EXTENDED FLOATING-CAR DATA FOR THE ACQUISITION OF TRAFFIC INFORMATION

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SUMMARY

If traffic information is to be up-to-date, a comprehensive and reliable data acquisition system is needed. However, financial constraints mean that this requirement cannot be satisfied for much of the road network. For this reason, road traffic engineers are making increasing use of intelligent vehicles as mobile sensors, so-called “floating cars”, to determine the traffic situation. In modern vehicles, the data available include not just vehicle speed but also a wide variety of other variables. These can be acquired in digital form from the vehicle’s data buses. With their help it is possible to develop better traffic information and new telematics services which contribute to increasing road safety and driver convenience. Together with partners from industry, BMW is working within the German MoTiV research program on the realisation of a field test in which this concept can be tried out. This paper provides an overview of the concept involved and of initial results.

INTRODUCTION

Experts estimate the annual cost of traffic jams, disruption and accidents at several billion marks in Germany alone. Given this situation, and the fact that there are ecological and economic limits to the expansion of the road network, intelligent transport systems and, in particular, traffic control and information systems are becoming increasingly important.

Up-to-date high-quality traffic information requires a reliable and comprehensive means of acquiring data. This requirement cannot be fulfilled in respect of large sections of the traffic network. While comprehensive traffic data detection is generally incorporated at the traffic planning stage in the case of collective traffic management systems on motorways, there is very little provision for obtaining traffic data that would enable up-to-date traffic information to be supplied over a wide area. Interruptions to the traffic flow are thus either detected far too late by the police or reported coincidentally by persons equipped with a mobile telephone. This limited and incomplete acquisition of data causes the quality of the traffic information services to suffer: car drivers complain that traffic messages are not broadcast at all or are heard too late on the radio, or may be tempted to try a promising diversion in the event of a traffic hold-up, only to find themselves in another traffic jam elsewhere.

The operators of traffic information services are therefore making increasing efforts to supplement the acquisition of traffic information with traffic data acquired by mobile means and thereby close any qualitative or quantitative gaps in the data base.

THE PRINCIPLE OF FLOATING-CAR DATA ACQUISITION

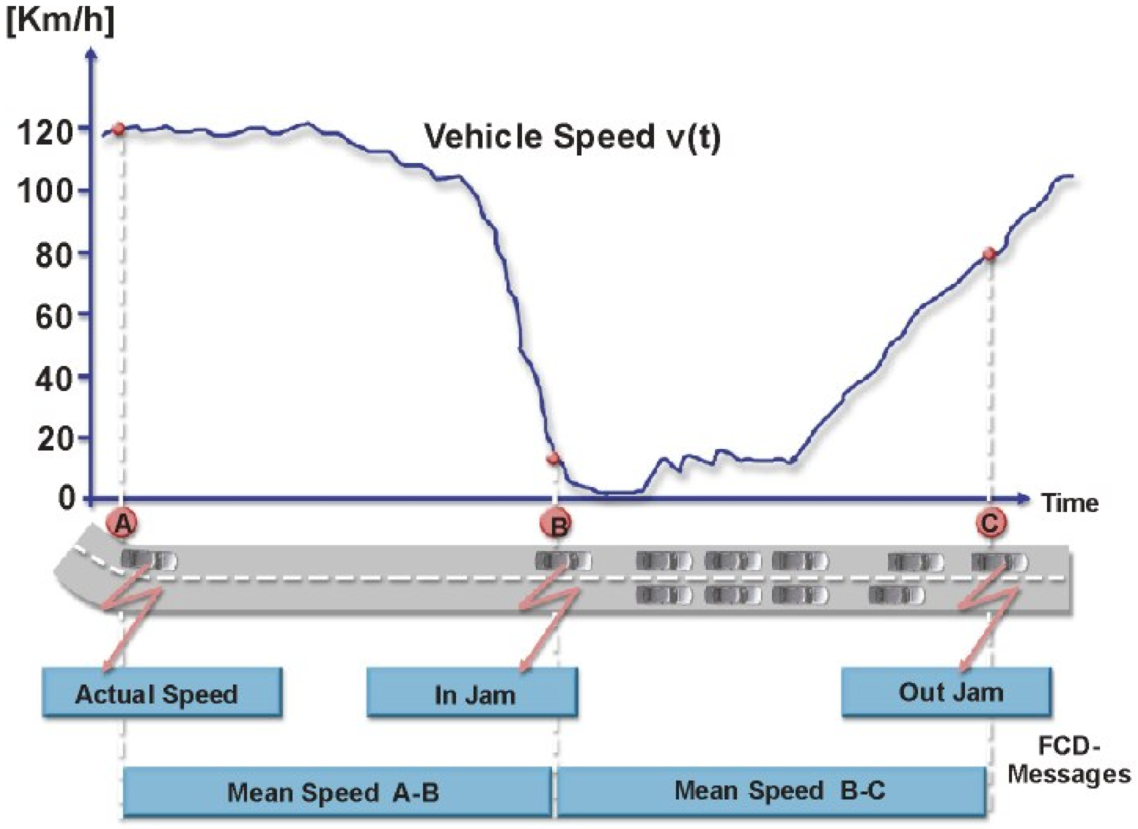
In Germany, there have been attempts to use vehicles that “float” with the traffic for data acquisition since the mid-eighties. These attempts were associated with individual route guidance systems that were intended to allow dynamic guidance to a destination via the road network by using vehicles participating in the system for traffic data acquisition. Examples of these systems are Ali- and Euroscout (Siemens) and SOCRATES (Philips). In these systems floating cars (FC) were used as mobile sensors to record speed-related parameters and to report this data (FCD) together with the vehicle’s position to a control centre.

