

INVETE

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**INTELLIGENT IN-VEHICLE TERMINAL FOR MULTIMODAL
FLEXIBLE COLLECTIVE TRANSPORT SERVICES**

Deliverable D16

Final Report

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EXECUTIVE SUMMARY

The main aim of the INVETE project is to specify, develop and validate a modular intelligent in-vehicle terminal (IVT), which can be used for different transport services (regular and flexible collective transport) and different transport modes (bus, taxi), and which operates in different environments (GSM, private radio network).

The INVETE Consortium consists of the Technical Research Centre of Finland (VTT), Instrumentointi (Finland, device manufacturer), Mobisoft (Finland, software developer), Softeco (Italy, software developer), ATAF (Italy, public transport operator), De Lijn (Belgium, transport operator), and MemEx (Italy, consultant), Tritel (Belgium, consultant) and ENEA (Italy, government agency).

The INVETE work has been performed in 8 Workpackages. WP3 analysed the user needs of drivers and operators for the different services, and developed the architecture and the specifications for the terminal. The INVETE terminal hardware and the software platform were developed in WP4, and the communication interfaces and terminal applications in WP5. Validation took place in two phases: a limited verification (WP6) and demonstration (WP7) in real operating conditions in three different test sites (Florence, Kuopio, and Tampere). The different test sites are characterised by different operating environments and transport services (regular public transport, DRT), different vehicles (bus, minibus, maxi-taxi) and different physical IVT interfaces and terminal options (GSM, PRN, voice interfaces). WP8 developed the validation plan, analysed the results and formulated project conclusions. WP1 is concerned with project management and WP2 with dissemination and exploitation.

The main results of the INVETE project are:

- The analysed user needs for regular and flexible collective transport in-vehicle terminals;
- The modular INVETE architecture. Modularity is realised both at hardware level (separate modules for interfacing functionalities and for the interface to the driver; modular construction of the terminals), and at software level, through the use of socket-based services and the development of a TCP/IP based protocol. The modularity of the terminal allows adapting the terminal more easily to the requirements of the different public transport operators and services.
- The INVETE terminal, consisting of the Base Module, of which different versions have been used in the test-sites, and the Application Module. Two different Application Modules have been developed for DRT services and for regular public transport services
- Applications for the INVETE terminal to manage the public transport services at the test sites (both for regular and demand responsive public transport)
- Validation at three different test sites. Starting from the same platform, three different test sites have been set up at the same time. The technical performance, user acceptance and cost-benefits have been evaluated in the different sites. The transferability of the INVETE platform to an existing environment has been analysed.
- The Business Case, which reviews the market and analyses the exploitation possibilities of the INVETE terminal. The Business Case has analysed how the INVETE platform can be implemented in new and existing monitoring systems.
- Recommendations to operators and authorities have been drawn up for the implementation of AVL/AVM systems.
- The project results in 16 deliverables.

- Two workshops have been organised: in Florence in May 2001, and in Tampere in May 2002. The project has been presented at international conferences.

The overall conclusion from INVETE is that the in vehicle terminal developed, with its open and modular platform based on a general-purpose Base Module (BSM) and an application-oriented Application module (ASM), provide valuable support and advance to both regular public transport and demand responsive transport services operations. The results of the INVETE evaluation process showed that it is possible to provide services that are accepted by the operators, and that good levels of technical performance could be achieved. When considering overall costs and impacts, all demonstration sites considered that the demonstrations systems and services were justified and viable.

The INVETE consortium members each aim to exploit the results of the experimental project in a number of key areas. The authorities and operators are encouraged to continue to operate and develop the services and systems utilising INVETE results. They expect that project results can especially help to satisfy obligations for personal mobility and participation in society at lower cost through more widespread deployment of DRT service concepts and related telematics.

Technology providers and developers in INVETE expect to be able to market and sell the core and value-added technology products such as communications devices, in-vehicle terminals, location devices, and in-vehicle software services. During project development, they were already able to get feedback from the experiences in the INVETE tests-sites providing valuable input and feedback.

Integration of public transport (regular and DRT) services (within national transportation policies) is a particular exploitation goal for some partners who have participated in INVETE. For instance without DRT there are no possibilities for seamless public transport outside public transport corridors. When implementing or updating monitoring systems for regular and/or flexible public transport, authorities and public transport operators are advised to take the complete life cycle of the system into account. For this reason, they should take the following criteria, which were addressed in the INVETE project, into consideration: openness, modularity, compliance to standards, updatability.

This document is the final report of the project, and reviews the work performed and the results achieved in the project. Chapter 1 gives an overview of the main achievements and the INVETE consortium. Chapter 2 deals with the original project objectives. Chapter 3 describes the approach followed during the different phases of the project. Chapter 4 describes the main project results more in detail, as well as the European added value of the results, and the relation with other projects. Chapter 5 gives an overview of the deliverables and the major dissemination efforts. Chapter 6 describes the project management issues and Chapter 7 the benefits, which the project has provided to each of the partners, and how they intend to use and exploit the project results further.

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1. PROJECT OVERVIEW

1.1. Main Achievements of the project

The main aim of INVETE was to specify, develop and validate a modular intelligent in-vehicle terminal (IVT), which can be used for different transport services (regular and flexible collective transport) and different transport modes (bus, taxi), and which operates in different environments (GSM, private radio network). In a nutshell all these objectives were successfully achieved.

The major achievements are:

- * **Development of the architecture and specifications of the terminal platform based on analysed user needs.** The needs of the operators and drivers involved in the project have been analysed, and the architecture of the INVETE terminal has been developed.
- * **TCP/IP based protocol for communication between the services.** The modularity of the terminal is, at software level, achieved by using standard socket based services. For the communication between the services a protocol has been developed. This protocol is based on TCP/IP.
- * **Design and prototyping of the terminal.** The INVETE terminal consists of two modules: the **Base Module (BSM)**, which has a real-time operating system and owns all interfaces, and the **Application Module (ASM)**, which has the interface to the driver and which is tailored to meet the needs of the services and the drivers. For the DRT services, the **DRT-ASM** has a 10-inch TFT-LCD touch screen and the Windows Embedded NT operating system, and it is connected through Ethernet with the BSM. For regular public transport services, the **AVL-ASM** is designed for affordability and it has a simple display, which is controlled by the BSM.
- * **Development of communication interfaces for the terminal.** Gateways have been developed for GSM and Private Radio Network. Seamless operation of GSM and PRN has been assessed. An interface to the CANopen network, based on the EN13149-6 pre-standard has been developed. Communication using Bluetooth for the platform has been assessed.
- * **Development of application services for the demonstration sites.** For the different demonstration sites, application software has been developed.
- * **20 prototype terminals installed in real operating vehicles** in three different test sites (Florence, Kuopio and Tampere). Different versions of the BSM, with respect to the interfacing options, have been used in the test sites. Starting from the same platform, at the same time customised terminals have been developed for 3 test sites.
- * **Verification of the terminal.** The terminal has been successfully submitted to mechanical, environmental and EMC tests. The user-acceptance of the terminal has been evaluated in Finland, Italy and Belgium. The terminal has been tested in real operating conditions in Finland and Italy.
- * **Demonstration in test sites.** The terminals have been installed in real operating vehicles and operated in Kuopio during 7 months and a shorter period in Tampere and Flor-

ence. The terminals have been operating in DRT environments (Kuopio, Florence) and in regular public transport services (Tampere).

- * **Validation of the terminal.** The technical performance, user-acceptance, and cost-benefits impact have been validated in the different test sites. The transferability of the terminal to a new site (Belgium) has also been assessed, i.e. how the INVETE platform can be integrated in an existing monitoring system.
- * **Business Case.** The Business case for the IVT for further commercial exploitation of the terminal platform has been assessed. The Business Case also addresses how the INVETE platform can be implemented in new and existing environments.
- * **Recommendations** have been drawn up for the actors in the field of public transport for the implementation of in-vehicle terminals and monitoring systems.
- * **Dissemination.** The terminal has been presented at different national and international conferences (ITS2000, ITS2001, and ITS Europe 2001). Two workshops have been organised, one in Florence on 30.5.2001, with 140 participants, and one in Tampere on 16.5.2002. Contribution to the Italian standardisation group on telematics architecture for public transport has also been provided.

1.2. Consortium: partners and their roles

- * **Technical Research Centre of Finland (VTT)** co-ordinator, has been responsible for the daily management of the project, contributed to the architecture and specifications of the INVETE terminal, for the development of the in-vehicle interface and for the Bluetooth assessment. VTT has been in charge of the dissemination activities, the validation plan and the verification and has been involved in the evaluation of the demonstration results of the Finnish sites.
- * **ATAF spa**, the Public Transport Company for the Florence Metropolitan area (Principal Contractor) has managed the Italian test site demonstration on ATAF's vehicles. ATAF has contributed to the analysis and definition of the operator and services requirements for the INVETE terminal and to the evaluation of the demonstration results.
- * **ENEA** (Assistant Contractor to ATAF), the Italian government agency for the new technology, energy and the environment has taken part in validation and in environmental and mechanical testing
- * **De Lijn** (Principal Contractor), a Belgian public transport operator, has participated in the requirements specification and contributed to the user acceptance evaluation phase. The transferability of the INVETE terminal to the architecture has also been assessed by De Lijn
- * **Tritel** (Assistance Contractor to De Lijn) has been in charge of the user need analyses, and participated to the functional specification of the terminal. Tritel acted as an external evaluator to the Finnish test site. Tritel has assessed the transferability of the INVETE terminal to the architecture of De Lijn.
- * **Instrumentointi** (Principal Contractor) has designed and prototyped the hardware and software platform development of the different modules. Instrumentointi has also developed the application software for the regular public transport test site in Finland and the

Private Radio Network gateway. Instrumentointi has been responsible for the regular public transport demonstration, which has been performed on vehicles operated by Väinö Paunu Oy.

- * **Softeco Sismat** (Principal Contractor) has developed, tested and implemented the application software for the Italian DRT services, which have been demonstrated in Florence.
- * **MemEx Srl** (Assistant Contractor to Softeco) has been involved in the requirement analysis and functional specifications for the terminal, and in the evaluation process.
- * **Mobisoft** (Principal Contractor) has developed the GSM communication gateway for the INVETE platform and the DRT application software for the Finnish Test Site. Mobisoft has contributed to the requirement analysis and the specification of the IVT, and been in charge for the demonstration test site in Kuopio.

2. PROJECT OBJECTIVES (FROM DESCRIPTION OF WORK)

Previous R&D projects on national and European level, which have addressed flexible collective transport services, such as SAMPO (TR1046, TAP) and SIPTS (TEN 45607, TEN-Telecom), have indicated that there is a need for a common in-vehicle terminal (IVT) for regular public transport (PT) services and flexible collective transport services.

The existing IVT's which are used for collective transport are mainly focused to Automatic Vehicle Location (AVL), and not suitable and operable for other collective transport services, like DRT (Demand Responsive Transport), shared taxi or taxi. DRT has different requirements than conventional public transport concerning the volume of exchanged data and the times when data exchange occurs, and this requires for the IVT specific design, innovative applications and services not available with the terminals currently on the market. Products that have been developed for collective transport services have generally been developed for specific operators or services and not for integration with other on-board services.

In order to improve the quality of collective transport, new telematic services are required. Further in order to manage these telematic services, there is a need for an intelligent multi-application IVT on which these services can be implemented, and which provides a common user-interface to different services.

The Mission of INVETE is:

Design, Realisation and Validation of an in-vehicle terminal for different transport services (regular PT, DRT, door-to-door, taxi) which operates in different environments (AVL GSM, Private Radio Network...). The IVT responds to the user needs of terminal users and transport companies for different transport modes. The IVT integrates the on-board devices and communication devices in order to connect with the control centre. Applications will be developed for flexible and regular collective transport services.

The IVT and the IVT services will be validated and evaluated in test sites in Finland and Italy characterised by different services and technological base infrastructures for different transport modes.

