SAFESPOT INTEGRATED PROJECT - IST-4-026963-IP

DELIBERABLE 4.4.2

Equipped Cars Integrating the Safety Margin applications

Deliverable No. (use the number indicated on technical annex) | D4.4.2
---|---
SubProject No. | SP4
Workpackage No. | WP4
Task No. | T4.4.3; T4.4.4
Task Title | Integration of the SAFESPOT applications in equipped vehicles; SAFESPOT application: system tuning and re-adjustment

Authors (per company, if more than one company provide it together) | Javier Ibanez-Guzman, Abdel Kader Mokaddem – RENAULT Giulio Vivo – CRF; Dehlia Willemsen - TNO
Status (F: final; D: draft; RD: revised draft): | F
Version No: | 1.2
File Name: | SF_D4.4.2_EquippedCarsIntegratingSMA_v1.2.doc
Planned Date of submission according to TA: | 30/04/2009
Issue Date: | 08/06/2010
Project start date and duration | 01 February 2006, 48 Months
# Revision Log

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Reason</th>
<th>Name and Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>02/03/2009</td>
<td>Template creation</td>
<td>G. Vivo - CRF</td>
</tr>
<tr>
<td>0.2</td>
<td>07/03/2009</td>
<td>First draft released</td>
<td>G. Vivo - CRF</td>
</tr>
<tr>
<td>0.3</td>
<td>11/03/2009</td>
<td>Included references to ESPOSYTOR</td>
<td>G. Vivo - CRF</td>
</tr>
<tr>
<td>0.4</td>
<td>24/03/2009</td>
<td>Some refinements to the ESPOSYTOR parts, changed pictures</td>
<td>M. De Gennaro – MMSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F. Tosetto - MMSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Giulio Vivo - CRF</td>
</tr>
<tr>
<td>0.41</td>
<td>24/03/2009</td>
<td>Contributions by Renault</td>
<td>J.Ibanez-Guzman &amp; A. K. Mokaddem - Renault</td>
</tr>
<tr>
<td>0.5</td>
<td>02/04/2009</td>
<td>Contributions by TNO, overall integration</td>
<td>D. Willemsen – TNO</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>G. Vivo - CRF</td>
</tr>
<tr>
<td>0.6</td>
<td>07/04/2009</td>
<td>Minor layout corrections</td>
<td>G. Vivo - CRF</td>
</tr>
<tr>
<td>0.7</td>
<td>08/04/2009</td>
<td>Typo Error Correction</td>
<td>J.Ibanez-Guzman - Renault</td>
</tr>
<tr>
<td>0.8</td>
<td>15/04/2009</td>
<td>Final version</td>
<td>J.Ibanez-Guzman – Renault</td>
</tr>
<tr>
<td>0.9</td>
<td>07/04/2010</td>
<td>Fixed some unresolved references. Removed some repeated sections. Update after the Amsterdam Showcase 2010</td>
<td>G. Vivo - CRF</td>
</tr>
<tr>
<td>0.9.1</td>
<td>18/05/2010</td>
<td>Description Daimler vehicles</td>
<td>M. Bogdanovic - Daimler</td>
</tr>
<tr>
<td>1.0</td>
<td>23/05/2010</td>
<td>Overall review; added contributions from TNO and LCPC</td>
<td>D. Willemsen – TNO</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. Glaser - LCPC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>G. Vivo - CRF</td>
</tr>
<tr>
<td>1.1</td>
<td>08/06/2010</td>
<td>Completion of the description of integrated software on Renault Vehicles</td>
<td>J.Ibanez-Guzman – Renault</td>
</tr>
<tr>
<td>1.2</td>
<td>30/08/2010</td>
<td>Revision implementing the remarks of the final review: chapter 6 updated (references to the COOPERS IP removed)</td>
<td>G. Vivo - CRF</td>
</tr>
</tbody>
</table>
# Abbreviation List