This basic principle was taken up again in 1997 by the two largest private telematic service providers in Germany, Mannesmann-Autocom and Tegaron, who carried out a field trial called VERDI using new technologies, like cellular mobile phone networks and GPS, and algorithms for vehicle data processing. The outcome was the CEN Standardisation Proposal of GATS (Global Automotive Telematics Standard).

In all the field trials, FCD based on specific sections of road was found to be of positive benefit for obtaining traffic information. However, to enable useful information to be obtained from FCD alone a certain proportion of the vehicle population has to be fitted with the system, this proportion varying from 1 to 5 % depending on what level of quality of traffic information is required. Until such rates are achieved, FCD can provide a means of acquiring rudimentary information about traffic disruption on a road network without sensors (e. g. rural roads) and a means of supplementing conventional systems for traffic data acquisition (e.g. those using induction loops) on specific sections of road.

Figure 1 shows the functional principle of floating car data (FCD) acquisition: speed values recorded second by second in the vehicle's transceiver device are analysed and stastistically condensed with the aid of algorithms. This yields either route-section or route-point related characteristic values or traffic flow events.

Fig. 1: Principle of FCD acquisition



Characteristic route-section related data are for example the journey time or the mean journey speed between two route points. GATS FCD reference implementation determines mean travel speeds for characteristic route sections. In addition to the mean travel speed value, its variation is also computed, since this provides information on the degree of traffic flow disturbance. Characteristic route sections are determined by an algorithm in the vehicle's transceiver device in accordance with "mean travel speed since start of journey" and "current travel speed".

At the same time, algorithms to detect congestion are run, and transmit a message to the control centre if events such as "entering congested stretch" or "leaving congested stretch" are identified. An event such as entering a congested stretch is defined if it has been detected by two independent algorithms. Leaving the congested stretch is also registered as an event in the vehicle's transceiver device in order to enable periods of time spent in traffic congestion and the length of the congested sections of road to be determined. The mobile radio telephone (GSM/SMS) is used to transmit these data after compression as information from the floating car to the control centre, either periodically or when an event occurs.

The vehicle's positions are compressed into what is known as a "string of pearls" by means of a further algorithm in its transceiver device. Each FCD message transmitted from the unit is accompanied by a position report that contains the vehicle's last-known positions. These position data are needed at the control centre for the map matching process.

Since 1997 the Gesellschaft für Verkehrsdaten mbH (ddg) has operated a private-enterprise control centre for the acquisition of traffic data in Germany, including FCD. At this centre, data from all vehicles are collected, analysed and processed into traffic information.

