eVALUE – A Test Programme for Active Safety Systems

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ABSTRACT

Active safety systems are massively implemented into new vehicle generations and offer a high potential in decreasing road accidents. While testing and rating of the passive safety of vehicles are based on established and accepted methods and programmes, no such are available for active safety of cars or trucks today. Thus it is difficult to assess the performance of those systems for industry, legislation and further stakeholders. In particular, the customer cannot judge about the active safety of different vehicles based on easy-to-understand ratings as they are offered by different NCAP programmes. This leads to a relatively low awareness of active safety systems and hinders a high market penetration.

The main focus of the European research project "Testing and Evaluation Methods for ICT-based Safety Systems (eVALUE)" is to define objective methods for the assessment of active safety systems. The methods are based on relevant traffic scenarios that, according to investigated statistics and databases, represent the majority of accidents, where active safety systems can come into effect. The considered systems are chosen based on market availability and penetration, e.g. ACC, Lane Keeping Assistant or ESC. Both the systems as well as the scenarios are clustered into four different domains, each being addressed with distinctive test procedures.

In the end, this new and highly needed test programme will allow the assessment of the overall safety performance of a vehicle with respect to active safety systems. However, the eVALUE consortium will only define the test methods while the thresholds for the specific values are not specified. This remains the competence of every institution adopting the test methods and actually applying them in order to assess different vehicles. The later results of the programme will increase the public awareness for active safety systems and foster the development within the industry.

INTRODUCTION

Modern society strongly depends on mobility, and the need for transport of both people and goods is expected to grow further in the future. Cleaner, safer and more efficient transport systems are needed. Mobility and especially road transport cause major societal problems: accidents, pollution and congestions. More than 40,000 lives are lost every year due to road accidents in the European Union only, and the costs are estimated to be about 2 % of its GDP [1].

The European Commission and its member states have made major efforts to improve traffic safety, and the results can be seen in a decreasing number of fatalities in many European countries [2]. Nowadays new ways must be found to reduce the number of fatalities and in-juries even further. The public awareness of the enormous impact that active safety systems would have on road safety must be raised. It must be easy for the customer to understand the benefits of safety systems based on Information and Communication Technologies (ICT).

The average car buyer cannot assess the performance of active safety systems in vehicles, nor their impact on traffic safety. Today, there are no publicly accepted test methods and no established ways to communicate the test results. The situation is quite different for passive safety systems, where test programs such as Euro NCAP have established impact test methods and ways to explain the test results in different levels of detail. While the car buyers may compare star ratings for passive safety between different cars, the professional safety engineer may compare measurement data from the tests.

Going forward to this goal of accident free traffic, evaluation and standardised testing methods for active safety systems are essential. This is the main focus of the European research project "Testing and Evaluation Methods for ICT-based Safety Systems (eVALUE)" which is funded under the

7th Framework Programme of the European Commission. It has a duration of 36 months. The consortium consists of eight partners from four European countries and is led by the Institut für Kraftfahrzeuge (ika) of RWTH Aachen University.

Partners come from both research organisations and industry, including vehicle OEMs. In particular, Centro Ricerche FIAT (Italy) and Volvo Technology Corporation (Sweden) contribute as OEMs while Germany's Ibeo Automobile Sensor is a supplier of laser scanners. SP Technical Research Institute of Sweden and Statens Väg- och Transportforskningsinstitut (VTI) are research organisations from Sweden with Fundación Robotiker and IDIADA Automotive Technology from Spain being well-known as research and testing suppliers.

OBJECTIVES

Performance test results presented to the public will help to promote the use of active systems. This has also been underlined by the eSafetyForum working group on Research and Technological Development in their "Recommendations on forthcoming research and development" [3].

By this means, also the research and development of new safety systems is encouraged. The long-term goal is to provide a basis for de-facto standards that will be used by all involved stakeholders. This has already proven to be an effective way in terms of promoting passive safety [4].

In the first phase, the eVALUE project is focusing on safety systems available for today's vehicles. Active systems currently under development or close to market entrance may be included in the project at a later stage. The aim is to identify evaluation and testing methods, especially for primary safety systems, with respect to the user needs, the environment and economic aspects.