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN</td>
<td>Controller Area Network</td>
</tr>
<tr>
<td>COSSIB</td>
<td>Cooperative Safety Systems Infrastructure Based</td>
</tr>
<tr>
<td>CW</td>
<td>Curve Warning</td>
</tr>
<tr>
<td>CVIS</td>
<td>Cooperative Vehicle-Infrastructure System</td>
</tr>
<tr>
<td>ESPOSYTOR</td>
<td>SAFESPOT System Monitor</td>
</tr>
<tr>
<td>ExtMsgApp</td>
<td>External Message Application</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>HOCEW</td>
<td>Head On Collision Warning</td>
</tr>
<tr>
<td>INCA</td>
<td>Instrumented Car</td>
</tr>
<tr>
<td>IRIS</td>
<td>Intelligent Cooperative Intersection Safety</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LCM</td>
<td>Lane Change Manoeuvre</td>
</tr>
<tr>
<td>LDM</td>
<td>Local Dynamic Map</td>
</tr>
<tr>
<td>OBU</td>
<td>On Board Unit</td>
</tr>
<tr>
<td>REC</td>
<td>Rear End Collision</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>RSU</td>
<td>Road Side Unit</td>
</tr>
<tr>
<td>RTK</td>
<td>Real Time Kinematics</td>
</tr>
<tr>
<td>SAFEPROBE</td>
<td>In-Vehicle Sensing and Platform</td>
</tr>
<tr>
<td>SCOVA</td>
<td>System Cooperative Vehicle Based Applications</td>
</tr>
<tr>
<td>SINTECH</td>
<td>Innovative Technologies</td>
</tr>
<tr>
<td>SLSD</td>
<td>Speed Limitation and Safety Distance</td>
</tr>
<tr>
<td>SMAEV</td>
<td>Safety Margin for Assistance and Emergency Vehicles</td>
</tr>
<tr>
<td>SP</td>
<td>Sub Project</td>
</tr>
<tr>
<td>SpA</td>
<td>Speed Alert</td>
</tr>
<tr>
<td>TS</td>
<td>Test Site</td>
</tr>
<tr>
<td>UDP</td>
<td>User Datagram Protocol</td>
</tr>
<tr>
<td>VANET</td>
<td>Vehicle Ad Hoc network</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Sign</td>
</tr>
</tbody>
</table>
Table of contents
Revision Log .......................................................... ................................................... 2
Abbreviation List .......................................................... ................................................... 3
Table of contents .......................................................... ................................................... 4
List of Figures .......................................................... ................................................... 4
EXECUTIVE SUMMARY .......................................................... ................................................... 5
1. Demonstrator vehicles provided by CRF .......................................................... ................................................... 6
   1.1. Functionality .......................................................... ................................................... 6
   1.2. Vehicles .......................................................... ................................................... 7
   1.3. Equipment .......................................................... ................................................... 8
2. Demonstrator vehicles provided by Daimler .......................................................... ................................................... 13
   2.1. Functionality .......................................................... ................................................... 13
   2.2. Vehicles .......................................................... ................................................... 13
   2.3. Equipment .......................................................... ................................................... 14
3. Demonstrator vehicles provided by RENAULT .......................................................... ................................................... 15
   3.1. Functionality .......................................................... ................................................... 15
   3.2. Vehicles .......................................................... ................................................... 15
   3.3. Equipment .......................................................... ................................................... 17
4. Demonstrator vehicles provided by TNO .......................................................... ................................................... 19
   4.1. Functionality .......................................................... ................................................... 19
   4.2. Vehicles .......................................................... ................................................... 19
   4.3. Equipment .......................................................... ................................................... 20
5. Demonstrator vehicles provided by LCPC .......................................................... ................................................... 22
   5.1. Functionality .......................................................... ................................................... 22
   5.2. Vehicles .......................................................... ................................................... 22
   5.3. Equipment .......................................................... ................................................... 23
6. Wrap Up after the Stockholm and Amsterdam demonstrations .......................................................... ................................................... 25
7. Conclusions .......................................................... ................................................... 26
8. References .......................................................... ................................................... 27