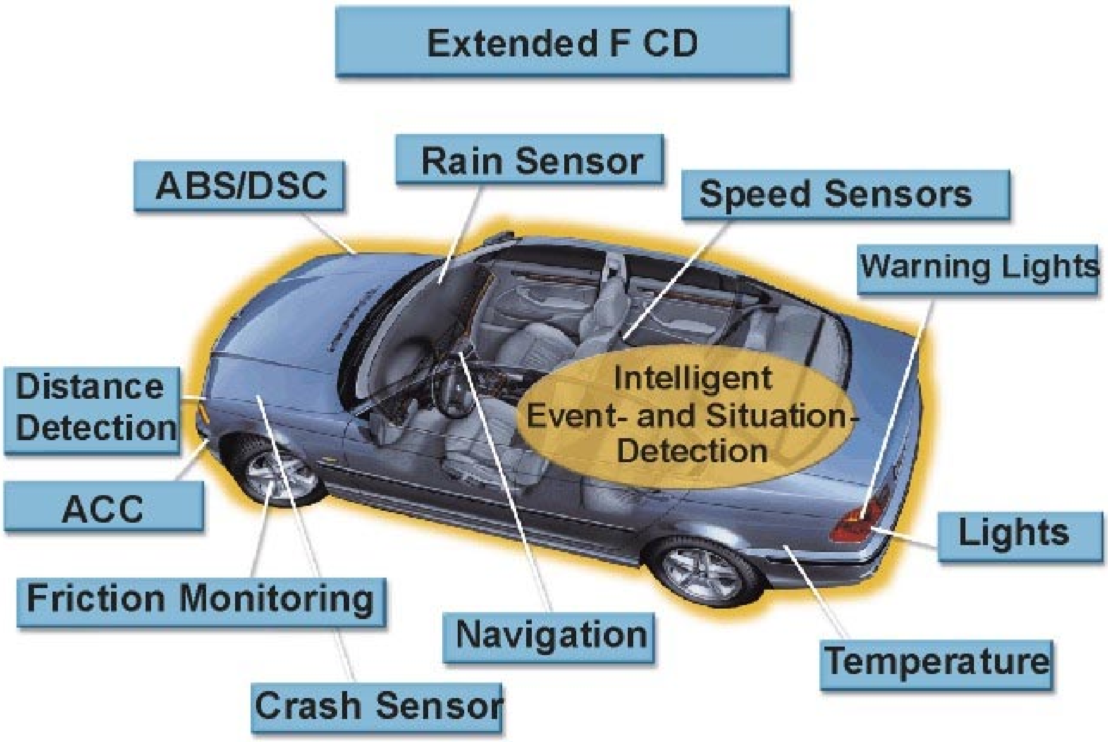
EXTENDED FLOATING CAR DATA

Beside the vehicle speed, there is a whole range of other operating and switching data available in digital form on the bus systems of modern vehicles. They are obtained from switches, sub-systems or sensors that are either standard or optional equipment on the vehicle. Being available in digital form, they can be registered on the vehicle without undue complexity and used for the process of obtaining traffic and environmental information. These data are referred to as Extended Floating Car Data (XFCD). Data from the following sources are of particular interest:

- the windscreen wipers or rain sensor,
- the external thermometer and the air-conditioning system,
- the vehicle's light system (brake and fog lights),
- the hazard warning flashers etc.
- the sensors for the systems controlling the vehicle dynamics,
- driver assistance systems.

By acquiring and evaluating these data it might be possible to obtain information on the traffic and the general situation that goes far beyond what was available initially with FCD. Figure 2 shows the vehicle data and systems used for XFCD data acquisition.

Fig. 2: Vehicle sensors and signals for XFCD acquisition



For any mobile data acquisition system, economically viable operation is a decisive factor. For this reason, condensation of the volume of data, effective coding and control of the transmitting activity are essential in order to limit the reported messages to essentials. XFCD is intended, in a similar manner to FCD data, to be processed on the vehicle into event, traffic situation and road condition messages and passed to a data centre. Based on route-section related and local traffic and hazard situations, for example

– approaching start of congested area
– heavy rain, aquaplaning or sheet ice
– poor visibility and fog

event identification algorithms are being developed that can infere from the avaiable measured values and identify and report these “events”. For instance, from the condition of the windscreen wipers, use of the fog lights and the vehicle's speed it is possible to derive assessments of the current weather situation and road conditions. If a traction control system is activated at a low outside temperature, this together with the windscreen wiper frequency and the road speed of the vehicle could be taken as an indication of a risk of slippery road surfaces locally.