An intensive communication with key stakeholders has been started and will accompany the project throughout its duration. The partners are aware of the fact that additional testing methods will not easily be accepted and adopted especially by involved industry. In addition, most manufacturers or suppliers already perform in-house testing of their systems and vehicles. Thus, a harmonisation of those methods is sought wherever possible. Besides industry, other stakeholders like national authorities, customer organisations or standardisation working groups active in this field are also contacted.

However, the project will not perform any activities which lead to a direct standardisation of the methods developed. Furthermore, there will not be any pass or fail criteria defined for the different performance values. The focus will be set on objective and repeatable methods while rating will be up to the users of these methods.

METHODOLOGY

Today, a number of passive and active safety systems as well as intelligent driver support systems are already in the market. A trend towards more pro-active and increasingly integrated safety systems is apparent. The performance of all these systems is affected substantially by the properties of the vehicle itself. For instance, such vehicle properties include tire characteristics, vehicle dynamics behaviour and friction potential in road/tire contact. Also the control strategy and algorithm quality of the active safety systems can improve the performance towards accident free traffic.

The Approach in Defining Test Methods

In 2007, the ASTE study [5] has investigated the feasibility of performance testing for active safety systems. In addition, it aimed at needed methods and principles for verification and validation of those systems. Therefore, different approaches were considered. The system approach is based on the capabilities of specific systems and mapped to traffic scenarios. Performance of the different systems with similar functions is then assessed.

The scenario approach is directly based on traffic scenarios. The vehicle is tested as a black-box and its overall performance in those scenarios is determined. As a third option, a document-based approach was discussed. This could complement physical testing and might be particularly valuable for HMI testing.

According to the conclusions of the study, vehicle active safety shall be tested following the scenario-based approach. It was further stated that performance testing of active safety systems is technically and economically feasible and that a consensus between different stakeholders will be possible. The importance of communicating test results in a very simple way was underlined.

The eVALUE project is a direct follow-up of this study. Most partners are now part of the eVALUE consortium. Together, objective methods will be developed, enabling the estimation of the safety impact the regarded active safety systems have.

Figure 1 gives an overview of a scientific approach for the development of the testing and evaluation methods. Based on accident statistics, relevant scenarios will be derived that represent the majority of accidents in which active safety systems could possibly mitigate the outcome. A vehicle will be assessed by applying the procedures. Those shall be recognisable also by the end customer as critical situations that can happen at any time. One example could be approaching suddenly congesting traffic or a similar, non-moving obstacle. The benefit of active safety systems (e.g. by automatic braking in this case) will thus be even more clear.

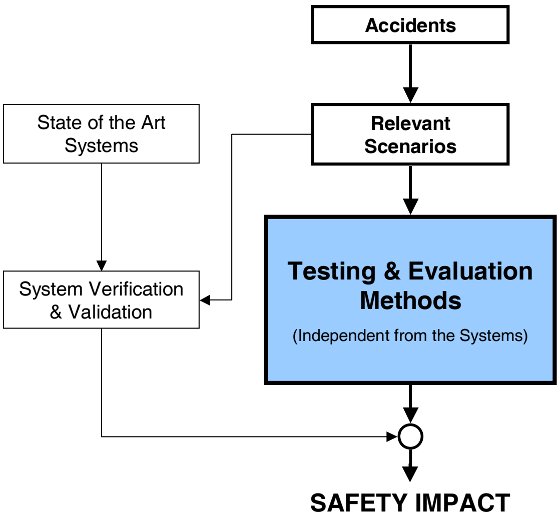

Figure 1. Scientific Approach for Assessment Development

Unlike the assessment of vehicle passive safety, the systems contributing to active safety will be regarded in detail. From verification and validation, e.g. fault rates are be analysed and their influence on the overall safety impact is taken into account.

Validation of the systems includes the interaction with the environment/infrastructure and driver actions. For both testing the vehicle as a whole and the systems in detail, relevant scenarios have to be found and/or defined.

Systems to be Regarded

The road-map of active safety systems with their time horizon is given in Figure 2. They are clustered into four domains. These are the longitudinal domain, the lateral domain, the domain for yaw/stability assistance and an additional domain. This additional domain is yet to be defined. Scenarios are defined for the same domains thus taking into account the interaction of different systems which might come into effect in the same situation.

