EmerT – a web based decision support tool for Traffic Management

Laura Bieker[1*], Michael Behrisch[1], Sten Ruppe[1]
German Aerospace Center (DLR)
1. Institute of Transportation Systems
Rutherfordstr. 2, 12489 Berlin, Germany, Tel: +49 30 67055 459
{Laura.Bieker, Michael.Behrisch, Sten.Ruppe}@DLR.de
* corresponding author

Abstract
This paper describes the EmerT portal (Emergency mobility of rescue forces and regular Traffic), an extended version of the DELPHI web tool. EmerT is a web decision support application for real time traffic situation, prognosis and traffic simulation. One of the main features in this system is to provide traffic state estimation and forecasts with use of the mesoscopic traffic simulation. Traffic bottlenecks can be identified by the simulation which helps the decision maker to take appropriate traffic management actions. Another feature is the information exchange and cooperation between the Traffic Management Center, Emergency Rescue Services, Police and Emergency Call Center. This application supports three demonstration regions in Germany, Cologne, Bonn and Munich, and will be extended for the whole region of Germany. The main purpose is to handle major incidents and large events which affect changes in the traffic demand and current traffic situation. The EmerT system supports users to get a quick overview of the current traffic situation. This paper aims to present the current development state of the EmerT portal with focus on the backend including traffic simulation, data acquisition and aerial imaging.

Keywords:
Decision Support, Traffic Management Center, Incident Management, ITS, Intelligent Transportation System, Mesoscopic Traffic Simulation

Introduction

The traffic situation has a major impact on the success of rescue measures during a major incident. The authorities need to get to the relevant places in a short period of time and have to find their places such that they do not hinder the transport of material or injured persons.

Furthermore many people on site may try to leave the place by means of individual transport. This situation calls for a tool which enables the authorities to have an overview of the current traffic situation as well as a prognosis how the traffic situation may evolve. The EmerT web portal provides such a system, backed by the microscopic traffic simulation tool SUMO [1] which was enhanced by a mesoscopic simulation model to give fast results even for large number of scenarios in big conurbations.

In this paper we give a short overview of the system focusing first on the presentation of the simulation part followed by a description of the other facilities such as traffic data acquisition and presentation (including online aerial pictures) and routing ending with a short overview of the live demonstrations showing the capabilities of the system.

Traffic Simulation

The model

The traffic simulation package SUMO [1] developed at DLR allows for the simulation of whole cities faster than real time. Its default microscopic car following model (based on the dissertation of Krauss) allows for the individual simulation of each vehicle in a time discrete and space continuous manner. The requirements for the crisis scenarios are however that it allows the calculation of several traffic forecasts for the next 30 minutes to be completed in about five minutes. This led to the implementation of a different model a so called mesoscopic queuing model by Eissfeldt [2]. In contrast to the microscopic model where each vehicle has an individual position and speed the vehicles queue up in edge segments of about 100 meter length and change between segments with change delays depending on the jam status (calculated from the number of vehicles in the segment). The basic model which gives good results for motorways was enhanced to reflect the special properties of city traffic. The resulting model is still about ten to twenty times faster than the microscopic one with deviations in the measured speeds in order of the errors in the input data.

As was already shown in the Eissfeldt thesis the model reflects basic traffic properties such as back propagation of jams and the flow density relationship in the so-called fundamental diagram. In order to model city traffic the following features were added:

1. Lane queuing

   While the original model only knows about one queue for all lanes on a road, inner city traffic needs individual queues especially in front of traffic light controlled junctions which have separate turn lanes. We decided to model this only on the last segment (about 100m) in front of a junction, which already helps to resolve most of the problems induced by cars with different destinations blocking each other.

2. Overtaking

   There are some notes on this feature in the original thesis but it is not considered a part of the model. We let cars overtake on segment change on multilane roads with a probability depending on the number of cars on the road. This feature has a much smaller effect since the speeds do not differ that much in inner city traffic

3. Junction control and traffic lights

The original model knows nothing about junctions so we decided to implement at least some basic priority rules which let the vehicles pass junctions only if they have free way either if there is no car on the last segment of a higher prioritized crossing road or if they have a green light. This helps a lot in modeling the effect especially of traffic light systems.

Traffic demand and routing

The expected traffic demand in the situation of major events was studied in the DLR during the soccer world cup 2006 and the world youth day in cologne 2005 [3]. Our first evaluations point into the direction that a safe estimation of a traffic demand in a crisis scenario can rely on the density of population in the region of interest. By assuming a fixed proportion of vehicles distributed evenly among the population, the simulation can efficiently show up the bottlenecks in the existing road network (under the assumption that they want to leave according to an evacuation distribution from historic data). Such a relative coarse demand is also able to show the effects (such as jam propagation) of rerouting measurements. In the case of an event scenario much more detailed demand forecast is possible because the number of available places as well as the usual distributions of arrival and depart traffic are known in advance.

