LIFE+10 ENV/IT/000389

INTEGREEN

Action 4: Implementation & Integration

P.4.2.3

On-board telematic unit prototype

Project Coordinating Beneficiary	Municipality of Bolzano
Project Associated Beneficiary n.2	TIS innovation park (TIS)
Project Associated Beneficiary n.3	Austrian Institute of Technology (AIT)
Project Associated Beneficiary n.4	Österreichisches Forschungs- und Prüfzentral Arsenal (ÖFPZ)

Document history

Date	Document Author(s)	Document Contribution
31/03/14	Roberto Cavaliere, Paolo Valleri, Stefano Seppi (TIS), Reinhard Kloibhofer, Wolfgang Ponweiser (AIT)	First document version submitted to the EC
31/05/15	Franco Fresolone, Reinhard Kloibhofer (AIT)	Second and final document version submitted to the EC

Dissemination level: CO[1]
Delivery month: M45
Status: submitted to the EC

[1] CO = Confidential (for members of the Consortium only, including the Commission Services)

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1 Introduction

The Implementation phase follows directly the design specification phase and it relies on the V-model approach as show here below in Figure 1.

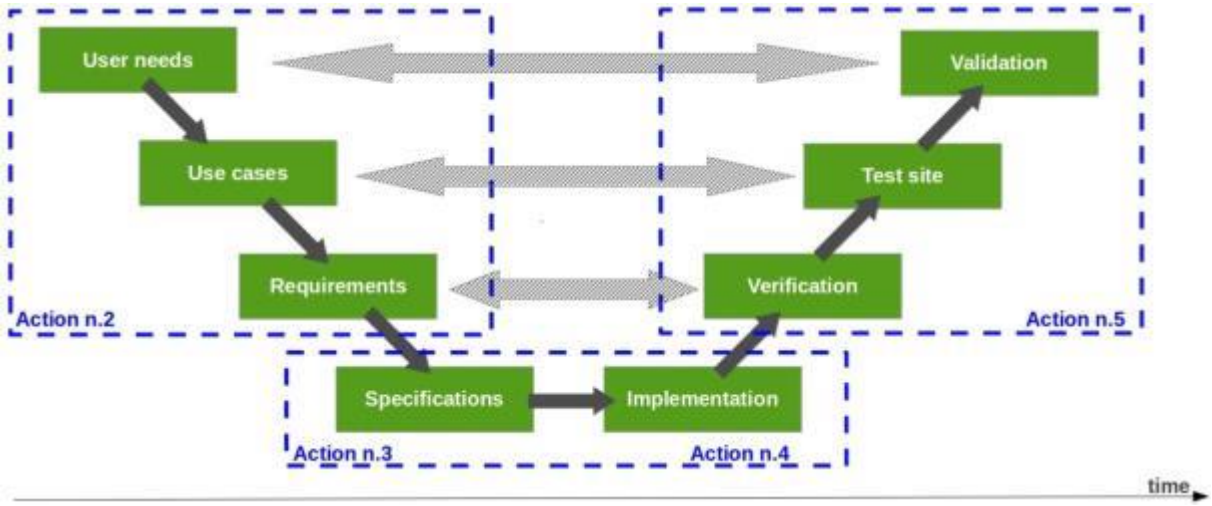

Figure 1: The V-model approach applied in the INTEGREEN project

The Implementation and Integration action aims primarily at producing the physical prototypes for the INTEGREEN Systems. It is executed after the Design phase which is the main input to this Action as it can be seen in Figure 1.

1.1 Purpose of the document

This document deliverable P.4.2.3 is one of the deliverables of Action 4: Implementation and Integration under the responsibility of AIT. AIT is the responsible beneficiary for the activities in Action 4 and directly responsible for the execution of Task 4.2 Mobile systems implementation as well as for the execution of Task 4.3 System integration. The execution of Task 4.1 Supervisory Centre component implementation is under the responsibility of TIS.

Task 4.2 is divided into four activities as follows:

- On-board traffic monitoring unit
- Environmental sensors
- On-board environmental monitoring unit
- On-board telematic unit

All the Mobile subsystems to be implemented and produced in Task 4.2 are clearly visible in Figure 2 below.

