AIM – APPLICATION PLATFORM INTELLIGENT MOBILITY

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ABSTRACT

In order to address the complexity of modern Intelligent Transportation Systems and Services (ITS) the German Aerospace Center will build an Application Platform for Intelligent Mobility (AIM) in the region of Brunswick, Germany. This large scale testing facility will connect research with every day applications and focuses on demand driven progress. AIM is designed to be a neutral and openly accessible platform for industry, public authorities and science, research and development. The versatile aspects of mobility and their interdependencies will be addressable in a real life environment with the scale of Brunswick city and surroundings. This paper introduces AIM and documents its progress.

KEYWORDS
Mobility, ITS-Test facility, open application platform, verification, quality management, real life environment, development, test bed, long-term research

INTRODUCTION

Modern research and development in the field of ITS aims to increase safety, efficiency and comfort for all traffic participants. Crucial fundaments of this progress are tests conducted in a real life environment. Thus, in Europe several small project driven test beds were constructed in recent years. Due to limited resources and time constrains, most of these test beds have a narrow focus on specific topics of mobility and a short life span [e.g. 1,2]. Additionally, these facilities are widespread on different locations which make their integration or the combination of the results nearly impossible. Therefore, the Institute of Transportation Systems of the German Aerospace Center in cooperation with the City of Brunswick will build-up the Application Platform for Intelligent Mobility (AIM) to establish a long-term connection between research, technologies and applications.
This testing facility with an undefined life span will be a neutral and open platform for industry and scientist for research and development. Covering big parts of the city of Brunswick and the surroundings AIM will be able to address the versatile aspects of mobility and their interdependencies and thus the complexity of modern ITS as a whole. AIM closely links research, technologies and applications in a real life environment allowing short innovation circles and a fast transfer of knowledge and technology into everyday life. Concentrating economical and technical resources onto a single facility offers an increased scope of applications while decreasing the amount of necessary project investments.

BRUNSWICK

Brunswick, Germany's city of science in 2007 has approximately 250000 inhabitants with a strong link to research and development. According to research [3], this regions percentage of employees working in R&D as well as its share in the gross domestic product is one of the highest in Europe. This surrounding of technical progress is an excellent location for the application platform.

The region represents many aspects of modern mobility. Fist of all, the city is located in the center of Germany next to one of the main east-west road connections, the Federal Motorway A2. Apart from a high amount of regional traffic it is an important connection between the border regions to France, Belgium and the Netherlands and Eastern Europe. This results in a high percentage of heavy goods vehicles. Furthermore, Brunswick combines urban requirements with those of bordering regions (Figure 1). Thus, the versatile challenges of future road traffic are all present.

Apart from road traffic, the general public transport is well established and has a high priority. In addition to the highly frequented main train station, Brunswick has a strongly developed net of trams and busses. Intermodal traffic is supported by Park&Ride-spaces and a preference control on nearly half of all traffic lights. Last but not least, the research airport Brunswick, which focuses on airborne traffic management, establishes a link to further topics of mobility research.

Concerning the traffic relevant infrastructure, Brunswick is a leading example of public private partnership. A single private company, the BELLIS GmbH [4], is responsible for the traffic and parking management and for maintenance of the traffic light as well as the traffic sign infrastructure. Facilitating a very substantial and up to date traffic management system, they are a key partner in AIM next to the city itself. More than 250 sensors and the data from the central control station of the public transport are the basis of their management system. More than 80% of the traffic lights, the park-routing system and several dynamic information signs are connected to it. This is the strong fundament on which AIM will build upon.