Out of those domains, the following eight systems have been chosen. This decision is mainly based on the availability on the market with a penetration rate of more than 50,000 vehicles:

- System Cluster 1 (longitudinal assistance)
  - ACC
  - Forward Collision Warning
  - Collision Mitigation, by braking
- System Cluster 2 (lateral assistance)
  - Blind Spot Detection
  - Lane Departure Warning
  - Lane Keeping Assistant
- System Cluster 3 (yaw/stability assistance)
  - ABS
  - ESC
- System Cluster 4 (additional assistance)
  - Not defined at this stage

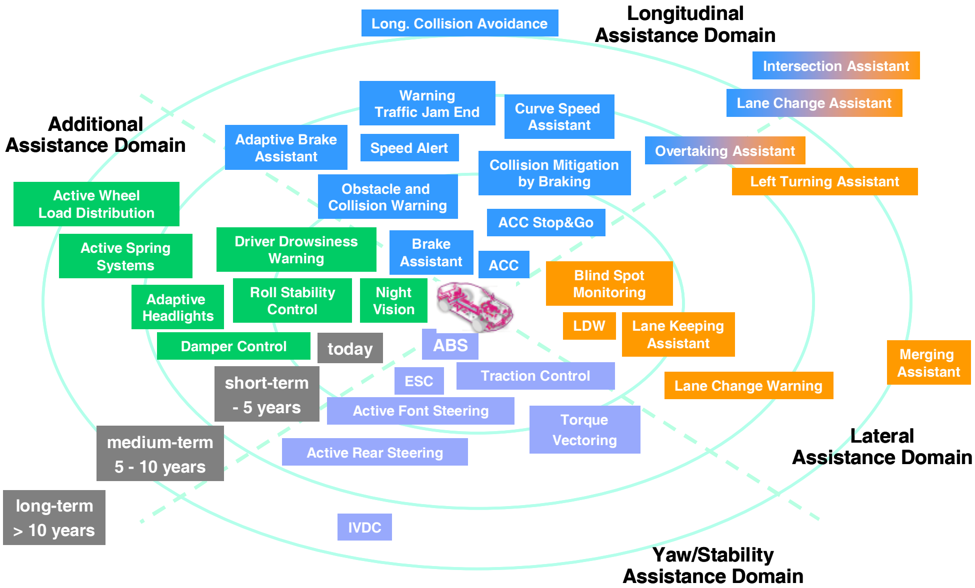

Figure 2. Clustered Road-map of Active Safety Systems

Considered Scenarios

The derivation of relevant scenarios from accident statistics directly has already turned out to be a challenge. No reliable accident databases are available that are capable of delivering a comprehensive analysis of accident circumstances for the whole of Europe. While some European projects such as TRACE [6] have been working on ideas for the harmonisation of accident statistics, waiting for them being available is not acceptable. Thus the partners have defined relevant scenarios based on information that is available today. This includes standards for testing of certain systems, results from other projects and the expertise of the involved institutions.

For System Cluster 1, three different scenarios have been chosen. They represent a straight road, a curved road and a target, which is transversally moving in the way of the subject vehicle.

Regarding the straight road, the objective of the chosen scenario is to validate that the subject vehicle can detect and handle (warn, support, and/or intervene) a target vehicle in the same lane, Figure 3.

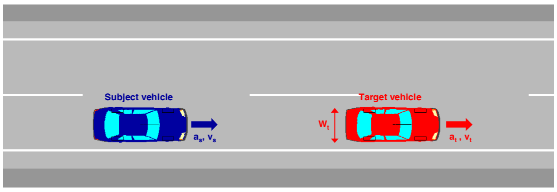

Figure 3. Straight Road Scenario (Cluster 1)

The same objective applies for the scenario, however for a curved road, Figure 4.

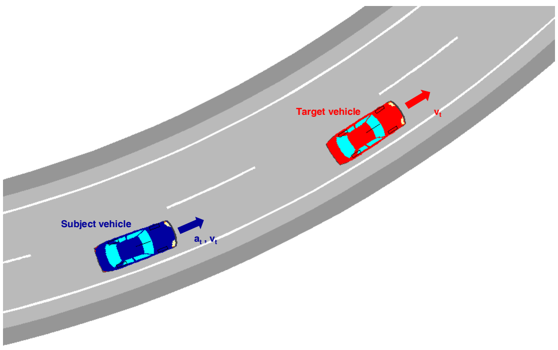

Figure 4. Curved Road Scenario (Cluster 1)

The objective of the third scenario is to validate that the subject vehicle can detect and handle (warn, support, and/or intervene) a target (e.g., other vehicle, pedestrian,…) which moves lateral to the subject vehicle, Figure 5.

