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Executive Summary

The European project euroFOT developed the first large scale Field Operational Test, with a focus on Intelligent Vehicles equipped with Advanced Driver Assistance Systems (ADAS) and used by ordinary drivers in real traffic. Its motivation was to evaluate different on-board functions with regard to traffic safety, efficiency and the environment. Also usability and acceptance were exhaustively evaluated. Participants either owned their test vehicles, leased them during the experiment or took part as professional drivers employed by freight companies. Data acquisition techniques ranged from questionnaires to continuous recording of vehicle signals, and also, in some cases, additional instrumentation with video and extra sensors. The following functions have been considered for passenger cars and trucks:

- longitudinal control functions: Forward collision warning (FCW), adaptive cruise control (ACC), speed regulation system (SRS)

- lateral control functions: Blind spot information (BLIS), lane departure warning (LDW), impairment warning (IW)

- advanced applications: Curve speed warning (CSW), fuel efficiency advisor (FEA), , safe human machine interface (SafeHMI)

The project started in May 2008 and ended with a Final Event at the Autoworld Museum in Brussels, Belgium in June 2012. Several hundred Terabyte of data have been collected from around 1200 drivers driving for more than 35 million km.

This deliverable summarizes the three major phases of the project: **specification/piloting, execution and data analysis.**

Field tests are a well-known method for manufacturers to look into the way their products are used by the consumer. For the first time euroFOT has brought together major European vehicle manufacturers and research institutes in order to collect data from different ADAS equipped vehicles in different countries but all with the same task: ordinary driving on real roads. Participants drove vehicles which did not look very different from standard vehicles and could be driven without special instructions. It was therefore necessary to assemble complex computer and sensor hardware, flying wires, instrument brackets or even maintenance intensive software into a nice and clean package, requiring low maintenance and worthy of the newly acquired customer vehicle.

During the first two years, euroFOT was dedicated to defining the framework for the analysis of research questions (specifying functions, experimental procedures, hypotheses, measures, indicators and questionnaires) and for testing the chain of data collection and processing (piloting). The data acquisition systems (DAS) for CAN-data, video and extra sensor recording were selected, modified or even developed from components and

programmed for the different vehicle lines involved. The acquisition of drivers had started early and many drivers did agree to participate, despite low take-rate of systems and the weak economic situation. In the third year almost 1000 vehicles were on the road and collecting data. Vehicle Management Centers (VMC) had been installed to oversee the installation and maintenance of instrumentation, to provide hot line support and to administer questionnaires. In the fourth year the comprehensive task of "Data analysis" applied the methodology that had been previously prepared and fine-tuned.

The results achieved are now available and summarised in a number of public deliverables. They can be used by research organizations, public bodies and other stakeholders in Europe and elsewhere to support the wider deployment of ADAS.

The analysis first focused on system performance and user aspects, especially in dangerous situations which could potentially lead to accidents (which have been defined as ‘incidents’). This was followed by impact studies on traffic safety, efficiency and environment. Finally, the project considered a Cost Benefit Analysis (CBA).

Results

The following points summarise the main conclusions of the analysis. Overall, the final results point to positive effects on safety, and positive effects regarding fuel consumption together with high levels of driver-acceptance.

1. For both, passenger cars and trucks, the time-headway increased significantly when drivers were following a lead vehicle while using **ACC+FCW**. In addition, the relative frequency of harsh braking events and incidents decreased. Regarding changes in driver behaviour, drivers of passenger cars using ACC+FCW were three times more likely to engage in visual secondary tasks during normal driving (e.g. reading maps, looking at passengers or objects in the car). However, this difference was not found during incidents. The results imply that drivers seem to be capable of managing secondary tasks such that they focus on the road ahead when the traffic situation requires doing so. In addition, ACC+FCW does not seem to affect the amount of drowsy driving. For trucks, no particular side effects on driver behaviour were observed.

   Projecting the safety indicators of widely deployed ACC+FCW to EU-27, it was concluded that ACC+FCW in passenger cars have a positive effect on the overall number of crashes. In trucks, this conclusion could only be made for motorways. Hence, assuming that the safety indicators are good indicators, for how the accident scenario would change if all vehicles were equipped, ACC+FCW cars could potentially affect up to 2.2-5.7% of the injury accidents on motorways, while ACC+FCW trucks could potentially affect up to 0.2-0.6% of these accidents. Further estimations based on the relevant rear-end target crash population can be made for EU-27, e.g. regarding involved injured individuals. Note that the presented percentages are based on an extensive set of assumptions, which are described in **Error! Reference source not found.**. They are therefore to be used with caution, and need to be put into the perspective of all the assumptions made within the analysis framework.

   Based on the positive influences of ACC+FCW on safety there were also positive (indirect) effects on traffic efficiency. Due to the potential reduction of accidents the annual incidental delay calculated in lost vehicle hours could be lowered by up to three million hours on an EU-27 level. The environmental impact was measured in terms of fuel consumption which showed a reduction of approximately 3% for passenger cars and 2% for trucks. This effect does not consider benefits from changes in traffic efficiency.