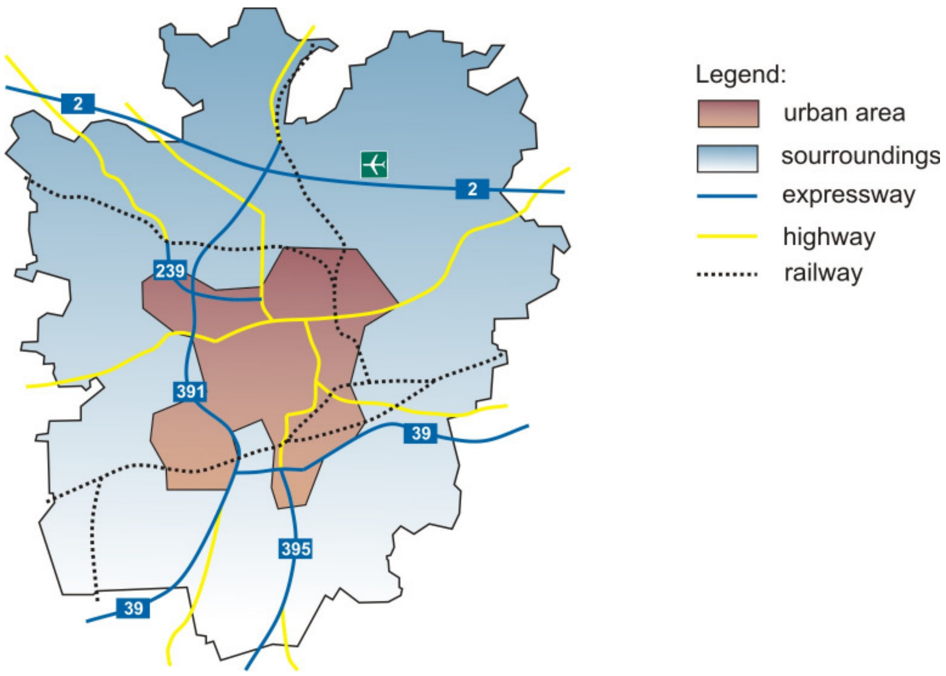

Figure 1 - City of Brunswick

DEVELOPMENT CONCEPT FOR AIM

In the years 2010 to 2014 research- and development-relevant hardware will be added to the existing equipment of the BELLIS GmbH. This hardware will mainly consist of sensor and actuator technology, interfaces and data-management systems. Independent from any specific installation, the technical realization will satisfy the following general requirements:

- A twenty-four-seven operational availability of all the measuring equipment must be secured.
- The temporal and spatial relations of all reference- and test-data must be available for processing.
- Substantial environmental- and context-data should be available for each measurement.
- Huge amounts of data can be stored and remain long-term accessible.
- Versatile tools for visualization and analysis have to be available.
- To insure quality management, the accuracy of all the measuring data must be quantifiable.
- The technical reproducibility of test-conditions has to be ensured.

These aspects will secure the long-term availability of high-quality reference data, which is the fundament to monitor or evaluate mobility applications.
In order to accommodate the complexity of mobility and thus AIM, the platform will be build up in different consecutive stages (Figure 2). This allows a recurrent reflection, revision and a knowledge driven progress. Experiences with already established DLR research facilities showed that the involvement of potential partners in and outside of the DLR into this process can be a substantial contribution to the success of such a platform. Therefore, the infrastructural installation and development will be accompanied by projects. This allows identifying and focusing on main functionalities of the platform. Thus technical und human resources can be used as efficiently as possible.