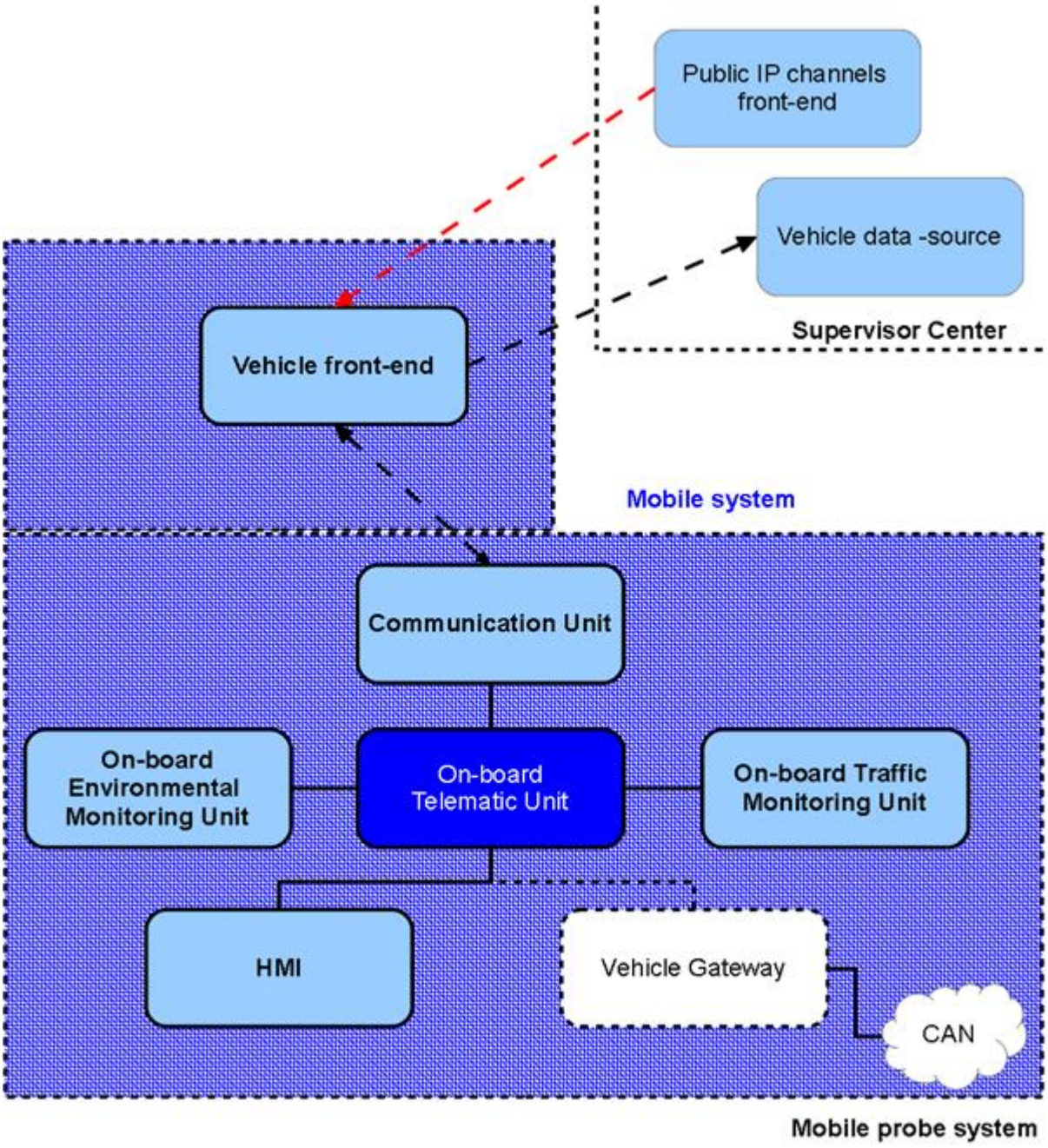

Figure 2: The reference architecture of the INTEGREEN mobile system

1.2 Mobile system implementation

The overall objective of the implementation phase has been to produce a solution based on the development of traffic and environmental monitoring units and selecting of a processing platform and components already present on the market and at the same time suitable for automotive applications. For the selection of a suitable off-the-shelf embedded platform and of the electronic components, the latest automotive standards and technological advancements have been taken into account.

Basic research and future components have not been considered as the final prototype

systems will have to be suitable for commercialisation after INGEGREEN.

In Task 4.2 a complete mobile system prototype suitable for automotive application has been produced. The physical prototypes will be the input for the next Task 4.3 System integration where a mobile systems with full functionalities which will allow vehicles to have traffic and environmental detection capabilities, as well as real-time communication functionalities, in particular between the On-board telematic unit and the Vehicle front-end and subsequently to the Supervisor Center system will be integrated in vehicles and tested.

The real result in Action 4 is the production and integration of the physical prototypes. Each prototype unit consists of physical HW and SW and will have to perform the specified functionalities. The document deliverables of Action 4 are the accompanying documentation which summarise and describe the main steps needed to deliver the physical prototypes.

