Danish)
Date and Year	2014.01.14
Location	Denmark
Event Purpose	Using GPS/CAN bus for Big Data
Event Description	
Event results	
Event URL	http://vbn.aau.dk/en/clippings/citathistorie-fra-dr-nordjylland-mange-arbejdspladser-at-hente-i-trafikit(f2dae144-809b-4710-8a92-

	d52e9561b76a).html

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	(Altinget.dk) (Altinget.dk/Transport) (Aau.dk (Aalborg Universitet)) (Altomteknik.dk) (Ing.dk (Ingeniøren)) (Videnskab.dk) (Ingeniøren) (Altinget.dk/Teknik) (Dagens.dk) (Ing.dk (Ingeniøren)) (Energy-Supply.dk) (Teknovation.dk)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Large Fluctuation in EV Range (in Danish)
Date and Year	2014.03.14
Location	Denmark
Event Purpose	Using GPS/CAN bus for Big Data
Event Description	
Event results	
Event URL	http://vbn.aau.dk/en/clippings/store-saesonudsving-i-elbilers-raekkevidde(16bf6d87-68ff-4a26-994d-e004f0511a5b).html

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	(Altinget.dk/Energi)
REDUCTION Partner	Aalborg University (AAU)
Event Title	Large Fluctuation in EV Range (in Danish)
Date and Year	2014.03.28
Location	Denmark
Event Purpose	Using GPS/CAN bus for Big Data
Event Description	
Event results	
Event URL	http://vbn.aau.dk/en/clippings/store-saesonudsving-i-elbilers-raekkevidde(41c57197-68df-48c0-ba0d-9d473bf8ed9e).html

PUBLIC PARTICIPATION AND AWARENESS	
Organisation Name	(Politiken) (Politiken.dk)
REDUCTION Partner	Aalborg University (AAU)
Event Title	EVs suffering when cold and hot (in Danish)
Date and Year	2014.04.05
Location	Denmark
Event Purpose	Using GPS/CAN bus for Big Data
Event Description	
Event results	
Event URL	http://vbn.aau.dk/en/clippings/elbiler-lider-i-baade-kulde-og-hede(8ef8a15f-e3d8-4d66-8c27-8158cd2f14b3).html

Table 13: Peer-Reviewed Publications in Reporting Period 3

PUBLICATIONS	
Authors	Umer Khan, Alexandros Nanopoulos, Lars Schmidt-Thieme
Publication Title	P2P RVM for Distributed Classification
REDUCTION Partner	University of Hildesheim
Publication Type	Conference Paper
Book title	Proceedings of the European Conference on Data Analysis, ECDA 2013
Date and Year	10-12 July 2014
Pages	N/A
Location	Luxemburg
Status	Accepted
Publication URL	N/A
Reason	Important conference on the fields of Data Mining and Knowledge Discovery
Main Audiences	Researchers and practitioners on the domains of Data Mining and Machine Learning

PUBLICATIONS	
Authors	Umer Khan, Alexandros Nanopoulos, Lars Schmidt-Thieme, Pavlos Basaras, Dimitrios Katsaros
Publication Title	Analyzing Cooperative Lane Change Models for Connected Vehicles
REDUCTION Partner	University of Hildesheim, University of Thessaly, Hellas (UTH)
Publication Type	Conference Paper
Book title	Proceedings of the International Conference on Connected Vehicles and Expo (ICCVE'14)
Date and Year	3-7 November 2014
Pages	N/A
Location	Vienna, Austria
Status	Accepted
Publication URL	N/A
Reason	Primary conference on connected vehicles and V2V technologies
Main Audiences	Researchers, industry experts and interested parties on V2V technologies

PUBLICATIONS	
Authors	Josif Grabocka, Nicolas Schilling, Martin Wistuba, Lars Schmidt-Thieme
Publication Title	Learning Time-Series Shapelets
REDUCTION Partner	University of Hildesheim
Publication Type	Conference Paper
Book title	Proceedings of the 20th ACM SIGKDD Conference on Knowledge Discovery and Data Mining

Date and Year	24-17 August 2014
Pages	N/A
Location	New York, USA
Status	Accepted
Publication URL	If exists; official publisher URL preferable
Reason	The top-most conference in the field of Data Mining and Knowledge Discovery
Main Audiences	Top researchers and companies of Data Mining and Machine Learning

PUBLICATIONS	
Authors	Josif Grabocka, Erind Bedalli, Lars Schmidt-Thieme
Publication Title	Supervised Nonlinear Factorizations Excel In Semi-supervised Regression
REDUCTION Partner	University of Hildesheim
Publication Type	Conference paper
Book title	Proceedings of the 18th Pacific-Asia Conference on Knowledge Discovery and Data Mining, PAKDD 2014
Date and Year	10-13 May 2014
Pages	188-199
Location	Tainan, Taiwan
Status	Accepted
Publication URL	http://link.springer.com/book/10.1007%2F978-3-319-06608-0
Reason	Internationally recognised conference on the fields of Data Mining and Knowledge Discovery
Main Audiences	Experts and Researchers on Data Mining and Knowledge Discovery

PUBLICATIONS	
Authors	Josif Grabocka, Lars Schmidt-Thieme
Publication Title	Invariant Time-Series Factorization
REDUCTION Partner	University of Hildesheim
Publication Type	Journal paper
Book title	Journal of Data Mining and Knowledge Discovery
Date and Year	July 2014
Pages	N/A
Location	N/A
Status	Accepted
Publication URL	http://link.springer.com/article/10.1007%2Fs10618-014-0364-z
Reason	The top-most journal in the field of Data Mining
Main Audiences	Researchers
PUBLICATIONS	
Authors	Josif Grabocka, Lars Schmidt-Thieme

Publication Title	Learning Through Non-linearly Supervised Dimensionality Reduction
REDUCTION Partner	University of Hildesheim
Publication Type	Journal paper
Book title	Journal of Transactions on Large-Scale Data- and Knowledge-Centered Systems (TLDKS), Springer LNCS
Date and Year	July 2014
Pages	N/A
Location	N/A
Status	Accepted subject to minor revision
Publication URL	N/A
Reason	Internationally recognised journal in the field of Data Warehousing and Knowledge Extraction
Main Audiences	Researchers

PUBLICATIONS	
Authors	Josif Grabocka, Lars Schmidt-Thieme
Publication Title	Mining Fuel-Inefficient Driving From GPS Trajectories Behaviors
REDUCTION Partner	University of Hildesheim
Publication Type	Conference paper
Book title	European Conference on Data Analysis, ECDA 2014
Date and Year	2-4 July 2014
Pages	N/A
Location	N/A
Status	Accepted Abstract, Full submission to be forwarded
Publication URL	N/A
Reason	Important conference on the fields of Data Mining and Knowledge Discovery
Main Audiences	Researchers and practitioners on the domains of Data Mining and Machine Learning

PUBLICATIONS	
Authors	Josif Grabocka, Alexandros Dalkalitsis, Athanasios Lois, Evangelos Katsaros and Lars Schmidt-Thieme
Publication Title	Realistic Optimal Policies For Energy-Efficient Train Driving
REDUCTION Partner	University of Hildesheim
Publication Type	Conference paper
Book title	IEEE Conference on Intelligent Transportation Systems, ITSC 2014
Date and Year	8-11 October 2014
Pages	N/A
Location	N/A

Status	Accepted
Publication URL	N/A
Reason	Flagship conference on ITS research
Main Audiences	Researchers and practitioners on the domains of ITS

PUBLICATIONS	
Authors	Josif Grabocka, Martin Wistuba, Lars Schmidt-Thieme
Publication Title	Scalable Classification of Repetitive Time Series Through Frequencies of Local Polynomials
REDUCTION Partner	University of Hildesheim
Publication Type	Journal paper
Book title	Journal of IEEE Transaction on Knowledge and Data Engineering
Date and Year	2014
Pages	N/A
Location	N/A
Status	Submitted major revision
Publication URL	N/A
Reason	Internationally recognised journal in the field of Data Warehousing and Knowledge Extraction
Main Audiences	Researchers

PUBLICATIONS	
Authors	Yu Ma, Bin Yang, Christian S. Jensen
Publication Title	Enabling time-dependent uncertain eco-weights for road networks
REDUCTION Partner	Aarhus University
Publication Type	Conference Paper
Book title	First International ACM Workshop on Managing and Mining Enriched Geo-Spatial Data
Date and Year	27 June 2014
Pages	N/A
Location	Snowbird, USA
Status	Published
Publication URL	N/A
Reason	Workshop of leading conference on the fields of data management
Main Audiences	Researchers and practitioners on the domains of geo-spatial data management

PUBLICATIONS	
Authors	Chenjuan Guo, Bin Yang, Ove Andersen, Christian S. Jensen, Kristian Torp

Publication Title	EcoMark 2.0: Empowering Eco-Routing with Vehicular Environmental Models and Actual Vehicle Fuel Consumption Data
REDUCTION Partner	Aarhus University
Publication Type	Journal Paper
Book title	Geoinformatica
Date and Year	N/A
Pages	N/A
Location	N/A
Status	In submission
Publication URL	N/A
Reason	Impact journal on the fields of geo-spatial data management
Main Audiences	Researchers on the domains of geo-spatial data management

PUBLICATIONS	
Authors	Bin Yang, Chenjuan Guo, Christian S. Jensen, Manohar Kaul, Shuo Shang
Publication Title	Stochastic Skyline Route Planning Under Time-Varying Uncertainty
REDUCTION Partner	Aarhus University
Publication Type	Conference Paper
Book title	30th IEEE International Conference on Data Engineering
Date and Year	March 31 – April 4, 2014
Pages	136-147
Location	Chicago, USA
Status	Published
Publication URL	N/A
Reason	Leading conference on the fields of data management
Main Audiences	Researchers and participants on the domains of data management

PUBLICATIONS	
Authors	Bin Yang, Chenjuan Guo, Yu Ma, Christian S. Jensen
Publication Title	Towards Context Aware, Personalised Routing
REDUCTION Partner	Aarhus University
Publication Type	Journal Paper
Book title	The VLDB journal
Date and Year	N/A
Pages	N/A
Location	N/A
Status	In submission
Publication URL	N/A
Reason	Leading journal on the fields of database management
Main Audiences	Researchers on the domains of database management

PUBLICATIONS	
Authors	Frank Ottenhof (TrafficLink/Trinité), Julie van Heteren and Thijs Muizelaar (DIVV Amsterdam), Saskia Müller (Amsterdam Smart City)
Publication Title	Amsterdam test Digitale Wegbeheerder (English version Amsterdam will test Digital Road Authority)
REDUCTION Partner	Trinité
Publication Type	Paper in Magazine
Book title	Verkeerskunde
Date and Year	April 2014
Pages	4
Location	The Netherlands
Status	Published in Verkeerskunde - 4
Publication URL	http://www.verkeerskunde.nl/internetartikelen/internetartikelen/amsterdam-test-digitale-wegbeheerder-%28vk-4-2014%29.37136.lynkx
Reason	Asked for publication about the Digital Road Authority by the magazine itself.
Main Audiences	Managers and decision makers in Traffic (mainly government related). Target group is always looking for new trends and possibilities in three focuspoints in traffic: safety, traffic flow and livability. With livability Reduction of CO2 is a big issue.

PUBLICATIONS	
Authors	Frank Ottenhof (TrafficLink/Trinité), Maarten de Haas (TrafficLink)
Publication Title	Digital Road Authority for optimal PPP Electronic solution connects governments and market
REDUCTION Partner	Trinité
Publication Type	Paper in Magazine
Book title	Verkeer in Beeld
Date and Year	March 2014
Pages	4
Location	The Netherlands
Status	Published in Verkeer in Beeld - 1
Publication URL	http://www.trafficlink.nl/de-digitale-wegbeheerder-in-verkeer-in-beeld/
Reason	Asked for publication about the Digital Road Authority by the magazine itself.
Main Audiences	Managers and decision makers in Traffic (mainly government related). Target group is always looking for new trends and possibilities in three focuspoints in traffic: safety, traffic flow and livability. With livability Reduction of CO2 is a big issue.

PUBLICATIONS	
Authors	Dimitrios Papakostas, Dimitrios Katsaros
Publication Title	A Simulation-based Performance Evaluation of a Randomized MIS-based Clustering Algorithm for Ad Hoc Networks
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Journal paper
Book title	Simulation Modelling: Practice And Theory (Elsevier)
Date and Year	Vol. 48, November, 2014
Pages	1-23 (subject to change when the journal's final issue will be formed)
Status	The issue is "in progress", but contains articles that are final and fully citable
Publication URL	http://www.sciencedirect.com/science/article/pii/S1569190X14001063
Reason	SIMPAT provides a forum for original, high-quality papers dealing with any aspect of systems simulation and modelling. The journal aims at being a reference and a powerful tool to all those professionally active and/or interested in the methods and applications of simulation. Submitted papers will be peer reviewed and must significantly contribute to modelling and simulation in general or use modelling and simulation in application areas.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.
Comment	This publication supersedes the "under submission" article, which appeared in D.6.1.1 under the title "Building Integrity in Ad Hoc Networks: Evaluating a Randomised MIS-based Clustering Algorithm" with the same authors

PUBLICATIONS	
Authors	Nikos Makris, Christos Zarafetas, Thanasis Korakis, Dimitrios Katsaros and Leandros Tassiulas
Publication Title	Enabling Intelligent Transport System Experimentation in the NITOS networking testbed
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Journal paper
Book title	IEEE Internet of Things Journal – Special Issue on Internet of Vehicles (IoV)
Date and Year	2014
Pages	1-8
Status	The article is under first round review
Publication URL	N/A
Reason	The new era of Internet of Things (IoT) is driving the evolution of conventional Vehicle Ad hoc Networks (VANET) into the Internet of Vehicles (IoV) paradigm. According to recent predictions, 25 billion of "things" will be connected to the Internet by 2020 among which vehicles will constitute a significant portion. The difference of the vehicle concept in VANET and IoV makes these two scenarios essentially different in the device, communications, networking, and services aspects. In VANET, a vehicle is mainly considered as a node to disseminate messages among vehicles. In the

	IoV paradigm, each vehicle is considered as a smart object equipped with a powerful multi-sensor platform, communications technologies, computation units, IP-based connectivity to the Internet and to other vehicles either directly or indirectly. In addition, a vehicle in IoV is envisioned as a multi-communication model, enabling the interactions between intra-vehicle components, vehicles and vehicles, vehicles and road, and vehicles and people. IoV enables the acquistion and processing of large amount of data from versatile geographical areas via intelligent vehicles computing platforms to offer various categories of services for road safety and other services to drivers and passengers.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.

