IMPAKT – Lane Specific FCD Analysis

Dr. Stefan Karmpe¹, Dr. Jörg Pfister²

1. TraffiCon - Traffic Consultants GmbH, Schillerstraße 25, A-5020 Salzburg, +43 (0) 662 461102, krampe@trafficon.eu
2. pwp-systems GmbH, Germany,

Abstract
The elaboration of the resulting impacts caused through the application of cooperative services in the FOT Telematic Testing Field in Austria forms the main goal of the accompanying IMPAKT study. The individual driver behaviour shall be determined through the setup of automatic assessment processes of the recorded GPS-Tracks and the assigned information content coming from the cooperative services. Therefore all tracks are mapped through novel algorithms onto a lane specific road network graph, which has been modelled through the application of OSM technology. This detailed but automatic approach enables an advanced technical assessment, which takes up the generated impact on individual vehicle observation and aggregates them by statistical measures, to determine the benefits of cooperative services for traffic management in general over the complete samples of trajectories from 3,000 expected users.

Keywords: Cooperative Services, Telematic Testing Field, Field Operational Test, Assessment and Evaluation, Lane specific FCD, Lane specific road network.

Motivation
The main aim of cooperative services is, to utilize the existing traffic infrastructure in a more effective manner. The targeted improvements in efficiency, safety and environmental impacts shall be achieved through a more balanced distribution of traffic load onto the available road infrastructure. Current developments on cooperative services focus on direct communication among vehicles and between infrastructure (traffic lights, traffic signs, etc.) and vehicle in a bi-directional connection. In the project Telematic Testing Filed in Vienna a field operational test (FOT) is currently conducted, where a consortium out of research, industry and public authorities applies cooperative services at large scale, in order to assess resulting impacts with respect to the goals of efficiency, safety and eco-friendly mobility in traffic management.
The accompanying study IMPAKT has been initiated by the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT) / Austrian Research Promotion Agency (FFG) to analyse the impact of cooperative services with respect to the issues of traffic safety, efficiency with the focus on traffic flow, environmental aspects like fuel consumption and carbon emission and user acceptance. One major criterion for IMPAKT is, to capture the driver behaviour (acceleration, deceleration, lane changes, etc.) in the presence of advanced traffic information. In this regard a dual approach will be applied, where the personal response of the users will be acquired through questionnaires (including pop-up dialogs before and after a trip) and interviews, while the technical assessment of the recorded trajectories (GPS-tracks) provides an independent source that complements the overall process with neutral indicators. This technical approach will be explained within the current paper and the main source of measurements consists of GPS-Tracks, which are recorded during the large scale FOT of the Telematic Testing Field, which intends to recruit up to 3,000 users. The spectrum of selected cooperative services in the FOT offers lane specific information to the individual vehicles. In turn for the IMPAKT study this requires the identification of the individual lane taken by the vehicle, in order to enable an adequate interpretation of the driver behaviour.

**Lane specific road network graphs**

One essential basis, which is needed to execute the assessment and evaluation process, comes with lane specific road network graphs. State of the art digital maps which are available on the market contain only one graph to represent the axis of the complete road section as separate geographical object, but the correct representation of a single lane (e.g. from a motorway section) is not given. In Figure 1 an example is depicted for a motorway section near Salzburg Austria.

![Figure 1: Representation of the road network (yellow) with only one network segment, shown for the example of exit “Salzburg North” at motorway A1.](https://www.google.com/maps)

It is easy to recognize that only 1 geographical object is represented for each direction that covers 3 lines plus an additional exit lane. The road network model misses a separate object for the exit and it is not known where this additional lane starts. For the assessment task of the IMPAKT study it is important to derive the lane specific behaviour of the users directly
through the technical analysis of the recorded GPS-Tracks, therefore the lane specific modelling of the road network graph forms an essential pre-requisite.

Approach

In a first step the precise location of the individual lanes has to be determined by their middle axis. This will be achieved with dedicated reference tracks from the high performance measurements with the scientific concept car of pwp-systems, which contains a dual frequency GPS receiver with kinematic carrier phase tracking, an inertial navigation unit acquiring the physical motion in 6 degrees of freedom at 100 Hz and with highest precision and an wheel shaft encoder that captures each wheel rotation with a resolution of 1,000 increments. The resulting lane specific trajectories shall be computed through the application of post processing algorithms and with an accuracy of less than 10 cm. In a second step the data from the conducted measurement campaign will be used as input to model the single lanes in a specific data model (OpenStreetMap). This approach is highly reliable, since it is based on independent geodetic measurements with high performance sensors that cost more than a 100,000 €. For the future a more economic approach would be preferable, which will also be realized on the basis of ortho-rectified areal images (see ). In order to validate the resulting quality of the derived lane trajectories both outcomes will be compared.

The mapping of the lane specific data in Figure 2 has been executed through a local OpenStreetMap data-server (OSM-API). Through the application of OSM technology this lane specific graph and the GPS-Tracks of the single vehicles from the Telematic Testing Field are assigned to the displayed information content transmitted through the cooperative services transmitted to the user. In the third step the driver behaviour will be analysed with special focus to lane changes after the reception of information content. The recorded GPS-Tracks with precision GPS receivers including EGNOS correction will enable such an analysis of the driver behaviour. The vehicle trajectories will be mapped onto the correct lane-graph through newly developed algorithms. This probability based algorithm provides better results with a high density of position fixes. Thus the applied GPS receivers should be capable operate with update rates of more than 5 Hz.
Figure 3: Assessment processing chain to derive the impact of cooperative services.

The elaboration of the resulting impacts caused through the application of cooperative services in the FOT Telematic Testing Field in Austria forms the main goal of the accompanying IMPAKT study. The individual driver behaviour shall be determined through the setup of automatic assessment processes of the recorded GPS-Tracks and the assigned information content coming from the cooperative services. Therefore all tracks are mapped through novel algorithms onto a lane specific road network graph, which has been modelled through the application of OSM technology. This detailed but automatic approach enables an advanced technical assessment, which takes up the generated impact on individual vehicle observation and aggregates them by statistical measures, to determine the benefits of cooperative services for traffic management in general over the complete samples of trajectories from 3,000 expected users. From such a powerful knowledge base, reliable statements can be derived about the impact of different cooperative services on the driving behaviour in general. An overview of the assessment and evaluation processing chain is given in Figure 3.

Acknowledgement(S) [Times New Roman 12 bold, Heading 1]
The research leading to these results has received funding from the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT) under the grant agreement n° [831747].