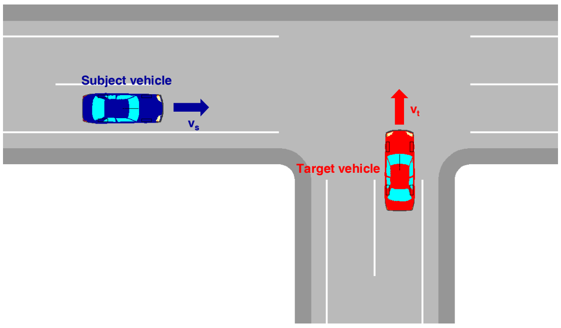

Figure 5. Transversally Moving Target Scenario (Cluster 1)

The System Cluster 2 is addressing systems which are providing lateral assistance. For straight as well as curved roads, a differentiation is made regarding lane and road departure. Accordingly, four different scenarios are considered.

The first scenario is meant to validate the subject vehicle capability to avoid involuntary (left/right) lane departure driving on a straight road, Figure 6.

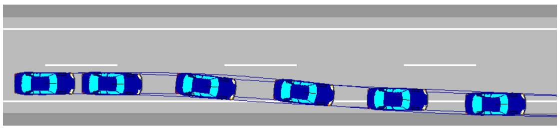

Figure 6. Lane Departure on a Straight Road Scenario (Cluster 2)

As a form of extension of the first scenario, the second is meant to validate the subject vehicle capability to avoid involuntary road departure driving on a straight road, Figure 7.

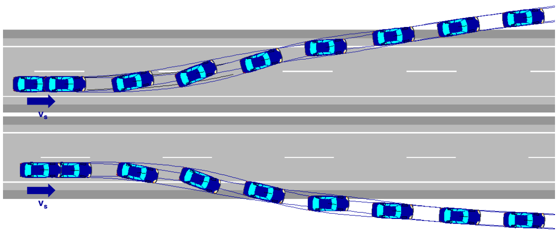

Figure 7. Road Departure on a Straight Road Scenario (Cluster 2)

Comparable to the first two, the second and third scenario of Cluster 2 regard lane or road departure while the subject vehicle is driving in a curve. Again, the capability to avoid the involuntary lane or road departure is the objective here, Figure 8.

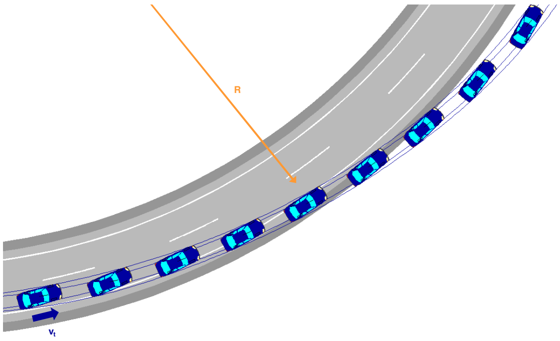

Figure 8. Lane or Road Departure in a Curved Road Scenario (Cluster 2)

A modification to the aforementioned is given by sceario five and six, namely to validate the subject vehicle capability to avoid involuntary lane departure driving on a straight road just before entering an upcoming curve, Figure 9.

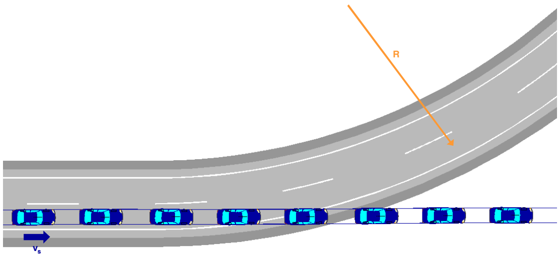

Figure 9. Lane or Road Departure on a Straight Road Just Before a Curve Scenario (Cluster 2)

While these scenarios do not consider interaction with a second (called target) vehicle, the seventh scenario does so. It addresses lane change collisions which are well-known in multi-lane traffic both at low and high speeds, Figure 10.