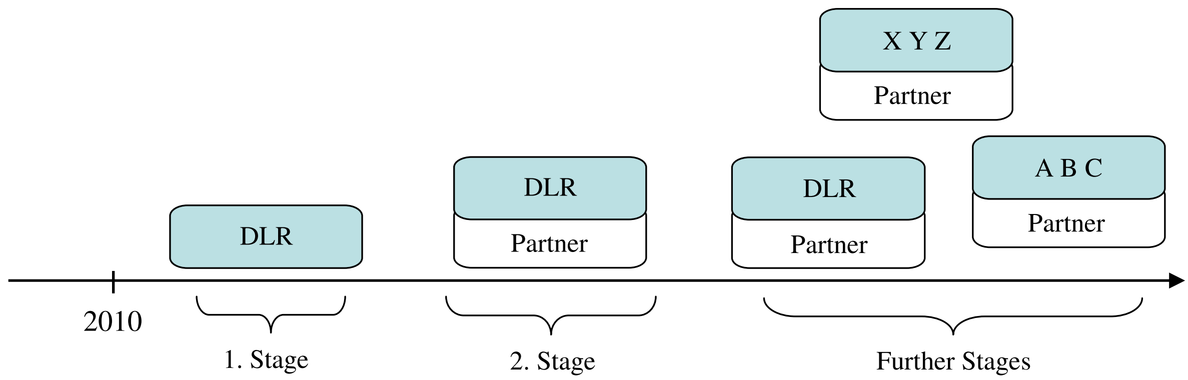

Figure 2 – Development Stages

Apart from the stages that will involve partners, the first stage will secure the basic functionality of the platform. This includes mirroring all available data acquired by BELLIS or other sources on DLR hardware. On the one hand, this involves static information like localization data about sensors and actuators, public transport schedules, origin-destination-estimation-matrices, land-use plan, traffic-light schedules etc. and on the other hand live data like detector output, weather and emission data, congestion reports and status information from control centers for individual and public transport. The data will be used in a simulation tool [4] to virtually model basic traffic and public transport behavior in Brunswick. This allows testing applications in a safe environment without a real impact on the actual traffic. Furthermore, test functions, services or applications can be analyzed in a precisely reproducible way, enabling conclusions which can't be drawn in a real environment because of the high value of uncontrollable variables. Since the virtual part of the platform will be highly accustomed to Brunswicks conditions and is based on up to date source-data, a high significance is added to the results. Furthermore, simulation is also a tool for predicting events. In this context, it can not only be applied as a basis for future control mechanisms but also for predicting results of field-operational tests. All these aspects make simulation a crucial aspect of the application platform to prepare tests in a real world environment.

On the opposite side, real tests in a real environment are also the basis for model and parameter identification for the simulation. Especially, in the area of traffic as well as driving simulation it is hard to get enough data to validate the simulators, e.g. the models and parameters used. Hence, there is an interrelation between simulations and real tests. Within this interrelation the simulations provides setups for tests in the platform and the tests in the platform provide data for evaluation and enhancement of the simulation. This interrelation only works in a well known area because the modeling of the environment is very difficult and therefore it won't be done only for sites which only address one project, independent of the size of this project.

Investigations conducted on the application platform obviously need means to influence mobility. For collective measures these can be management strategies for individual or public transport. For the individual traffic participant, aspects of navigation and personal assistance are key factors of influence. In the first stage AIM will rely mainly on infrastructure and technologies that are already available, since this is often a main requirement for near-term results.

After conducting tests, several means to qualify and rate mobility will be required. This can be done on different levels. The most basic level is the quality of measurements and thus the quality of individual sensors. The next level is the quality of traffic data which are aggregated, fused or otherwise processed measurements. But rating management systems and strategies and furthermore traffic systems as a whole will be the main goal of AIM. Therefore, the first stage will already make basic quality measures available for each of these levels.

Combining all those different aspects creates a fundamental control loop (Figure 3) in the first stage. Mobility will be available as a virtual and a real life scenario. On this basis, several means of control can be applied. The effects of this influence will be quantifiable either in the virtual environment or in real life. Easy access to aspects of this control loop will already enable a broad spectrum of applied research and testing.

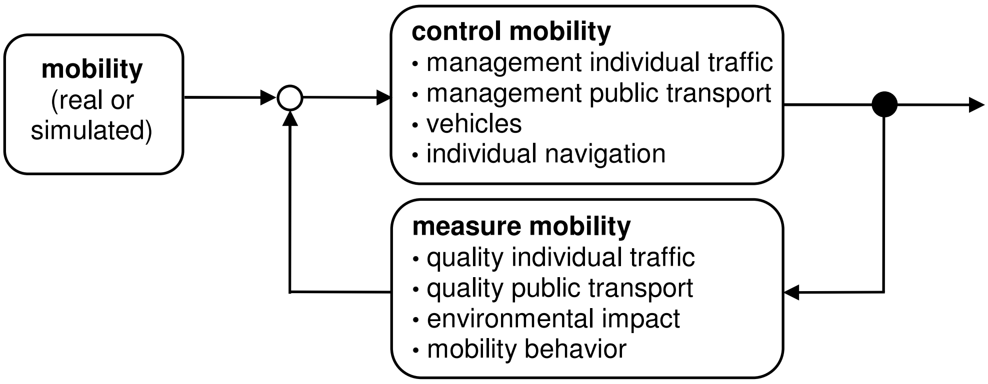

Figure 3 - AIM as a control loop

Further stages will be focused on project driven extensions. Such extensions include communication aspects like Car2X, alternative sources of information like Floating Position Data, new technologies for individual assistance and others. The accompanying projects ensure a growth and development of AIM that is aligned to the market.

