Smart Mobility Systems

Introduction

Mobility of persons and goods is a key asset in modern society; in order to preserve and enhance mobility new mobility solutions are needed that guarantee both safe and sustainable 'throughput', in an environment-friendly manner. Wikipedia states: "Mobility is the ability and willingness to move or change". In practice, mobility is associated with various aspects

- Logistics - transport systems,
- Mobility of persons: being able to move around, taking a personal environment 'along'
- Tracking & tracing: tracking objects, RFID technology, virtualization of physical objects

Domain challenges

In the table below we give the prominent domain challenges.

Domain challenge	Description
Towards a sustainable mobility system, for people and goods	Moving people and goods takes its toll: in terms of fossil fuels, noise and particulate matters. Can we reduce unnecessary movements, or replace them with more sustainable ones? What are the commercial, legal and behavioral thresholds?
Reducing traffic jams, increasing system throughput	The average fill rate in logistics is 45%, the average car-to-car distance in the Netherlands lies below the average European distance (2 seconds). What is required to further increase the throughput? How do the various aspects (human in the loop, technology, commercial / legal) contribute to the current status quo?

Safety	Roads get more crowded, and are used by multiple modalities (pedestrians, bikes, cars, buses, trucks ...). Reduction of casualties is a key ambition of many European countries, and directions involve both technology as well as the human in the loop. For instance, car-to-car and car-to-roadside communication could assist in preventing accidents to occur.

Extrapolation: with the increase of people living in cities, all three challenges will only become more prominent. Together they form important cornerstones of a livable city.

Special constraints: suggested technical directions make clear that some important boundary conditions need be obeyed:

- Availability and reliability of information, in relation to potentially limited connectivity via mobile networks
- A sufficient level of inherent privacy of user generated data; a sufficient level of open access to data to stimulate service innovation and service eco-system
- Scalability of small-scale solutions

Trends and Solution directions

Current leading visions on mobility are:

- ITS (Intelligent Transport Systems): Navigation systems will develop into a full-fledged information system, with which the user has access to information about the traffic situation to be expected, can reserve and pay for parking places, can be given advice on his route and destination, all tailor-made for his situation and preferences. The car communicates with systems on the road and systems in the car. These systems can warn the user of special or dangerous situations and help the user to take action. In special situations, such as traffic jams or in emergency situations or on special lanes, the car will take over the driving from the driver. (IIP MAIS).

- Personal smart mobility: Multimodal, in real time informed and enriched travel information. A traveler with a journey from a to b, get's provided with modality suggestions (public vs. real-time information on deviations, congestion and other irregularities, relevant context information and extended service options such as reservation, billing and ticketing or presence information.

More specific trends:

- Intelligent cars/vehicles. This is enabled by the concept of 'Connected cars': car-to-car communication, car-to-roadside communication
- Automated Traffic guidance
- Multimodal route planning: integration of public transport in navigation systems
- Intelligent routing (in particular in the logistics sector)
- Congestion management: pay for use, incentives to change standard mobility patterns ...

Scenario Mobility 2020

Twenty years ago, the average Dutch citizen viewed traffic jams as an unsolvable problem, or even as a characteristic of the daily routine. This perspective changed radically in the second decade of this millennium. The possibility to choose reliable alternatives at any moment of a journey persuaded even the most convinced car owner. A recent crowd-sourced investigation by TNS NIPO showed that 80% of the respondents use on a daily basis at least two traffic modalities. Moreover, 50% indicated to use three or more! The most important drivers are the reliability of predictions of ToA (time of arrival) and the punctuality of the various public transport alternatives. The high percentages in the TNS NIPO investigation are remarkable because of the recently introduced cooperative driving mode on the main highways in the Randstad. Cooperative driving has improved the throughput (car-to-car distance decreased to 0.7 seconds) and the reliability, and has decreased the chances to end up in a traffic jam. In a twin-interview with the president of the ANWB and the minister for Mobility and Logistics, the former indicated that the tax on personal CO2 footprint should be viewed as the most important reason for this change in behavior. This tax addresses sustainability in the widest sense of the word and leapfrogs the controversial and hotly debated road pricing proposal from 2009/2010. The minister proudly mentioned the European award in the area of 'sustainable regulation', a price for implemented policies and regulations that stimulates sustainable behavior.