PUBLICATIONS	
Authors	Leandros Maglaras, Dimitrios Katsaros
Publication Title	Social clustering of vehicles based on semi-Markov processes
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Journal paper
Book title	IEEE Transactions on Vehicular Technology
Date and Year	June, 2014
Pages	1-33
Status	The article is under third round review
Publication URL	N/A
Reason	The IEEE Transactions on Vehicular Technology is dedicated solely to vehicular technology. This scholarly journal consists of high-quality technical manuscripts on advances in the state-of-the-art of vehicular technology in the areas of: land, airborne and maritime mobile services; portable commercial and citizen's communications services: vehicular electrotechnology, equipment and systems of the automotive industry; traction power, signals, communications and control systems for mass transit and railroads.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.

PUBLICATIONS	
Authors	Dimitrios Papakostas, Leandros Maglaras, Dimitrios Katsaros
Publication Title	A Rich Dictionary Markov Predictor for Trajectory Forecasting in Vehicular Environments
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Journal/magazine article
Book title	IEEE Vehicular Technology magazine
Date and Year	March, 2014
Pages	7 pages
Location	N/A

Status	The article is under second round review
Publication URL	N/A
Reason	Because it is the established international technical reference in its three main areas of interest: mobile radio, automotive electronics, and transportation systems.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.
Comment	This publication supersedes the "Submitted" article, which appeared in D.6.1.2 under the same title and with the same authors

PUBLICATIONS	
Authors	Athanasios Oikonomou Dimitrios Katsaros
Publication Title	Design, implementation & performance analysis of a vehicular cloud using Hadoop over wireless links
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Journal/magazine article
Book title	A major journal/magazine on communications/networking
Date and Year	July, 2014
Pages	12 pages
Location	N/A
Status	The article is under first round review
Publication URL	N/A
Reason	This journal is dedicated solely to vehicular technology. This scholarly journal consists of high-quality technical manuscripts on advances in the state-of-the-art of vehicular technology in the areas of: land, airborne and maritime mobile services; portable commercial and citizen's communications services: vehicular electrotechnology, equipment and systems of the automotive industry; traction power, signals, communications and control systems for mass transit and railroads.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.

PUBLICATIONS	
Authors	Leandros Maglaras, Pavlos, Basaras, Dimitrios Katsaros
Publication Title	Exploiting Vehicular Communications for Reducing CO_2 Emissions in Urban environments
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Conference article
Book title	Proceedings of the 2nd International Conference on Connected Vehicles and Expo (ICCVE)
Date and Year	December 2-6, 2013
Pages	32-37
Location	Las Vegas, Nevada, USA
Status	Proceeding publication

Publication URL	http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6799765
Reason	ICCVE is the premier Connected Vehicles conference that gathers all the relevant communities together.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.

PUBLICATIONS	
Authors	Nikos Makris, Thanasis Korakis, Dimitrios Katsaros, Leandros Tassiulas
Publication Title	Enabling ITS Real World Experimentation in NITOS Future Internet facility
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Conference article
Book title	Proceedings of the 11th IEEE/IFIP Annual Conference on Wireless On-demand Network Systems and Services (WONS)
Date and Year	April 2-4, 2014
Pages	97-103
Location	Obergurgl, Austria
Status	Proceeding publication
Publication URL	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6814728
Reason	Providing secure, reliable, and dependable wireless services is the primary objective of modern data networks. While enabling technology for "on-demand" services through any of the common wireless architectures, such as WiMax, WiFi, ad hoc networks, sensor networks, and vehicular networks, has made large strides, many formidable challenges remain to be overcome, such as the integration of infrastructure-based and ad hoc networks, robust algorithms for self-organising, reconfigurable wireless networks, on-demand service models and their performance in highly-volatile interconnect topologies as well as the smooth interoperability of different architectures. IEEE/IFIP WONS has established itself as a high-quality forum to address these challenges in the context of a conference that is rich in intense interactions and based on innovative contributions by experts in the field.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.

PUBLICATIONS	
Authors	Alexandra Stagkopoulou, Pavlos Basaras, Dimitrios Katsaros
Publication Title	A Social-based Approach for Message Dissemination in Vehicular Ad Hoc Networks
REDUCTION Partner	University of Thessaly, Hellas (UTH)
Publication Type	Conference article
Book title	Proceedings of the 6th International Conference on Ad Hoc Networks
Date and Year	August 18-19, 2014
Pages	1-12
Location	Rhodes island, Greece
Status	Proceeding publication

Publication URL	http://inf-server.inf.uth.gr/~dkatsar/papers/ADHOCNETS14sbk.pdf
Reason	AdHocNets'14 covers a variety of network paradigms for specific purposes, such as mobile ad hoc networks, sensor networks, vehicular networks, underwater networks, underground networks, personal area networks, and home networks, with a broad range of applications in civilian, commercial, and military areas.
Main Audiences	Researchers, academicians, practitioners, and students from universities, industries and government agencies.

PUBLICATIONS	
Authors	Michael Levin, Ehsan Jafari, Rohan Shah, Natalia Ruiz Juri, Kyriacos C. Mouskos
Publication Title	14-5689 Dynamic Traffic Assignment Framework to Assess Short-Term Network-Level Impacts of Eco-Routing Strategies
REDUCTION Partner	CTL Cyprus Transport Logistics Ltd.
Publication Type	Conference Paper
Book title	N/A
Date and Year	12-16/01/2014
Pages	17
Location	Transportation Research Board. 500 Fifth St. NW, Washington, D.C. 20001
Status	TRB 2014 Proceedings Publication
Publication URL	http://amonline.trb.org/trb-55856-2014a-1.823612/t-1116-1.840954/576-1.841084/14-5689-1.841085/14-5689-1.841091?qr=1
Reason	TRB is the largest transport meeting in the world and attracts 11,000 participants per year at the Annual meeting in Washington DC. It is one of the most common places to send transport places especially for
Main Audiences	Transport modelers, Transport energy and air quality

PUBLICATIONS	
Authors	Benjamin B. Krogh, Ove Andersen, and Kristian Torp
Publication Title	An Open-Source Based ITS Platform
REDUCTION Partner	Aalborg University (AAU)
Publication Type	Conference paper
Book title	2013 IEEE 14th International Conference on Mobile Data Management LBS n.0 Workshop
Date and Year	2013.04.03
Pages	6
Location	Milan, Italy
Status	Accepted
Publication URL	http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?isnumber=6569035
Purpose	Overview of the platform delivered in WP3 and used in WP5

PUBLICATIONS

Authors	Benjamin B. Krogh, Ove Andersen, Edwin Lewis-Kelham, Nikos Pelekis, Yannis Theodoridis, Kristian Torp
Publication Title	Trajectory based traffic analysis
REDUCTION Partner	Aalborg University (AAU)
Publication Type	Conference paper
Book title	21st SIGSPATIAL International Conference on Advances in Geographic Information Systems, SIGSPATIAL 2013
Date and Year	2013.11.05
Pages	4
Location	Orlando, FL
Status	Accepted
Publication URL	http://dl.acm.org/citation.cfm?id=2525314
Purpose	Presentation of part of WP3 prototype.

PUBLICATIONS	
Authors	Karsten Jakobsen, Sabrine C. H. Mouritsen, Kristian Torp
Publication Title	Evaluating eco-driving advice using GPS/CANBus data
REDUCTION Partner	Aalborg University (AAU)
Publication Type	Conference paper
Book title	21st SIGSPATIAL International Conference on Advances in Geographic Information Systems, SIGSPATIAL 2013
Date and Year	2013.11.05
Pages	4
Location	Orlando, FL
Status	Accepted
Publication URL	http://dl.acm.org/citation.cfm?id=2525314
Purpose	Use of CAN bus data.

PUBLICATIONS	
Authors	Ove Andersen, Benjamin B. Krogh, Kristian Torp
Publication Title	Analysis of Energy Consumption from EVs (in Danish)
REDUCTION Partner	Aalborg University (AAU)
Publication Type	Peer-review journal (ISSN 1903-1092)
Book title	Trafik Dage
Date and Year	2014.07.16
Pages	12
Location	Aalborg, Denmark
Status	Accepted
Publication URL	http://www.trafikdage.dk/program/Program_netudgave_2014.pdf
Purpose	Use EV CAN bus data

PUBLICATIONS

Authors	Benjamin B. Krogh, Nikos Pelekis, Yannis Theodoridis, Kristian Torp
Publication Title	Path-based Queries on Trajectory Data
REDUCTION Partner	Aalborg University (AAU)
Publication Type	Conference Paper
Book title	N/A
Date and Year	2014.07.31
Pages	10
Location	N/A
Status	Submitted for publication
Publication URL	N/A
Purpose	Use of path queries.

PUBLICATIONS	
Authors	Benjamin B. Krogh, Ove Andersen, Kristian Torp
Publication Title	Analyzing Electric Vehicle Energy Consumption using Very Large Data Sets
REDUCTION Partner	Aalborg University (AAU)
Publication Type	Conference Paper
Book title	N/A
Date and Year	2014.07.31
Pages	10
Location	N/A
Status	Submitted for publication
Publication URL	N/A
Purpose	Evaluation of EV CAN bus data.

PUBLICATIONS	
Authors	Benjamin B. Krogh, Ove Andersen, Edwin Lewis-Kelham, Kristian Torp
Publication Title	Efficient One-click Browsing of Large Trajectory Sets
REDUCTION Partner	Aalborg University (AAU)
Publication Type	Conference Demo
Book title	N/A
Date and Year	2014.07.31
Pages	4
Location	N/A
Status	Submitted for publication
Publication URL	N/A
Purpose	Evaluation of EV CAN bus data.

Table 14: Dissemination activities planned after the end of the project

Dissemination Activities planned after the end of the project		
Nature of activity	**Partner**	**Details**
Paper Publication	TrainOSE	Greek Scientific Magazine: "Supply Chain and Logistics", Oct 2014
Conference Presentation	TrainOSE	Conference: "INTELLIGENT TRANSPORTATION SYSTEMS ITS 2014& SMART CITIES", University of Patras, 19-22 November 2014.
Conference Presentation	TRI	NVC 2014, presentation & paper about DDW Slot management (CO2 redution for logistics)
Exhibition Presentation	TRI	Verkeer & Mobiliteit 2014 (exhibition), presentation about DDW slotmanagement & demonstration of first results
Project	TRI	ITS projects for Government platform "connecting mobility"
Software	FlexDanmark and AAU	Deploy the WP3 advanced prototype at FlexDanmark for production use.
Software prototype	FlexDanmark and AAU	Extend the advanced WP3 prototype to support real-time GNSS and CAN bus data.
Multi-modality calculations	FlexDanmark and AAU	These calculations will be integrated into a countrywide project: "The Joint Trip" which will run until 2018.
Industrial Ph.D. stipend	FlexDanmark and AAU	Industrial Ph.D. application for scientific assistant working for the REDUCTION project in approximately 2 years. Research ideas in new Ph.D. study partly derived from work done in the REDUCTION project.
Post doc position	AAU	Two year post doc position for former Ph.D. student working fully on the REDUCITON project
Project proposal	AAU	Using the technology from WP3 to support electrical vehicles. Seeking support from the Danish Energy Agency.
Project proposal	AAU	Extending the software prototype to support electrical vehicle charging patterns. Seeking support from the Danish Energy Agency.
Paper publication	AAU and AU	Paper on efficient trajectory handling and extension of what has been done in the REDUCTION project.
Demo paper	AAU and AU	Software prototype and demonstration paper for reduction the GHG emission from private vehicles.
Presentation	CTL	Mouskos, K.C., N. Ruiz-Juri, E. Jafari, N. Bentenitis, P. Vicuna, "Implementing eco-routing in DTA using a generalised cost function," Ground Transportation Symposium: Big Data and Innovative Solutions for Safe, Efficient and Sustained Mobility, New York City, NYIT, 2014/11/19

Presentation and Publication	CTL	Ruiz-Juri, N., E. Jafari, K.C. Mouskos, N. Bentenitis, P. Vicuna, "Implementing eco-routing in DTA using a generalised cost function," Annual TRB Conference, Washington DC, 2017-01.
Presentation	CTL	"OSEL Nicosia field Study Results," OSEL and the Cyprus Public Works Department, Spring, 2015
Presentation	CTL	"IST-CPO Nicosia field Study Results," OSEL and the Cyprus Public Works Department, Spring, 2015
Presentation and Publication	CTL	Gregoriades, A., I. Costantinou, U. Khan, J. Grabocka, L. Schmidt-Thieme, K.C. Mouskos, P. Vicuna, "Dynamic driver behavior analysis for traffic congestion detection," IEEE ITSC 2015, Las Palmas de Gran Canaria, Spain, 15 – 18 September 2015

2.6.5 Deliverables in WP 6 during the 3rd Reporting Period

Deliverable 6.3.3: Final report on Contributions to Standards

D6.3.3 reviews all available standards to see which are the most suitable to use and build upon, and to describe the efforts during the lifetime of the project on the implementation and extension of the Geonetworking protocol, as well as on dissemination protocols. A summary table (table 15) for the objectives of the deliverable is shown below:

Table 15: Objectives of Deliverable 6.3

Objective to achieve	Task	Methodology
Traffic information exchange	Setting a common set of data exchange specifications	Use of DATEX II standard
Network management	Interoperability of road traffic management systems	Further development of the DVM-Exchange standard
V2X communication (SAE J2735, SAE 2945)	Support for application processes	DRSC message sublayer
V2V multi-hop vehicle communication	Georouting capabilities	Extensions to the Geonetworking protocol (IEEE 1609.3)
V2V network-wide communication	Network-wide broadcasting	A better alternative than IETF RFC3626

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 include 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 are to be accomplished. Moreover, the Administrative Manager gives continuous support to the entire consortium during the preparation of the 3rd periodic report and the final report.

2.7.3 Project management activities during the current reporting period

- Maintained management structures to facilitate planning and coordination of project activities and quality management
- Monitored all contractual, financial and administrative issues
- Ensured effective communication within the consortium and with the Commission and other external stakeholders
- Organisation of the 3rd periodic report and the final report

Consortium tasks and achievements

The project coordination office made use of the already established reporting structures to accomplish project controlling by eliciting quarterly reports on activities from all partners. Also the established communication infrastructure had been used during the last year of the project to support regular exchange between partners and work packages.

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

The coordination team has hosted quarterly telephone conferences to assess progress.

An internal review process was organised for the completion of the deliverables due on months 36.