List of Figures
Fig. 1: CRF SAFEPROBE (red car) and SCOVA (blue car) demonstrator vehicles .................. 7
Fig. 2: CRF COSSIB vehicle .............................................................................................................. 7
Fig. 3: System architecture of the SAFEPROBE and SCOVA CRF demonstrators .................. 8
Fig. 4: System architecture of the COSSIB demonstrator .......................................................... 9
Fig. 5: Physical architecture and data exchange for the COSSIB demonstrator ..................... 10
Fig. 6: SAFEPROBE and SCOVA demonstrators HMI .......................................................... 10
Fig. 7: Main page – Ego Vehicle – of the ESPOSYTOR system monitoring tool ............... 11
Fig. 8: VNET page – Ego Vehicle – of the ESPOSYTOR system monitoring tool ............. 12
Fig. 9: DAIMLER vehicles: SMART Fortwo and Mercedes S-Class .................................. 13
Fig. 10: The Espace IV at the test site during data acquisition trials ........................................ 16
Fig. 11: The Laguna III at the test site during communication link trials ............................... 16
Fig. 12: Equipment layout inside the Laguna III vehicle ........................................................ 17
Fig. 13: Block Diagram Representation of Test Vehicle ........................................................ 17
Fig. 14: Implementation SAFESPOT System in the Renault Vehicles ............................ 18
Fig. 15: Activation of Safety Margin for the Use Case 1f ........................................................ 18
Fig. 16: The Citroen C4 (left) and the Volkswagen Passat INCA (right) ............................ 19
Fig. 17: The BMW at the Intertraffic in Amsterdam .............................................................. 19
Fig. 18: Citroen C4 SAFESPOT equipment ................................................................................ 20
Fig. 19: Volkswagen Passat (INCA) SAFESPOT equipment ................................................ 21
Fig. 20: BMW SAFESPOT equipment ..................................................................................... 21
Fig. 21: Full SAFESPOT architecture outside of the vehicle .................................................. 22
Fig. 22: LCPC OBU Vehicle ....................................................................................................... 23
Fig. 23: LCPC implemented architecture .................................................................................. 24
EXECUTIVE SUMMARY

As part of the SP4 SCOVA and the different Test Site SPs, a series of demonstrator cars have been developed: CRF, TNO, RENAULT, DAIMLER, LCPC contribute each with two or more fully equipped vehicles. The vehicles host the hardware and software proposed within SAFESPOT with implementations differing regarding to the safety applications that have been demonstrated and the sites where these tests have been carried out.

The development of test and demonstrator vehicles is one of the most important activities of the work package WP4.4 (Implementation and Prototypes); the overall objectives of this work package are as follows:

- To implement the Safety Margin algorithms for the computation of the characteristic parameters;
- To develop the safety applications to be used in the validation and evaluation phases;
- To integrate the experimental vehicles with the SAFESPOT developed systems (cars, trucks, motorcycles);
- To enhance the developed applications based on preliminary tests and validation results.

The present document is an accompanying report of Deliverable D4.4.2 (this consists of passenger car demonstrators). It also supports the presentation of the on-board prototype systems and functions running the vehicle based Safety Margin applications. The demonstration of these applications forms part of the Test Site activities running in throughout the final year of the SAFESPOT project.

The demonstrator passenger vehicles described in this deliverable are:

- Vehicle 1: SCOVA, FIAT Bravo Multijet 1.9 Blue (CRF)
- Vehicle 2: SAFEPROBE, FIAT Bravo Multijet 1.9 Red (CRF)
- Vehicle 3: COSSIB, FIAT Croma Multijet 1.9 Black (CRF)
- Vehicle 4: Mercedes S-Class vehicle (DAIMLER)
- Vehicle 5: Smart Fortwo vehicle (DAIMLER)
- Vehicle 6: RENAULT Laguna III (RENAULT)
- Vehicle 7: RENAULT Espace IV (RENAULT)
- Vehicle 8: Citroen C4 (TNO)
- Vehicle 9: Volkswagen Passat – INCA demonstrator (TNO)
- Vehicle 10: BMW vehicle (TNO)
- Vehicle 11: SAFEPROBE, RENAULT Clio Eco 3 (LCPC)
- Vehicle 12: COSSIB, RENAULT Clio Eco 3 (LCPC)
- Vehicle 13: FULL COSSIB, Citroen Jumper J5 (LCPC)