In the case of an emergency we plan to give the user of the portal some choice of scenario (e.g. slow evacuation or panic) which together with the population density will give some rough estimate on the number of vehicles to be expected. As little is known about equilibrium states in such rare circumstances it is rather hard to predict how the cars will distribute and we may be forced to use plain shortest path route choice.

While the pre-calculated demand and routes might be quite inaccurate due to the number of assumptions made and small amount of reference traffic data related to real incidents, the simulation can still achieve a high online precision due to the constant adaption to external data sources such as induction loop data and measurements extracted from aerial images. This data will have immediate impact on the number of vehicles in the simulation and on their route choice and may very well outrule the static demand. The quality of this adaption depends highly on the quality of the input data (see below).

Multi scenario simulation

The simulation is already useful in itself by predicting traffic on roads not covered by real data and the evolvement of the situation. Its full power however is unleashed when it comes to the simulation of scenarios either during the event or in training and evaluation situations.

Using the EmerT portal the users will have the possibility to study the potential traffic effects of different management measures (for instance road blockings) and adapt their strategies accordingly. They can also study in advance the weaknesses of the road network and identify critical roads in the case of emergencies at certain risky locations.

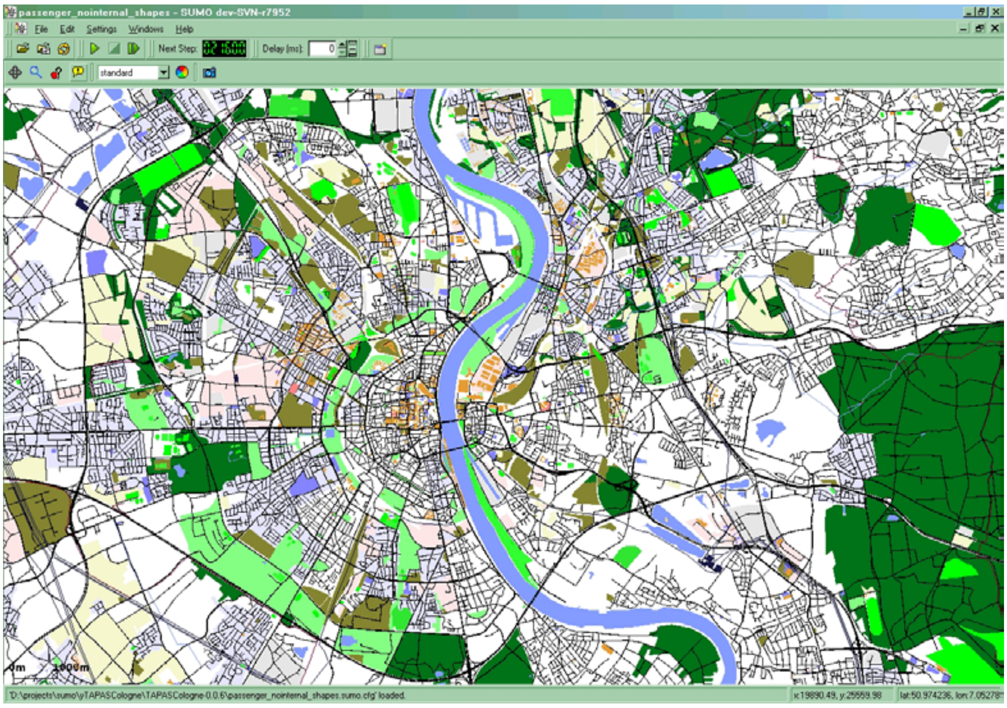

Fig. 1. Visualization of the Cologne simulation area in the SUMO environment

EmerT Portal

Traffic monitoring

Detailed and well-presented information facilitates the decision process and can contribute to effective problem solving. For decisions affecting the traffic an overview of a comprehensive traffic situation is a basic requirement. EmerT supports state of the art traffic monitoring like data from induction loops, floating car data, and real-time data of occupancy rate of parking garages. In focus of further development EmerT include new approaches like bluetooth detection, input data from low resolution uncalibrated web cameras. Further the integration of a new approach named Dynamic Indirect Traffic Detection based on mobile detectors is planned. EmerT brings together the information to a web based portal prepared for the end user like authorities and safety agencies. The most exclusive source of information however is the integration of aerial pictures and extracted traffic data delivered online by a plane flying above the area of interest (see next section). All these data sources are evaluated concerning their quality and made available to the user in an aggregated manner (mostly as a level of service on roads) and as individual data sets.