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

The project coordinator has also maintained regular contact with the External Advisory Board (EAB) to update them regarding project events and progress. EAB meetings were held on yearly basis and during those meetings, each work package and the corresponding deliverables were presented to advisors to seek their comments through detailed discussions. The comments from advisors were noted by each WP leader and subsequently the deliverables were revised accordingly. EAB members also gave useful suggestions in terms of problems related to data acquisition and field trials.

Deliverables due in Reporting Period 3

D 7.4 Final 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:

- The Administrative Manager changed at LUH from Georgia Kache to Sonja Alles.
- At Trinité the PI changed from Marcel Morssink to Youssef Bahara

List of project meetings, dates and venues:

The below table 16 gives an overview of the major project meetings held in Reporting Period 3. Agendas, meeting minutes, participant lists and presentations can be found in the password-protected groupware platform under http://147.172.223.242/bscw/.

Table 16: Overview of face-to-face project meetings RP3

Overview of Project Coordination Meetings RP3	
2nd Technical Review Meeting, Brussels, Belgium	31.10.2013
I. General Assembly and Steering Committee Meeting, Brussels, Belgium	01.11.2013
II. General Assembly and Steering Committee Meeting, Berlin, Germany	23.-24.01.2014
III. General Assembly and Steering Committee Meeting, Nicosia, Cyprus	10.-11.04.2014
IV. General Assembly and Steering Committee Meeting, Copenhagen, Denmark	03.-04.07.2014

In addition, several informal work package meetings and teleconferences have been held to facilitate the communication concerning tasks / deliverables / milestones (see table 17).

Table 17: Overview of telephone conferences RP 3

Overview of telephone conferences RP3	
Telephone conference 1	18.09.2013
Telephone conference 2	16.10.2013
Telephone conference 3	26.02.2014
Telephone conference 4	21.05.2014

I. General Assembly and Steering Committee Meeting in Brussels, Belgium 01.11.2013

1. Attendance

Participants

- UHI: Lars Schmidt-Thieme (WP2, WP7)
- AAU: Kristian Torp (WP3)
- TRI: Marcel Morssink (WP4, WP6)

- TRI: Nikos Makris (WP5, replacement for UTH member)

Observers:

- UHI: Josif Grabocka
- UHI: Umer Khan
- AU: Christian Jensen
- TrainOSE: Athanasios Lois
- TrainOSE: Alexandros Dalkalitsis
- FlexDenmark: Nick Christiansen

Missing

- DDE representative

2. Minutes of Meeting

- Topic 1: Decide on the reviewers' proposal regarding a pre-final review. The majority of the partners voted in favour of not deviating the schedule of the project and the deliverables from the Description of Work.

- Topic 2: Forthcoming Deliverables: Assigning Internal Reviewers
    - Coordinator will ask the rescheduling of D5.3 to M36.
    - If partners agree to the pre-final review, then the internal deadline of M36 deliverables is shifted to M33 (end of May 2014).
    - The assignment of internal reviewers for the forthcoming deliverables is agreed.

- Topic 3: Accepting and finalising the dates of the forthcoming plenary meetings Berlin meeting: EAB meeting agreed on 22/01/2014, plenary meeting on 23-24/01/2014
    - Nikosia meeting: Plenary meeting agreed on 10-11/04/2014
    - Copenhagen meeting, Conditionally:
        - If pre-review meeting is approved by partners, then tentative dates for 3rd pre-final review and plenary meetings are 2-3-4/07/2014.
        - If pre-review is not approved by partners, then plenary meeting is scheduled on 3-4/07/2014.

II. General Assembly and Steering Committee Meeting in Berlin, Germany, 23.-24.01.2014

1. Attendance

Participants

- Dimitrios Katsaros, UTH, Acting Leader of WP-I, Leader of WP-V
- Lars Schmidt-Thieme, UHI, Leader of WP-II, Leader of WP-7
- Kristian Torp, AAU, Leader of WP-III
- Marcel Morssink, TRI, Leader of WP-IV, WP-VI
- Athanasios Lois, TrainOSE
- Niels Tvilling Larsen, FlexDenmark
- Kyriakos Mouskos, CTL
- Christian Jensen, AU

Observers

- Josif Grabocka, UHI
- Umer Khan, UHI
- Alexandros Dalkalitsis, TrainOSE
- Nick Christiansen, FlexDenmark
- Andreas Gregoriades, CTL
- Daphne Van Leeuwen, TRI

Missing partners: Delphi representative

2. Minutes of Meeting

- Topic 1: Agree on the minutes of SCM on 01 November 2013, held in Brussels.
    - Participants agreed to the MoM of the Brussels meeting held on 1st November 2013.
- Topic 2: Decide on the reviewers' proposal regarding a pre-final review
    - The majority of the partners voted in favour of not deviating the schedule of the project and the deliverables from the Description of Work.
- Topic 3: The format of future teleconferences: on the necessity of presentations

o Partners agreed to prepare a progress presentation per each work package and present it during the teleconference

o The WP lead is responsible for collecting the contributions of the partners inside his/her WP.

- Topic 4: Decide the dates of future teleconferences

o UHI will provide a Doodle with the alternative dates of forthcoming presentations

- Topic 5: Quality of future deliverables

o Partners agreed to prepare a project description and a deliverable reading guideline

o A review form will be provided by UHI and partners will use it during the review of revised deliverables.

- Topic 6: Commitment of Delphi

o Coordinator to discuss the commitment of DDE for reworking the deliverables to be revises

o In case DDE doesn't commit then UTH takes over responsibilities related to standards.

III. General Assembly and Steering Committee Meeting in Nicosia, Greece, 10.-11.04.2014

1. Attendance

Participants:

- Adalbert Mika Kurosawa, DDE, Acting Leader of Work Package I
- Lars Schmidt-Thieme, UHI, Leader of Work Package II, VII
- Benjamin Krogh, AAU, Acting Leader of Work Package III
- Daphne Van Leuwen, TRI, Acting Leader of Work Package IV, VI
- Dimitrios Katsaros, UTH, Leader of Work Package V

Observers:

- Josif Grabocka, UHI
- Umer Khan, UHI

- Athanasios Lois, TrainOSE
- Alexandros Dalkalitsis, TrainOSE
- Kyriakos Mouskos, CTL
- Andreas Gregoriades, CTL
- Mike Ma, AU

Missing Partners: FlexDenmark

2. Minutes of the Meeting

- Topic 1: Partners agreed to the Minutes of the previous SCM, held in Berlin, 22/01/2014
- Topic 2: DDE accepted to transfer funds to UTH as a remuneration to UTH for 2PM costs (in UTH's PM scale), following the preparation of D6.3.2 by UTH
    - As a consequence, the coordinator will ask approval from the PO for the transfer of funds
    - In addition, UTH and DDE agreed that the next standards deliverable D6.3.3 (due M36) be prepared by UTH. As a result, DDE will transfer 2 PM funds (UTH's PM scale) in recompense to the efforts of preparing D6.3.3.
    - Overall, DDE is to transfer 4 PM (UTH's PM scale) funds to UTH for D6.3.2 and D6.3.3
    - Furthermore, DDE should contact the PO and explain that the level of detail for the final exploitation deliverable is limited due to marketing confidentiality.
- Topic 3: New partner representatives were introduced: Peter Störmer (DDE), Sonja Alles (LUH), Youssef Bahara (TRI).
- Topic 5: Coordinator will ask if booking a workshop at ITS World Congress is feasible (Detroit, September 2014). Otherwise, the next agreed possibility is to participate to organize a workshop in an ITS conference in Cyprus, end of June 2014.
- Topic 6: Partners agreed to reply with the financial spending until 07.05.2014.
- Topic 7: CTL and DDE agreed to submit the quarterly reports to Sonja Alles as soon as possible.

IV. General Assembly and Steering Committee Meeting in Copenhagen, Denmark, 03.-04.07.2014

1. Attendance

Participants:

- Sven Kopetzki, DDE, Acting Leader of Work Package I
- Lars Schmidt-Thieme, UHI, Leader of Work Package II, VII
- Kristian Torp, AAU, Acting Leader of Work Package III
- Daphne Van Leuwen, TRI, Acting Leader of Work Package IV, VI
- Dimitrios Katsaros, UTH, Leader of Work Package V

Observers:

- Josif Grabocka, UHI
- Umer Khan, UHI
- Alexandros Dalkalitsis, TrainOSE
- Kyriakos Mouskos, CTL
- Bin Yang, AU
- Niels Tvilling Larsen, FlexDanmark
- Casper Jul Nielsen, FlexDanmark
- Nick Christiansen, FlexDanmark
- Sonja Alles, LUH
- Ove Andersen, AAU

Missing Partners: None

2. Minutes of the Meeting

- Topic 1: Partners agreed to the Minutes of the previous SCM, held in Nikosia,11/04/2014
- Topic 2:
    - o DDE will check the status of funds' underspending for the period 01/09/2011-31/08/2014. Sven Kopetzki to respond with a status until 11/07/2014.

o AAU, UHI, FlexDanmark, AU, CTL report to likely overspend and therefore to be able to accommodate/intake extra funds resulting from the underspending of other partners.

o Other partners to consider the option of taking over extra funds resulting from underspending until 11/07/2014.

o Scheduling the Review Meeting:

o Coordinator proposes to the PO that the draft Yearly and Final reports are submitted until end of September 2014 and the review meeting is held within Mid-till-End of October 2014.

o The preferred location was agreed to be Aalborg, Denmark, due to the proximity to the technical facilities for demonstration purposes.

- Topic 3: Use-case partners agreed to provide feedback for the concrete summary findings of their studies, such that UTH can incorporate them into a Work Package Summary.

- Topic 4: A project workshop was agreed to not be organised due to the lack of important ITS venues until the end of the project (31/08/2014).

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

After consultation with the PO Deliverable 5.3 has been submitted at month 36.

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 was updated regularly to feature current and upcoming events. Publications were 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 and kept up to date 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.

On April 30, 2014, the coordinator participated and presented in a workshop organised in Brussels among other EU FP7 ICT call projects with a focus on ICT Emission modelling and Multimodal optimisation. The agenda of the workshop is given in table 18.

The REDUCTION project presented the consortium and the field-trials of the project. Throughout the meetings there were interesting talks on different perspectives of introducing the ecological aspects for transportation. Those approaches, among others, included eco- routing, eco-driving, eco-incentives, and efficient modelling of fuel consumption/emissions.

The workshop was hosted by the iMobility forum and the following projects participated:

1. COLOMBO
2. AMITRAN
3. REDUCTION
4. CARBOTRAF
5. ICT-EMISSIONS
6. SIMPLICITY
7. MOBINET
8. e-COMPASS
9. PEACOX
10. SUPERHUB
11. TEAM
12. DECOMOBIL
13. GET SERVICE
14. MODUM

Table 18: Agenda of the European Commission Concertation Workshop in Brussels

08:30-09:00	*Registrations and coffee*	
09:00 – 09:10	**Opening & objectives of the EC concertation workshop** *Stefanos Gouvras, European Commission, DG CONNECT*	
09:10 – 10:30	**1) Parallel session streams: EC Project presentations**	
	<u>**ICT Emission modelling**</u> *Moderator : Irmgard Heiber, European Commission, DG CONNECT* *Rapporteur: Andre Winder, ERTICO – ITS EUROPE* 5 minutes presentations of ecoDriver , COLOMBO, AMITRAN, REDUCTION, CARBOTRAF, ICT-EMISSIONS	<u>**Multimodal optimisation modelling**</u> *Moderator: Stefanos Gouvras, European Commission, DG CONNECT* *Rapporteur: Paul Kompfner, ERTICO -ITS EUROPE* 5 minutes presentations of MOBINET, e-COMPASS, PEACOX, SUPERHUB, TEAM, SIMPLI_CITY, DECOMOBIL, MOBIS, GET SERVICE, MODUM
10:30 – 12:30	**2) Parallel discussion streams: Modelling techniques**	
	<u>**ICT Emission modelling**</u> *Moderator : Irmgard Heiber, European Commission, DG CONNECT* *Rapporteur: Andrew Winder, ERTICO – ITS EUROPE*	<u>**Multimodal optimisation modelling**</u> *Moderator: Stefanos Gouvras, European Commission, DG CONNECT* *Rapporteur: Paul Kompfner, ERTICO-ITS EUROPE*
12:30- 13:30	***Lunch break***	
13:30 – 15:00	**3) Parallel discussion streams: Problems / highlights / synergies with projects**	
	<u>**ICT Emission modelling**</u> *Moderator : Irmgard Heiber, European Commission, DG CONNECT* *Rapporteur: Andre Winder, ERTICO – ITS EUROPE*	<u>**Multimodal optimisation modelling**</u> *Moderator: Stefanos Gouvras, European Commission, DG CONNECT* *Rapporteur: Paul Kompfner, ERTICO -ITS EUROPE*
15:00 : 15 :30	***Conclusions from Moderators and Rapporteurs***	

The REDUCTION project presented the consortium and the field-trials of the project. Throughout the meetings there were interesting talks on different perspectives of introducing the ecological aspects for transportation. Those approaches, among others, included eco-routing, eco-driving, eco-incentives, and efficient modelling of fuel consumption/emissions.

Moreover, the REDUCTION project participated in the final event of the interacIVE and EcoMove projects held in Aachen, Germany, on November 20-21, 2013. The REDUCTION participant shared with other projects their insights into ecological fuel saving through eco-routing and eco-driving.

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 **second EAB of the REDUCTION project** was held in Berlin, 22/01/2014 (during the 3rd reporting period), 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

Deliverables indicated in blue within table 19 have been prepared during the 3rd reporting period.