The specific objectives of the INVETE project are:

- * **To identify and analyse the different types and levels of needs** of drivers (taxi, bus, minibus), operators (public transport company, taxi associations), control centre, authorities and the different transport services (flexible and regular public transport, conventional and shared taxi). The architectural constraints and technological options of the different system environments will be taken into account, as well as the requirements of on-board devices. The IVT will make advantage of in-vehicle networks, like CAN. The IVT will include a high quality and safe and easy to use user interface (HMI) taking into account the HMI Statement of Principles developed by the European Commission.
- * **To develop functional specifications and the architecture for the IVT** based on the IVT requirements. The technical feasibility of the requirements and the user acceptance of a draft IVT will be verified through benchmarks.
- * **To design and prototype a modular multi-application IVT.** Modularity allows the IVT to be adapted and customised for operation in different types of DRT services and management schemes. The modularity refers both to the software interfaces, to the

communication interfaces, to the in-vehicle network interfaces and to the selection of input and output devices.

- * **To develop an IVT with open software interfaces.** In order to maximise the community added value the IVT platform will be aimed to be as open as possible. The IVT will provide an open platform and environment, allowing a high degree of interoperability with different PT management systems and services.
- * **To maximise the market opportunities through the development of an affordable IVT.** In order to enhance penetration of the IVT market place and facilitate large-scale deployment of DRT applications, the financial viability of the INVETE IVT will be of great importance. Low cost solutions will have to be pursued, allowing development of IVT systems for smaller DRT applications, taking into due consideration the economic requirements and constraints of a number of different possible environments (rural areas, small towns, etc.) and operators (small service companies, small fleets, etc.).
- * **To improve the level of integration between different telematic applications in the vehicle. The IVT will allow providing a single user-interface to different telematic services.** By integrating different telematic applications in a single device, the number of displays and input devices can be reduced, which has a positive effect on the behaviour of the driver, on operation management and on the maintenance of the on-board devices. During the INVETE demonstrations, only new services will be addressed. Well-functioning services will not be altered, in order to avoid liability problems. The project will develop specifications for the interfaces of future telematic devices, which will be integrated with the IVT.
- * **To develop communication protocols between the vehicle and the control centre.** The IVT will allow interfacing to different types of communications (Private Radio Network [PRN], GSM) and will address existing and emerging communication protocols. By providing real-time communication of data and voice, the IVT will allow real-time information exchange between the driver, the vehicle and the control centre. The integration of new and existing on-board communication and location devices with the control centre will allow improving the quality and the reliability of the services provided to the citizens.
- * **To develop application software for the IVT for the demonstration.** Software will be developed for regular and flexible collective transport services to be demonstrated, and software, which allows evaluating the added value, provided by the IVT to the different users.
- * **To verify the IVT in three member states.** The user acceptance of the IVT and the software will be evaluated in Finland, Italy and Belgium.
- * **To prototype 30 IVT's.** The majority (20) of these IVT's will be used for demonstration, 3 for verification and the rest for support, development and maintenance.
- * **To demonstrate, validate and evaluate the IVT and the IVT services for different transport modes and different services in test sites in two member states.** The IVT will be validated in real operating conditions in Finland and Italy. The test sites are complementary: different communication networks are used (GSM, PRN), different transport modes (bus and taxi), different transport services (regular and flexible trans-

port services), and the sites are also characterised by different cultures and different operational approaches. The test sites are technologically well infrastructured. Attention will also be paid to training of the users. These technological environments will be the guarantee for carrying out an effective validation. Validation includes **technical** (system performance), **impact** (safety, transport efficiency), **user acceptance**, **socio-economic** and **financial** (added value for the company) **assessment**.

- * **To determine the business case for the IVT and the added value of using the IVT for the users.** Attention will be paid to the business case and the exploitation plan for the commercialisation of the IVT and improving the added value for transport operators. The IVT equipment will be included in new vehicles early in the next decade as OEM (Original Equipment Manufacturer)/aftersales market.
- * **To disseminate the INVETE results to the transport industry and the RTD community** through publications and seminars. INVETE partners, and especially industrial partners, will promote results towards industry through major events like ITS2000 and ITS2001.

At the end of the project, the project results will be assessed, both in which aspect the different objectives have been met, and which is the impact of the project on e.g. the development of new transport and telematic services and on the performance of DRT services. The project management will be assessed, as well as the dissemination procedures, compared to the plans from the Dissemination and Use Plan, and the validation phase will be assessed towards the Validation Plan.

3. APPROACH

3.1. Overview

The INVETE project is divided in 8 Workpackages, the relations between which are shown in Figure 1. WP1 (Project Management) and WP2 (Dissemination and Implementation) are horizontal activities, which last over the whole project.

During WP3 (Requirements and Specification), the first activity, the user needs were analysed and the architecture of the terminal and the specifications have been developed. In WP4 (IVT Platform), the IVT hardware, the software platform and the physical prototypes have been produced. In WP5 (Communications and Applications, the applications and the communication gateways have been developed. In WP8, the validation plan (deliverable D3) has been developed to provide the procedures to be followed in the validation.

The validation consists of two phases: a small-scale verification (WP6), and a large-scale demonstration (WP7). During the verification phase (WP6), the terminal software has integrated with the hardware and tested both in laboratory conditions, and in a few public transport vehicles. In WP7 the terminals have been installed in 20 real operating conditions in Italy and Finland. The demonstration has been evaluated, the project has been assessed and project conclusions and recommendations have been formulated in WP8 (Assessment, Evaluation and Conclusions).

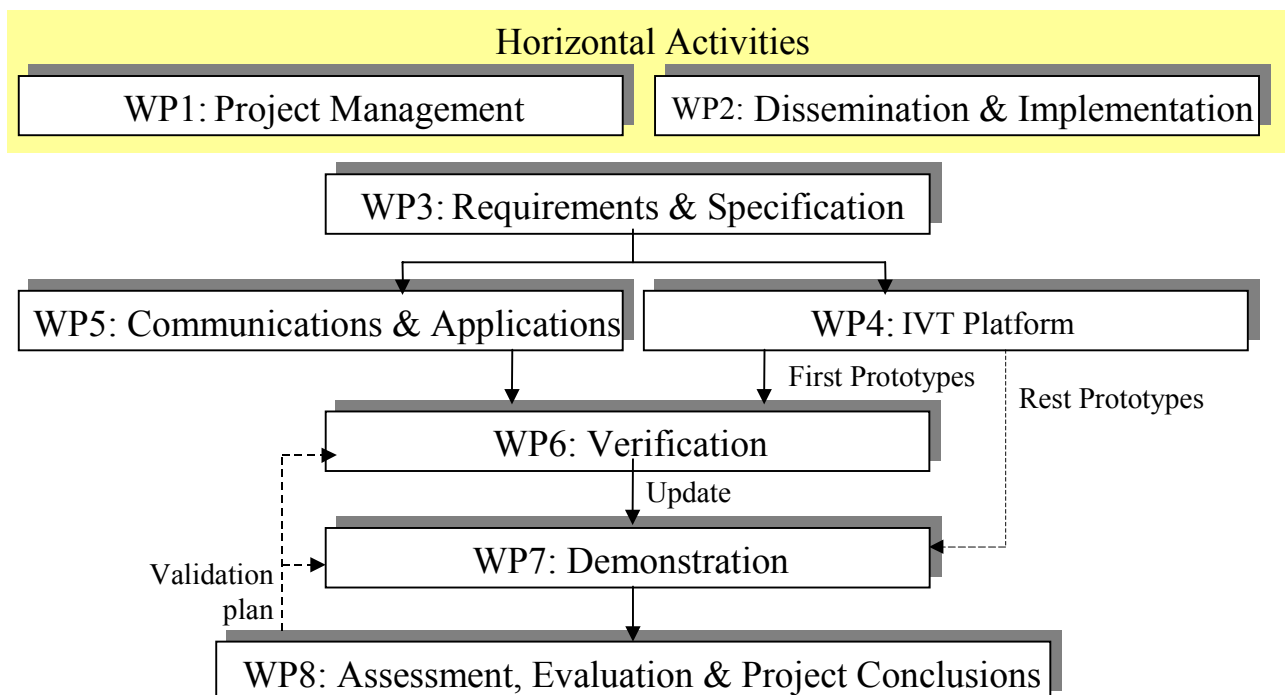


Figure 1: Relation between workpackages in INVETE

3.2. WP3: User Needs Analysis and Architecture

The main objective of this workpackage is to set up the requirements for the IVT, based on user needs, to design the architecture for the IVT and to produce the specifications for the IVT. The work in this workpackage has been completed. The workpackage results in two deliverables: D2 on IVT requirements and D5 on IVT specifications.

Deliverable D2 describes the *user needs and the requirements* for the IVT. The approach followed is based on the Guidelines for User Needs Analysis of the CORD project. The us-

ers have been identified: the main direct user is the driver, the main indirect user of the terminal is the operator. Also the needs of the developers have to be addressed. Information has been retrieved through interviews and discussions with end-users and operators, and based on the experiences gained from a/o SAMPO, SAMPLUS, SIPTS projects. An overview of the results is given in Section 4.1.1

The **resulting reference model** for the IVT is based on two interconnected modules: a **Base Module (BSM)** and an **Application module (ASM)**, which have been specified in functional, information, communication and physical terms. This architecture will allow to cope with the particular requirements of DRT operations not covered by products currently available on the market (mainly oriented towards regular bus operations) and to support regular public transport service operations as well. The Base Module performs the basic and real-time functions, the application module provides advanced graphical possibilities. The Application Module is tailored towards the public transport service. For DRT systems, the application module (**DRT-ASM**) hosts a commercial operating system, has a TFT-LCD screen and an Ethernet link to the Base Module. For AVL systems, the application module (**AVL-ASM**) consists of a simple display with a controller type CPU, which is hosted by the base module.

A **benchmarking** of the different requirements was also carried out with the aim of assessing the feasibility, technical risks and implications of the identified requirements and to select the relevant ones to be considered for the subsequent phases of system design and development. The benchmarking activities have been carried out partly in the form of a critical review of the users' requirements (D2) and partly with the help of physical and user-interface mock-ups for the INVETE IVT, which have been produced in order to get feedback from the end users on the key concepts and characteristics of the IVT. Finally an analysis of the main technological solutions for the physical realisation of the IVT was carried out. The different technological options were analysed on the basis of the functional and operational point of view, taking into account the main existing and emerging standards for the key architecture aspects (communication, interfaces among modules, information flow, etc.). The results of the benchmarking task are reported in Deliverable D5.

The methodology/approach followed for the **IVT Specifications & Architecture** takes into account previous work and recommendations largely adopted by 4thFP Transport Telematics projects, specifically the guidelines for system architecture specification elaborated by the CONVERGE project. This allowed providing a description of the different IVT architecture levels in a uniform way and with the same format. The work on IVT Architecture and Specifications has been reported in Deliverable D5.

The different possible operating systems were benchmarked for a/o stability. Based on the benchmark test QNX was selected as operating system for the Base Module, and Embedded NT for the Application Module for DRT services.

3.3. WP4: IVT Platform development

The main objective of WP4 was to design the IVT hardware for the different units, the IVT software platform and the IVT user interface, and to develop the prototypes for the different units. The work was done in parallel with the work in WP5 on the IVT communications and applications. The work has been reported in D6.

Instrumentointi Oy was responsible for WP4 and performed the largest volume of work. The hardware of the three modules (BSM, DRT-ASM, AVL-ASM) was developed as much as

possible in parallel, and is based on the specifications and the architecture, which were developed in WP3. The terminal design has been based on the PC104 approach, which supports the modular and open hardware environment to meet the versatile customer needs, but proved also out to be risky due to delays in deliveries. The first boards, which were ordered, did not fulfil the required specifications, which caused a delay in the project.

An open software platform has been developed to provide different services, which can be accessed by the application services developed in WP5. Instrumentointi, Mobisoft, Softeco and VTT have developed a common message protocol and specifications of the messages between the processes. Due to the protocol, applications can be developed in a modular way, independent of the method of external communication used (GSM, private radio network, WLAN, etc.), and independent of the way on-board devices are connected to the in-vehicle terminal (either through the CAN-network or through a non-standard serial line). The open communication platform has been achieved with the TCP/IP socket base interface both in vehicle and in TDC environment. The INVETE project has created and tested the first iteration of the messages, which cover the communication functionality.

