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Traffic Flow Quality from the User´s Perspective

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Abstract
The knowledge of the current traffic state is an important prerequisite for effective traffic management. This paper presents the development of a uniform classification concept defining the traffic conditions on freeways and urban roads. In order to determine an appropriate traffic flow parameter for a comprehensible representation of the traffic condition, data from freeways and urban roads in Germany were collected and analyzed based on both segment-based and local measurements. As expected, the average speed per segment leads to a more precise description of the traffic condition than local speed values from stationary detectors. GPS test runs with probe vehicles were made to record the floating car's driving speed. During the test runs, a subjective evaluation of the traffic flow quality was provided by probands. Based on these data, threshold values for a six-step classification scheme were derived. For providing more comprehensible traffic information for the road users, the developed scheme was converted into a three-step system. The scheme was tested using examples from cross-competence traffic management. The developed classification scheme is mainly suitable for application in traffic information systems. For traffic control applications, more specific definitions of traffic states are usually required.

Keywords: Quality of Service, Traffic Management, Traffic Information, Data Collection, Traffic State

1 Introduction

The optimal utilization of the existing road infrastructure is an essential goal of traffic management for both federal highways and the urban road network. For implementing traffic management and control applications, the current traffic conditions within the network must be known. Besides operating intelligent traffic systems, traffic management increasingly implies the provision of both pre-trip and on-trip traffic information. Consequently, it is important to precisely determine the current traffic condition for a particular route or network. The task of standardizing the measurement of traffic parameters is complicated by the lack of cross-competence definitions of traffic conditions for real-time applications. This concerns both freeways and the subordinate road network.

In the German Highway Capacity Manual HBS (FGSV, 2015), the parameters used to evaluate the traffic flow quality differ depending on the traffic facility and the type of road. For freeways, the quality of service assessment is based on the volume-to-capacity ratio, whereas in the HCM (TRB,

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2010), traffic density is used as the measure of effectiveness. Furthermore, there are various methods differing in the number of service levels as well as the parameters used for evaluation. The approaches reach from two steps (fluid and congested traffic) to six steps (Kim and Keller, 2001). Many of these methods are based on a differentiation of traffic states in the flow-density diagram (Greenshields, 1934, Kerner and Rehborn, 1998, Zhang, 1999, Kerner, 2000, Kim and Keller, 2001, Regler, 2004, Brilon et al., 2005). Other approaches define service levels based on speed (Breitenstein et al., 1980), traffic flow or traffic density (Breitenstein et al., 1980, Schnabel and Lohse, 1997). In addition, there are approaches being limited to evaluating congested traffic, using various parameters (Brilon and Estel, 2009) or jam patterns in space-time-diagrams (Treiber and Kesting, 2010).

The quality of transport in the subordinate road network can be evaluated according to the HBS (FGSV, 2015) and the HCM (TRB, 2010) by determining a ratio of the expected driving speed in relation to the aimed or optimal driving speed. Other approaches use the ratio of achieved and optimal travel time (Busch et al., 2004) or the average driving speed (Schnabel et al., 1998, Brilon and Schnabel, 2003, Spangler, 2009). The number of steps differs between three and six being defined by threshold values of the used parameter.

In this paper, the development of a uniform classification scheme for road traffic conditions is presented. This uniform classification scheme should be applicable for all stakeholders (e. g. federal state and local road authorities, private service providers) and both infrastructure and vehicle-based applications. The classification scheme was developed based on traffic flow measurements and GPS test runs with probands who subjectively evaluated the traffic flow quality. Furthermore, the capability of different data collection methods to obtain a realistic representation of the current traffic condition on a road link was evaluated.

2 Literature Review and Expert Interviews

In the first step, an extensive analysis of national and international sources on existing methods for classifying traffic conditions was carried out. Theoretical approaches for describing different traffic conditions as well as operating guidelines were considered. In order to compile current methods of classifying the traffic condition and to take into account the requirements of all stakeholders, experts from traffic management centers, public and private providers of traffic information services, as well as representatives of the ITS industry were interviewed.

The results of the literature review confirmed that neither uniform definitions nor comparable classification schemes are being used for describing the traffic flow quality. This applies to both freeways and the subordinate network. Several different approaches to describe the traffic flow on freeways are in use. These approaches differ in complexity as well as the evaluation of the parameters they are based on. Traffic flow on urban roads is mostly determined by the delays at intersections. Therefore, either the average travel time per road section or the resulting average travel speed is generally used as a parameter of traffic flow quality. Alternatively, a travel time index is applied as a parameter which is related to either a reference travel time or speed. In both cases, various threshold values are in use.

The accuracy requirements for the use of traffic classification schemes in intelligent traffic control systems are considerably higher than in traffic information systems. During the expert interviews it became apparent that determining the traffic flow quality for traffic control applications is a complex type of evaluation. The methods using merely one parameter for distinguishing different levels of quality (e. g. according to the German Highway Capacity Manual HBS) are usually not sufficient.