Table 19: 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	1	3	3. AAU	R	PU	29.02.2012	Month 6	Done	Yes	

	specification, data-flow analysis and the 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 algoriothms	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 framework	1	4	6. TRI	R	PU	31.08.2012	Month 12	Done	Yes	
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 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 5.2	Report on	1	5	2. UTH	R	PU	28.02.2013	Month 18	Done	Yes	

	collective evaluation from field-trials in Phase 1										
D 2.4	Report with localized motion prediction algorithms in vehicular environments	1	2	2. UTH	R	PU	30.04.2013	Month 20	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 on advanced predictive analytics models	1	2	1. UHI	R	PU	31.08.2013	Month 24	Done	Yes	
D 3.4	Prototype of advanced highperformance eco-route methods	1	3	4. AU	P	PU	31.08.2013	Month 24	Done	Yes	
D 4.3.1	Report on second pilot (to be used for field study 2)	1	4	6. TRI	R	PU	31.08.2013	Month 24	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	1	6	6. TRI	R	PU	31.08.2013	Month 24	Done	Yes	

	on Exploitation										
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	
D 1.4.2	Test report with communication between the Bluetooth detectors and the in-car system or smart phones	1	1	6. TRI	R	PU	28.02.2014	Month 32	Done	No	After consultation with PO shifted to Month 32
D 5.3	Report on collective evaluation from field-trials in	1	5	2. UTH	R	PU	30.04.2014	Month 36	Done	No	After consultation with PO shifted to Month 36

	Phase 2										
D 2.3.2	Report on advanced predictive analytics models	1	2	1. UHI	R	RE	31.08.2014	Month 36	Done	Yes	
D 3.5	Final versions of prototypes	1	3	4. AU	P	RE	31.08.2014	Month 36	Done	Yes	
D 4.3.2	Report on second pilot (to be used for field study 2)	1	4	6. TRI	P	PU	31.08.2014	Month 36	Done	Yes	
D 4.4	Market-ready product	1	4	6. TRI	R	RE	31.08.2014	Month 36	Done	Yes	
D 6.1.3	Final report on Dissemination	1	6	4. AU	R	PU	31.08.2014	Month 36	Done	Yes	
D 6.2.3	Final report on Exploitation	1	6	6. TRI	R	PU	31.08.2014	Month 36	Done	Yes	

D 6.3.3	Final report on Contributions to Standards	1	6	5. DDE	R	PU	31.08.2014	Month 36	Done	Yes	
D 7.4	Final report	1	7	1. UHI	R	PU	31.08.2014	Month 36 + 60 days	Done	Yes	

3.2 Milestones

Milestones indicated in blue within table 20 have been accomplished during the 3rd reporting period

Table 20: 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	
MS4	Field Trials for Phase 2	WP 5	2. UTH	Month 32	Yes	Month 32	

MS5	Final System	WP 1, WP 2, WP 3, WP 4	6. TRI	Month 36	Yes	Month 36	

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 the 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)3.

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 (see section 5, table 26).

[3] 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.

An overview of the project progress is given in table 21 (Gantt Chart). An overview of the human and financial resources of the REDUCTION project over the reporting period 3 as well as the total life time is given in the figures and tables below (order as specified below):

Table 22: PM Expenditure for Year 3 (planned vs actual)

Figure 23: PM per WP for Year 3 (planned vs actual)

Figure 24: PM per partner for Year 3 in %

Table 23: Total PM Expenditure for Years 1 + 2+3 (planned vs actual)

Figure 25: PM per WP for Year 1+2+3 (actual vs planned)

Figure 26: PM per partner for Year 1+2+3 in %

Figure 27: EC Contribution per partner in Year 3 in %

Figure 28: EC Contribution per partner in Year 1, 2, 3 in %

Table 24: Actual costs used vs planned per WP and partner (Year 3, in Euro)

Figure 29: Actual costs per partner (year 3, in %)

Figure 30: Actual costs per WP in Euro (actual and planned, year 3)

Table 25: Actual costs used vs planned per WP and partner (Year 1+2+3, in Euro)

Figure 31: Actual costs per partner (year 1+2+3, in %)

Figure 32: Actual costs per WP in Euro (Year 1+2+3, actual vs planned)

Table 21: 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 22: PM Expenditure for Year 3 (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:	23,78	0,00	0,00	4,31	4,97	0,00	6,30	7,83	0,00	0,00	0,38
		Planned PM total duration:	10,41	0,00	0,00	0,93	2,00	3,00	2,40	1,70	0,00	0,00	0,38
WP2	Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation	Actual PM current total:	21,54	12,00	0,00	3,21	0,00	2,00	0,00	3,03	0,00	1,00	0,30
		Planned PM total duration:	9,30	7,00	0,00	0,00	0,00	1,00	0,00	0,00	0,00	1,00	0,30
WP3	Data Management for Environment Aware Routing and Geo-Locational Analysis Application	Actual PM current total:	30,27	0,00	0,00	3,30	11,44	12,50	0,00	2,67	0,00	0,00	0,37
		Planned PM total duration:	18,09	1,00	0,00	1,36	6,35	7,50	1,00	0,50	0,00	0,00	0,38
WP4	System Design & Integration	Actual PM current total:	38,10	0,00	0,00	14,24	5,01	0,00	0,00	17,45	0,00	1,00	0,40
		Planned PM total duration:	19,22	1,00	0,00	6,92	2,00	3,00	2,00	3,00	0,00	1,00	0,30
WP5	Case Studies for assessing Energy-Efficiency and CO2 Reduction	Actual PM current total:	49,60	7,00	0,00	6,96	6,11	3,00	0,00	8,16	9,29	3,95	5,14
		Planned PM total duration:	26,16	2,00	0,00	1,29	4,65	3,00	2,00	3,00	3,00	3,00	4,22
WP6	Dissemination, Exploitation, Standards	Actual PM current total:	24,74	6,00	0,00	0,00	2,20	2,00	0,00	11,41	2,69	0,00	0,44
		Planned PM total duration:	12,10	0,00	0,00	2,00	1,00	2,00	2,80	3,00	1,00	0,00	0,30
WP7	Project management	Actual PM current total:	10,20	4,00	4,96	0,14	1,03	0,00	0,00	0,07	0,00	0,00	0,00
		Planned PM total duration:	4,38	0,00	3,00	0,00	0,98	0,00	0,00	0,40	0,00	0,00	0,00
TOTAL PERSON MONTHS		Actual total:	198,23	29,00	4,96	32,14	30,76	19,50	6,30	50,62	11,98	5,95	7,02
		Planned total:	99,66	11,00	3,00	12,50	16,98	19,50	10,20	11,60	4,00	5,00	5,88

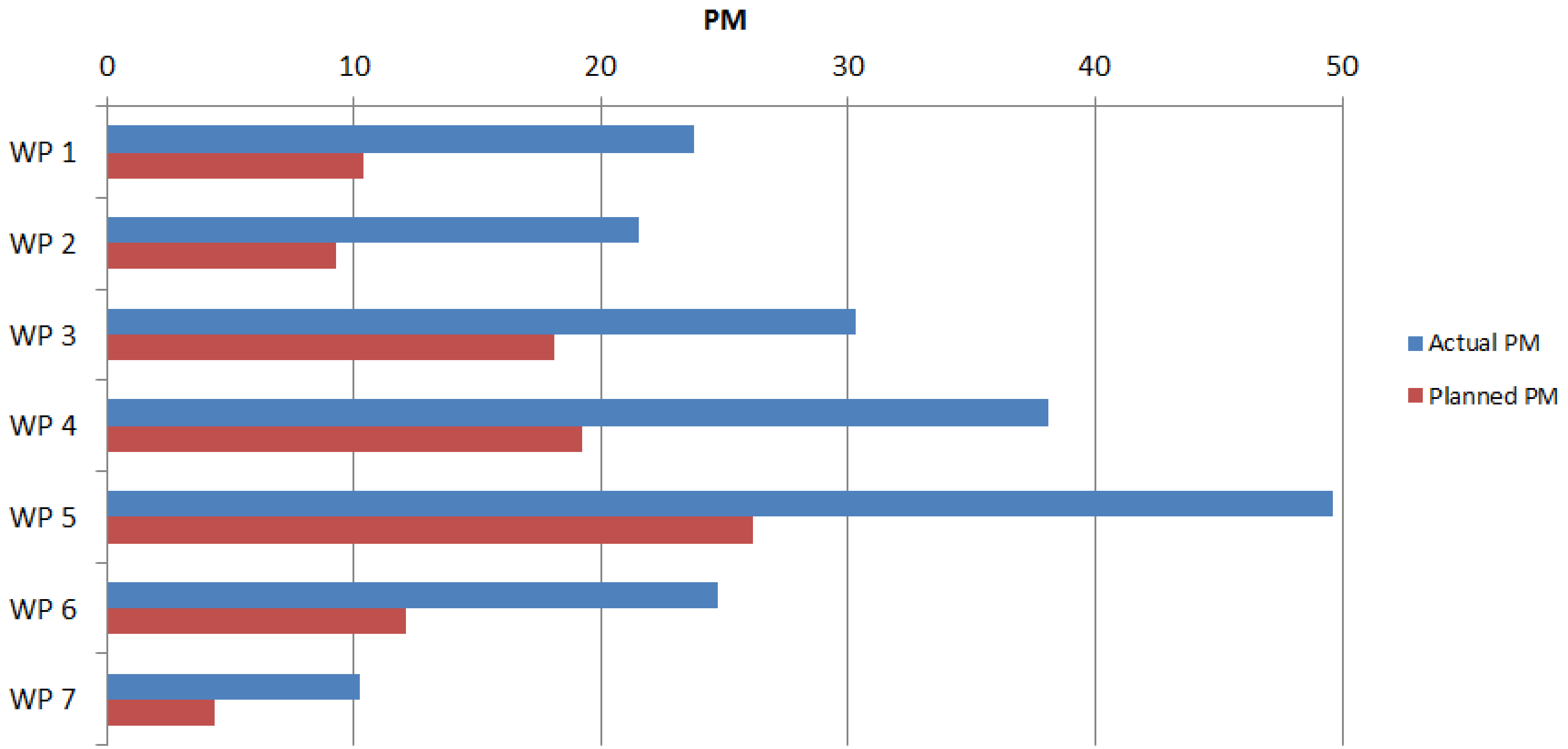

Figure 23: PM per WP for Year 3 (planned vs actual)

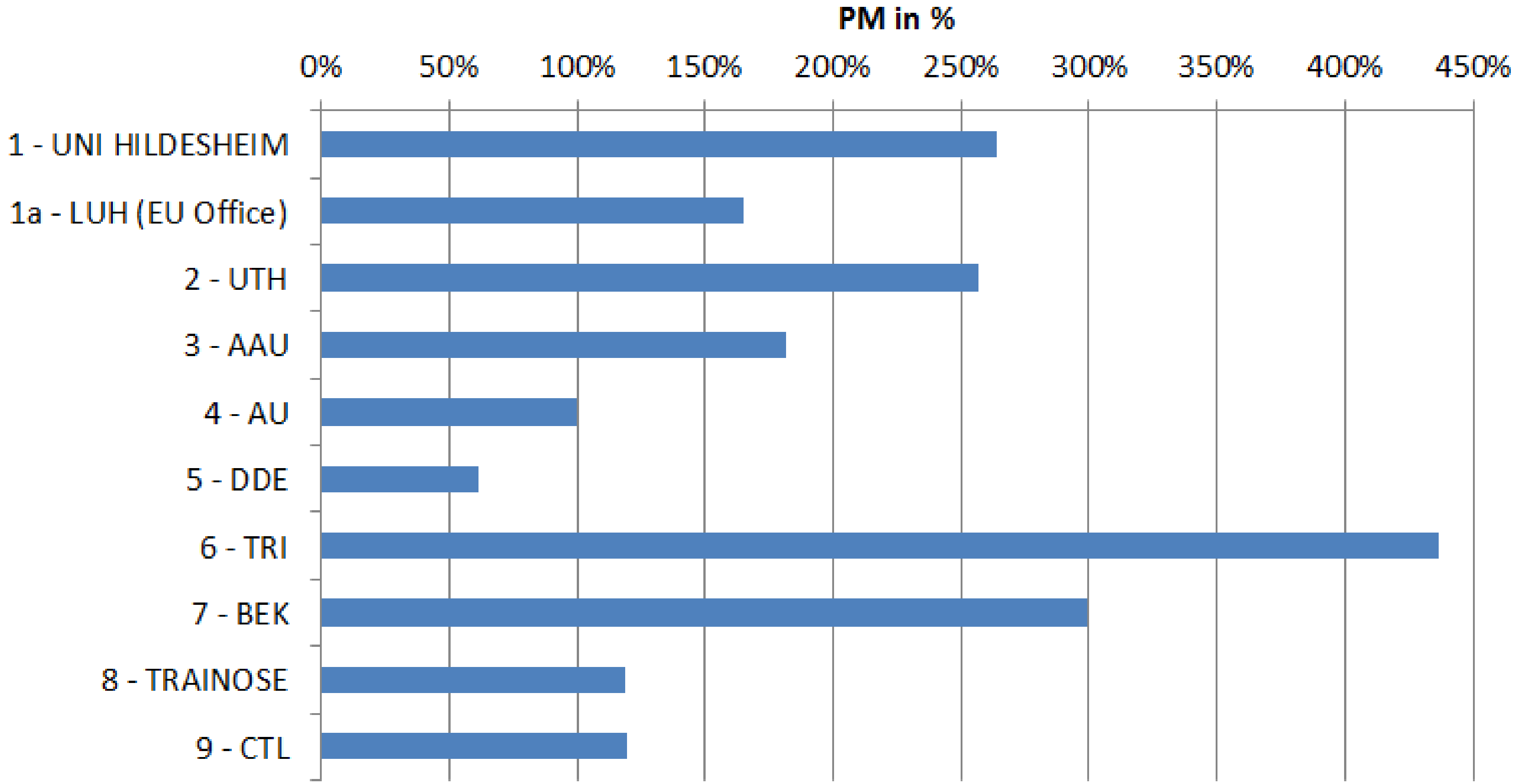

Figure 24: PM per partner for Year 3 in %

Table 23: Total PM Expenditure for Years 1 + 2+3 (planned vs actual)