For the user interface, attention has been paid to ergonomics. The design work has been done in collaboration with Dr Juha Luoma, ergonomics expert from VTT Building and Transport. Visits of the bus coach workshops and discussions with operators have been carried out at the start of the physical design both in Tampere and Kuopio (Finland) and in Florence (Italy) to clarify the details of the demonstration environments.

The development of the IVT concept resulted to a practically open platform. The Base Module provides the SW platform having versatile socket based services for vehicle telematics and the Base Module provides the HW platform fitting the existing de facto standards for serial communications such as Ethernet, RS485 or CAN. The developed DRT-ASM could be replaced with any unit having an Ethernet communication. Both the Base Module and DRT-ASM use a PC104 Pentium level processor, which provides the open PC platform regarding the operating system and the PC104 accessory units. The AVL-ASM is hosted by the Base Module through the RS485 and has the same services available as the DRT-ASM.

The development process has been challenging because of the close co-operation of the partners to have a common understanding of the all functionalities, which have to be implemented, assembled and tested. The development of the IVT Platform including the hardware and software functionalities and the user interfaces has resulted to three modules, which have been installed in versatile environments during the INVETE project.

Attention has been paid to the affordability of the IVT, especially for the solution developed for regular public transport services. The solution, developed for DRT, has been selected based on the requirement for advanced graphical possibilities, and is hence not very cheap.

The test environment for the IVT has been specified and developed by VTT in co-operation with Instrumentointi, to have a common base for IVT development tests and functional verification.

3.4. WP5: Communications and applications

The main objective of this Workpackage was to develop the communication protocols and the software for the DRT and AVL services. The work, which has been performed in this Workpackage, has been reported in D7 (IVT Communications) and D8 (IVT Applications).

The methodology and approach for the work in WP5 has been planned and agreed upon by the partners. In the approach the CONVERGE guidelines provided the backbone.

3.4.1 Communications

Communication gateways for the IVT platform have been developed in INVETE for both GSM (by Mobisoft) and Private Radio Network (by Instrumentointi). The gateways transfer the messages, from the IVT in-vehicle protocol, to the control centre. The IVT protocol allows to seamlessly change the communication channel, and to use the most optimal channel for communication (e.g. private radio network in the area covered by the radio), GSM otherwise). Due to the modularity, the terminal is open for new communication methods, such as GPRS and UMTS. New communication methods have been assessed. Drivers for new communications, such as WLAN and Bluetooth are however not available for the QNX 4.25 operating system, which has been used for the BSM. The use of Bluetooth as a communication medium to exchange messages over short-range communication for the IVT platform has been assessed on Linux computers.

The work done in WP5 has been strongly dependent on the previous work packages and interaction with them. On the other hand it has shown to be important to work dynamically so that for instance the IVT specifications, validation activities and IVT communications planning are done simultaneously. Indeed, they affect each other, as it has been the case in INVETE.

The planning and development work of the IVT communications was very challenging since the IVT consists of two modules: Application Module (ASM) and Base Module (BSM) and two kinds of applications are addressed by the INVETE project: regular public transport (AVL) and DRT. In addition to that, the DRT application was developed in two countries; Finland and Italy, and has to be used in the existing service where the systems have to work reliably and to meet the needs of real users. This all set a lot of requirements for the IVT communications and messages to be used.

It is also very important to take into account the needs of not only the communication between the modules and applications but also the needs of the validation phase in INVETE. The IVT communications was planned also to support the validation phase and to help collecting data for the indicators to be used in the validation phase. It became clear that close co-operation with validation and IVT communications development is needed. During WP5 there were several technical meetings in which it was carefully checked that the IVT communications would provide all the data needed in the validation phase.

The terminal was designed to be as interoperable as possible with current and future telematic devices, mainly through compliance with the EN13149-6 standard on CANopen in public transport. The development of this standard took much more time than originally expected. The standard is still in the approval process, and hence the messages were not yet finally fixed by the end of INVETE.

It became also clear that the projects dealing with new and emerging technologies are very often dependent on the work done elsewhere than in the project itself and there may be unexpected delays in the technological development. This kind of drawbacks cannot be prevented by the project.

3.4.2 Applications

Starting from the specifications for the applications from WP3, the applications for the different test sites have been developed:

- * **DRT application for Florence.** The main aim of the application, which has been developed by Softeco, was to manage the DRT service in Florence. The application allows real-time communication between the driver and the control centre. The user-interface on the DRT-ASM touch screen display allows showing the actual position of the vehicle on a map of the network, with information on the route and the next stops. Icons are used to send pre-coded messages
- * **DRT application for Kuopio.** The main aim of the application, which has been developed by Mobisoft, was to manage the DRT service in Kuopio. Also this application allows real-time communication between the driver and the control centre. The user-interface on the DRT-ASM touch screen display only uses limited graphics.
- * **regular public transport application for Tampere.** Instrumentointi has developed the application for the AVL-ASM touch screen display. The application allows the driver to communicate both with GSM and PRN with the control centre. The user interface is based on simple text information, with buttons to send messages and an LED scale for advance/delay information.

The applications interact with the other services in the IVT using the IVT protocol. The operators have been actively involved during all phases of the design of the user interface. For the design of the user-interface, Dr Juha Luoma, ergonomics expert from VTT Building and Transport has acted as a consultant. In this way it has been assured that the applications comply with the recommendations for HMI of the European Commission.

The physical modularity of the IVT hardware platform and the design options followed result in several important characteristics and general capabilities for the INVETE IVT. These include:

- *Modularity of the IVT services architecture.* The different services have been designed and developed to be as loosely coupled and as modular as possible. This allows, in principle, different configurations and provision of services on the IVT, in order to meet different requirements of the operators. Indeed, the two DRT applications have different requirements and characteristics and these are reflected in the different services available with the IVT (DRT-ASM) in the two sites.
- *Coverage of the IVT service architecture.* The different services provided with the INVETE IVT address most key in-vehicle operations with both regular and DRT schemes. Provided services include most key tasks in AVL operations.
- *Openness of the IVT services architecture.* The overall architecture of the IVT software platform (including both the ASM and BSM components) is in itself open and has potentials to support further developments and extensions. The services developed reflect the main requirements and needs identified with the transport operators participating in INVETE. However, care has been put in the software design of higher-level IVT services so that new functionalities could be included if required.
- *Provision of logging facilities.* The IVT includes internal logging facilities, which enable recording a number of events, indicators and information useful for later analysis of in-vehicle operations. Besides the usual reasons of self-diagnosis of the

terminal, this is relevant also from the point of view of evaluation and assessment of service provision and operation schemes. This may be of particular importance in relation to DRT operations, where the dynamic nature of the service provision scheme may benefit from enhanced data collection for the purposes of assessment, evaluation and, eventually, modification of the ways service operation is done.

- *Standards and openness to emerging technologies.* The overall design of the IVT has been undertaken with due attention to currently emerging standards and communication technologies, as well as to technologies which are expected to be available in the next few years. These include, for instance, CANopen, as regards in-vehicle networking, and various communication technologies (e.g. Bluetooth, GPRS...). An interface to CANopen has been developed and assessed. An interface to Bluetooth has been tested, and been assessed on a Linux platform. Whereas other services were successfully ported from Linux to QNX, the porting of the Bluetooth interface failed since the used Bluetooth stack used Linux specific timing commands, the porting of which requires many resources, and was seen as bringing only less additional value to the project. The work on the new technologies (CAN and Bluetooth) has been reported in Annex B to Deliverable D8.

3.5. WP6: Verification

Verification was the first part of the validation phase of the INVETE projects, and had as main objectives to test the prototype and to integrate the prototype with on-board equipment, and to test the prototype during a limited time in real-operating conditions. The work performed has been described in deliverable D10. The terminal and application prototypes, which were used during demonstrations, have been described in deliverable D9.

The Design, Development and Integration processes have taken much more time than it was originally planned. In the DRT test site in Kuopio, Finland, the verification in real operating conditions took place from June 2001 onwards, as planned, but in the other test sites was limited to test runs on personal vehicles. The user acceptance of the terminal was verified in Belgium, Italy and Finland.

The IVT prototypes were tested for CE-compliance in the laboratories of ENEA, VTT and of Satakunta Polytechnic (Rauma, Finland). During the tests some minor problems were notified, which are corrected in the final prototype. Also the integration of the terminal with the on-board and communication equipment required in some test sites much more time than originally planned, due to a number of technical risks, which were realised. Problems, which occurred, were a/o: incompatibility between SIM-cards and the GSM modules; problems with the accurate time on the GPS boards;

In June 2001, the first prototype was installed on a real operating vehicle in Kuopio. The results of the tests were very positive. The drivers were interviewed on the user acceptance and they were satisfied with the terminal. The remarks of the drivers have been taken into account in the software, which has been used during the full-size demonstration.

In the two other test sites, Florence and Tampere, the verification in real operating conditions was limited to a test run on a vehicle. In Tampere, the drivers had been extensively involved in the specification of the user interface and participated to the test runs. In Florence, user acceptance was tested after a first test drive. In both sites, the proper working of the terminal was tested extensively before installing it in the real vehicle.

In Belgium, the terminal and the software in the different test sites, was presented to representatives of the drivers and the operator. The participants were satisfied with the terminal and with the services. The participants preferred the Finnish software, which is graphically less complex, to the Italian software.

Table 1: Overview of Verification Results

| Test Site | Verification Work | Verification Results | Proceeding to demonstration |
|-----------------------|---|--|---|
| All sites (technical) | Environmental, mechanical and EMC tests | EMC tests ok. Minor problems in vibration, dust and water tests | The problems have been solved in the prototypes used for demonstration |
| Kuopio | Terminal in operation vehicle since June 2001. | Technical performance ok. The users were satisfied with the terminal, and had some minor comments | The terminals and software were installed in 4 vehicles. The comments of the users have been taken into account in the demonstration software. Transfer of location has been added. |
| Florence | Extensive testing in laboratory during integration; test run with operational vehicle and interviews with driver | After test run, the terminals were operating without problems. The users were satisfied with the terminal. | The terminals and software are installed in 8 vehicles. The terminal installation is improved. Voice call support has been added. |
| Tampere | Extensive testing in laboratory during integration; test run with real vehicle and interviews with driver and operator. | After test run, the terminals were operating without problems. The users were satisfied with the terminal. | The terminals and software are installed in 7 vehicles. The combination of GSM and PRN communication has been added. |
| Belgium | Group interview with representatives of drivers and operators. | The global impression was good. | No demonstration site. Transition to INVETE terminal has been assessed. |

During the verification phase the terminal has thus been thoroughly tested and the user acceptance verified, which gives a good starting point for the full size demonstration.

3.6. WP7: Demonstration

The design of the INVETE terminal prototypes and the integration of the prototype with the software have taken much more time than originally planned. A first prototype of the ASM, available for software integration was available mid March 2001. The first prototype of the Base Module and the communication gateways was ready in May 2001. Integration of the software with the hardware was performed concurrently for the three test sites.

The implementation proceeded the fastest in Kuopio, which in a first phase used only the GSM interface and no other sensors. In this site a thorough verification was performed, in the other sites, verification in operating conditions was limited to a test run, in order to achieve approval for installation of the remaining prototypes. In Kuopio, all 4 vehicles were equipped with in-vehicle terminals in the beginning of October 2001. In the other sites, test runs were made in November and installation in all vehicles in the beginning of 2002.

Table 2: Overview of INVETE test sites

| Country | City / Region | Service | Communications |
|---------|------------------------------------|--------------------------|----------------|
| Italy | Florence (Campi Bisenzio) | bus - DRT many-to-many | GSM |
| | Florence (Scandicci) | bus - DRT service | GSM |
| Finland | Kuopio | bus/taxi - DRT | GSM |
| | Greater Tampere | regular public transport | GSM, PRN |
| Belgium | Province of Limburg (verification) | urban and sub-urban DRT | PRN, GSM |

The shared taxi service, which was planned in Florence, was not realised. The terminals, which were intended for this test site were moved to the other Italian test sites, in which both 4 vehicles were tested.

In the Tampere urban public transport test site, the number of intended terminals was very low compared to the total number of vehicles, so that it would have been difficult to do a good assessment. The terminal was shifted to a vehicle from Paunu (long range public transport). The demonstration and validation results are described in Section 4.1.6.