This document deliverable contains the third output of Task 4.2, namely a description of the on-board telematic unit prototype.

2 Implementation of the On-board telematic unit system

In Figure 2 the structure of the INTEGREEN Mobile system is shown. The system is divided in the Mobile probe system and the (stationary) Vehicle front-end blocks. The implementation of the On-board Traffic monitoring unit (including CAN-bus access) and the On-board environmental monitoring unit are described in other deliverables.

The summary of the implementation of the remaining components (On-board telematics unit, HMI, Communication Unit, Vehicle front-end) is written in this chapter.

The detailed design of the Telematic unit system is covered in the deliverable D.3.2.1.

2.1 On-board telematics unit prototype and Communication unit prototype

The goal for the development of the Telematic unit was to find a suitable off-the-shelf platform and to implement the necessary software to fulfil the function descripted in the design deliverable.

For the INTEGREEN project two test vehicles with the Mobile probe system on board have been used:

- AIT test vehicle: this vehicle is more technical orientated and intended for testing of different functions which are not visible to the end user
- TIS test vehicle: this vehicle is more end-user orientated. The system should run fully automatically without any intervention of the end user

Therefore the selected telematic unit platform for the AIT test vehicle was selected with more calculation and interface resources while the platform for the TIS test vehicle was selected to fulfil the function with future expansion possibilities.

The selected embedded processing unit for the AIT vehicle is shown in Figure 3. The box is completely passive cooled (no moving components).

Figure 3: Embedded processing unit

The main characteristics of the embedded processing unit are summarised here below in Table 1.

Processor	Intel® i7
Graphic	Intel® GMA HD 4000, shared Memory
Trusted Platform Modul	Infineon SLB9635, LPC-Interface
Hardware-Monitor	Temperature, Voltage
Ethernet	2 x 10/100/1000 Mbps
Graphic-Interfaces	DisplayPort 1, DisplayPort 2, DVI-D, VGA, LVDS
Serial Ports	3 x RS-232, 1 x RS-232/422/485
USB	4 x USB 3.0, 2 x USB 2.0, 2 x USB 2.0 intern
Mini-PCIe	1 x Mini-PCIe-Sockel: PCIe + USB mit SIM-Card-Slot; 1 x Mini-

	PCIe-Sockel: PCIe + USB
Voltage	6…36 VDC
Dimension	260 mm x 175 mm x 79 mm
Operation temperature range	-25…70 °C
Humidity	10 % bis 95 % RH, non-condensing
Vibration	random: 0,5 G_{rms}, 5-500 Hz corresponding IEC60068-2-64, sinusoidal: 0,5 G_{rms}, 5-500 Hz corresponding IEC60068-2-64

Table 1: Main characteristics of the embedded processing unit

The choice of the operating system was Windows 7 because many tools are already available.

The description of the detailed SW design and architecture can be found in deliverable D.3.2.1 in chapter 4.2 (Software Architecture of the On-board telematics unit).

The function of the communication unit was implemented with an off-the-shelf mini-PCIe module for GSM/UMTS (3G / 3.5 G). The SIM-card connector is already available on the motherboard. The GSM/UMTS antenna is not integrated on the modem, so an external antenna connector on the back side of the Telematic unit was mounted and connected with a coax-cable to the modem. The used external miniature antenna is shown in Figure 4.

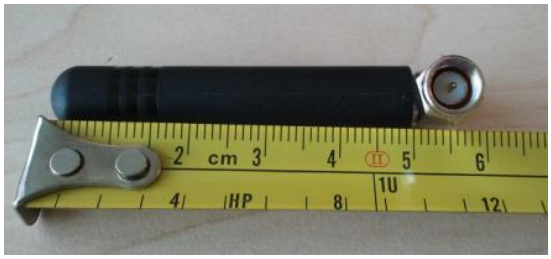

Figure 4: External GSM/UMTS antenna

2.2 On-board HMI prototype

As mentioned above in the INTEGREEN project two test vehicles have been used. Also for the HMI there is a difference between these two vehicles:

- AIT test vehicle: a graphical display connected direct to the Telematic unit has been used (Figure 5). A special holder for the display in the vehicle was realised. With a wireless keyboard and wireless mouse (Figure 6) the co-driver can control all functions of the sensor units as well as the SW on the telematics unit and the communication unit. Measured sensor values are displayed in real-time numeric values. Additionally, a graphical user interface ("GTE" (G)raphical (T)imeseries (E)ditor) is used to present the measurement results in a comfortable format. Information from the Supervisior Center can be displayed in a standard web browser because the Telematic unit is permanently connected to the internet.