Person Months per WP and per Partner												
		TOTALS	1 - UNI HILDESHEIM	1a - LUH (EU Offic	2 - UTH	3 - AAU	4 - AU	5 - DDE	6 - TRI	7 - BEK	8 - TRAINOSE	9 - CTL
Onboard Technology and Wireless Communication	**Actual PM current total:**	**88,45**	4,50	0,00	23,48	6,65	9,00	34,14	9,65	0,00	0,00	1,03
	Planned PM total duration:	**71,00**	3,00	0,00	20,00	6,00	9,00	25,00	5,00	1,00	1,00	1,00
Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation	**Actual PM current total:**	**62,36**	39,50	0,00	5,89	0,00	8,00	0,00	7,00	0,00	1,00	0,97
	Planned PM total duration:	**42,00**	26,00	0,00	3,00	0,00	8,00	0,00	3,00	0,00	1,00	1,00
Data Management for Environment Aware Routing and Geo-Locational Analysis Application	**Actual PM current total:**	**113,39**	4,00	0,00	7,78	36,57	54,00	0,00	4,12	5,88	0,00	1,05
	Planned PM total duration:	**79,00**	3,00	0,00	6,00	24,00	36,00	3,00	2,00	3,00	1,00	1,00
System Design & Integration	**Actual PM current total:**	**90,94**	4,50	0,00	21,15	10,80	6,00	0,00	46,39	0,00	1,00	1,10
	Planned PM total duration:	**61,00**	3,00	0,00	16,00	4,00	6,00	4,00	26,00	0,00	1,00	1,00
Case Studies for assessing Energy-Efficiency and CO2 Reduction	**Actual PM current total:**	**105,08**	11,50	0,00	15,61	16,28	8,00	0,00	14,74	13,27	14,84	10,84
	Planned PM total duration:	**71,00**	5,00	0,00	5,00	10,00	8,00	5,00	6,00	10,00	12,00	10,00
Dissemination, Exploitation, Standards	**Actual PM current total:**	**38,94**	9,00	0,00	0,00	3,03	5,00	3,65	14,21	2,69	0,28	1,08
	Planned PM total duration:	**31,00**	2,00	1,00	3,00	3,00	5,00	8,00	6,00	1,00	1,00	1,00
Project management	**Actual PM current total:**	**20,26**	6,00	9,99	1,56	2,17	0,00	0,00	0,54	0,00	0,00	0,00
	Planned PM total duration:	**11,00**	0,00	8,00	1,00	1,00	0,00	0,00	1,00	0,00	0,00	0,00
PERSON MONTHS	**Actual total:**	**519,41**	**79,00**	**9,99**	**75,45**	**75,50**	**90,00**	**37,79**	**96,65**	**21,84**	**17,12**	**16,06**
	Planned total:	**366,00**	**42,00**	**9,00**	**54,00**	**48,00**	**72,00**	**45,00**	**49,00**	**15,00**	**17,00**	**15,00**

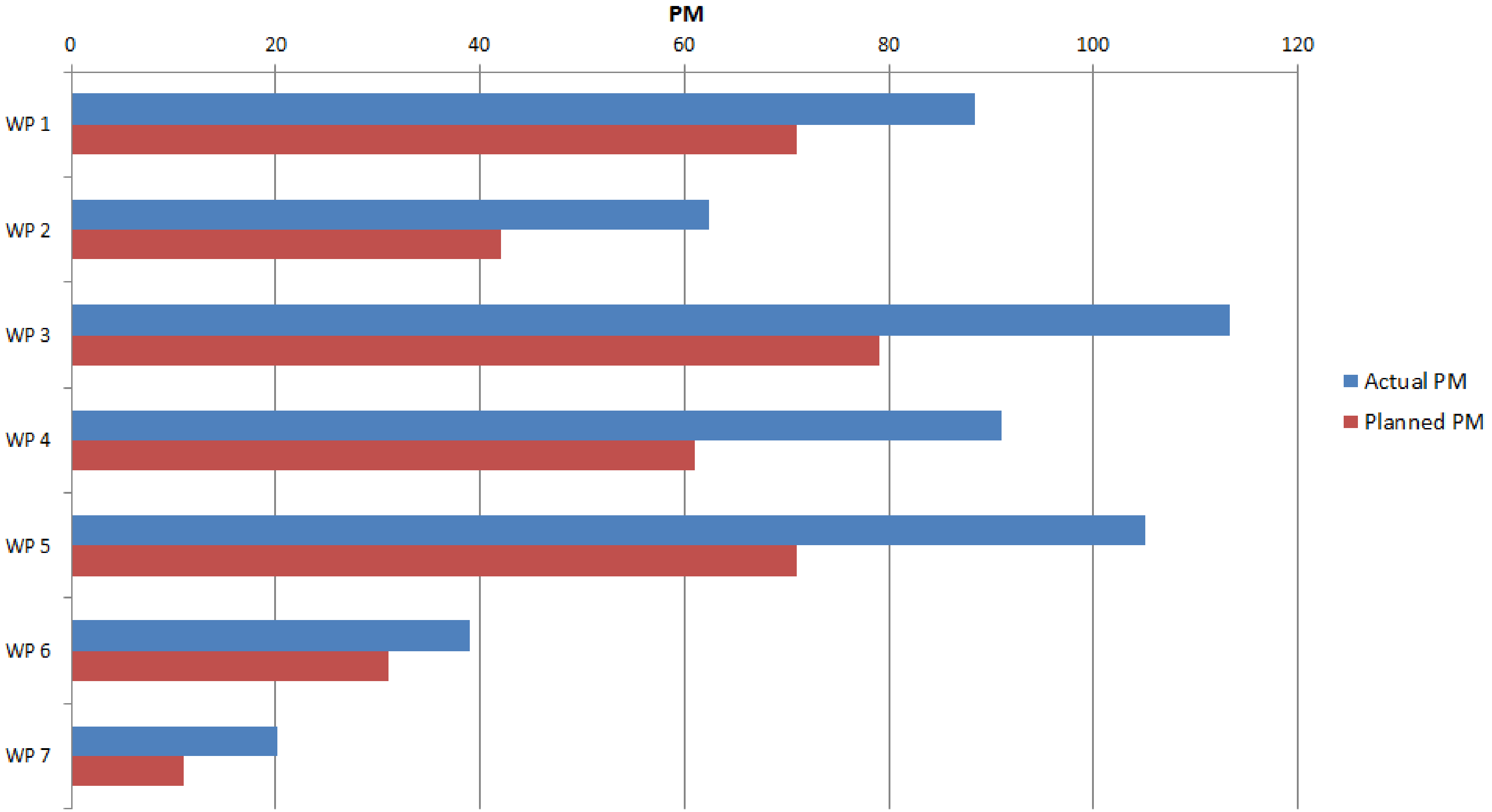

Figure 25: PM per WP for Year 1+2+3 (actual vs planned)

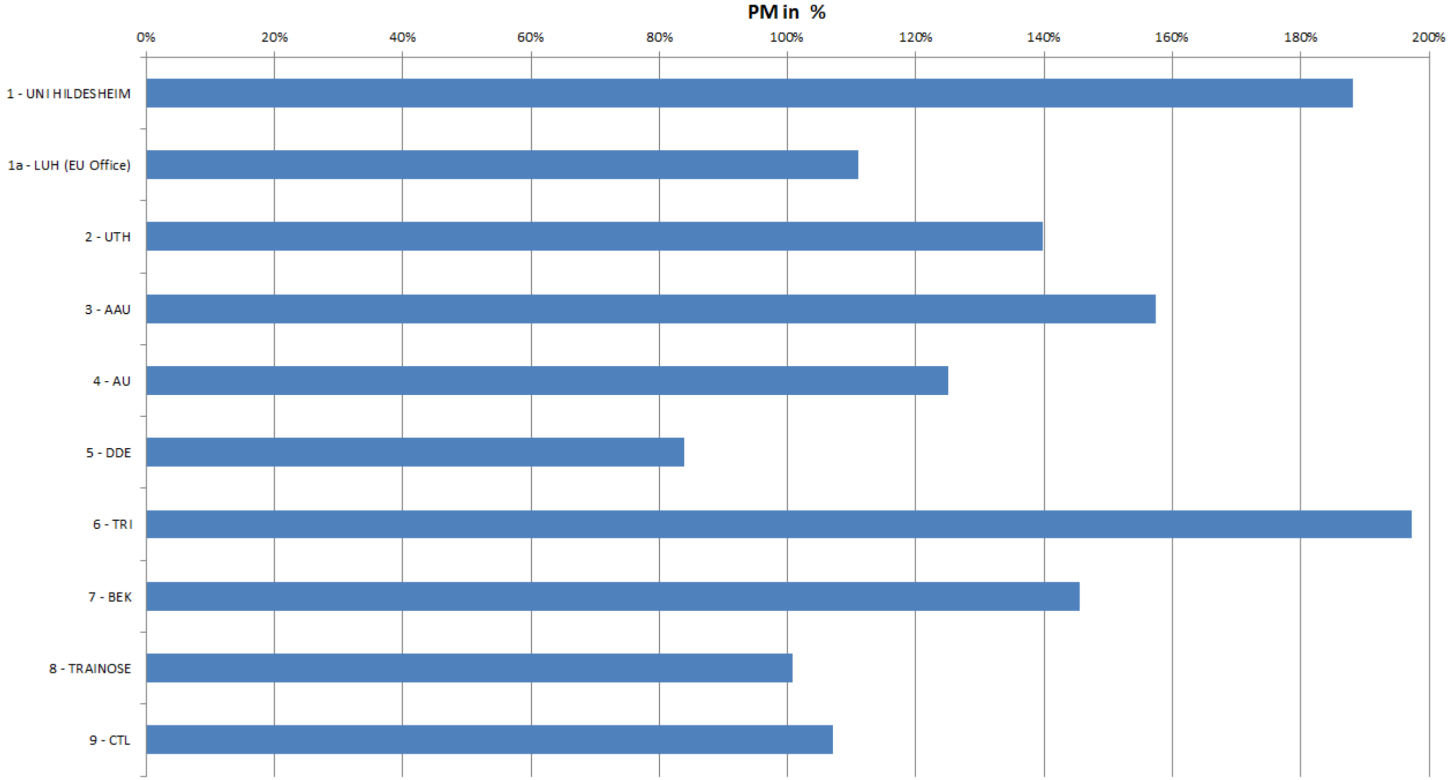

Figure 26: PM per partner for Year 1+2+3 in %

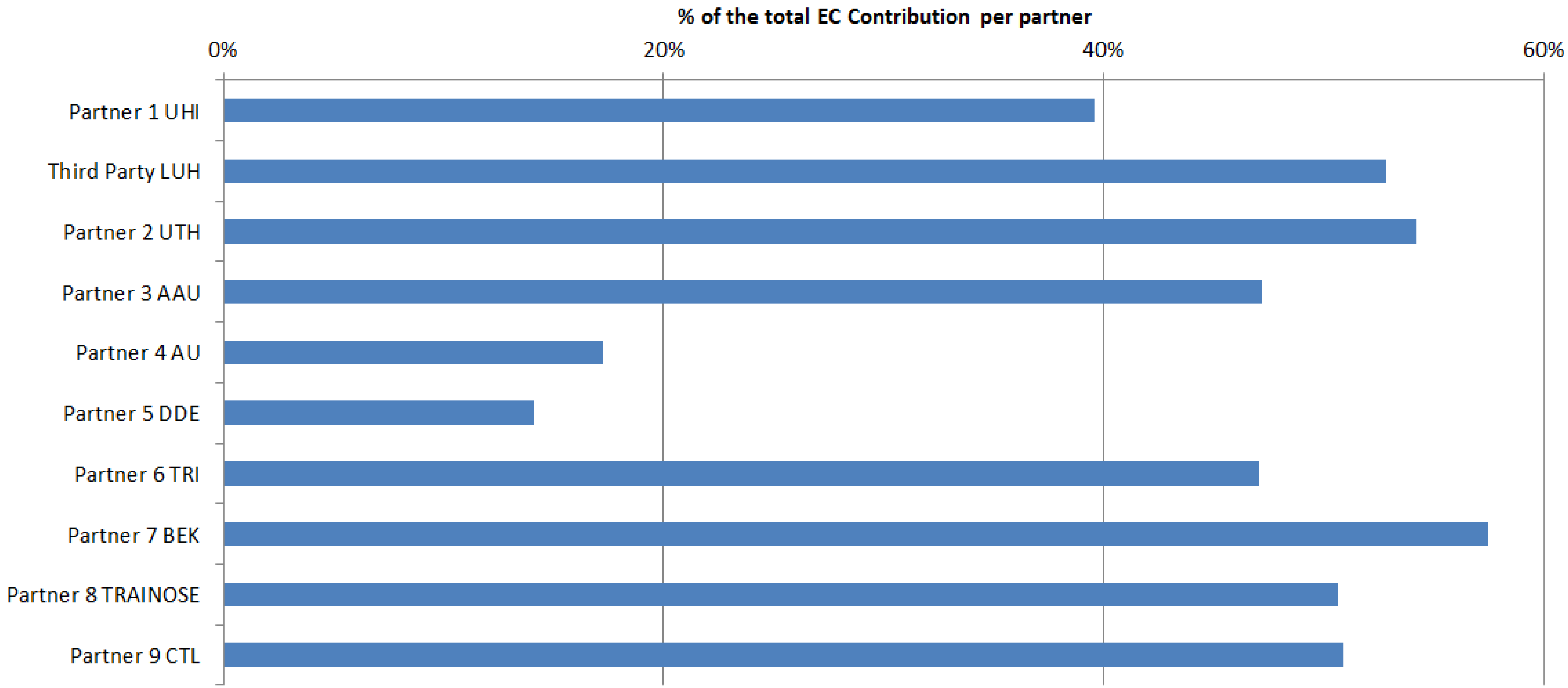

Figure 27: EC Contribution per partner in Year 3 in %

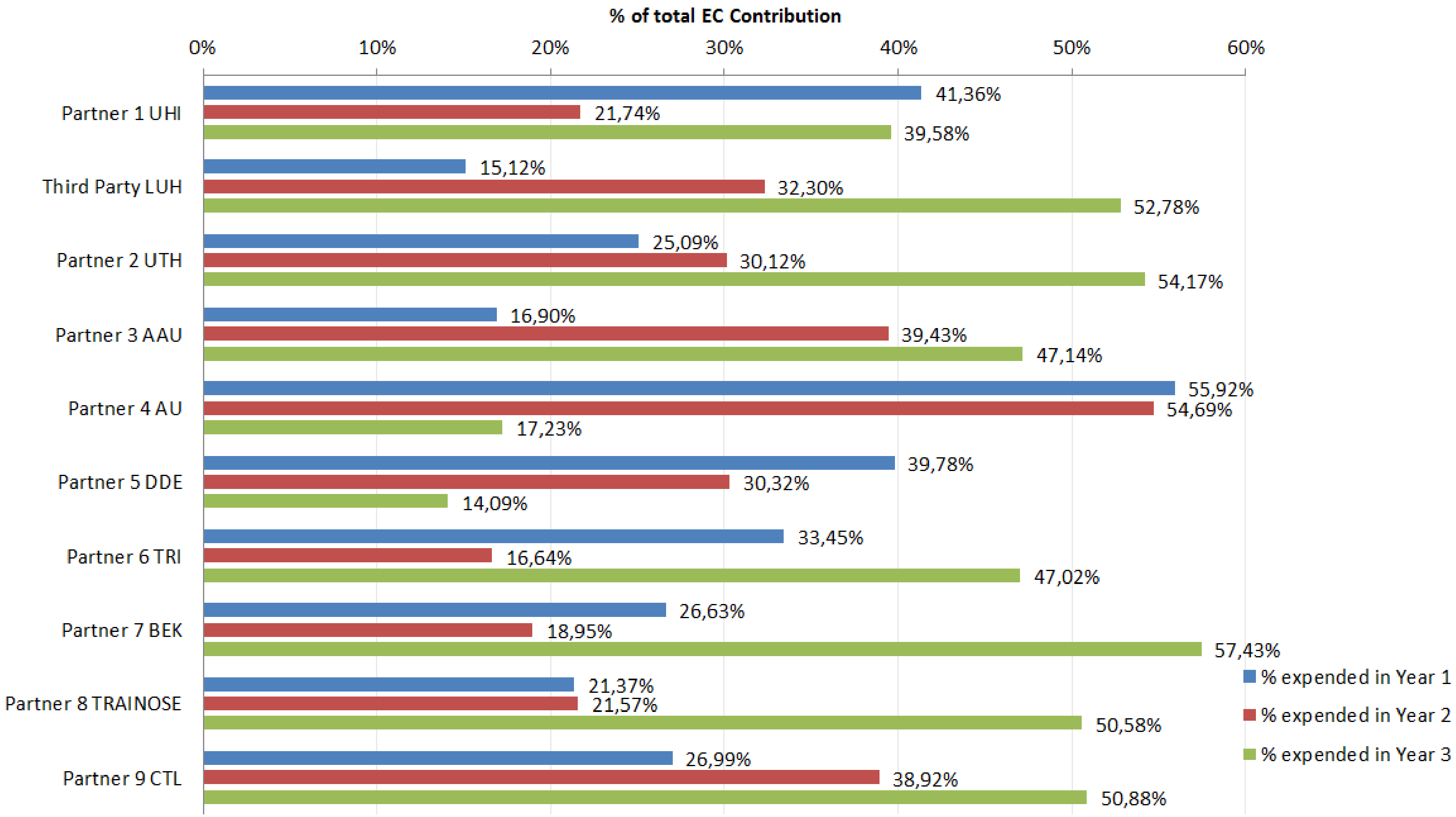

Figure 28: EC Contribution per partner in Year 1, 2, 3 in % - EC Contribution for Calculation not cut to 100%