This document gives a short overview and illustration of the manner in which the vehicles have been equipped. The most of the components and sub-systems, on the technology platform developed by SP1-SAFEPROBE, have been detailed in deliverable D1.4.2 – “HW and SW specifications of prototype and test bed components” [1] and in deliverable D1.4.5 – “Probe vehicles prototypes” [2].
1. Demonstrator vehicles provided by CRF

1.1. Functionality

Three demonstrator vehicles have been developed by CRF: the FIAT Bravo “SCOVA”, the FIAT Bravo “SAFEPROBE” and the FIAT Croma “COSSIB”. The functionalities implemented in these demonstrator vehicles are the ones needed to host and to demonstrate the SP5 SMAEV application (Safety Margin for Assistance and Emergency Vehicles) and the following SP4 applications:

- HOCW - Head On Collision Warning
- REC - Rear End Collision
- SLSD - Speed Limitation and Safety distance
- CW - Curve Warning
- ExtMsgApp - External Message Application

The FIAT Croma “COSSIB” is a safety car, mostly used as a “Mobile Road Side Unit” in the Italian TS, supporting both the SP5 and the SP4 activities. The two FIAT Bravo cars are used as cooperative vehicles implementing the SP4 software framework and hosting the HOCW, REC and CW applications. For these three applications and for the ExtMsgApp, CRF is directly responsible of the whole chain of development, from the definition of the User Needs and Requirements, to the Specifications, to the Implementation, to the Evaluation to the Validation; in other terms, in the internal jargon of SP4, CRF is the Application Leader. For the SLSD Application, MMSE is the Application Leader. The ExtMsgApp is an applicative component, of horizontal nature, needed to allow the access to the on board HMI resource to External Applications (for instance in order to support the SP5-COSSIB applications or the CVIS ones).

Concerning SP4, the implemented applications have been initially introduced in D4.2.2 - Safety Margin concept [3] and in D4.2.3 - Use case and typical accident situation [4]; the related functional specifications have been detailed in D4.3.2 - SP4 Applications Functional Specifications [5]; the adopted HMI solutions are fully compliant with the ones recommended in D4.3.4 – Conceptualization of on-board information system and extended HMI [6].

The single “special” sensing component installed in the SCOVA vehicle -apart the obvious usage of the VANET, performed by the SINTECH router, is a Fujitsu Ten millimetre wave radar. The SAFEPROBE vehicle has a richer sensing equipment: it is equipped with the Fujitsu Ten long range radar and with an IBEO Laser Scanner Unit.
1.2. Vehicles

The SAFESPOT system is implemented in three normal production cars. All of the vehicles are mid-size passenger cars, two Fiat Bravo (1.9 Multijet 16V 150CV, Dynamic, 5 doors), shown in Figure 1 and one FIAT Croma (1.9 Multijet), shown in Figure 2.

The models have been chosen primarily as a typical mid-size passenger car, where advanced safety functions have a potential to provide added value. In addition, the car types have a representative and up to date electrical and electronic architecture, suitable for the integration of new features.

Fig. 1: CRF SAFEPROBE (red car) and SCOVA (blue car) demonstrator vehicles

Fig. 2: CRF COSSIB vehicle
1.3. Equipment

Several modifications and adaptations have been necessary in order to equip the vehicles with the sensors and actuators required for the SAFESPOT applications to be implemented and demonstrated. Figure 3 presents a sketch of the networking architecture of the SAFEPROBE and SCOVA demonstrators, together with the physical location of the subsystems.

The scheme indicates the main system components: the millimetre wave radar sensor, the various processing units and the networking interconnections.

It should be pointed out that systems #18 (IBEO Laser Scanner) and #19 (Laser Scanner Control Unit) are present only in the SAFEPROBE demonstrator.