These messages from the vehicles can then be processed in a data centre and transmitted to other road users as traffic information or warning messages. Such ideas are currently being followed up in a German research project called MoTiV (1996-2000) involving German motor-vehicle manufacturers and suppliers and will be put to the test in a field trial.

THE LOCOMOTIV FIELD TRIAL

Conceptual Design

An XFCD system of this kind is currently being designed as part of the MoTiV project. The Short Message Service (SMS) available on the cellular mobile phone network (GSM) has already been successfully tested in the FCD trials and would be an economical means of data transmission. GPS is used to locate the vehicle. Commercially viable telematic devices that meet the GATS specification are being used as terminals. In the LoCoMoTiV field test, BMW is trying out the entire telematic information chain from mobile traffic data detection to the extraction of information at the control centre and the provision of traffic information in the vehicle. The field test is to be held in three phases (Figure 3):

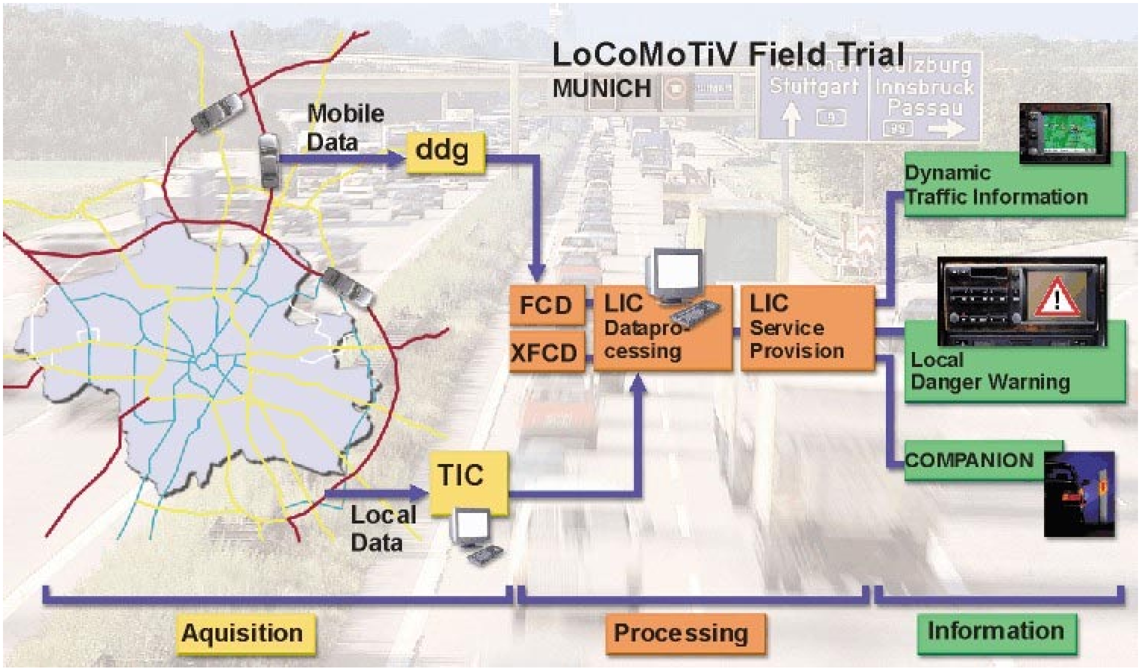
In Phase 1, 100 test participants in the Munich area of Germany were selected and their vehicles equipped with a commercial FCD transceiver. FCD generation is automatic and transmission takes place to a data centre developed and set up specially for the field trial, the LoCoMoTiV-Information-Center (LIC) in Munich. In addition, the local traffic data obtained conventionally from the Traffic Information Center Bayern (TIC Bavaria) are also supplied to the LIC. This makes it possible to assess the value of the mobile traffic data compared with local measurements and to generate an integrated form of information on the traffic situation.

In Phase 2a of the field trial, the emphasis is on equipping experimental vehicles to obtain XFCD data. With the aid of the infrastructure created in Phase 1, compressed traffic, hazard and road-condition information obtained from XFCD sources is transmitted to the LIC and subjected to further processing there. The recognition models to be tested are implemented on a vehicle PC, which has two interfaces, one for the telematics terminal and one for the car data bus to obtain the vehicle data. When a particular situation is detected, the terminal encodes and transmits the message to the LIC.