Due to the prolonged development and integration phase, the demonstration has been agreed to continue until November 2002 - to get the full benefit of the work done in INVETE project and the responsibilities will continue as they were during the project.

3.7. WP8: Validation

This Workpackages had three different tasks: to develop the Validation plan (D3), to validate the demonstration, and to derive the project conclusions.

The validation plan was based on the guidelines provided for by the CONVERGE Project TR 1101. Starting from the expected impacts, the procedures for technical, service provision, user acceptance, and cost-benefit evaluation and for assessment of the open architecture were determined. The main procedures used included automatically logged data at the IVT, Device Under Test diary, manual measurements at the IVT, questionnaires and interviews of the drivers, operators and developers and observations of the drivers. The different test sites used the same procedures and indicators, which insured harmonisation at a European level. The demonstration and validation results are described in Section 4.1.6.

Based on the validation results, the business case and the experience gained during the different phases of the project, the project conclusions and recommendations have been formulated.

3.8. WP1: Project Management

Project management issues are described in Section 6.

3.9. WP2: Dissemination and Exploitation

3.9.1 Dissemination

The Dissemination and Use Plan (DUP, D4) was developed in the beginning of the project, and it sets out the activities planned for dissemination, the expected results and plans for exploitations of the results.

The Project Presentation (D1) was developed in summer 2000. This Project Presentation has been used as template for a flyer to inform the public on the project. A public Web site was developed at the beginning of the project (www.vtt.fi/aut/kau/projects/invete). The public deliverables (D1 and D9), and a White Paper on the IVT protocol have been placed on the Web site. The workshops have been announced at the Web site. A logo was developed for better recognising the project. Project fact sheets on the 2 contracts have been generated for the CORDIS IST Website.

The dissemination activities are also described in Sections 5.2 (Workshops), 5.3 (Presentations) and 5.4 (Industrial Exhibitions).

Links have been made with bus manufacturers, through Scania and CRF. With CRF the discussions were held on the in-vehicle terminal architecture.

INVETE has participated to the Concertation activities organised by the ADASE 2 cluster (8.10.2000 Turin, 1.2.2001 Brussels and 24-25.10.2001 Brussels), and also participated to the Concertation event of the IMAGE project in Tampere on 26.3.2002.

Links have been established in Finland and in Italy with the projects and programmes in the field of public transport. The INVETE project has joined the Finnish NAVI programme on Personal Navigation.

Input was delivered to the CEN TC 278/WG3 workgroup on in-vehicle networks, related to the specific requirements of DRT services for EN-13149-6. ATAF, ENEA and Memex have contributed to the Italian standardisation group on Telematics architecture for public transport.

A publication, intended for UITP, is under preparation. Papers on the INVETE evaluation have been prepared for eSafety Lyon and the ITS World Congress in Chicago.

3.9.2 Exploitation

From the content of the DUP, a provisional Business Case is being extracted. This Business Case has been further refined and the Business Case and Technology Implementation Plan have been developed. The results of the Business Case are described in Section 0.

Regarding the IPR issues, first a consensus was made regarding the IVT protocol, which will be distributed free of charge to interested parties, in order to assure the openness of the platform.

4. PROJECT RESULTS AND ACHIEVEMENTS

4.1. Project Results

4.1.1 User Needs

The user needs are reported in more detail in Deliverable D2.

The main concern of the **operator** is to operate the services timely and cost-effective. The IVT should be easily maintainable and updatable and should be easily expandable and interoperable with current and future telematic services. The main concern of the **drivers** is to drive safely, to realise the services according to the schedule and to be informed on the service to be realised and on changes in the service. For this, the driver needs an easy accessible and high quality interface to an increasing number of applications that support the operation of the service. To reduce complexity and assure the quality of the work place, an integrated interface is required. **Passengers** want to have real-time information on the buses to which they are boarding.

In **regular transport**, AVL/AVM (Automatic Vehicle Location/Automatic Vehicle Monitoring) systems are used to monitor all the vehicles of the fleet. This imposes stringent requirements on the communication between the vehicle and the control centre: the vehicle should send location and status data in a short time interval. In regular public transport vehicles, there are a growing number of in-vehicle telematic systems, with which the IVT should work seamlessly together. The use of standardised in-vehicle networks, such as CAN (CEN prEN 13149-6), allows to control these devices from a single user-interface. For regular public transport, the user interface should be simple, and consists mainly of an indicator of the advance/delayed status of the vehicle, buttons to send pre-coded messages to the control centre, and a display for text messages, either from the control centre or from the vehicle diagnostics.

In **flexible collective transport** systems (DRT), a user interface having more extensive graphical requirements, is desired, e.g. for representing maps if the destination is unfamiliar to the driver. Since the trip plan is more complex and more dynamic than for regular public transport services, more textual information has to be displayed. Location information is less frequently transmitted to the control centre, but the messages exchanged between control centre and the vehicle with e.g. the next trip plan or changes in the current trip are normally much longer.

The main need of the **developer** is to have an open environment, which can be used to develop tailored applications for different operators, and offers sufficient development support.

4.1.2 The INVETE Architecture

The major objective of the INVETE project is to develop a modular in-vehicle terminal. The modularity of the terminal has been achieved in different ways:

- ◆ **a modular physical architecture:** the terminal was built of two modules, the Base Module, which owns all interfaces to on-board devices and communications, and the Application Module, which owns the interface to the driver. In this way, the terminal is easily tailored towards the needs of the operator.
- ◆ **a modular construction of the Base Module,** based on the PC104 approach

- ◆ **a modular software platform**, which was realised through the use of socket-based services and the use of Ethernet communication. Services, defined (and developed) during the INVETE project, include location services, communication services, maintenance and logging services, application services and in-vehicle network services. Additional services, e.g. for monitoring, can be easily added to the platform. In this way the architecture supports the multi-application character of the in-vehicle terminal: new services can be added by adding a new socket-based service to the platform.
- ◆ **the IVT protocol**, defining the messages between the different services. The protocol was based on TCP/IP. This IVT protocol gives the different services on the IVT access to the information generated by the other services on both modules in a manner independent of the way the service is implemented. For the communications, the protocol allows seamless integration of different communication media (e.g. GSM, Private Radio Network).

The protocol has been designed for public transport applications, but can easily be extended to other mobile and static devices, e.g. for freight or logistics. The protocol can be applied to any equipment, using TCP/IP based communication.

Through the modularity and the IVT protocol, the architecture also complies with the objective of developing an IVT with open software interface, since it offers an IVT which allows a high degree of interoperability with different public transport management systems and services.

4.1.3 In-vehicle terminal modules

4.1.3.1 Base Module

The Base Module (BSM), as the heart of the INVETE IVT platform, provides all the services needed in the DRT or AVL/AVM applications and having the in-vehicle interfaces to chassis and telematics units added with the external multi-communication (GSM, PRN, SRC). The BSM is delivered with the set of services defined in the IVT Protocol, through which the interfaces of the physical layer are available.

The physical architecture of the BSM is based on internal modularity, which provides the moderate integration level, supports a wide scale of alternative models to be built up and prolongs the BSM life cycle with the updatability of both hardware and software. The PC104 processor unit as the core unit has as much as possible integrated functionalities (Ethernet, RS232, RS485, etc.) together with the accessory PC104 cards for PCMCIA, I/O, Memory, CAN, Audio, etc. The BSM features a real-time operating system.

The Base Module has been delivered with the following services: positioning services, logging services, maintenance services. Table 3 lists the different versions of the BSM, which were developed for the different test sites during the INVETE project.

Table 3: Versions of the BSM

| Function \ BSM module | Kuopio | | Tampere/ Paunu | Florence |
|---|--------|----|-------------------|----------|
| | v1 | v2 | | |
| GSM data | X | X | X | X |
| GSM voice (handset, microphone & loudspeaker) | | | | X |
| PRN | | | X | |
| GPS | | X | X | X |
| odometer | | | X | X |
| alarm button | | | | X |
| door sensor | | | | X |

The BSM has been developed for public transport application, but can also be used for other mobile equipment requiring communications and sensor interfacing.

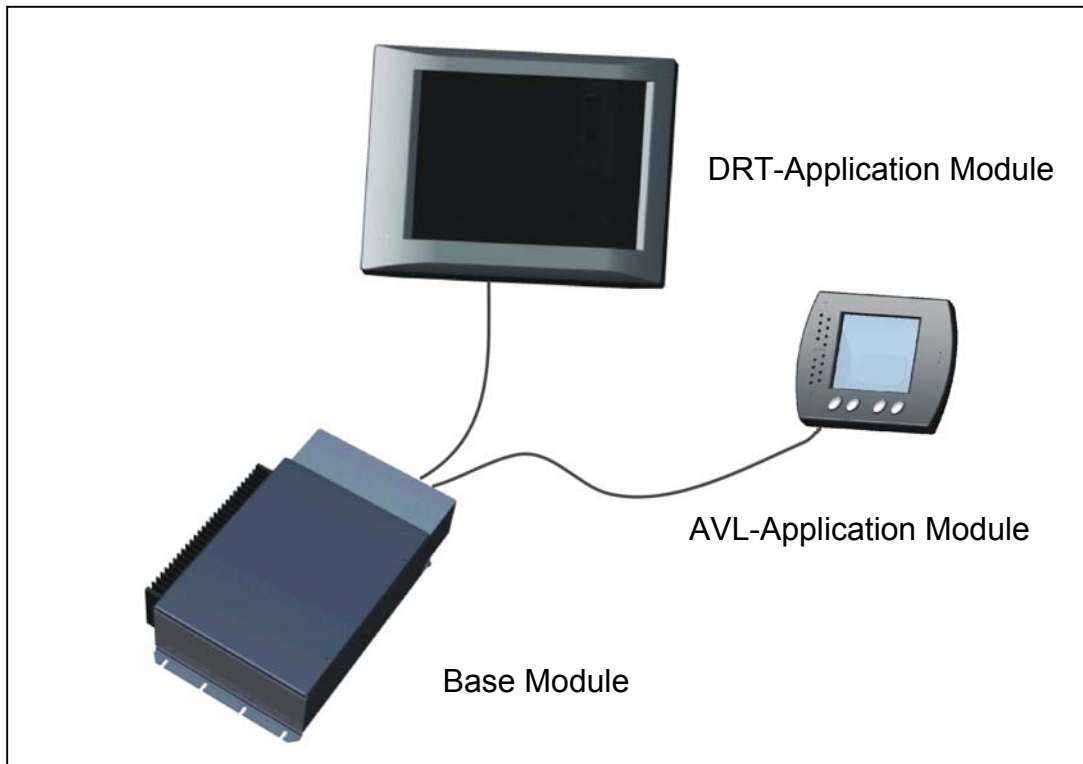


Figure 2: INVETE Terminal

4.1.3.2 Application Module for DRT applications (DRT-ASM)

The DRT-ASM has been designed for the driver, who operates DRT services, and for the application developer. The system integrator/application developer implements in the DRT-ASM the application software, which is based on customer needs and which runs on the chosen operating system. The DRT-ASM is connected to the Base Module services through Ethernet, but DRT-ASM functions also as a stand-alone unit with an external communication unit and GPS unit, if no in-vehicle communication or chassis information is needed.

The physical architecture of the DRT-ASM is based on the 10-inch full colour TFT-LCD display, which allows the showing of a map and which is covered with a high quality touch screen. The PC104 processor unit as the core supports the open approach with the possibility to choose the integrated functionalities (Ethernet, RS232, USB, etc.) and the accessory PC104 cards. The housing of the DRT-ASM is made from metal sheet, thus further devel-

opment with smoother design and change of material is needed for the market entrance. The DRT-ASM supports the integration into the dashboard of a vehicle.

The DRT-ASM is designed for the management of flexible collective transport services, but is also useful as user-interface for other services (e.g. freight transport).

4.1.3.3 Application Module for regular public transport applications (AVL-ASM)

The AVL-ASM (Application Module for Regular Public transport services in INVETE project) is designed to be used as the driver's user interface in the regular public transportation. The AVL-ASM was based on the need to have a small and affordable unit, which provides flexibility to show both text and icons and to have a keyboard only for accepting and selecting, not for text input. The AVL-ASM can be used as a separate module or with further development it can be embedded to the dashboard according to the customer needs.