Table 24: Actual costs used vs planned per WP and partner (Year 3, in Euro)

Resources 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 Resources current total:	**176.020**	0	0	25.439	36.414		68.012	43.430	0	0	2.724
		Planned Resources total duration:	**99.264**	0	0	9.152	25.988	10.252	27.501	24.401	0	0	1.970
WP2	Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation	Actual Resources current total:	**121.430**	73.123	0	9.000	0	11.040	0	20.519	0	5.400	2.349
		Planned Resources total duration:	**146.493**	132.600	0	0	0	3.417	0	0	0	8.920	1.555
WP3	Data Management for Environment Aware Routing and Geo-Locational Analysis Application	Actual Resources current total:	**121.837**	0	0	16.218	54.508	31.867	0	16.549	0	0	2.695
		Planned Resources total duration:	**161.075**	18.943	0	13.384	82.512	25.631	11.459	7.177	0	0	1.970
WP4	System Design & Integration	Actual Resources current total:	**185.685**	0	0	61.834	25.254	0	0	89.502	0	6.254	2.840
		Planned Resources total duration:	**199.735**	18.943	0	68.099	25.988	10.252	22.918	43.060	0	8.920	1.555
WP5	Case Studies for assessing Energy-Efficiency and CO2 Reduction	Actual Resources current total:	**226.356**	24.851	0	28.561	34.833	13.400	0	16.677	58.666	22.846	26.522
		Planned Resources total duration:	**282.902**	37.886	0	12.695	60.422	10.252	22.918	43.060	47.036	26.760	21.874
WP6	Dissemination, Exploitation, Standards	Actual Resources current total:	**119.387**	17.112	0	2.841	15.623	6.239	0	56.932	17.600	0	3.040
		Planned Resources total duration:	**131.889**	0	0	19.682	12.994	6.835	32.085	43.060	15.679	0	1.555
WP7	Project management	Actual Resources current total:	**79.393**	26.421	25.979	1.582	10.321	2.822	650	3.820	0	4.859	2.940
		Planned Resources total duration:	**40.496**	0	22.021	0	12.734	0	0	5.741	0	0	0
TOTAL RESOURCES		Actual total:	**1.030.109**	**141.507**	**25.979**	**145.475**	**176.954**	**65.366**	**68.662**	**247.431**	**76.266**	**39.359**	**43.110**
		Planned total:	**1.061.855**	**208.372**	**22.021**	**123.011**	**220.638**	**66.641**	**116.880**	**166.500**	**62.714**	**44.600**	**30.478**
		% Expended	**97,01%**	**67,91%**	**117,97%**	**118,26%**	**80,20%**	**98,09%**	**58,75%**	**148,61%**	**121,61%**	**88,25%**	**141,45%**

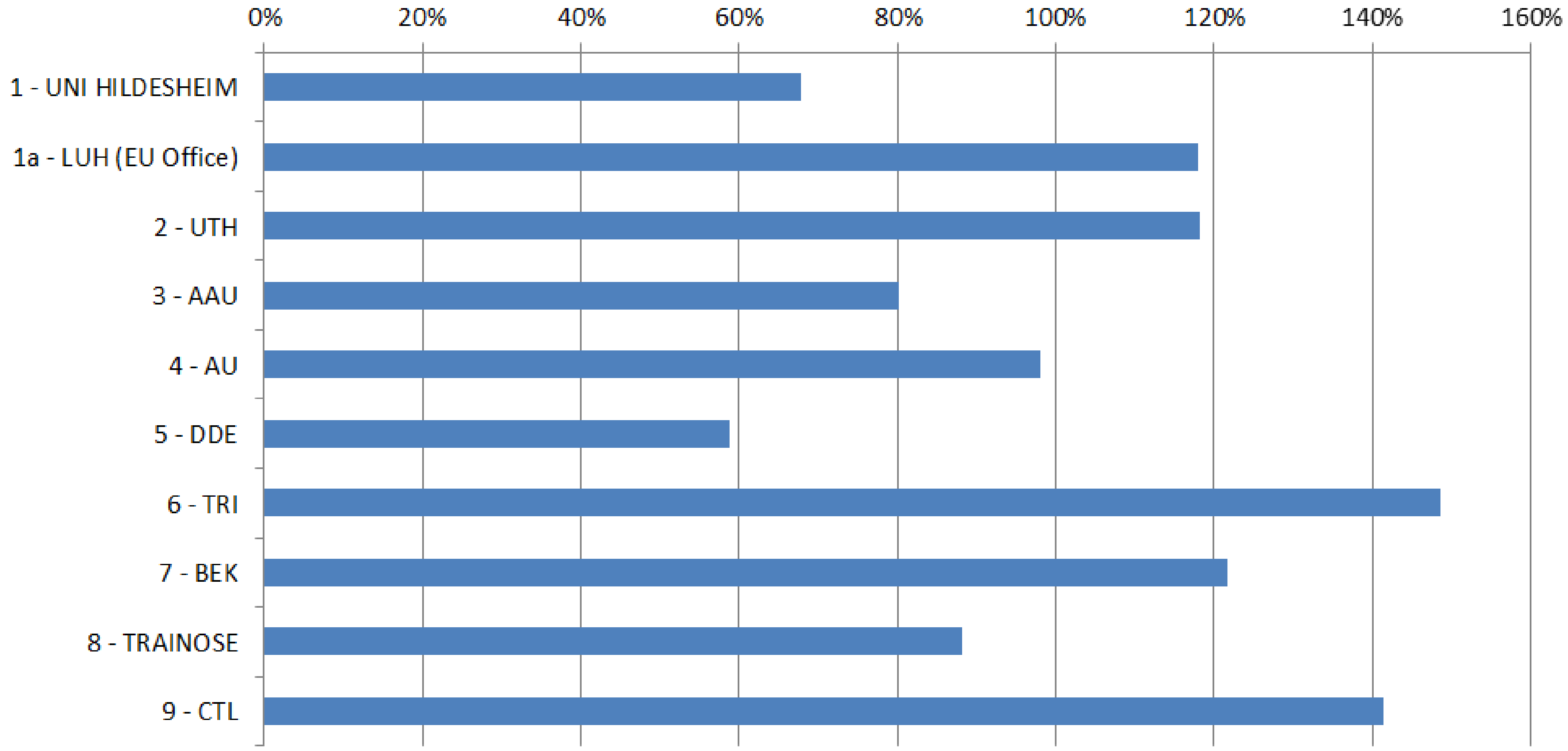

Figure 29: Actual costs per partner (year 3, in %) – 100% equals the planned status

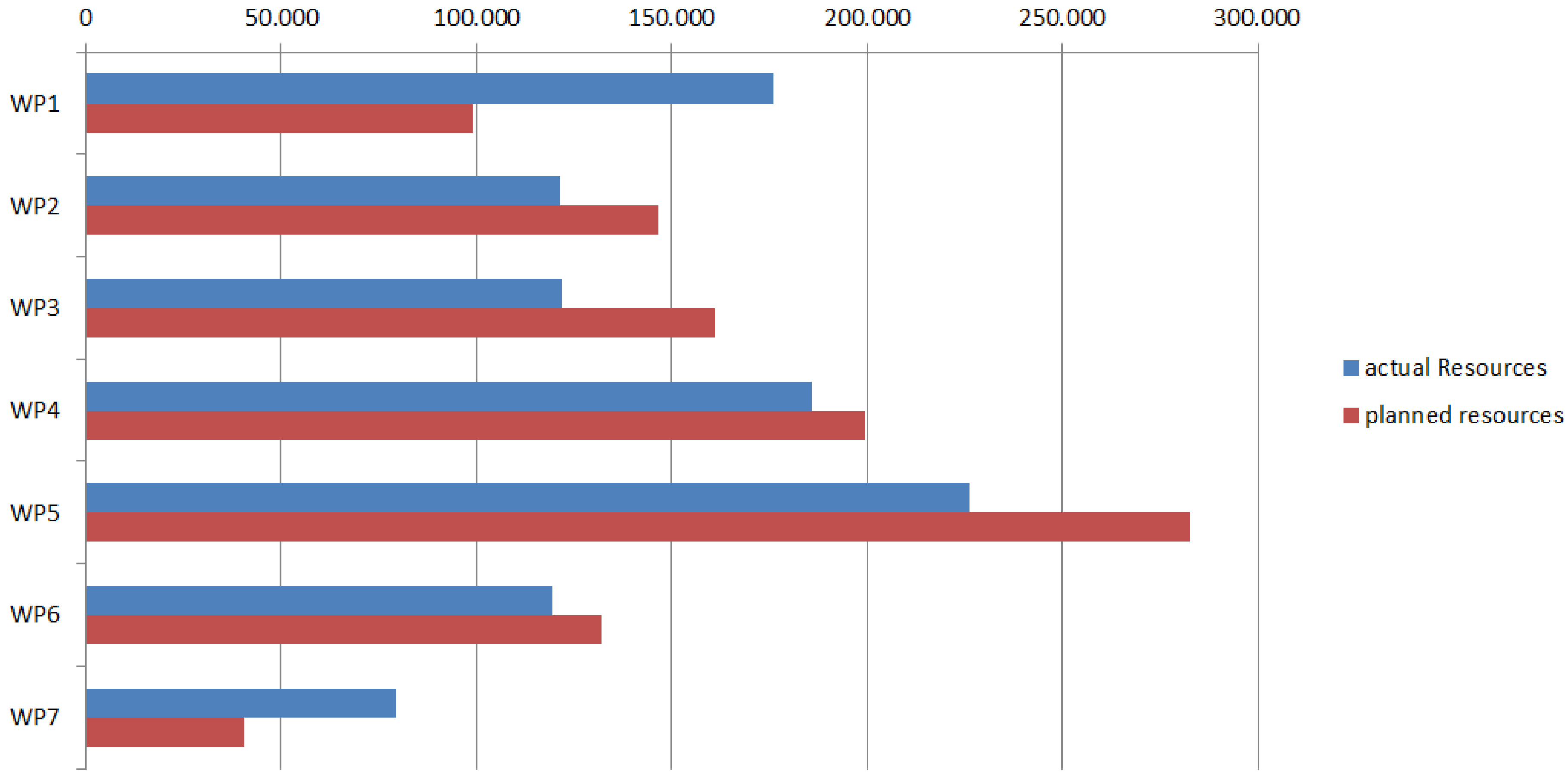

Figure 30: Actual costs per WP in Euro (actual and planned, year 3)

Table 25: Actual costs used vs planned per WP and partner (Year 1+2+3, in Euro)-Adjustments not taken into account

Resources per WP and per Partner for Years 1 + 2 + 3			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:	538.301,68	24.750,00	0,00	75.616,00	48.320,35	37.791,00	287.645,00	56.164,33	0,00	0,00	8.015,00
		Planned Resources total duration:	424.550,17	16.502,00	0,00	58.375,02	50.987,99	40.365,46	201.145,18	40.900,86	5.893,00	3.300,00	7.080,67
WP2	Predictive Analytics Models for Energy-Efficient Driving and Driver-Behaviour Adaptation	Actual Resources current total:	321.178,46	192.439,63	0,00	18.000,00	0,00	62.137,50	0,00	35.503,33	0,00	5.400,00	7.698,00
		Planned Resources total duration:	293.020,85	215.414,36	0,00	12.000,00	0,00	41.720,49	0,00	8.000,00	0,00	8.920,00	6.966,00
WP3	Data Management for Environment Aware Routing and Geo-Locational Analysis Application	Actual Resources current total:	565.879,05	20.642,00	0,00	33.498,00	155.477,07	287.622,65	0,00	25.150,33	35.359,00	0,00	8.130,00
		Planned Resources total duration:	500.487,73	30.270,91	0,00	31.770,60	161.811,86	207.550,15	24.904,82	17.676,72	15.893,00	3.300,00	7.309,67
WP4	System Design & Integration	Actual Resources current total:	491.128,80	23.487,00	0,00	90.516,00	68.084,41	25.510,00	0,00	268.915,33	0,00	6.254,06	8.362,00
		Planned Resources total duration:	462.160,24	32.760,91	0,00	113.605,89	41.484,99	23.887,46	36.363,65	198.060,34	0,00	8.920,00	7.077,00
WP5	Case Studies for assessing Energy-Efficiency and CO2 Reduction	Actual Resources current total:	479.398,92	47.623,98	0,00	66.806,00	78.808,13	46.079,50	0,00	52.194,33	74.398,00	54.790,98	58.698,00
		Planned Resources total duration:	501.634,25	53.066,82	0,00	27.186,74	83.894,07	42.932,46	43.086,65	57.060,34	87.035,50	53.260,00	54.111,67
WP6	Dissemination, Exploitation, Standards	Actual Resources current total:	180.970,47	30.534,41	0,00	2.841,00	20.975,98	20.047,75	10.085,00	69.227,33	17.600,00	1.731,00	7.928,00
		Planned Resources total duration:	211.537,28	9.100,00	4.000,00	19.681,76	23.862,99	20.643,97	52.254,71	56.560,34	15.678,50	3.300,00	6.455,00
WP7	Project management	Actual Resources current total:	130.094,20	34.928,00	49.315,67	6.357,00	17.425,00	2.822,00	650,00	10.798,00	0,00	4.858,53	2.940,00
		Planned Resources total duration:	74.700,49	0,00	45.221,00	2.880,00	12.858,11	0,00	0,00	13.741,38	0,00	0,00	0,00
TOTAL RESOURCES		Actual total (Year 1+2+3):	2.706.951,58	374.405,02	49.315,67	293.634,00	389.090,94	482.010,40	298.380,00	517.952,98	127.357,00	73.034,57	101.771,00
		Planned total (Year 1+2+3):	2.468.091,01	357.115,00	49.221,00	265.500,01	374.900,00	377.100,00	357.755,00	392.000,00	124.500,00	81.000,00	89.000,00
		% Expended	109,68%	104,84%	100,19%	110,60%	103,79%	127,82%	83,40%	132,13%	102,29%	90,17%	114,35%