As illustrated, a unified Ethernet LAN network is used to connect the different SAFESPOT units. The two CAN buses of normal production and the private CAN bus of the microwave radar are mapped into the Ethernet network, based on a dedicated SAFESPOT UDP protocol [7]. This mapping is carried out by the SAFESPOT vehicle gateway.

The COSSIB demonstrator is a Safety Car targeted for the SMAEV_01 (SP5) application; additionally it is used as a mobile road side unit for the SP4 Curve Warning application. Following figure presents an overview of the components installed in the vehicle.

Fig. 3: System architecture of the SAFEPROBE and SCOVA CRF demonstrators

The scheme indicates the main system components: the millimetre wave radar sensor, the various processing units and the networking interconnections.
The following components are integrated in the COSSIB vehicle:

- **Main PC** with SP1 framework, implementing the SP5 SMAEV and the SP4 Curve Warning applications, LDM, Data Acquisition and a reduced version of SAFESPOT positioning software for vehicles;
- **VANET router**, provided by SP3, to exchange information with VANET;
- **Gateway** board, provided by SP4, to acquire vehicle data;
- **Ethernet Switch** for LAN connection;
- **VMS Panel**;
- **GPS sensor**;
- **Yaw Rate sensor**;
- **The HMI client**, which is a laptop connected to the vehicle LAN.

Figure 4 shows the locations where the above components are placed within the vehicle. In particular, the VMS panel is a model used for Road Service Vehicles mounted on top of the vehicle.

Next figure illustrates the components of the physical architecture and gives a high level view of the data exchanged between modules.
In the COSSIB vehicle the HMI PC can be easily substituted by a much smaller one; the VMS panel is usually present in assistance vehicles signaling events. For the SAFEPROBE and SCOVA vehicles the HMI components are shortly illustrated in the following picture. The detailed description of the other components can be found in the SAFESPOT deliverables [1] and [2].
An additional important component of the CRF demonstrators is ESPOSYTOR: the diagnostics and System Monitor tool developed by MMSE. It has been designed and implemented to clarify and help the understanding of the functioning of SAFESPOT, in all its components. By using this tool, it is possible to monitor the work of each module of the SAFESPOT architecture, in order to give to the developers the support for monitoring and diagnose of the single module job.

ESPOSYTOR specifications have been defined in D4.3.5 - On Vehicle diagnostics and monitoring specification [8], with the contribution of partners from SP1, SP2, SP3, SP4 and SP5, starting from their user needs and requirements.

Figure below shows the main page of ESPOSYTOR.

![Fig. 7: Main page – Ego Vehicle – of the ESPOSYTOR system monitoring tool](image)

Deliverable D3.4.5 – ESPOSYTOR Prototype Implementation [9], is structured in the form of a User Manual, in order to give detailed instructions and tips for the usage of ESPOSYTOR.

An example of usage of ESPOSYTOR as format verifier is showed in the figure below; here it is possible to see the VANET page, where all the traffic at the UDP level from and to the VANET router is proposed in a comprehensive window, whose list boxes and panels report the different messages available for inspection.
Fig. 8: VANET page – Ego Vehicle – of the ESPOSYTOR system monitoring tool
2. Demonstrator vehicles provided by Daimler

2.1. Functionality

The Daimler demonstrator vehicles participated successfully in following use cases, demonstrated in the Dortmund TS and during the Amsterdam Showcase 2010:

- Wrong Way Driver Warning
- Slippery Road Warning
- Right Turn Pedestrian/Bicycle Warning
- Red Light Warning
- Left Turn with oncoming Traffic Warning

2.2. Vehicles

Daimler supported two research vehicles:

- Mercedes S-Class
- Smart fortwo

The focus of both test vehicles is to show a perfectly integrated SAFESPOT solution, i.e. no wires are visible. In the S-Class even the HMI is presented on original production devices.