The user interface of the AVL-ASM has a graphical, backlighted 4-inch LCD display and four backlighted buttons to control the operation. Additionally, there are 16 LED's available, which can be used for example to show the Ahead/Delayed –information. Feedback or notice can be given with a buzzer. The communication to the Base Module is via RS485 interface.

4.1.3.4 IVT test device

In order to test the basic functionalities of the Base Module of the IVT, a testing device was developed by VTT. The IVT testing device is specified and designed in co-operation with Instrumentointi. The device produces the external inputs for the Base Module, e.g. GPS, odometer, CAN-signals. The main aim of the testing device is to test and simulate the technical functioning and operation of the IVT.

Instrumentointi will, after the project, develop the test device further to be a main tool for the support of the IVT.

4.1.4 In-vehicle terminal interfaces

4.1.4.1 GSM-gateway

The GSM gateway provides the interface between a GSM modem and the applications, running at the in-vehicle terminal. At the TDC side, a similar gateway to the gateway at the IVT side can be used, since the protocol to transmit messages between the TDC software and the gateway is the same as in the IVT

4.1.4.2 PRN gateway

The communication in the IVT is socket based and the PRN gateway takes care of the timing, packaging and error correction coding/decoding of the messages. At the Base Station the TX- and RX-modems transmit and receive the messages independently to the transmitting and receiving PRN Base Station gateway, which takes care of the timing, packing and error correction coding/decoding of the messages, correspondingly. The communication between the PRN Base Station and Control Centre is based on socket communication.

The PRN -gateway is based on the accurate time base of GPS, which is available both in vehicles and base stations. The time slots for each bus to send data to Control Centre (uplink) have been defined application dependent as well as the time slots for PRN Base Station transmission to buses (downlink). The uplink and downlink may have different frequency channels, because of the programmability of the PRN-modems.

In case of several base stations the vehicles change their frequency channel automatically according to the location information. Normally the uplink information of each bus is sent every 15-30 seconds and the downlink information every 5-10 seconds.

The IVT has been designed to support a smooth switching from GSM to PRN and vice versa and, for example, the location information may activate the switching.

4.1.4.3 CAN-network interface

A gateway has been developed between the IVT platform and the CAN standardised network (CEN prEN 13149-6). The gateway is implemented on hardware level (CAN-processor) and on software level (bi-directional conversion of the IVT messages to/from CAN-messages).

The CAN-gateway allows the IVT to connect to the standardised CAN network and allows to use the IVT as common user-interface for all on-board devices, which are connected to the in-vehicle network. The interoperability of the CAN-interface with other telematic devices (ticketing machine, information display) is tested in the Finnish BusLAN project, which is piloted on buses of Tampere City Transport and Väinö Paunu Oy in Tampere.

4.1.4.4 Bluetooth

The use of Bluetooth for transmitting data between a computer and the BSM has been assessed. The assessment has been performed on two Linux computers, with communication complying with the IVT protocol.

4.1.5 INVETE Applications

4.1.5.1 DRT application for Italy

The IVT-DRT application in Italy was implemented in Florence, in the context of existing DRT services operated by ATAF. The DRT-ASM services for the Italian site have been developed by Softeco Sismat SpA, the supplier of the PersonalBus™ TDC software, which provides day-by-day planning and management of ATAF DRT. In Florence, the IVT was linked to the PersonalBus™ TDC, allowing demonstration and evaluation of the added value of INVETE within the operational chain of automated management of DRT services.

The general model of DRT services in Florence is based on both off-line reservation and on-line booking of personalised trips for the customers. The PersonalBus™ TDC sends updated journey plan information to the IVT's at regular time intervals (i.e. the updated blocks of trips for the next 30 minutes) so that the driver has always the latest state of planned journeys within a given time window. The state of current journey is continuously updated and presented to the driver, including indications of updated vehicle position on the map, last stop point/junction passed within the planned route, advance/delay with respect to scheduled journey times, text messages from the TDC and alarm conditions.

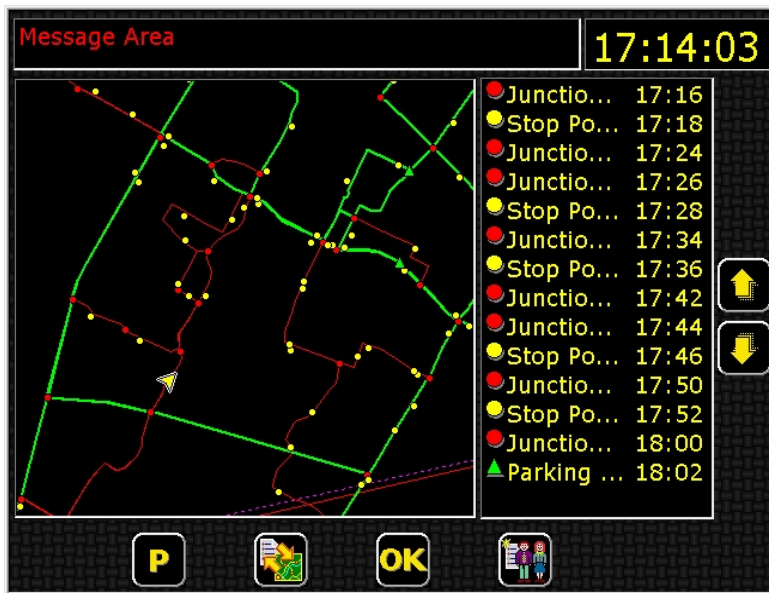


Figure 3: User interface for the DRT application demonstrated in Italy

4.1.5.2 DRT application for Finland

Mobisoft has developed the DRT software to be used for DRT services with the IVT. The Finnish DRT application in the IVT application is used together with an existing DRT System, in this case MobiRouter™ in the Kuopio region. The Travel Dispatch Centre (TDC) in Kuopio takes the orders/bookings and communicates with the vehicles using the IVT's for DRT.

The system has a comprehensive description of the transport services available for the customers. The DRT vehicle drivers will use the IVT and related DRT software to receive and send information related to the service provision. Thus for the IVT the DRT software will be developed and suitability of the IVT for DRT will be assessed and experiences gained. The TDC delivers information to the driver, who uses the IVT DRT services, and receives messages from him/her.

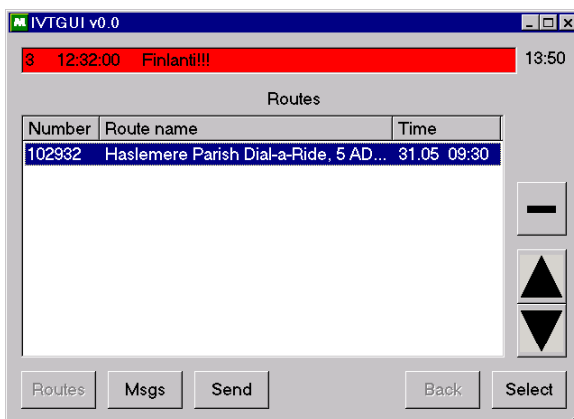


Figure 4: User interface for the DRT application demonstrated in Finland

4.1.5.3 Regular public transport application for Finland

Instrumentointi has developed the IVT-AVMi services to be applied in the autonomous regular public transportation. The IVT-AVMi application in Finland was implemented in Tampere, in the context of existing regular intercity Tampere-Helsinki services operated by Vainö Paunu OY (PAUNU).

The approach in the IVT-AVMi service is based on an autonomous bus, which has the route and timetable data on board in the IVT and, as the bus knows the current run, the bus is able to provide the advance/delay information to the driver and to the depot (and further on to PIS), if deviation (or alarm or maintenance request) occurs. The next run is fed to the IVT from the ticketing machine or from the predefined run list. The status of the fleet is monitored at the depot. The IVT on board uses normally the cellular communication (GSM-data), but in case the existing AVM/PIS at urban areas uses Private Radio Network (PRN), the IVT is able to log in to the system.

4.1.6 INVETE Validation Results

Twenty in-vehicle terminals were installed in INVETE into collective transport vehicles in real operation conditions in different test sites in Finland and Italy. The user-acceptance of the terminal by drivers and operators was verified, as well as the effect on service provision, and the technical performance.

The terminals, which were installed, operated without major technical problems. As a whole, the results of the user-acceptance tests, conducted in the INVETE test sites and addressing the usability and ergonomics issues in relation to the operation of the different user categories, can be considered rather positive and satisfying. In particular attitudes and acceptance levels were rather good in relation to the functionalities made available by the IVT for uploading information and requests to the TDC, to reliability, accuracy and usefulness of the information provided and to presentation and ease of handling of information.

The validation has demonstrated that the INVETE terminal is a logical and effective addition to the technological systems currently supporting the DRT and AVL operations. The IVT complements the use of existing on-board devices and DRT dispatching technologies and produces a synergistic effect when combined with them, thanks to its capability of storing and subsequently displaying multiple dispatch messages (passenger pick-up and drop-off addresses and routing instructions), of recording and provisionally storing specific types of information about each passenger pick-up and drop-off, and of interoperating with the other electronic on board devices, such as automatic odometers, vehicle location devices and card readers. Another important benefit coming from the use of the IVT is that it becomes possible to create more robust and flexible DRT applications with the advantage to make more attractive and effective the service. The terminal is also open for future applications and, since it complies with standard in-vehicle networks, interoperable with future on-board devices. This gives the operator a possibility to implement new devices or software in the future without major replacement costs. For the AVL system, the use of historical will allow scheduling trips more optimally, resulting in an improved service provided to the customers and a higher fuel-efficiency.

Significant benefits associated to the use of the INVETE terminal has accrued from the simplification and speeding up of a number of service operations performed by the drivers and the TDC team. Compared to the situation without INVETE terminal, consistent timesaving for drivers and TDC operators have been experienced while performing their tasks. This timesaving may result in increased labour productivity for the transit agency. The use of the IVT has also reduced the number of delayed trips due to faster communication and visualisation of the trip schedule, as well as reduced the number of failed trips. The use of the IVT also caused a decrease of the trip time especially when the driver does not know the address of the requested pick-up/drop-off locations. Also in the AVL approach, the IVT relieves the drivers from the need to search for details on the route in paper documentation.

Also the feeling of safety for drivers and passengers has been improved thanks to the functions associated with the INVETE terminal pre-coded messages (accident, vehicle breakdown, medical assistance, etc), that allow immediate positioning of the vehicle and appropriate response by the dispatchers, who can then notify transit agency security, local law enforcement officers or medical services as necessary.

Table 4 gives an overview of the statistical results on the communications in the DRT test sites in Kuopio and Florence. The table lists figures for the communication error rate (i.e. the number of failed communications per communication attempts), the number of communications per day both for communications opened by the in-vehicle terminal (from IVT to TDC) and for communications opened by the TDC (from TDC to IVT). The following rows give the average duration of the communications and the number of messages exchanged in both directions, dependent on the device opening the communications. The last rows indicate the number of bytes sent and received dependent on the device opening the communication and the number of service hours per day. The range of average values for the different terminals in the demonstration is given.

Table 4: Comparison of the communications between the DRT sites in Florence and Kuopio

| Indicator | Florence | Kuopio |
|---|--------------|---|
| T11 (Communication Error rate) | 3.0 - 5.5% | 1.5-4.6% |
| T17: Communications from IVT to TDC per day | 69.6-73.9 | 1.8-2.4 |
| T17 Communications from TDC to IVT per day | 13.6 - 14.85 | 6.8-9.5 (service bus) 26 (maxi-taxi) |
| Average communication duration from IVT to TDC (seconds) | 15.3-16.0 | 14.5-17.3 |
| Average communication duration from TDC to IVT (seconds) | 32.2-33.1 | 13.7-15.9 |
| Average number of messages to IVT per communication from IVT to TDC | 1.01-1.03 | 1.02-1.13 (service bus) 1.86 (maxi-taxi) |
| Average number of messages from IVT per communications from IVT to TDC | 0.52-0.71 | 1.05-1.14 (service bus) 2.05 (maxi-taxi) |
| Average number of messages to IVT per communications from TDC to IVT | 2 | 1.53-1.90 |
| Average number of messages from IVT per communications from TDC to IVT | 2 | 0.95-0.99 |
| Average number of bytes sent to IVT during communications from IVT to TDC | 572-715 | 167-312 (service bus) 916 (maxi-taxi) |
| Average number of bytes received from IVT during communications from IVT to TDC | 108-137 | 345-636 |
| Average number of bytes sent to IVT during communications from TDC to IVT | 429-502 | 1918-2454 (service bus) 748 (maxi-taxi) |
| Average number of bytes received from IVT during communications from IVT to TDC | 95-115 | 110-138 |
| Service hours per day | 9.3-10.5 | 7.1-10.2 |

Table 5 compares the results of the user-acceptance surveys. The interviewed persons (drivers, control room personnel, maintenance personnel), gave their opinion on a scale from 1 to 5, with 1 indicating very unsatisfied, 3 neutral and 5 very satisfied.