- TIS test vehicle: For the HMI a Smart Phone permanently connected to the internet has been used. The information will come directly from the Supersior Center.

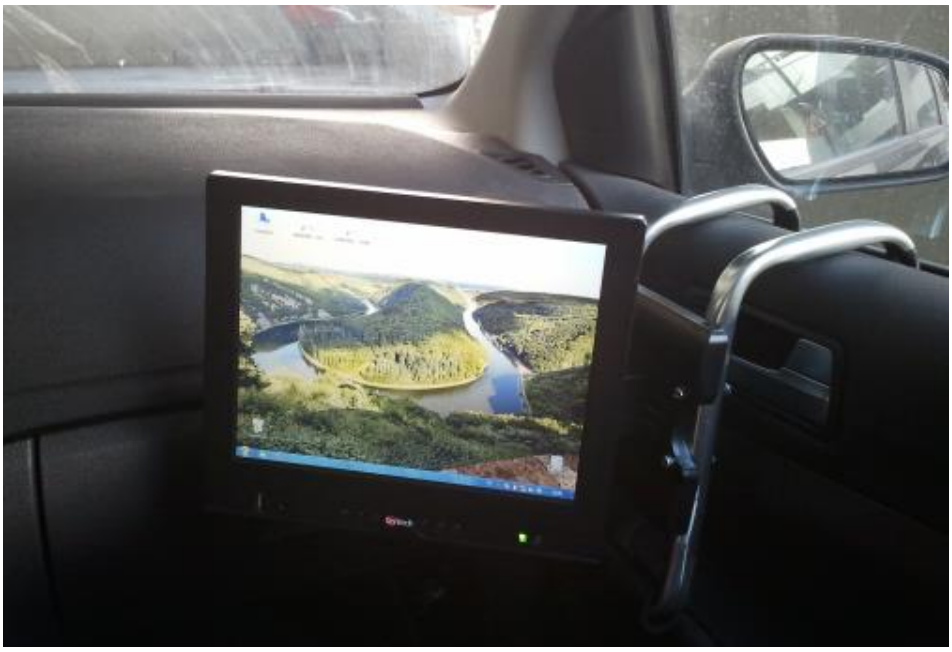

Figure 5: On-board Display in the AIT test vehicle

Figure 6: Wireless Keyboard and mouse for the On-board system

2.3 Vehicle front-end

The Vehicle front-end system is a computer server which can communicate with one or more INTEGREEN vehicles and communicate directly via the Vehicle data-source with the Supervisor Center

The SW running on this server is very similar to the On-board telematics unit SW. The SW architecture is described in the INTEGREEN deliverable D.3.2.1 in chapter 7.3 (Software design of the Vehicle front-end).

In a first step, a separate PC platform was used. But then the operational issue that the computer must be administrated had to be solved. Typical operational issues to solve were: what happens after a power failure, where is the unit physically located, connection cost due continuous operation, data back-up, updates for the operating systems etc. etc.).

In a second step, the solution chosen was to create a virtual computer on the AIT infrastructure. The INTEGREEN SW was exactly the same but the administrative tasks are now covered by central IT support and processes.

Conclusions

The overall objective of the implementation phase has been to produce a solution based on the development of traffic and environmental monitoring units as well as to select a processing platform and components already present on the market and at the same time suitable for automotive applications. For the selection of a suitable off-the-shelf embedded platform and of the electronic components, the latest automotive standards and technological advancements have been taken into account.

The results of Action 4 is the production and integration of the physical prototypes. Each prototype unit consists of physical HW and SW that will have to perform the specified functionalities. The three prototypes are the On-board traffic monitoring unit prototype, the On-board environmental monitoring unit prototype and the On-board telematic unit prototype.

The main steps of the implementation phase that are common to the three prototypes are the following:

- Electronic schematic design
- PCB layout design
- PCB production
- Component purchase
- Electronic component mounting
- Labelling and testing and of mounted PCBs
- Housing and integration
- Power supply connection
- USB connection
- Interface description unit

Specific steps for the Implementation of the On-board telematic unit prototype have been necessary, namely:

- On-board HMI prototype connection
- Vehicle to front-end wireless communication

Once the three prototypes have been completed the integration of the complete INTEGREEN mobile system has been executed on board of the AIT test vehicle.

Subsequently several Field Tests have been successfully executed in Vienna as well as in Bolzano where the End-to-End functionalities of the Mobile System have been verified.

Appendix A: Acronyms and Definitions

FW: Firmware

HW: Hardware

lpm: litre per minute

Pb: lead

PCB: Printed Circuit Board

SW: Software