The chain of information is closed in Phase 2b, in which once again test vehicles will be equipped with PC-based telematic platforms specically developed for this purpose. These vehicle devices receive local hazard warning messages and supply them to the driver.

Results how FCD/XFCD could best be used as part of a traffic information management system and what proportion of vehicles would have to be equipped to provide the various information systems with a more adequate supply of data will be available with the end of MoTiV in the year 2000. Moreover, the acquisition of XFCD is a pre-requisite for the construction of new traffic information services that can focus on local dangers, which would warn the driver of unforeseeable dangers during a journey.

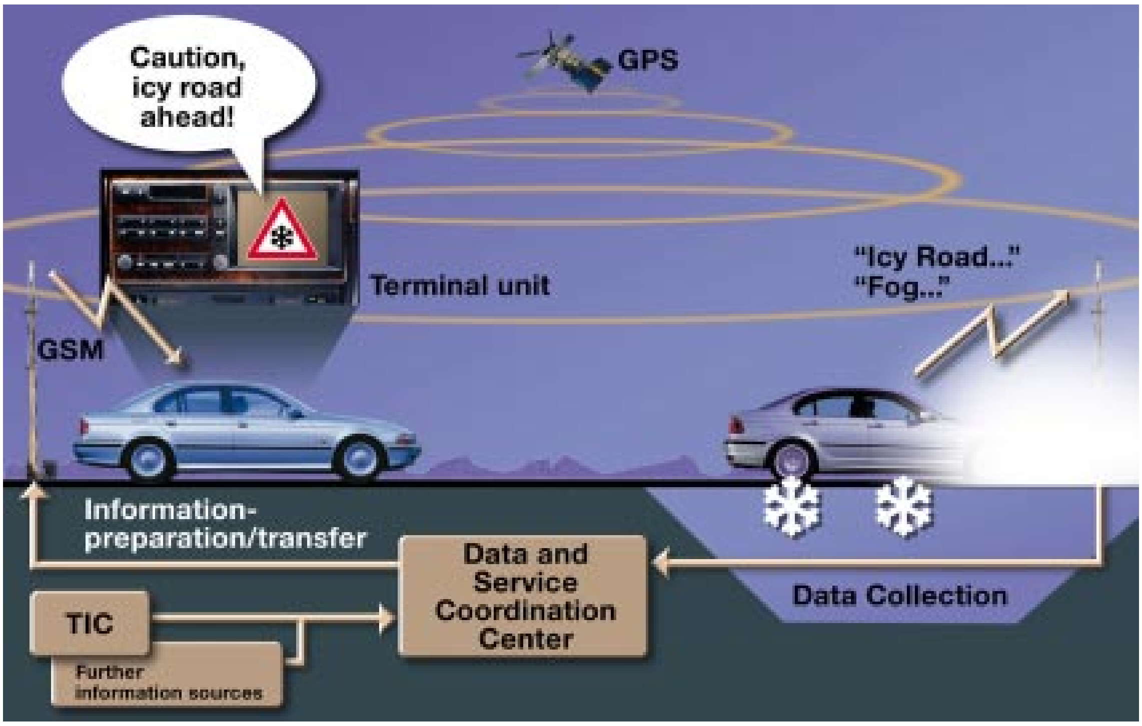
Fig. 3: Architecture of the LoCoMoTiV Field Trial



<u>Telematic Service: Local Danger Warning</u>

By the time LoCoMoTiV has ended, a demonstration service known as Local Danger Warning will have been developed, and will supply the driver with a visual and audible warning of danger-areas on the road. In order to enhance the warning effect as sensed by the driver, the warnings will only be supplied if the vehicle is moving towards the danger area. In the vehicle's transceiver device the traffic messages are subjected automatically to a relevance check with the aid of GPS and the navigation system, to confirm that the vehicle is in fact situated on the affected section of road. The traffic information is generated in the LIC data and service centre. For the XFCD, data from other sources such as Traffic Information Centres (e.g. the Bavarian TIC) are taken into account if available. The vehicle's telematics device received the GATS-coded messages via the mobile telephone and subjects them automatically to further processing. If the relevance check is satisfactory, the driver is supplied with information such as, for example, "Caution, icy road 2000 metres ahead" as speech output and on a display (Figure 4).

Fig 4: Local Danger Warning based on XFCD



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