Table 5: Comparison of the user-acceptance results between the test sites (results on a scale from 1 to 5, with 1 indicating very unsatisfied, 3 neutral and 5 very satisfied).

| INDICATOR | | Campi | Scandicci | Kuopio | Tampere |
|------------------------------------|--------------------------------------|-------|-----------|--------|---------|
| Driver's global impression | | | | | |
| U7 | Global impression | 4.50 | 4.17 | 3.50 | 3.63 |
| U12 | Ease of use of the terminal | 3.83 | 3.67 | 3.83 | 5.00 |
| U29 | Satisfaction with user manual | 3.67 | - | 3.33 | 3.25 |
| Size and place | | | | | |
| X1 | Size of the terminal | 4.83 | 5.00 | 3.83 | 4.25 |
| U14 | Place of the terminal | 2.00 | 3.50 | 3.33 | 3.13 |
| Screens and buttons | | | | | |
| U15 | Easy to read by day | 4.00 | 4.00 | 4.83 | 3.13 |
| U16 | Easy to read by night | 5.00 | 5.00 | 5.00 | 4.75 |
| U24 | Display of the time | 4.83 | 5.00 | 4.66 | 3.00 |
| U17 | Position of the buttons | 4.17 | 4.50 | 4.66 | - |
| U18 | Size of the buttons | 4.75 | 4.83 | 4.66 | 5.00 |
| U19 | Distance between buttons | 4.83 | 5.00 | 4.66 | 4.75 |
| X2 | Number of buttons | 4.33 | 4.67 | 4.00 | 4.75 |
| Functionalities | | | | | |
| U20 | Functions of the buttons | 4.00 | 4.67 | 4.00 | 3.38 |
| U8.U9 | Understandability of info | 4.42 | 4.83 | 4.16 | 4.00 |
| U30 | Log-in/start procedures | 4.50 | 4.83 | 4.66 | 5.00 |
| U21.U22 | Application ease of use | 4.08 | 4.00 | 4.16 | 4.75 |
| U23 | Advance/delayed indication | 4.92 | 5.00 | 4.33 | 4.25 |
| U13 | Terminal response time | 3.92 | 4.00 | 4.83 | - |
| U32 | Sending messages | 4.75 | 5.00 | - | - |
| U33 | Receiving data | 4.17 | 4.17 | 3.33 | 4.13 |
| U34 | Service confirm or refuse | 4.25 | 4.50 | 4.16 | - |
| U36 | End procedures | 3.83 | 4.33 | 3.40 | 5.00 |
| U25 | Map representations | 3.67 | 3.83 | - | - |
| U37 | Automatic switch-off procedure | - | - | - | 4.25 |
| U26 | Journey updates | 4.17 | 4.33 | 3.66 | - |
| U27 | Status of other devices | - | - | - | 3.25 |
| Problems in use | | | | | |
| T8.T10 | Terminal functioning | 3.75 | 3.83 | 3.50 | 3.50 |
| T11 | Communication functioning | 4.17 | 4.00 | 3.50 | - |
| T13 | Next stop recognition | 4.83 | 4.83 | - | 5.00 |
| T15 | Climate/vibration problems | 4.25 | 4.17 | 5.00 | 5.00 |
| U39 | Distraction | 4.67 | 4.67 | 4.66 | 4.88 |
| Effect on service provision | | | | | |
| X3 | Adherence to time schedule | 3.25 | 4.00 | 2.83 | 3.50 |
| S14 | Speed and easy of learning | 4.25 | 4.33 | - | 4.00 |
| Socio-economic impact | | | | | |
| SE1 | Access to needed information | 3.83 | 4.67 | 4.50 | 4.25 |
| SE2 | Feeling safer | 4.83 | 4.83 | - | 3.75 |
| SE3 | feeling more comfortable or stressed | 3.08 | 3.33 | 3.50 | 4.00 |
| SE5 | Passenger satisfaction | 3.00 | 4.00 | 3.50 | 3.88 |
| Control room personnel | | | | | |
| T11 | Communication problems | 4.60 | 5.00 | - | - |
| U32 | Sending data procedure | 4.00 | 4.00 | - | - |
| U33 | Receiving data procedure | 4.50 | 4.50 | - | - |
| U34 | Procedure to confirm or refuse | 4.33 | 4.33 | - | - |
| U35 | Status of the driver | 4.83 | 4.83 | - | - |
| S7 | Trip failure rate due to driver | 1.67 | 1.67 | - | - |
| SE4 | Comfort | 4.67 | 4.67 | - | - |
| Maintenance personnel | | | | | |
| U40 | Easiness of installation | 4.67 | 4.67 | 4.00 | 4.00 |
| U41 | IVT hardware maintenance | - | - | - | 4.00 |
| U42 | Easiness of SW maintenance | - | - | 5.00 | 3.00 |
| U43 | Easiness of database maintenance | - | - | - | 3.00 |

4.1.6.1 Validation results for Florence

The terminals are operated in two different DRT services, one in Campi Bisenzio and the other in Scandicci. In total 8 terminals were installed: in 6 vehicles in Campi Bisenzio and in 2 vehicles in Scandicci. During the test period, the in-vehicle terminals worked in the Florence test sites without major problems. The number of daily communications is much higher than in Kuopio: about 70 communications from TDC to IVT and 14 from IVT to TDC. Due to the confirmation procedure, communications from TDC to IVT last on average 32 seconds, whereas communications from IVT to TDC last about 15 seconds.

The users acceptance results in both Campi Bisenzio and Scandicci can be considered very satisfying. In Campi Bisenzio, from the 44 indicators estimated, 41 (93.2%) received a value of more than 3 on a scale of 1 to 5, being from rather satisfying to very satisfying, and as many as 31 (70.4%) received a value of 4 or more meaning those characters (indicators) were very satisfying. In Campi Bisenzio, two indicators got a score below the neutral 3, in Scandicci only one. In Campi Bisenzio, the first one concerns the placement in the vehicle of the IVT: ten drivers out of twelve considered the terminal installed on-board not well placed because of some impediments to the view of the screen. In both sites, the negatively scored indicator is from the survey to the TDC operators and concerned the occurrence of trip fail due to errors by the driver. The TDC operators stated that a few times per week the drivers changed the trip route due to reasons not dependent from IVT malfunction such as congestion and accident that hold up the traffic. Therefore one can state that the negative impression of this indicator is not linked to a fault of the IVT functionality. A neutral scored indicator, relating to the effects of IVT functionality on passenger's satisfaction, was got from survey on socio-economic impact. Finally, the satisfaction of the maintenance personnel on the installation of the IVT was high.

An objective and conservative economic and financial assessment has been carried out in the test sites of Florence, where only the more predictable and quantifiable monetary benefits associated with the INVETE terminals have been estimated. This analysis, based on cautious assumptions and considering a 5 years lifetime of the INVETE device, has shown that the net benefits broadly exceed the related costs. This analysis did not take into account some of the major benefits of the terminal, such as the openness and the possibility to update and integrate new devices.

4.1.6.2 Validation results for Kuopio

The INVETE terminals have been installed on four vehicles in a DRT service in Kuopio: on 3 service buses and in a maxi-taxi. Originally, one in-vehicle terminal was planned to be installed in a normal taxi (Peugeot 405) instead of in the third service bus, but the terminal - which was designed towards the requirements of minibuses - was too large for this vehicle. In all four installations, the old terminal (Aplicom) was not removed from the vehicle, and could be used by the drivers if required, if needed. The drivers although used the INVETE terminal most of the time. The INVETE terminals functioned without major problems. Compared to Florence, there are only few communications: about 2 communications from IVT to TDC and about 8 communications from TDC to IVT for service buses and 26 for maxi-taxis. The communication from TDC to IVT is mainly trip plans, and the average size of the messages from TDC to IVT is 1900-2500 bytes for the service buses and 750 bytes for the maxi-taxi. This reflects the difference in service: since the capacity of the maxi-taxi is smaller, there are more, but less complex, rides per day. The communication error rate is comparable to the error rate of the previous terminal so there were basically no changes in the error rate.

The user acceptance results can be considered very good. The drivers told that they were mostly satisfied with the INVETE driver's terminal and that it was better than the former terminal they had had. From the 31 indicators asked from the drivers, 30 (97%) received a value of more than 3 on a scale of 1 to 5, being from rather satisfying to very satisfying, and as many as 18 received a value of 4 or more meaning those characters (indicators) were very satisfying. Only one of all the indicators got a figure below the neutral 3. That was Helpfulness of the terminal in order to keep better to the timed schedule. However, also in this case 5 drivers out of 6 thought the new terminal does not have any effect on the keeping to the schedule as it depends on other issues than the terminal. Also the person responsible for the TDC and the person responsible for maintenance were satisfied.

In Kuopio, the INVETE terminal replaced the previous Aplicom terminal. When replacing the terminal without changing procedures in the control centre and the vehicle, the cost benefit is much smaller. The major cost benefit comes from the wireless updating feature which reduces the need for travelling for repair and updating and hence shortens the reaction time and increases the service level in case of software or database problems. The INVETE terminal has features, which are impossible with the older terminal, and allows developing new applications faster - due to the open environment and the use of familiar tools. For example the new terminal allows remote logins into the vehicle so that ASM and BSM can be configured/updated even when the vehicle is on route. This is also possible in Florence.

4.1.6.3 Validation results for Tampere

The IVT is installed in 7 vehicles from Väinö Paunu Oy, which are operating a long-distance service between Tampere and Helsinki, and one terminal with CAN interface is installed in May 2002 after the verification with other manufacturers CAN-equipment (Ticketing Machine, Signs). The vehicles are in operation almost 24 hours per day. The late installation took place, because the Base Module services used in Kuopio and Florence were prioritised higher and because of the delay in ticketing machine updating to support the feeding of the run code to the Base Module. The demonstration will be carried out as planned (at least 6 months), although delayed.

The results of the Tampere tests can be considered rather good. The IVT Terminal, the system approach and the gathered data from the service induced positive impression to the drivers, to the management of operations and to the maintenance personnel. The driver's global impression of the IVT was rather good. The high level of automation will not leave much to do for the driver, so it was regarded easy to use.

At each bus stop, the vehicles send information on the location and the delay to the control centre. The average duration of the communication is 21.6 seconds, which leads to an average cost per call of 0.13 Euro. Hence, if the operator wants at each moment real-time information on the position of the vehicle at each bus stop (2 messages per bus stop), this leads to a cost of 6.50 Euro per run. This cost can however be reduced, if the bus only transmits deviations from the schedule (and not when it is on time). However, the stored information is important for the operator to have statistical information

The drivers were very satisfied with the size of the AVL display, and satisfied with the placement. The retrofitting of the different devices to the dashboard is always a tedious task, so the AVL-ASM should be integrated into the dashboard, if possible. The drivers were very satisfied with the visibility by night, but were neutral towards the visibility by day. To improve the visibility in the daylight some shadowing element for the sunlight should be added, as was proposed by one of the drivers.

The drivers liked the application, since they do not need to consult anymore paper documentation. Only the time indication has to be enlarged, so that time can be read at a glance.

At the start of the demonstration, there were some problems, but the manufacturer solved these. According to the drivers, the system was reliable. Climate conditions or vibrations did not generate any harm, and the use did not cause any safety problems.

The management personnel considered the possibilities to control the fleet and to plan based on the real data very important. But this will also induce challenges to the organisation, that the data will be utilised for the optimising of the service.