Fig. 9: DAIMLER vehicles: SMART Fortwo and Mercedes S-Class
2.3. Equipment

Both, the S-Class and the Smart use the classic SAFESPOT equipment arrangement, consisting of:

1. main PC: common car pc where also the applications are running
2. positioning: TU-Chemnitz positioning PC
3. CAN-access gateway
4. CVIS router
5. HMI S-Class: standard head unit display and speakers
   HMI Smart: extra display and standard speakers
3. Demonstrator vehicles provided by RENAULT

3.1. Functionality

Renault (France) is contributing with two vehicles hosting the SAFESPOT architecture, namely, an Espace IV and a Laguna III. These vehicles are incorporated as part of the West Site test in France and will be mainly involved in V2V applications. The demonstrations centre on safety related with focus on road intersections. Renault will be hosting the applications to be demonstrated by Continental at the West Site. These include:

- SP4_UC_Approaching Emergency Vehicle Warning – 1f
- SP4_UC_Accident at Intersections – 1a
- SP4_UC_Obstructed view at Intersections – 1b
- SP4_UC_Permission denial to go-ahead – 1c
- SP4_UC_Defect traffic signs – 1d
- SP4_UC_Other vehicle brakes hard due to red light – 1e

The applications linked to the use cases 1a, 1b, 1c, 1d, and 1e are within the scope of activities of Continental whilst the Use Case 1f is within the responsibility of Renault. Each of these parties is responsible of their applications. The applications are based on the use of the Navteq LDM implementation.

These applications have been initially introduced in D4.2.2 - Safety Margin concept [3] and in D4.2.3 - Use case and typical accident situation [4]; the related functional specifications have been detailed in D4.3.2 - SP4 Applications Functional Specifications [5]; the HMI implementations associated to these applications should follow the guidelines proposed in D4.3.4 – Conceptualization of on-board information system and extended HMI [6].

The initial deployment includes a high precision localisation system other than the one proposed by SP3. It consists of an fibre optic inertial measurement unit, surveyor type GPS and data from the vehicle can-bus, plus algorithms to estimate the vehicle pose at 10Hz. With this configuration it will be possible to time stamp and follow very closely the response of the vehicles during tests and to analyse the effects of the various applications. Depending on the balance, to assess, of effort vs. time vs. resources, the SAFESPOT localisation systems will be also integrated.

3.2. Vehicles

Renault is using two different series production passenger cars. The first is a Renault Espace IV, as shown in Figure 10, multipurpose, large passenger vehicle. This vehicle is normally used as a data acquisition unit, as such it has several additional sensors, it is considered as the main vehicle. The other vehicle consists of a mid-size passenger saloon car, a shown in Figure 11. This vehicle was mainly used for testing the communications components.
The vehicles are representative of typical units that would be hosting first communications based applications including the most appropriate architectures. The model has been chosen primarily as a typical mid-size passenger car, where advanced safety functions have a potential to provide added value. In addition, the car type has a representative and up to date electrical and electronic architecture, suitable for the integration of new features.

![Image of Espace IV](image1.jpg)

**Fig. 10:** The Espace IV at the test site during data acquisition trials

![Image of Laguna III](image2.jpg)

**Fig. 11:** The Laguna III at the test site during communication link trials
3.3. Equipment

The vehicles have been equipped following the guidelines described in the various deliverables of the project.

A major feature is the use of an advanced trajectory measuring system that allows for the recording of the vehicle dynamic response and geolocalisation anywhere. Figure 12 shows the layout of the equipment inside the boot of the Laguna III vehicle. It can be clearly observed the Hitachi RF modem, the VANET computer and the Inertial Measuring Unit making part of the localisation system.

![Equipment layout inside the Laguna III vehicle](image)

**Fig. 12: Equipment layout inside the Laguna III vehicle**

A system block diagram for one of the vehicles is shown in Figure 13. The main characteristics are outlined in the diagram as well as the interaction with the various components. A fundamental characteristic of the systems is that direct contact with the vehicle is made using the Vehicle Gateway that reads data in the vehicle can-bus.

![Block Diagram Representation of Test Vehicle](diagram)

**Fig. 13: Block Diagram Representation of Test Vehicle**

Figure 14 shows the schematic description of the hardware deployed in the vehicles. The messages sent to the driver were displayed on a LCD screen connected to the application computer.
Figure 15 shows the manner in which the Safety Margin is displayed for the Use-Case 1f, Emergency Vehicle, with respect to the spatial situation of the applications as the SV arrives to an intersection at the same time as the Emergency Service Vehicle.