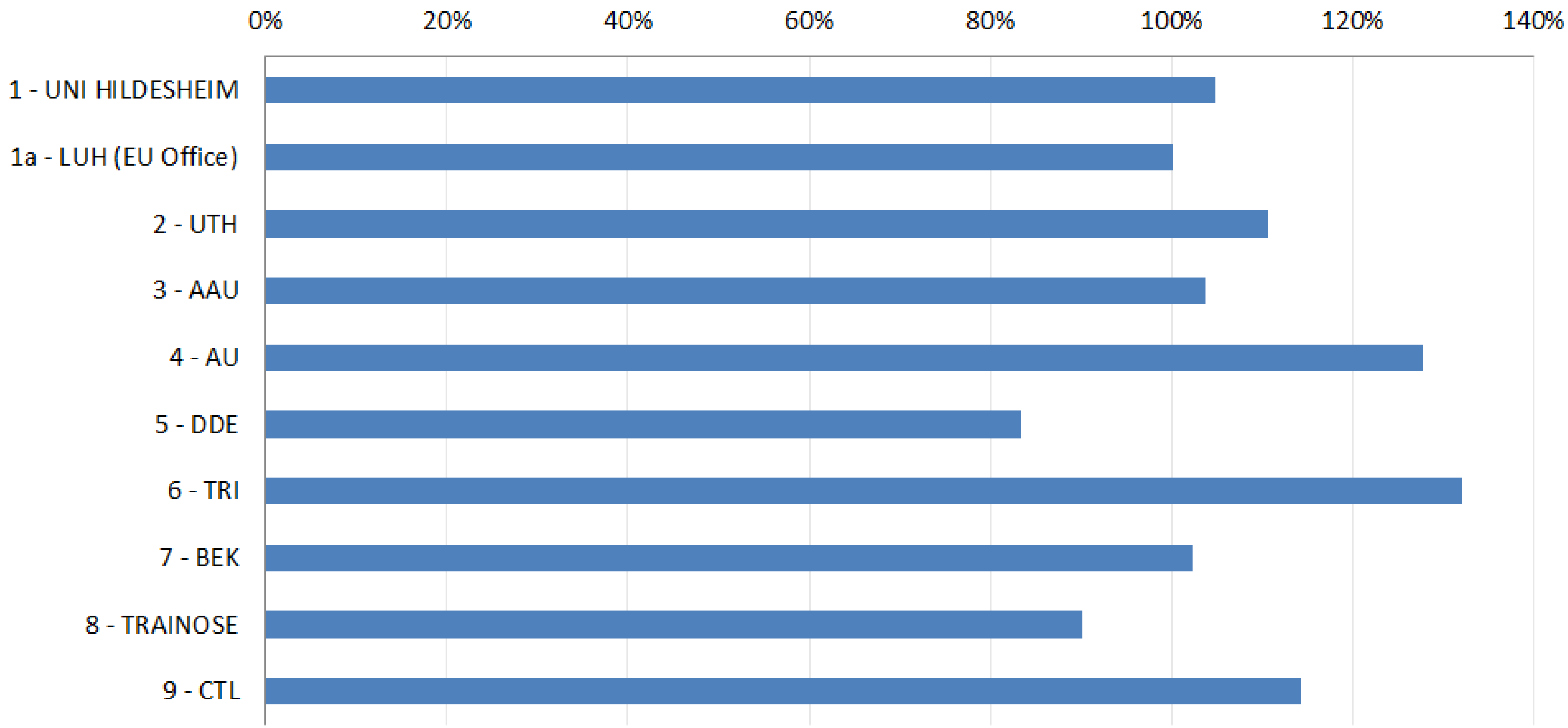

Figure 31: Actual costs per partner (year 1+2+3, in %) – 100% equals the planned status

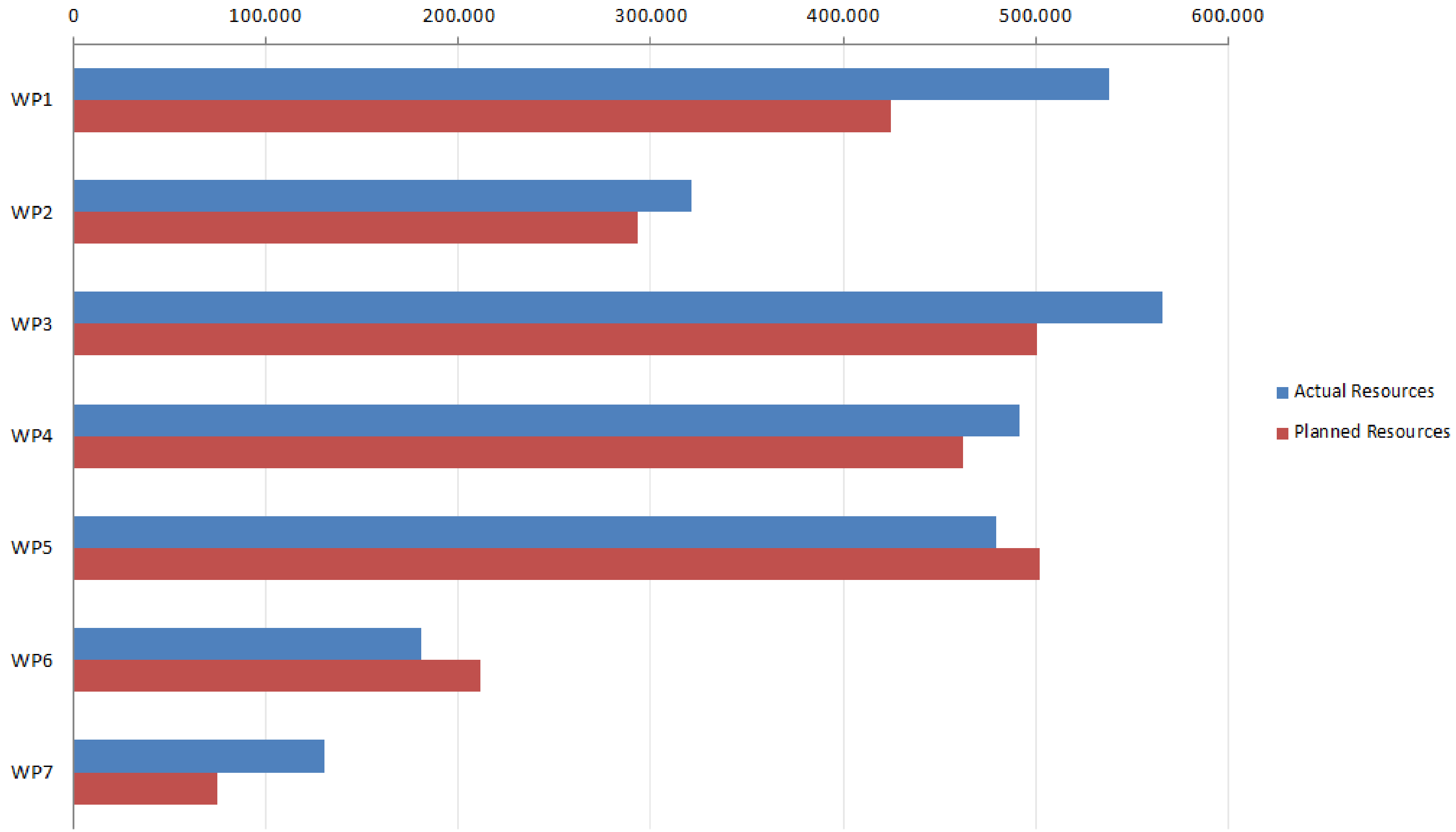

Figure 32: Actual costs per WP in Euro (Year 1+2+3, actual vs planned)

Explanation of deviations of PM and resources

1. **Deviations per partner**

   a. **Partner 1 – UHI**

UHI allocated resources in the third year of the project in order to fulfil the assignments of Task 2.3, in terms of developing advanced analytics models.

An important section of the work was devoted to support the TrainOSE and CTL field trials, by conducting research on the data collected from the trials and experimenting eco-driving methods on the data.

Last, but not least, UHI spend efforts into numerous qualitative publications work, such as top quality journals and peer-reviewed conferences.

In order to achieve those tasks UHI recruited junior researchers (PhD students), whose PM costs are lower than senior staff (PostDoc, Junior Professor) . Therefore for the same overall monetary budget (no significant violations in terms of monetary budgets from DoW), a higher number of PMs can be booked.

As a result of the dominant allocation of PMs on Year 3, the resources for Year 3 are also proportionally higher.

   b. **Partner 2 – UTH**

During the 3rd reporting period UTH allocated additional resources in order to fulfil the assignments of preparation of Deliverables

D6.3.2 (Contribution to Standards) D6.3.3 (Contribution to Standards) that initially were allocated to Delphi and shifted to UTH as discussed and agreed within the Steering committee and communicated to the EC. In addition, UTH allocated additional resources for the finalisation of WP3 and specifically deliverable D3.5 - Final versions of prototypes and WP4 and specifically deliverables D4.3.2 - Report on second pilot (to be used for field study 2) and D4.4 - Market- ready product, as discussed and agreed within the consortium.

   c. **Partner 3 – AAU**

At AAU it as always the plan to have a significant hours in the third year to implement the software prototype. There was a significant effort in coordinating the effort with companies and handling data from more than 15 different data sources. AAU has not spent more money than planned. The extra PMs spent has been paid for by AAU.

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 their 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

DDE had an underspend within the 3rd year of the project as they have been mainly involved in WP 1, which has been carried out mainly within year 1 and 2. Moreover, tasks in the frame of 4 PM have been transferred to UTH.

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. That the realization will be different from the budget is actually a given, because the reality is always more stubborn. This is also reflected in the actual figures of Trinite.

The first year of REDUCTION proceeded very slowly. Trinite received no information by the partners which was required for links with thier DSS software. Their employees Yubin and Vale have repeatedly requested this, unfortunately this led to nothing but the time went on. Here's very much time lost. Eventually it was decided that each party had to go its own way.

In the second year of REDUCTION Yubin left TRI and his knowledge had to be transferred to another employees. 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 third year.

g. Partner 7 – BEK

For WP3 and for the WP5 field trials at FlexDanmark a number of tasks was much more time consuming to complete than planned. Extra time was used for

- o Getting access to GNSS data
- o Getting access to CAN bus data
- o Making the software architecture flexible to support many input formats
- o Getting access to bus and train data.

h. Partner 8 – TrainOSE

Due to certain delays in defining the test cases in detail, almost all effort from TrainOSE staff took place in the 3rd year. Despite the work of TrainOSE team and the use of multiskilled personnel it was not possible to reach the forecasted goals of spending. Limitations (in fact major decreases) in salaries due to international supervision of Greek economy and the subsequent law obligations, together with the limit in person months available did not allow TrainOSE to reach the declared spending goals.

i. Partner 9 – CTL

The DDE devices that were originally provided did not function as intended within the OSEL bus environment. This required substantial effort and extra lab and field testing of the devices to identify the reasons for those malfunctions. CTL and DDE finally managed to overcome these obstacles by September, 2014.

2. Deviations per WP

a. WP1

Main reasons for exceeding the planned resources of WP1 were caused by unexpected efforts needed to develop, integrate and test the on-board system to get access to the CITARO Fleet-Management-System. According to the DoW, the original project plan did not reserve any resources to reverse engineer the API's provided by the system. Knowledge about this system and support from the operators was assumed when planning this task.

b. WP2

There is overspending in WP2 because of the overspending of UHI in Task 2.3. Such a behaviour is attributed due to the hiring of junior researchers (PhD students), for which a high number of PMs can be booked within the same monetary budget, as compared to PostDocs or Junior Professors. Please note that there is no significant deviation in terms of monetary resources.

c. WP3

For WP3 field trials at FlexDanmark a number of tasks was much more time consuming to complete than planned. Extra time was used for

- Getting access to GNSS data
- Getting access to CAN bus data
- Making the software architecture flexible to support many input formats
- Getting access to bus and train data.

d. WP4

No significant deviation

e. WP5

No significant deviation

f. WP6

Due to the huge effort of the WPL TRI and the Coordinator UHI all objectives of WP6 have been fulfilled. The planned effort of PM has been reached. However, as some partners had a smaller contribution to WP6 as actually panned and calculated a high amount of personnel costs in the proposal (e.g. DDE 7639€/PM). Due to this reason the actual costs for WP6 are lower than actually planned.

g. WP7

There is a slight monetary overbooking in WP7 due to 4 additional PMs needed for the period September 2014 - October 2014. UHI invested efforts to prepare the periodic reports, yearly reports, manage the submission of deliverables, organize the review meeting and conduct final dissemination work.

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.

