Reducing Environmental Footprint based on Multi-Modal Fleet Management Systems for Eco-Routing and Driver Behavior Adaptation

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REDUCTION Overview

Eco-routing

Driver behaviour adaptation Eco-driving

Mutlimodal fleet management

Environmental footprint reduction

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REDUCTION Vision

- ▶ Enable fleet managers in EU to "go green" by using advanced ICT solutions for substantially reducing mileage and fuel consumption. Based on historic and real-time data about driving behaviour, routing information and emission measurements.
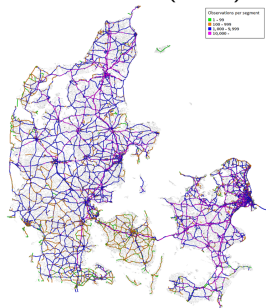
REDUCTION Partners

- ▶ Project Duration: 01.09.2011 – 31.08.2014
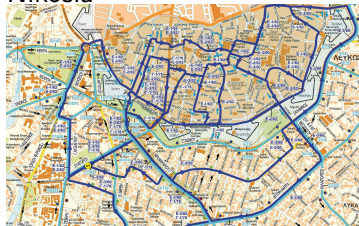- ▶ Project Homepage: http://reduction-project.eu
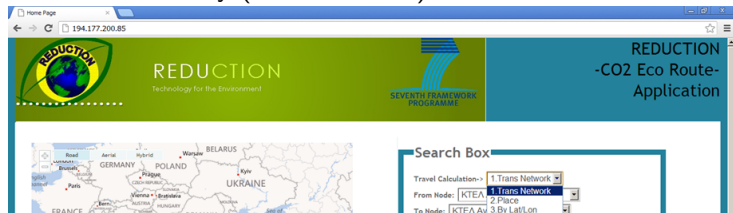
REDUCTION Field Trials

I. flex routes (taxis): FlexDenmark

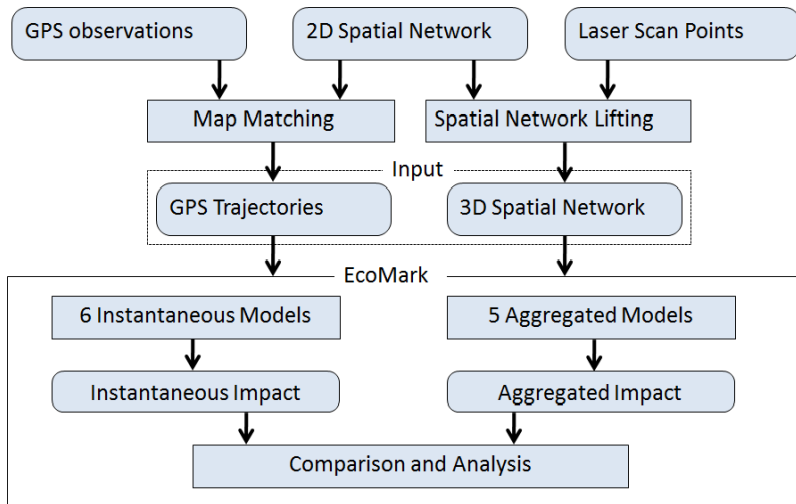II. fixed routes (busses): CTL, Nikosia
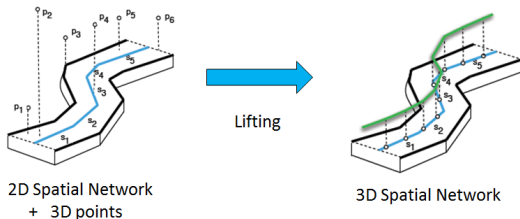

III. Multi-modality (trains & taxis): TrainOSE

Eco-Routing: The Eco-Mark Framework

Eco-Routing: Spatial Network Lifting

2D Spatial Network
+ 3D points

Lifting
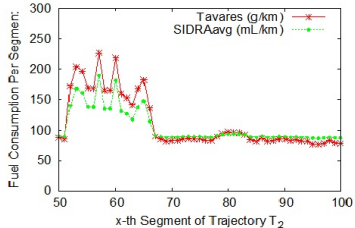
3D Spatial Network
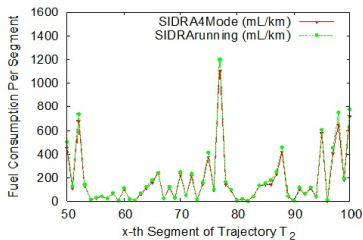
- ▶ Motivation
    - ▶ Eco-routes are highly correlated to the elevation of road segments.
    - ▶ TomTom states ITS using 3D spatial network will result in an annual fuel saving of 6 Billion USD in American. [L. Sugarbaker et. al. 2012]
    - ▶ 3D spatial network is constructed by using a laser scan point cloud for lifting a 2D spatial network
    - ▶ Yields a model with high accuracy

Speed and Eco Maps

Distance: 132km
Average Speed: 73km/h

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Contextualized Eco-Routing

- ▶ More accurate estimations can be made when taking context into account such as
  - ▶ vehicle type,
  - ▶ driver,
  - ▶ time of day,
  - ▶ weather,
  - ▶ road conditions,
  - ▶ traffic conditions, etc.

- ▶ from observed data, taking averages:
  - ▶ build a map for each context value,
    e.g., a map each for mornings, afternoons and nights.
  - ▶ problem: observations in each cell become sparse,
    esp. when combining several contexts.

REDUCTION solution:

*estimate travel time and fuel consumption for a road segment
and some context using a probabilistic model.*

Eco Driving Aspects

- ▶ Eco Analytics:
  - ▶ provide insight into dependency of fuel consumption on different contexts
    (driver behavior, vehicles, technical conditions, etc.)

- ▶ Local Eco Routing
  - ▶ lane change
  - ▶ finding parking lots
  - ▶ . . .

- ▶ Acceleration/Deacceleration recommendations
  - ▶ traffic light ahead
  - ▶ speed limit ahead
  - ▶ slow cars ahead etc.

Distributed Data Mining

- Distributed predictive models, which are communication efficient, scalable, asynchronous, and robust to dynamic topology, which achieve accuracy as close as possible to centralized ones.
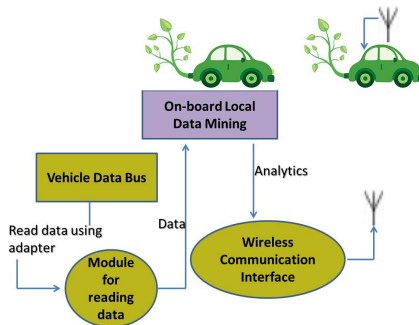

Figure 1: DDM in Vanets

Conclusions

- ▶ Eco Routing and Eco Driving are the fundamental building blocks for eco-friendly transport addressed in REDUCTION.

- ▶ Estimating Fuel Consumption from GPS Data can be greatly improved by elevation maps.

- ▶ Contextualized Estimation of Fuel Consumption can be efficiently accomplished by factorization models.

- ▶ Eco-driving aspects are targeted through behavior analysis, local eco-routing prediction and driving recommendation to reduce [de]/acceleration

- ▶ Distributed Data Mining in Vehicular Networks can help to bring machine learning methods to vehicular networks.

References I

M. Umer Khan, Alexandros Nanopoulos, and Lars Schmidt-Thieme. Experimental evaluation of reduced support vector machines and relevance vector machines for communication efficient distributed classification in peer-to-peer networks. In *submitted*, 2012.