FIELDS OF RESEARCH

Due to its scale and versatility, AIM is applicable for a huge amount of aspects in mobility. Each one of these generally tries to improve safety, efficiency and comfort of mobility while reducing the environmental impact. Advances in these fields can be made through measures in collective management or individual assistance. AIM is a tool to address the arising challenges associated with these measures. Figure 4 lists some important examples.

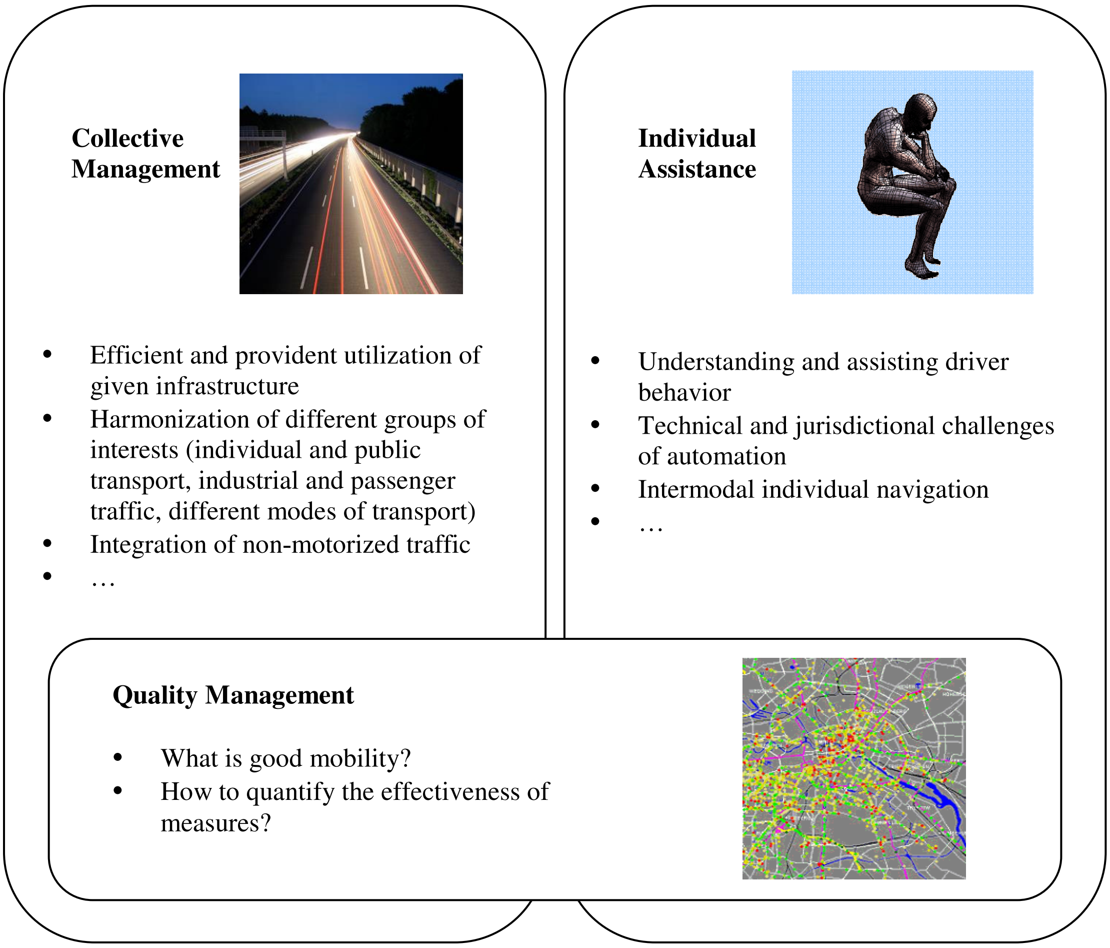

Figure 4 - Challenges that will be addressed with AIM

Concerning measures through collective management, the optimized use of traffic infrastructure is the most evident aspect. Due to financial and spatial constraints the infrastructure usually can’t grow as fast as the demand. Thus, using the given infrastructure as efficient and provident as possible is a prerequisite to cope with future mobility. Furthermore, there are miscellaneous aspects for optimization, like noise and CO_2 emission, travelling time, number of stops or occupancy degree. Not only by themselves, but their interdependencies will play an important role in future research. Knowledge about the correlations between these parameters will enable unified management strategies.