Fig. 15: Activation of Safety Margin for the Use Case 1f
(images courtesy of Continental S.A.)
4. Demonstrator vehicles provided by TNO

4.1. Functionality

Two demonstrator vehicles were originally developed by TNO: the Citroen C4 and the Volkswagen Passat INCA (Instrumented Car). Later, another vehicle (BMW 5 series) was equipped with the SAFESPOT system as well to participate in the Amsterdam Showcase 2010 demonstration as the C4 vehicle was already reserved for other demonstrations. The functionalities implemented in these demonstrator vehicles are the ones needed to host and to demonstrate the following SP4 applications:

- LCM - Lane Change Manoeuvre
- ExtMsgApp - External Message Application

Besides for SP4, the vehicles also participate in testing of SP5 applications; in particular the IRIS application for which the external message application is required, and the wrong way driver application.

4.2. Vehicles

The demonstrator vehicles are testing and demonstration vehicles of TNO; also used in other projects (like e.g. CVIS). The Volkswagen Passat also comprises a haptic gas pedal, tactile driver seat and driver and road observation cameras.

![Fig. 16: The Citroen C4 (left) and the Volkswagen Passat INCA (right).](image1)

![Fig. 17: The BMW at the Intertraffic in Amsterdam](image2)
4.3. Equipment
Both the Passat and the C4 vehicles have identical SAFESPOT equipment. The BMW used the SAFESPOT equipment of the C4. The Volkswagen Passat has additional possibilities for HMI like an haptic gas pedal and vibrating sides of the driver seat. The Passat and C4 vehicles have an onboard computer, which is a TNO development and called ControlCIT. It is a PC104 based real-time platform connected to the vehicle CAN bus and other sensors and actuators, depending on the vehicle. The BMW uses a dSPACE Autobox onboard computer. Besides the vehicle gateway, it also runs the Vehicle State Estimator that provides an estimation of the friction coefficient between the tyre and the road.

The SAFESPOT equipment consists of (see Fig. 18, 19 and 20):

1. Main PC: common laptop where also the applications are running
2. Positioning: RTK GPS connected to the on-board ControlCIT/dSPACE computer
3. Gateway: ControlCIT/dSPACE computer
4. HMI via CVIS box and ControlCIT computer. Note that the CVIS box also provides audio feedback in both vehicles. The HMI in the BMW was realised differently through ControlDesk of dSPACE.
5. Router/VANET: first integration was done with the Alix/Ubiquity solution, and then the CVIS router was taken as the SAFESPOT router to be interoperable with CVIS.
Additionally (not detailed in figure 19) the INCA comprises two PC’s for logging of video images of the driver and outside scene and a PC for the test leader to monitor the tests and start /stop data logging. These PCs are included in the vehicle network via Ethernet.
5. Demonstrator vehicles provided by LCPC

5.1. Functionality

Three demonstrator vehicles have been developed by LCPC: one RENAULT CLIO eco 3 used as “SAFEPROBE” vehicle, one RENAULT CLIO eco 3 used as a minimal “COSSIB” vehicle and a JUMPER J5 used as a full “COSSIB” vehicle. These demonstrators have been developed accordingly to the test and evaluation carried out in the SP5 and West test site, mainly for the SpA (Speed Alert, SP5) applications.

Both “COSSIB” vehicles are cars used as “Mobile Road Side Unit” in the west test site to demonstrate the West test site application. The “COSSIB” RENAULT CLIO eco 3 is a small version of a Road Side Unit that is used for external presentation, as during the Cooperative Mobility Showcase in Amsterdam. The “COSSIB” JUMPER J5 is a full version of the Road Side Unit with several external sensors as: a camera on a 15m telescopic pole for visibility detection, a weather station and a connection with a highway type variable message sign.