The main cost-benefits are expected to come from a more optimal planning. The application is expected to motivate the drivers to drive more fuel efficient, both through the real-time advance/delayed information, and by planning the time schedules more to the actual driving times. The operator sees also benefits in the reduction of passenger claims, as historical data provide a verification tool. Based on a first analysis of the costs and benefits, the expected payback time is 4-5 years.

As more and more information will be used in the bus, the wireless automatic updating procedures, in use in the Kuopio test site, have to be implemented.

4.1.6.4 Validation results for Belgium

The INVETE terminal and the applications were demonstrated to a team of experts, consisting of representatives of the drivers and the management of De Lijn. The overall impression for the DRT implementation was good, and all participants were convinced of the future possibilities of the terminal and its potential to integrate a lot of vehicle/transportation functions.

During the validation phase, the transferability of the INVETE Terminal to the vehicles of the Flanders Test Site was analysed at a conceptual level. Based on a roadmap of future technologies and devices that will be implemented, the different phases in the implementation of the INVETE terminal in the monitoring system have been defined. The identification of the different levels of functions is very important for the public transport operator who wants to optimise as much as possible the investments already made. This requires a progressive implementation finding a balance between the needs of new functions and the lifetime of existing devices. Also for the INVETE Terminal, these levels are important because in this way, the possibilities of implementing the INVETE Terminal are increased. The analysis in Belgium shows how, thanks to its modularity and interoperability with on-board devices, the INVETE terminal can be gradually implemented.

Depending on the level of implementation, the software in the Base Module or Application Module developed for the Italian and Finnish sites can be used with minor or more modifications. If the Base Module has not been implemented, some additional software needs to be developed for the ASM (DRT services), or for the current processing unit in the AVL vehicles.

4.1.7 Business Case

The trend of growing business opportunities in the telematics of public transport is based on the predicted grow of telematic services in the vehicles. The growth comes partly from the young flexible transport services, which will have an increasing number of users needing the group personalised services, because the persons are not able or will not use private cars.

The EU has also put emphasis on the principle of improving all links in the transport chain, especially to create an accessible environment to the door-to-door services and to connect the different means of transport. Additionally, the first generation AVL-systems suffer of the low updating possibilities, which will induce the need for second generation AVM/PIS systems.

As there will be more telematic application on board, there is no possibility to have an own user interface for each application, thus the interoperability of several applications in one user interface is required. The multi-communication environment (GSM/GPRS, Private Radio Network, WLAN, etc.) and different in-vehicle networks will need the possibilities to update the hardware configuration and to transfer data (application software, route and timetable updates, gathered data) wirelessly.

The experiences gathered during the INVETE project prove, that the specified open IVT Platform will meet the technical requirements so, that it can be applied in the different kind of services and it will support different kind of user interfaces and application software. Thus the Transport Operator facing a situation, in which a fleet equipped with regular PT on board devices can not support the driver in flexible transport services, could be avoided in future.

The market size is tens of thousands in the next five years, so that big enough volumes are available. The difficulty is how to prove to the Purchaser's decision-makers, that the cheapest (having not the functionality and updatability, what was looked after) is not the most economical investment in the long term. The analysis of the return of investment both in DRT and AVL Applications resulted in the payback time of 4 – 5 years, which is at the same level as the minimum lifetime of the equipment.

The AVM type telematics in DRT or regular PT systems are today a crucial part (like a gearbox or benches) of the transport service, because a vehicle having a non-functioning IVT is not able to operate the transport service. As the investment for the IVT is at level of at least 5 k€/vehicle (telematics with signs, etc. totally 10...15k€/vehicle), the importance of the maintenance organisation is emphasised. The continuous maintenance fee to the supplier would be one solution and will also ensure the availability, updatability and maintenance of the IVT product.

Based on the long-term experiences from mainly the Italian market, an "AVM Global Service" concept has been presented. This concept differs from the conventional approach in that the operator does not specify, purchase or adapt the technical system. Instead, the operator specifies the functional requirements, and a supplier builds, installs and supports the technical system to meet these requirements. The operator pays the supplier according to an agreed schedule for the AVM Global Service. It is called a Global Service since it should be a turnkey solution covering all of the needed tools and supports.

4.1.8 Recommendations: implementation of the INVETE IVT.

The overall conclusion from INVETE is that the in vehicle terminal developed, with its open and modular platform based on a general-purpose Base Module (BSM) and an application-oriented Application module (ASM), provide valuable support and advance to both regular public transport and demand responsive transport services operations. The results of the INVETE evaluation process showed that it is possible to provide services that are accepted by the operators, and that good levels of technical performance could be achieved. When con-

sidering overall costs and impacts, all demonstration sites considered that the demonstrations systems and services were justified and viable.

The INVETE consortium members each aim to exploit the results of the experimental project in a number of key areas. The authorities and operators are encouraged to continue to operate and develop the services and systems utilising INVETE results. They expect that project results can especially help to satisfy obligations for personal mobility and participation in society at lower cost through more widespread deployment of DRT service concepts and related telematics.

Technology providers and developers in INVETE expect to be able to market and sell the core and value-added technology products such as communications devices, in-vehicle terminals, location devices, and in-vehicle software services. During project development, they were already able to get feedback from the experiences in the INVETE tests-sites providing valuable input and feedback.

Integration of PT (regular and DRT) services (within national transportation policies) is a particular exploitation goal for some partners who have participated in INVETE. For instance without DRT there are no possibilities for seamless public transport outside public transport corridors.

Overall, the results and recommendations are related to several actors in the field of public transport and related services, including:

- Authorities
- Public transport operators
- System integrators
- Developers

There are some key technological issues to consider and recommendations to be made based on the results of INVETE:

- The openness and the level of standardisation of the system are major criteria when developing monitoring and management technologies for public transport. The closed, non-standard systems may sometimes be even cheaper and easier to implement as open, standard systems. However, if the objective is to develop new solutions that can be integrated with other PT technologies, the only solution that remains is the use open and standard technologies and architectures/applications.
- The communication links and protocols should be effective, fast and reliable (as proven in INVETE). There will be new opportunities for the INVETE results, as soon as the new generation mobile phones and networks (GPRS, UMTS) will be gradually introduced. The INVETE terminals can utilise the new emerging technologies.
- Naturally the INVETE terminals require also effective monitoring and management systems to operate properly. It is envisaged that concepts to be realised be based on effective monitoring and dispatching solutions (open and standard). The terminals, since they are based on modular and open solutions, will be used as supporting tools. The monitoring and management systems will set the pre-conditions for the in-vehicle terminals, not vice versa.

- Proper testing (verification and piloting) is needed before the terminals are taken into full use. The feedback from testing, piloting and, indeed, from the full-scale use has to be taken into account, when further developing the terminals. This (working feedback system) is a pre-condition for user-responsive technological development.
- There is a need to arrange also proper update and maintenance process so that the users can be sure that there will be no problems, if/when they start/continue using the INVETE terminals in real PT operational environment.
- The experiences show that there is never too much information offered to the users of the equipment. To make the best use of INVETE terminals there is a need for future discussion and training events and seminars. The technology providers have to arrange continuous system for collecting user feedback (continuous 'INVETE User Group' activity)

4.2. Recommendations for Authorities

When planning monitoring and management systems for regular public transport services or for DRT services, the whole life cycle of the product or service should be taken into account, including possible changes to the service concept and/or its size and future applications. These include, for instance, real-time passenger information on-board or video surveillance to increase the driver and passenger safety. It is therefore advisable to include the following aspects in the call for tender criteria for assessing:

- *Modularity*. The roadside or communication network infrastructure can change during the lifetime of the product, forcing the operators to perform substantial investments
- *Openness*. During the life cycle of the product, the system provider may shut down the production of the terminal, so that a new manufacturer has to be sought. By using an open system, it is possible to replace the manufacturer/terminal with a device, which uses the open same protocols.
- *Compliance* to standards and possibilities to integrate the terminal with current and future on-board devices. The EN13149-6 standard, will become a standard in the coming years, and new on-board devices will have to be compatible with this standard.
- *Updatability*. The possibility to update the software wirelessly or to upgrade the terminal without major work at the terminal. This was already realised and tested in INVETE and it proved to be effective.

The INVETE platform offers a standardised way for the communication between the vehicle and the control centre. It becomes hence possible to use the same platform for all vehicles operating in the region.

In a deregulated environment, services may be subsidised or contracts prolonged dependent on the quality of the service. An in-vehicle terminal can be used to objectively measure the quality of the service, and relay this information in a standardised way to the control centre.

4.2.1 Recommendations for Public Transport Operators

When implementing new systems, the life cycle of the system has to be taken into account. During the life cycle of the terminal the vehicle may be moved to another environment (city, region), which uses different communication methods. The vehicle could also be used in another service (e.g. DRT service instead of regular line). Therefore, attention has to be paid to

the modularity, openness, and interoperability with current and upcoming standards (see previous section).

The INVETE terminal offers the dispatch centre a standardised way to communicate with the driver, and the terminal can easily be moved to another environment without major hardware and software adaptations.

When replacing or updating a current monitoring/management system, the INVETE terminal may also provide a path to make the system more modular. Based on a roadmap of the future functionalities, the gradual replacement of the existing terminals by the INVETE-terminal can be outlined.

An AVM system is a complex system, and a small operator does not always have the possibility to maintain such a system. The operator is therefore a demanding party for an "AVM Global Service", in which the System integrator takes not only care of system maintenance and assures that the technological system is properly working, but also takes care of the investment costs, so that the operator can concentrate on operating the service.

4.2.2 Recommendations for System Integrators

The system integrator is liable for the working of the complete system. If the system integrator has to purchase the in-vehicle terminal, he should take care that the aspects of openness, modularity, updatability and interoperability are fulfilled as mentioned above. In this way, the replacement costs can be reduced in the future and 'the doors are open' for future development and enhancement of the system.

The in-vehicle platform developed in the INVETE project is open, which makes it basically possible to select the in-vehicle terminal between different manufacturers, without having to perform major software changes (if the manufacturers use the same operating system).

4.2.3 Recommendations for Developers

The INVETE Application Module is based on a commercial operating system, which makes the development of new features and services easier, since widely adopted software development tools can be used. The basic software platform is a *de facto* standard, and the component-based architecture facilitates further extensions of application services.

The modularity of the terminal makes it possible to select the application module to satisfy the demands of the operator.

The wireless maintainability functionality for the GSM communications makes it possible to update the terminal software remotely, so that easier can be reacted in case of software or database problems, and travel costs are reduced, since the software can be updated from the remote office. This proved to be very useful in INVETE and it is recommended to be used wherever possible.

4.2.4 Recommendations related to Institutional and Organisational Issues

Rapid technological development has created new opportunities for the future work of the INVETE Consortium. From this perspective, the INVETE results encourage to continue the further exploitation activities.

However in several cases the institutional framework, organisational and juridical issues may have difficulties and barriers to match these technological development and opportunities. The following issues should be considered and cleared in the planning phase:

- juridical status of DRT
- potential operators and competitive situation
- potential buyers of the DRT service (the payers)
- impeding with other public transport modes and services
- pricing issues
- payment and ticket systems
- privacy protection issues
- operational area
- dispatching issues
- compulsory competing
- co-operation with different actors (public-private-partnerships)

4.2.5 Future research needs

Based on the results of the INVETE project, further research is suggested round the following subjects:

- Development and integration of flexible transport services, by taking advantage of advanced ITS technologies. The INVETE concept and terminal can be exploited in the FAMS project (see Section 4.7.3).
- Application of in-vehicle terminal platforms to other areas, such as logistics. The INVETE concept and terminal can be exploited in the eDRUL project (see Section 4.7.3).
- Integration of the in-vehicle terminal with other on-board devices, through the use of in-vehicle networks, such as CANopen or Ethernet. The use of Ethernet in public transport allows developing and implementing new applications, which require high data rates for e.g. security or infotainment.
- Alternative architectures for the in-vehicle terminal. The tailor-made ASM is, due to the small series, still expensive equipment, especially for taxi services. Alternative physical architectures, which use the IVT protocol for communication between the different services, are:
 - * the ASM could be replaced by a PDA or smart phone, which communicates through Ethernet with the BSM;
 - * alone DRT-ASM (without BSM) by integrating mobile communications and a limited amount of interfaces;
 - * ASM + separate radio unit.
- Concerted action on the "AVM Global Service". This concept, present in the INVETE Business Case, is based on the long-term experiences from mainly the Italian market. In the AVM Global Service concept the System Provider owns and runs the AVM/PIS service, and the Transport Operator only has to face the operational and organisational issues.