A similar goal can be defined for the future of different groups of interest in mobility. Combining the needs of individual and public transport, industrial and passenger traffic or of different modes of transportation in a single management strategy is a challenging task. Nevertheless, it will be a valuable contribution for the evolution of mobility. It requires a well know environment in which the correlation between those needs can be monitored, experience can be gained and generalized conclusions can be drawn. AIM will provide this environment.

Another future challenge is the closer integration of non-motorized traffic participants into management strategies. But to meet this goal, several different tasks have to be dealt with first. Most importantly, the automated detection of the demand by sensors is a key factor for progress in this area. New sensors or technologies have to be tested and approved. Furthermore, this local demand must be integrated into global traffic models. And last but not least, new dynamic management strategies incorporating the non-motorized traffic have to be derived.

When thinking about how to influence individual traffic participants, one has to address the borderline between collective management and individual assistance. Incorporating individual demand with public goals will be an important challenge in the future. For example, providing individual routing assistance is generally a commercial task today. If highly coordinated, it is estimated that re-routing can avoid approximately 10-15% of all congestion. Therefore, their integration into public intermodal strategies will become a necessity in the future and a goal for AIM.

In the area of the individual traffic participants, AIM will push research which addresses the natural behavior and the means to change this behavior in an intended way as well as the means to judge and document these changes. In more detail, naturalistic driving studies are planed with an enriched collection of situational elements not gathered so far in such studies. Furthermore, field operational tests will be conducted addressing different assistance systems. Real world validations will be performed, as a part of the development cycle for in-vehicle assistance and automation systems. Last but not least, the platform can be used to provide the data bases for different kinds of model identification starting from the driver behavior up to the behavior of technical systems, like vehicle2vehicle communication devices [6].

From the perspective of individual transport, the operational processes are controlled by traffic management centers, the structure and the design of the components of the vehicles through assistance and automation. The assumed impact of “advanced driver assistance systems” (ADAS) on future ITS is huge. In the area of road transport it is estimated that, depending on the definition, between 40% and almost 100% of all accidents are caused by people. Correspondingly, the potential for assistance and automation (A&A) to avoid these accidents is very high. An expert estimate as part of the "Sustainable Mobility Project” [7] showed that in 2030 75% of these accidents will be avoidable by A&A. In addition to the improved safty, a significant reduction of congestions are the result. It is estimated that by preventing accidents, approximately 27% of all congestion related to 2002 could be prevented. This in turn, positively affects the environment, so that the CO2 emissions in Germany could be reduced by 5%.

Besides the potential for accident and traffic jam avoidance and thus also for the indirect prevention of environmental damage, A&A can also be used to directly influence the fuel consumption by support the manoeuvres execution as well as by the route choice. Since approximately 15-20% of the fuel consumption depends on driving style, there is also a considerable potential for savings.

The goal of AIM is to provide the infrastructure for the implementation in the required quality and quantity. This also applies to the necessary basic technologies such as sensors, communications, positioning, information processing and actuators. Prerequisite for ITS systems are also high-quality data bases, exceeding the current digital maps. Additionally, there must be a corresponding legal framework for the use of the systems available. AIM can be important key to push these frameworks.

Last but not least, independent from collective or individual heritage of the stated measures, due to its nature, AIM will tremendously advance the progress in quality management. Performance analysis and acceptance evaluation are core aspects of AIM and may help to set standards for the future. AIM will be a tool to find generalized answers to seemingly simple but actually very challenging questions like: What is good mobility? or How to quantify the effectiveness of new measures?

CONCLUSION

The planned Application Platform for Intelligent Mobility was introduced. AIM is an open platform for industry and science and enables research and development in a real life environment. It aims to help evaluating the versatile aspects of modern mobility and their interdependencies. Synergetic effects of consecutive and parallel projects enables a broader spectrum of services with high cost efficiency thus giving AIM the focus of attention in future ITS research.

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