Overall, ACC+FCW seems to be a highly appreciated and well used function that increases driver comfort as well as potentially having a positive effect on safety. Questionnaire data indicated that the driver expectations were fulfilled. The positive experiences of the drivers can also be seen in the increased use during the treatment phase (31% in travel time and 53% in the activation frequency).

2. While driving with **LDW** (**+IW** for passenger cars), drivers showed a slightly improved lateral control and a small increase in turn indicator usage. There was also a trend (although not statistically significant) toward less involvement in lateral incidents. Regarding driver behaviour, drivers were more likely to engage in secondary tasks. However, this difference was not found during incidents. This result mirrors the outcome for ACC+FCW and seems to indicate that drivers are capable of adjusting secondary task engagement to the traffic demand.

   Overall, drivers indicated in the questionnaires that LDW is a useful function. Some of them perceived the association between warning and actual crash risk as weaker than for the ACC+FCW. Hence, many warnings were perceived as unnecessary. An effective warning strategy is required to meet drivers varying expectations/requirements under different driving conditions. For IW, the congruence between warning strategy and the users' perception of their level of drowsiness/inattentiveness seems to be high since user ratings were highly positive and stable over time.

3. For the **Speed Regulation System** (SRS = SL+CC), it was observed that over-speeding and harsh braking events were reduced when SL is active. The effect of CC on over-speeding was a strong increase while strong jerk, critical time gap, and harsh braking occurrences were reduced. These findings highlight the relationships between system usage and driving condition showing that the level of traffic is likely to be an important factor for system use.

   The analysis showed that no safety effects occur when using that system, despite an increase in speed. The a priori acceptance of the SRS was very positive and the use of the systems confirmed this tendency. Ratings of usefulness and satisfaction generally increased over time, except for a slight decrease experienced with SL. Drivers used the cruise control (CC) mostly in free flow conditions and on motorways (40% and 66%). Usage of the SL was lower (about one third of the driven km, less on motorways).

   Since a change in the mobility behaviour was found neither in the objective nor in the subjective data, the effect of the SRS on traffic efficiency is related to the change in average speed which increased about 2.4% on motorways. Environmental aspects of the system showed also a positive trend towards reduced fuel consumption through the system use (approximately 1%).

4. The analysis shows that **navigation systems**, as part of SafeHMI, are highly accepted and also widely used. Results indicate that route choice while driving with an active navigation system is more time efficient than the baseline condition when no navigation system was available. As expected significant positive effects on travel distance and travel time were found in the analysis. The system was used mostly on long trips on unfamiliar routes. For the tested built-in device the usage rate on these trips (long, unfamiliar) reached almost 100%. Furthermore, navigation systems seemed to support a fuel efficient route choice, depending on their routing algorithm.

   It was observed that on urban roads potentially safety relevant indicators show a positive effect if the system is activated. This positive effect is reflected in positive changes in lane keeping behaviour, distance to the lead vehicle and harsh braking events.

5. Overall, drivers indicated that **BLIS** is highly appreciated. The acceptance rating remains high over time, which indicates that drivers continue to perceive it as useful as they experience interacting with it over an increasingly large variety of conditions. Approximately 80% of drivers felt that BLIS increases safety. It was perceived as most useful on urban roads in heavy traffic and does not increase workload. However, most hypotheses tested showed no significant effect on safety or driver behaviour based on the objective data. An exception was the frequency of turn indicator use, which slightly decreased when the system was available and drivers were not simultaneously using LDW+IW. However, from the free text comments it is clear that most drivers consider BLIS as an important complement to visual checks, rather than as a primary source of information.

6. **CSW** has also a good overall evaluation in terms of usability and acceptance. The values for satisfaction and useful categories increased significantly while using the system. According to the survey, around 75% of the drivers felt that safety is increased thanks to CSW. They also found it most useful while driving on rural roads. Some participants stated that they used CSW as indicator or for practising a more cautious driving style. Moreover, participants trust in the system increased after usage. The trustworthy and reliability scores were higher after some experience with the system.

7. **FEA** is specifically designed to help reduce fuel consumption. The analysis of the data therefore focused on the environmental impact and did not consider possible side effects that may impact traffic efficiency and safety. The treatment phase showed a reduction in fuel consumption of 1.9% based on 3.6 million kilometers from 50 trucks.

In order to supplement the above findings also some final considerations and several **lessons learned and good practices** for future FOTs are included in this report.

FOTs can definitely contribute to the evaluation of Intelligent Vehicles, but are not the unique solution for all investigations concerning new automotive systems. The methodologies that are available need to be adapted to the specific systems, also taking into account existing constraints in time and resources. Conditions that are necessary for a successful implementation of FOTs include a large variety of aspects: in particular various aspects pertaining to the industrial, technical, organisational and methodological viewpoints.