The SAFEPROBE RENAULT CLIO eco 3 is used to provide the SP5 applications with data from vehicle and to display HMI messages from the infrastructure. Moreover, during the Cooperative Mobility Showcase, it was also used to demonstrate several use cases along with the RENAULT partner.

5.2. Vehicles

The demonstrator vehicles are mainly used for the SAFESPOT project. However, the full architecture is fully “plug and play”, as shown on the Figure 21, in order to easily exchange architecture between vehicles and be able to work outside of the vehicle.

Fig. 21: Full SAFESPOT architecture outside of the vehicle
5.3. Equipments

Basic architecture is the same for the three equipped vehicles and fully follows the SAFESPOT specification:

1. Vanet PC: VANET is running on a dedicated PC. First integration was on a ALIX board, then we switch toward a more conventional PC in order to have more space for logging.

2. Main PC: The main PC hosts the LDM and the SP1 framework on a shuttle PC.

3. Application PC: This PC hosts several applications:
   a. The gateway with the CAN bus, mainly to get vehicle speed and other interesting data for the beacon process.
   b. The localization application: depending on the vehicle (acting as RSU or OBU), the localization uses respectively a conventional GPS or a RTK GPS. For this last one, the GPS is set in native mode, we only use the higher frequency.
   c. The main application:
      i. On the mobile RSU the main applications are, depending on the case Speed Alert, SMAEV, IRIS and/or Road Departure. For the Cooperative Mobility Showcase, only the Speed Alert application was installed.
      ii. On the OBU, the main applications are the HMI message display and the intersection application provided by Renault and Continental.
Fig. 23: LCPC implemented architecture
6. Wrap Up after the Stockholm and Amsterdam demonstrations

During the final demonstrations of SAFESPOT project (Helmond 2009, Stockholm ITS 2009 and Amsterdam Showcase 2010), all of the vehicles described in the present report have been adopted, in order to show to a large audience the achievements and the applications based on vehicle to vehicle and vehicle to infrastructure Use Cases.

The interoperability with the CVIS Integrated Projects has been also largely demonstrated.

SAFESPOT equipped cars acted as primary actors or secondary actors for the different Use Cases demonstrated in the different Test Sites of the project and in the above mentioned public demonstrations.
7. Conclusions

Thirteen demonstrator vehicles have been equipped by CRF, DAIMLER, RENAULT, TNO, LCPC with SAFESPOT components and subsystems to develop, evaluate and demonstrate the different applications of the SCOVA SP.

All vehicles have been built based on the same common architecture as described in D7.3.1 – Global System Reference Architecture [10], but there are differences with respect to actual selected components and applications considered.

The CRF test vehicles have been mainly be used to support the Italian TS SP with the vehicle based applications whose CRF and MMSE are application Leaders, namely the Head On Collision Warning, the Rear End Collision, the Speed Limitation and Safety Distance and the Curve Warning.

The DAIMLER demonstrator vehicles were adopted mostly to support the Dortmund TS SP, especially focusing on the IRIS application and for the applications demonstrated during the Amsterdam Showcase 2010.

The RENAULT test vehicles concentrates on safety applications for road intersections and uses a dedicated positioning solution with comparatively high accuracy and resolution.

The TNO experimental vehicles host and demonstrate the SP4 applications: LCM - Lane Change Manoeuvre and ExtMsgApp - External Message Application.

The LCPC demonstrators have been developed specifically to support the test and evaluation carried out in the SP5 and West test site, mainly for the SpA (Speed Alert, SP5) applications.
8. References

[1] C. Zott, P. Lytrivis “SAFESPOT D1.4.2 - HW and SW specifications of prototype and test bed components”.


[4] G. Vivo, “SAFESPOT D4.2.3 - Use case and typical accident situation”.


[6] A. Sayn, K. Belhoula (CA), C. Marberger (USTUTT), M. De Gennaro (MMSE), E. Bianco (CRF), L. Bjelkeflo, P. Piamonte (Volvo), P. Cravini (Piaggio), “SAFESPOT D4.3.4 - Conceptualization of on-board information system and extended HMI”.


...