Due to the number of available data sources there is a redundancy in information which is used for validation purposes as well as a fall back system in case some sources are unavailable in case of an emergency (such as flooded induction loops).

Air monitoring

Road sections which have no or only little qualitatively reliable information can be recorded via an airborne monitoring system. This system consists of a high-resolution optical camera system and a radar-based sensor system. The sensors can detect large areas from the air with a high resolution. With the radar system detection is possible in poor visibility and weather conditions and at night [4]. For special events such as major events or disasters, the DLR airborne monitoring system can provide further crucial insights.

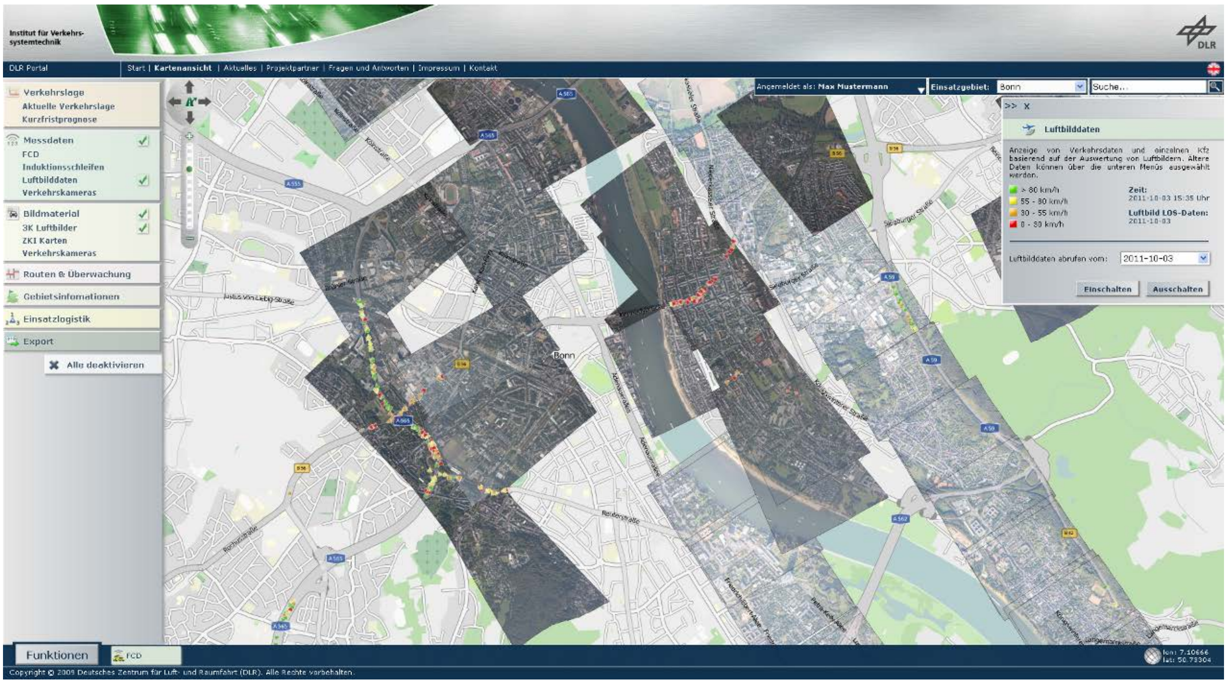

Fig. 2. EmerT portal with aerial pictures used in Bonn at the Day of German Unity

At the research airport Oberpfaffenhofen an aircraft is stationed, equipped with camera systems and a radio transmission unit. It can estimate the traffic situation for specific streets within and outside the operational area and can process aerial images.

As shown in Figure 2 the aerial images can be directly viewed from the EmerT portal giving an almost live image of the traffic situation as well as the environment. The high resolution pictures taken by 3 camera system are transformed on board to fit on the map. Scanning for vehicles and their velocities takes place in an on board unit as well such that the downlink only needs to transmit pictures of lower resolution and the extracted data.

In addition to moving vehicles the system can also identify the allocation of parking space on certain pre-defined areas. This is an important feature when it comes to the identification of assembly areas for the rescue forces.

Traffic data platform

The different traffic data sources (from e.g. induction loops, floating car data and aerial photos) are merged to get an overview of the traffic situation in the whole region. The accumulation, validation and quality estimation is performed in the traffic data platform developed by DLR. It supports a variety of input formats and stores in an accessible format in an SQL database.