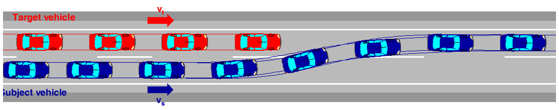

Figure 10. Lane Change Collision Avoidance on a Straight Road Scenario (Cluster 2)

Yaw and stability assistance is given by systems which have been collected under System Cluster 3. Here, some manoeuvres are already established in testing. One example is braking on μ-split, i.e. surfaces with different friction coefficients, Figure 11.

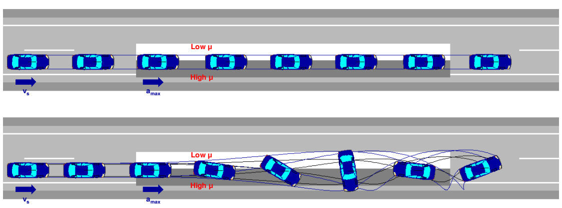

Figure 11. Emergency Breaking on μ-Split Scenario (Cluster 3)

The capability of the vehicle to avoid loss of control in a sudden obstacle avoidance manoeuvre is regarded with the second scenario in Cluster 3, Figure 12.

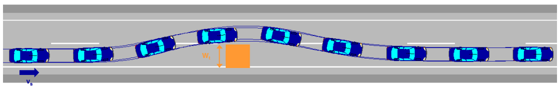

Figure 12. Driver Collision Avoidance Scenario (Cluster 3)

Finally, critical situations linked to curved roads are represented by the third and fourth scenario of Cluster 3, Figure 13-14.

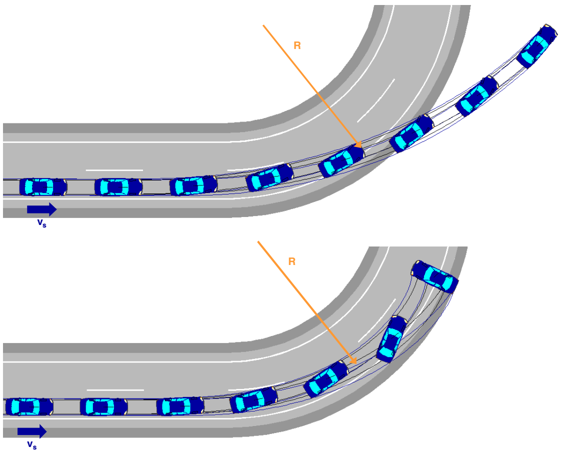

Figure 13. Fast Driving into a Curve Scenario (Cluster 3)

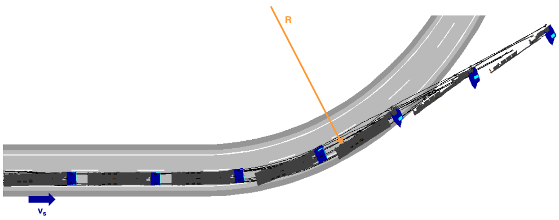

Figure 14. Roll Stability Scenario (Cluster 3)

All scenarios do not only consider passenger cars but generally also apply for trucks and busses. However, it has not been decided yet to what extent the project can regard the special requirements by commercial vehicles concerning active safety test methods.

Current Development and Next Steps

Having defined the scenarios, the development of the methods themselves has been started. The main focus will be on physical testing with a certain support from simulation where this seems appropriate. Verification and validation of the systems will mainly be done by lab testing. In general, the most suitable methods and procedures will be taken to reveal the active safety performance in the best way.

CONCLUSIONS

In the development of automotive active safety systems, no generally accepted standards are available today. Manufacturers of systems, components or vehicles all need to develop their own testing procedures in order to provide both development goals and means to evaluate the system performance. Large R&D efforts are undertaken in parallel by various companies in order to provide the technological background for the development of testing procedures.

Due to this situation of inhomogeneous testing practice throughout the industry, test results acquired in different manufacturer-specific tests cannot be compared by customers and authorities. Furthermore, manufacturers have no means to assess their systems in a generally accepted way.

The outcome of the eVALUE project will be explicit testing procedures/protocols for active safety systems that can found the basis for a de-facto standard whilst and after the duration of this project. In addition, communication with stakeholders that might be involved in a later standardisation process has been established to get a broad picture of currently on-going standardisation efforts towards those systems.

The project started in January 2008 and will continuously generate results. Due to the production deadline, the latest findings cannot be covered by this paper but are available on the project's website under www.evalue-project.eu.

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NOTE

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