Use case scenario: Somewhere in the not so far away future...

It's Saturday, and Melanie wakes up with a smile on her face. Ever since the daily stress for traffic jams vanished, and her last resort-telephone calls to Harm to pick up Claire from OSC (out-of-school care) were no longer needed, Melanie can start her weekend more refreshed. And today is even more special - the whole family will have a day out at the Deventer book market. Her 6-year old son Pim works already for some days on his tablet to prepare a suitable travel scheme. This month at school is dedicated to 'sustainable mobility', and the various groups compete with their personal CO2 footprint for a mouth-watering price: a long weekend in 'the house of the future' in Almere, including a survival in the Oostvaardersplassen. Melanie indicated that she wanted to combine sustainability with relaxedness, and since Pim's sister Claire is only 4 years old, he should take careof a number of constraints ...

Two hours later, Melanie is enjoying a lovely ristretto in the newly build Utrecht CS Experience Centre - the Centre has been finished recently as the first part within the CU2030 plans of the city, and has already been nominated as the largest multi-modal transferium in Europe. Pim and his father have been able to combine their personal all-in travel-voucher with some nice surprises: a reduced price for the ristretto and for every member of the family a free e-book. Claire is playing with her 3D version of Cinderella. However, close to Apeldoorn the excellent mood disappears: the driver-avatar appears on the screens in the back of the seats, and indicates that the journey will come to an abrupt end. A cooperative driving vehicle on the loose has created havoc on one of the nearby crossings. Luckily, the Dutch railways are able to quickly provide an alternative: taxi-coaches. However, Pim objects to this alternative, since he will loose too many CO2-goodies... Using his tablet he finds a better plan B: the high-speed bus on the A1 makes an extra stop at the Apeldoorn-transferium, and will continue directly to Deventer. With a delay of only 5 minutes the family meets with the rental-bike owner in Deventer, and two minutes later they are cycling on their fashionable bikes to the book market...

Challenge and research questions for Mobility

The Mobility challenge is meant to stimulate the explicitation of research challenges for the Mobility domain, but also to provide focus and scope. Key focus is on the deployment of an ITS communications platform; a platform that enables sharing of data and information, thereby stimulating cross-sectored service development:

- services that enable citizens to travel informed, in a safe and sustainable way
- services that enable stakeholders (carriers, service providers, urban planners) to make optimal use of (shared) resources
- services that influence the behavior of travelers, in order to reduce the potential overload of the traffic system.

Research questions

The most important research questions are categorized as follows:

- *Realizing scalability:*
  - How to use spatial selectivity (e.g. using position dependent beaming with multi-antennas) to improve the efficient reuse of resources
  - How to manage distributed systems of variable size?
- *Striking the balance between ad hoc and infrastructure based solutions*
  - Efficient use of spectral resources for tracking and tracing
  - How to integrate the mobility and logistics domain with the IP domain?
- *Sustainable solutions: low-power / long life time*
  - How can we develop ultra-low power solutions for positioning (RFID and ultra low cost tags)

- How to develop intelligent tags, with more info, enabling two-way (send/receive) communication?

- *Realizing trust and privacy:*
  - Trust to enable domain-crossing cooperation and service development
  - Trust to authorize proper access
  - (Inherent) privacy to stimulate on the fly aggregation of information
- *(Technologies enabling) system innovation*
  - Charting market imperfections and unwanted control points that stale innovation
  - Realizing an inventory of standards and systems that could enable the various services
  - Data fusion for large-scale sensor systems
- *Towards cooperative driving*
  - How to take care that vehicles are able to drive closely together at high speed?
  - How to use broadband mobile (RF, wireless) communication for inter-car communication, anti-collision communication, radar, ...

Proposed Actions and Opportunities

Proposed Actions

- Multi-modal traffic guidance
- Experiments with car-2-road technologies, for instance in the Helmond testbed.

Opportunities

- Participation in FP7 PPP-Future [1]
- Involvement in the EIT ICTlabs activity around Intelligent Mobility and Transportation Systems [2]


1


2

References Mobility

- *IIP MAIS, www.iipmais.nl*
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- *EU ITS Action plan , ec.europa.eu/transport/its/road/action_plan/action_plan_en.htm*
- *Adaptive und kooperative Technologien für den intelligenten Verkehr, www.aktiv-online.org*