5. Certificates on the Financial Statements

Table 26: 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	Yes	CFS required / to be uploaded in NEF
1a	LUH	No	EC contribution under threshold, no CFS required
2	UTH	No	EC contribution under threshold, no CFS required
3	AAU	Yes	CFS required / to be uploaded in NEF
4	AU	No	EC contribution under threshold, no CFS required
5	DDE	No	EC contribution under threshold, no CFS required
6	TRI	Yes	CFS required / to be uploaded in NEF
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

The main objective of work package 1, the development of the on-board technology, was successfully achieved. The REDUCTION project has successfully fulfilled its objectives under the scope of the first work package. The risk of failing to create an operational communications hardware did not happen, since the respective partner had been operating (practically) the same hardware for industrial use for many years, and thus the hardware adaptation to the REDUCTION's purposes was not a significant issue. The basic communication infrastructure and wireless communication was implemented supporting multi-modal fleets. During the 3rd year of the project life time the focus was based on testing and reporting the AccessPoint software for Bluetooth tracing. By developing a new Bluetooth detection system, there was a risk that the hardware or software would not be ready in time. The company that developed the SmartNodes delivered the system in time, but the system didn't work properly. The system wasn't ready for testing. An alternative plan was set up, which caused some delays in D1.4.2. The alternative plan was to update the previous BlueTracking system and set up the test with this system. The BlueTracking tests and results were as expected and planned. The travel time that this system can provide is well suited for the TrafficLink Management system and integrated easily into the DSS middleware.

The risk of failing to have OBU's installed on vehicles on the CTL field trial has unfortunately taken place, but it did not had a major impact on the smooth running of the project, for two reasons: a) using extensive simulated studies with established simulators provided trustworthy results, b) real protocol implementations (e.g., Geonetworking) were tested in a wireless testbed maintained by a partner. The risk of failing to develop communications/networking software that is compatible with other EU projects/standards did not also happen, since DSRC/WAVE standards were used at the low layers of the stack. Finally, the risk of failing to test and get results by the Bluetooth detectors did not also happen, as the detectors were gracefully integrated into the DSS middleware.

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

The REDUCTION project has successfully fulfilled its objectives under the scope of the second work package. Progress in terms of ecological driving analysis was completed using the data from train driving collected during the TrainOSE field trial. Velocity vs distance plots of a high recording frequency were analysed and two different approaches were inspected. The inefficient driving behaviours were localised and identified by clustering similar groups of behaviours on local segments of the railway. The potential saving that can be achieved if all the inefficient behaviours would follow the efficient ones was demonstrated. In addition, a novel algorithm that computes the optimal driving policy as a non-linear optimisation of driving segments was applied. Results showed a considerable potential if drivers would follow the optimal policy. The method was successfully applied to the TrainOSE field-trial of WP5.

In addition, the distributed/decentralised decision-making aspect was successfully achieved by introducing new local predictive models for isolated routing, meaning lane changing. The methods described in D2.3.2 can optimise global criteria like the total travel time of a group of vehicles, their overall fuel consumption, etc..., even though each vehicle makes an isolated and decentralised decision. The validity of the analysis was shown in a large-scale simulation study.

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

The insufficient access to GNSS data was fairly quickly solved in that FlexDanmark was able to provide data from their vehicles. In addition, AAU got access to 15 different other data sources. At the end of the project more than 3.3 billion GNSS measurements was available from more than 15.000 vehicles. The consortium is not aware of any other project that has such large data sets available.

The insufficient access to CAN bus data was a major challenge. Eventually the project succeeded in getting accesses to CAN bus data from approximately 260 vehicles. In totally the REDUCTION has access to more than 330 million CAN bus data measurements (with GNSS data). It has been very time consuming to negotiate access to the CAN bus data. However, the consortium is not aware of any project that has access to such massive CAN bus data sets.

The risk too large diversity to input data was dealt with by making a plugin software architecture. Currently 13 different plugins have been built. Designing and implementing the plugin architecture was more time consuming than first expected. However, this flexibility in the architecture was required to get access to the very large sets of both GNSS and CAN bus data.

The risk no access to bus or train data was handled by contacting bus companies. GNSS and CAN bus data from buses were collected. It was not possible to get access to GNSS and CAN bus data from trains. However, online resource could be used for estimating the travel-time and fuel consumption for trains. Getting access to bus and train stops was more difficult than expected. To enable estimates of fuel saving using multi-modal transport therefore required reverse engineering part of the bus and train routes.

The risk decrease in oil price did not happen during the project.

6.4 WP4 System Design and Integration

The field trials involving FlexDanmark, 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 trial 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. Some less important functionalities of the architecture are postponed to a second release.

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 field trial in Nicosia regarding the development of efficient fuel consumption driving profiles for the OSEL bus company and the CPO company will be completed outside the official duration of REDUCTION independently by CTL, DDE and UHI by mid-Spring, 2015.

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 to deal with are the increasing competition and associated app builders.

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

The REDUCTION project has successfully fulfilled its objectives under the scope of the fifth work package. The risks associated with TrainOSE field trial was either not happened or properly addressed. The inexistence of APIs to retrieve bus schedules was addressed by manually entering the needed data. The risk of not gaining access to train driving data was also not happened and thus the partners could perform data mining tasks on them. Of course, any issues related to software development (e.g., development of Web-based multimodal services) could not and did not happen, since the partners are highly trained at software development. The risks associated with the Bektra/FlexDanmark field trial were also appropriately addressed, e.g., gaining access to CANbus data. The risks associated with the simulated field trials (UTHs and CTL's) had also negligible probabilities of taking place, since they involved only software development and use of simulators. The risk of failing to have OBU's installed on vehicles on the CTL field trial has unfortunately taken place, but it did not had a major impact on the smooth running of the project, for the two reasons explained in the respective section of WP1. Finally, the risk of having Trinite's field trial in a not mature and unfinished state due to administrative delays from the municipality of Amsterdam, it also took place, and even though the design seemed to be the correct one, there was no chance to run the trial to its completion and gather/process the data.

6.6 WP 6 Dissemination, Exploitation, Standards

For dissemination the biggest risk is the continuation of spreading the word about REDUCTION. All involved partners must take their responsibility in this. Dissemination must be changing its content from “informing about the project” to “providing evidence of the products” with results from test cases.

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, 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.

Exploitation has four (larger or smaller) risks:

1) The first risk is about actively participating and continuing exploitation activities in the project by all partners. All partners have different perceptions of what Exploitation contains and it was 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. It cannot include all possible areas of exploitation. Why should the commercial sector adopt /sell our products and why should public authorities be interested? It has to be narrowed 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.

6.7 WP 7 Project Management

In order to improve the quality of Deliverables the consortium established a proofreading concept. Nevertheless, a moderate risk has been identified in the timely submission of Deliverables. In many cases the circulation of papers took more time than expected.

Taking this process into account the roadmap for the preparation of the 3rd periodic report and the final report was already developed during the last face-to-face Steering Committee Meeting in Copenhagen at the beginning of July. The Administrative Manager has joined the face-to-face meeting for the first time. The early initiation of the preparation of the period report and the detailed roadmap with tight deadlines has been identified as a good concept.

Moreover, a moderate risk was again the delay of the Form C submission for the periodic report 3. This risk is caused due to the parallel preparation of CFSs by 3 partners reaching the 3750.000€ threshold. In order to minimise the risk the Administrative Manager has provided the first information concerning the procedures of the first level audit in June 2014. Thereafter, frequent support has been provided for all 3 partners.

Another moderate risk was identified that partners don’t make use of their total EC Contribution. This risk was minimised by a financial controlling during the summer 2014. Following this process some tasks have been shifted to another partner and the budget has been rearranged ahead of the preparation of Form C.

7. Conclusion

7.1 Summary of the 3rd year periodic report

During its third year (01/09/13-31/08/14) the REDUCTION projects achieved significant results, meeting entirely its objectives, in particular the second phase of the all the field trials was completed and qualitative research with top-quality dissemination and exploitation was conducted.

FlexDenmark used results from WP3 to address the goals of (i) GHG emission reduction from the vehicles of Flex-Traffic (D5.3) and (ii) estimation of GHG emissions based on GNSS measurements. The field trial was based on 3.2 Billion GNSS measurements from more than 15000 vehicles. Concrete results were presented in D5.3 on the fuel efficiency and economic aspects of applying Eco-Routing techniques to the field-trial setup.

The TrainOSE field-trial completed the second phase, with the objectives of improving the energy consumption of electric locomotives in the main rail-line of Greek rail network, by producing and applying eco-driving behavioural guidelines for locomotive drivers. Optimal driving policies from WP2 (D2.3.2) were applied on real-trips and the energy-efficiency of the eco-driving methods was asserted (D5.3). Similarly, during its second phase the CTL use-case tested the V2V communication technologies from WP1.

In terms of scientific contributions the REDUCTION project conducted innovative research under WP2 and WP3. WP2 achieved significant results in the computation of the optimal driving policies for trains and cooperative lane-changing methods (D2.3.2). On the other hand, state-of-the art advanced eco-routing methods like the stochastic skyline route planning and personalised eco-routing methods were developed in WP3 (detailed in D3.5).

Overall, REDUCTION conducted very qualitative dissemination that sums up to 31 publications for the third year. In addition, the publications include top journals such as VLDB Journal, IEEE Internet of Things, Journal of Data Mining (impact factor 2.9) and top peer reviewed conferences, among which SIGKDD (14% acceptance) and SIGSPATIAL (complete dissemination in D6.1.3). In addition, the project had important exploitation work such as the participation, with a dedication stand, in the CEBIT international technology fair and a project specific poster in the "Informatik" conference.

Regarding its management, the project made correct usage of the resources according to the DoW, with no significant deviations. The allocated PMs were dedicated to the tasks as initially aimed and the resources were consumed in accordance with the planning. The risks assessed in the first two years were eliminated (details on WP summaries) and all the objectives of the project were successfully fulfilled.

7.2 Summary of the consortium management

In the third year of the project the coordination team has maintained the monitoring and communication structures within the consortium.

Controlling of budget and Person Months resources has been carried out on a regular basis. A separate financial controlling has been carried out during the summer 2014 in order to identify any over- underspend. The tables with overviews of resources planned vs actual have been integrated in the EC Periodic Report 2 and 3. Moreover, detailed justification was given. Quarterly reports been further on carried out to monitor the progress of the scientific work and to serve as background for writing the 3rd EC periodic report. As described in the risk assessment (6.7) a roadmap for the preparation of the periodic report has been developed already at the beginning of

July 2014.

Deliverables and milestones have been achieved mostly at the deadline set in Annex I; 2 Deliverables have been sent at a later time point after consolation of the PO. As outlined in D6.2.3, chapter 10 “Policy and Administrative Issues” commercial partners have delivered input to Deliverables concerning the market analysis, where necessary. The five exploitation plans were written in year two and completed in the third year with risk assessment, strategic choices and recent and future exploitation activities. No further (individual) input was needed for D7.4 by the commercial partners. Input concerning the marked and situational analysis has already been delivered for other Deliverables during the third year. D7.4 has mainly been created by the input of all Work Package Leaders and results already written down in different Deliverables.

As requested by the reviewers 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 can be seen in the password-protected groupware platform under http://147.172.223.242/bscw/.

8. Glossary

AAU	Aalborg University
ACM	Association for Computing Machinery
ALPR	Automatic License-plate Recognition
ATM	Area Traffic Manager
AU	Aarhus University
BEK	Nordjyllands Trafikselskab
C2C	car-to-car communication
CAN	Controller Area Network
CANBus	Controller Area Network Bus
CCU	Communication and Control Unit
CFS	Certificate on the financial statement
CO2	Carbon Dioxide
CPO	Costas Papaellinas Organisation
CSS	Cascading Style Sheets
CTL	Cyprus Transport Logistics Limited
CyPWD	Cyprus Public Works Department
DATEX II	Standard for information exchange between traffic management centre
DBMS	Database Management System
DDE	Delphi Deutschland GmbH
DIVV	Dienst Infrastructuur Verkeer en Vervoer
DOW	Description of Work
DRT	Demand responsive transport
DSRC	Dedicated Short Range Communication

DSS	Datapool Script Support
DTA	Dynamic Traffic Assignment
DUE	Dynamic User Equilibrium
DVM	Dynamisch Verkeersmanagement
e.g.	for example
EAB	External Advisory Board
EC	European Commission
EDBT	Conference on Extending Database Technology
E-GC	energy-based generalised cost
EMEL	Limassol Buses and Bus Routes
EMIT	Emissions Inventory Tool
ETL-Process	Etract, Transform, Load
ETSI	European Telecommunications Standards Institute
EU	European Union
FMS	Fleet Management System
GHG	Greenhouse Gas
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hr	hour
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
ICDE	Conference on Data Engineering
ICT	Information and Communication Technologies
ID	Identification

IEEE	Institute of Electrical and Electronics Engineers
IST	Istognosis Ltd.
ITE	Institute of Transportation Engineers
ITS	Intelligent Transport Systems
Kg	kilogram
Km	kilometre
KWh	kilowatt-hour
LUH	Leibniz University Hannover
MAC	Media-Access-Control-Adresse
MDM	Mobile Data Management
mHz	mega hertz
Min	minutes
MOBIL	Minimising Overall Braking Induced by Lane Changes
MoM	Minutes of the meeting
MP	Motor Power
MyFI	name for wireless routers that act as mobile Wi-Fi hotspots
NEF	module used in the Research Participant Portal
NM	Network Management
OBU	On-board-unit
OD	Origin-Destination
OMNet++	an extensible, modular, component-based C++ simulation library and framework, primarily for building network simulators
OSEL	public transport service Nicosia
P2P	Peer-two-Peer
PHP	Hypertext Preprocessor

PI	Principal Investigator
RSU	roadside units
SCM	Steering Committee Meeting
Sec	second
SIDRA-Inst	SIDRA INTERSECTION-Software
SIGMOD	Association for Computing Machinery's Special Interest Group on Management of Data
SIGSPATIAL	International Conference on Advances in Geographic Information Systems
SME	Small and Medium-sized Enterprises
SQL	Structured Query Language
SSD	Solid-State-Drive
SUMO	Simulation of Urban Mobility
TM	Traffic Management
TrainOSE	Hellenic Railways Organisation
TRAIN-TAXI	combination of transportation between a train and taxi for passengers who travel to Thessaloniki
TRI	Trinite Automatisering B.V
UHI	University of Hildesheim
UTF	Unicode Transformation Format
UTH	Department of Electrical and Computer Engineering
V2I	Among Vehicles and The Centralised Infrastructure
V2V	Between Vehicles
V2X	Vehicle to Infrastructure
VANET	A vehicular ad hoc network
VISTA	Visual Interactive System for Transport Algorithms
VMS	Variable Message Sign

VT-Micro Virginia Tech microscopic emission model

WAVE Wireless Access in Vehicular Environments

WP Work Package

WSGI Web Server Gateway Interface