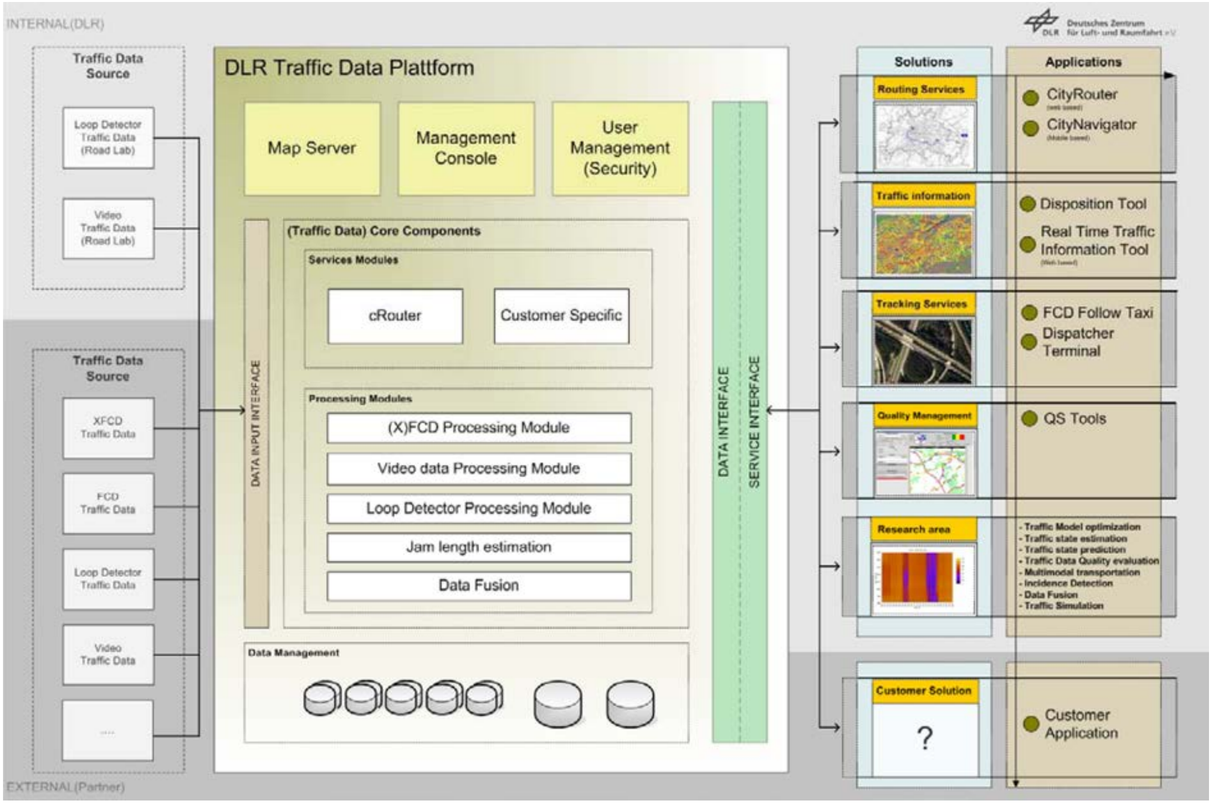

Figure 3. Schematic view of the DLR traffic data platform

Demonstrations

The EmerT portal was already tested at several demonstration events and during police exercises with the THW (Technisches Hilfswerk, technical aid association). One large event in Germany is the Oktoberfest in Munich. Every year there are about six millions of people travelling to Munich to take part at the largest public beer festival in the world. For traffic managers this event is a big challenge. The traffic demand to the festival is increasing, but nevertheless it is necessary to provide a functioning traffic network for rescue routes, hospitals and logistics.

During the Oktoberfest 2010 we could demonstrate the efficiency of aerial monitoring together with a simulation based prediction of jams (based on induction loop data on the motorways).

Together with the THW we performed a test of the EmerT portal which included online monitoring of their vehicles which gave the THW the possibility to collect their forces effectively and using the portal as a management and communication platform.

Figure 4. The EmerT portal at a recent THW exercise

Concluding remarks

The EmerT portal serves as a showcase of what benefits modern ITS can bring to rescue forces and traffic managers. In this paper we showed only he backend functionality of how and which data is collected and what the simulation can do with it. The big challenge arising from the availability infrastructure is how to create a user interface which does not only present the data available and gives routing information (as it is in the present case), but allows for the creation and evaluation of complex scenarios for training and event purposes. Another point which is not covered by the system yet is the availability and usage of public transport. This will be covered in a future version.

Together with our partners at the rescue forces and in the government we aim at a fully functional decision support system in the next years.

References

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