4.3. Scientific/technological quality and innovation

The in-vehicle terminal, which is developed in the INVETE project, offers an open and modular platform with open interfaces for communications and applications, which:

- is designed towards the needs of collective transport operators and drivers, under different collective transport services scenario (from conventional to DRT service). Most of the IVT's, which are available on the market, have mainly been developed for heavy vehicles and for Automatic Data Collection. The IVT's developed for collective transport are mainly focused to AVL/AVM systems and do not fulfil the requirements of flexible

transport services. They are not open and are mode-specific, so that they can only be used for the vehicle for which they are defined.

- has a high degree of interoperability with on-board devices, and allows the use of a single user-interface to control and integrate various on-board telematic systems;
- is adaptable to different real-time voice and data communication networks between drivers and the control centre (i.e. GSM and private radio network);
- has an open platform and open interfaces for communications and applications. This eases the development of new telematic applications and services, and the integration of new telematic on-board hardware, and allows a high degree of interoperability with different public transport management systems and services.

4.4. Community added value and contribution to EU policies

4.4.1 European dimension of the problem

The ECMT Council of Ministers made the recommendation [1] that flexible transport services should be promoted, in order to meet the mobility needs of older and disabled people. These services serve also people living in rural areas where conventional public transport is not economical.

Flexible transport services may consist of complex trip plans, and hence demand for an in-vehicle terminal for the management of the service by the driver and the control centre. The INVETE project has developed an open platform, which makes the development of applications for DRT and the implementation of DRT services easier. The INVETE platform is also targeted to regular public transport, allowing improving the management of the transport services. The platform is compatible with the new European standard on in-vehicle networks, making it interoperable with other devices. The use of an open protocol makes the flow of information more transparent, and decreases the dependency of a transport operator to a single manufacturer, making upgrading and replacements easier.

4.4.2 Contribution to developing S&T co-operation at international level. European added value

The INVETE Consortium brings together terminal manufacturers, software developers and operators from 3 different member states, from Northern, Western and Southern Europe. The test sites are complementary and characterised by different vehicles, different collective transport services, different communication and management methods and different cultural environments.

The user acceptance tests in three member states have assured that users coming from different cultures accept the IVT. With the test sites most of the operations, management and infrastructures have been addressed thus giving the largest possible transferability throughout Europe. The software developers involved are important players in Europe in the field of DRT software, and hence form a critical mass of software developers, so that the support for the IVT by the terminal manufacturer can be organised on an economically viable basis. The IVT offers an open platform, with interfaces to standard in-vehicle networks. This will make integration of telematic services, which comply to the new standard, easily.

4.4.3 Contribution to policy design or implementation

INVETE addresses policy issues relating to communication, transport and rural areas. The provision of real-time communication between the IVT and the control centre, opens possibilities for the operator to improve fleet management and passenger information systems, resulting in a more optimal use of the vehicles and an improved service quality for the cus-

tomers. The INVETE project supports the development of flexible and more user-oriented collective transport like DRT Services, especially for citizens living in rural areas and to elderly and disabled, as desired in the Citizens' Network Green Paper.

4.5. Contribution to Community social objectives

4.5.1 Improving the quality of life in the Community :

By providing real-time communication between the control centre and the vehicle, the in-vehicle terminal allows to improve the working conditions of the driver. The project eases the implementation of flexible transport services, and has hence an indirect impact on the mobility and hence on the quality of life of European citizens.

4.5.2 Provision of appropriate incentives for monitoring and creating jobs in the Community

The in-vehicle terminal aids the driver in managing the operation service, and hence has a positive effect on his/her working conditions and skills. The project gives new business opportunities for the software developers and terminal manufacturers, by making an open platform targeted to flexible collective transport available. These companies can offer their services to operators, for which new transport and telematic services can be developed.

4.5.3 Supporting sustainable development, preserving and/or enhancing the environment

The IVT makes it possible to develop telematic services, which increase the quality and the reliability of collective transport, and which give a better service to the citizens. The provision of better quality and more reliable services will make collective transport more attractive and cause a modal shift to collective transport, and will also result in an increasing mobility and energy efficiency.

4.6. Economic development and S&T prospects

The INVETE project provides an open platform, which allows operators to implement more easily new collective transport services. The terminal has an improved modularity, openness, compliance to standards and integration possibilities and updatability. In this way, they can improve the provision of public transport services to the citizens, especially in rural areas and during nights and weekends, as well as improve fleet management. The open platform gives the operator an improved life cycle support, since the specifications can be taken into account in future call for tenders.

The open platform complies with the upcoming EN13149-6 standard for in-vehicle communications for public transport, and hence allows integrating on-board devices more easily. The IVT allows functioning as a single user-interface for different EN-13149-6 compliant telematic devices. This will have a positive effect on the working conditions and the safety of the driver. Integrated telematic services will allow improving the (real-time) information to the passenger. Through real-time information on the vehicle location, the operator will be able to develop applications to improve the roadside vehicle information to the passengers

For the software developers, the platform gives the ability to apply the same platform to various applications, and makes it easier to tailor the applications to the requirements of the operator. For the IVT manufacturer, it gives volume in both production and support, whereas the modular structure still allows tailoring the design to the specific user requirements.

The business opportunities of the INVETE terminal are described in Section 0 on the results of the Business Case.

4.7. Relations and synergies with other projects

4.7.1 Collaboration with other projects

The project has actively co-operated with other national projects in the field, in which the project partners are involved:

- SIPTS (TEN-TELECOM). Exchange of experiences in user needs analysis and evaluation.
- Collaboration with the ALIFE project funded by the Italian Environment Ministry for a logistic distribution in urban area where the Operators have requested a terminal similar to INVETE.
- Collaboration with the Tuscany Region in the Flexible Mobility Service Project where the need of an INVETE terminal was determined.
- Finnish NAVI programme on Personal Navigation.
- TRAVEL-GUIDE: exchange of information on public transport user needs

The INVETE project was asked by the Commission to participate to the ADASE cluster meetings. INVETE has participated to the Concertation activities organised by the ADASE 2 cluster (8.10.2000 Turin, 1.2.2001 Brussels, and 24-25.10.2001 Brussels), and participated to the Concertation event of the IMAGE project in Tampere on 26.3.2002.

4.7.2 Relation between INVETE and other projects in the Tampere test site

In June 2000 Instrumentointi won the bid of the Tampere PIS/AVM system (PARAS). Originally the implementation in PARAS was to be based on Instrumentointi's PRS10 terminal, of which 350 are installed in ELMI-PIS/AVM monitoring system in city of Espoo (in the Helsinki Metropolitan area) since 1998. The user requirements for the PARAS system were ready in February 2001, later than originally planned. Due to the timing of the PARAS implementation, the INVETE approach influenced the development of the PARAS terminal.

Instrumentointi used its background experience from the ELMI system, experience from the traffic light priority test project of TAMPA and the experience gained from the INVETE project for the development. The features from the ELMI-system and TAMPA project and the hardware and software from the PRS10 were transferred to the new IVT platform to guarantee the support of ELMI system, and the newer features (such as socket-based communication) were adopted from the experience gained in the INVETE project. In this way, the PARAS project will be piloting the commercialisation of the IVT Platform and give a possibility to test the INVETE concept in another real environment (free of charge to the Commission)

Figure 5 shows the relation between the INVETE and PARAS approach. The INVETE project produced different versions of the BSM (see Table 3), which are totally based on the INVETE approach. The PARAS terminal is based on the PRS10, and uses elements from the INVETE approach. The BusLAN (Open LAN for the intercommunication of in-vehicle devices in transit buses) project is a Finnish national project, dealing with in-vehicle networks based on CANopen (EN13149-6 standard). The aim of this project, which is piloted

in Tampere (both on vehicles of Tampere City Transport [TKL] and of Paunu), is to test the interoperability between an in-vehicle computer, ticketing machine and line display which comply with the CANopen standard.

Mr Pertti Peussa from VTT is the representative of Finland in CEN TC 278 WG3. The requirements for the in-vehicle network for flexible collective transport are passed through the BusLAN project to the CEN committee. The interoperability of the INVETE IVT with other devices complying with the EN13149-6 standard will be verified.

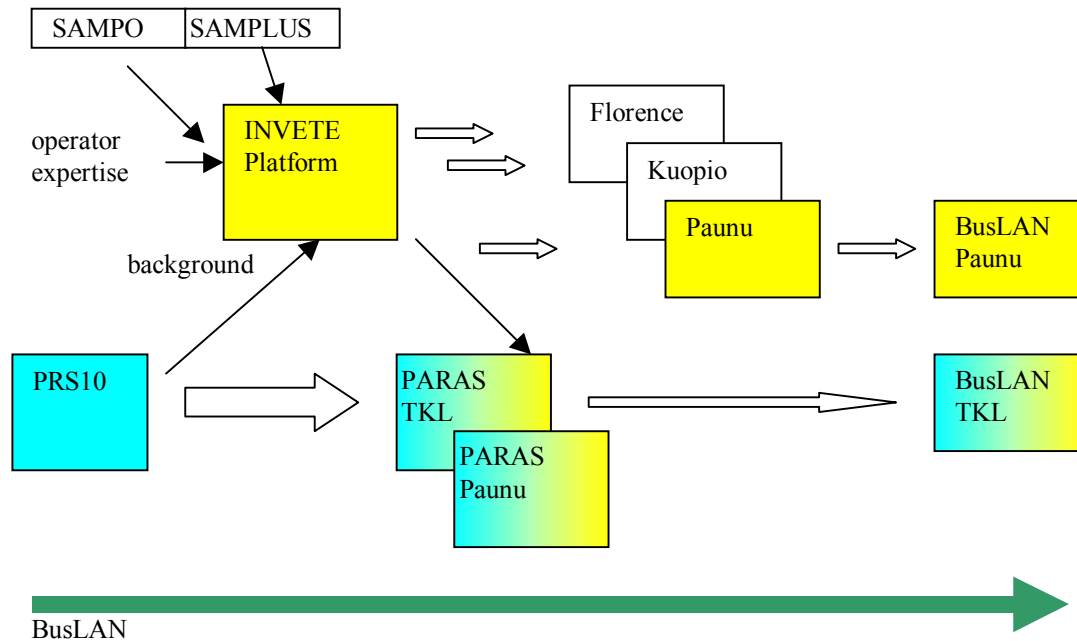


Figure 5: Relation between the INVETE, PARAS and BusLAN terminals

4.7.3 New projects exploiting INVETE results

The application of the INVETE concepts and terminal are foreseen to be exploited in two European projects approved in the 7^o call of the IST programme held at the end of 2001: FAMS and eDRUL.

FAMS, is a IST Trial Project with the aim to scale up technology, service and business models presently adopted in Demand Responsive Transport and to support the evolution from single DRT applications towards the concept of a Flexible Agency for Collective Demand Responsive Mobility Services.

INVETE IVT will be integrated in the overall architecture with the objective of testing novel GPRS based communication services available in the trial sites, and evaluating their impacts in terms of technical performance and the service / business models supported.

The overall objective of eDRUL Project is to investigate, develop and validate an innovative IST platform, and supported service models, for improved management of freight distribution and logistic processes in urban areas. Strongly based on and integrated with e-Commerce/e-Business architectures and concepts, the developed solutions will enable:

1. Communication and team working among the various actors involved in the freight distribution process, through a set of innovative networked e-Business services (B2B segment);

2. Optimal use and improved interaction among the consumers and the logistics and retail system, through a number of e-Commerce services (B2C segment);
3. Management of available resources of the logistic system (fleets and available capacity, logistics platforms, goods collection and unload areas, routes, etc.) in a way to realise flexible, demand-driven freight distribution schemes integrated with the ITS urban scenario.

The INVETE terminal will be integrated in the eDRUL architecture in order to provide the route planning and the delivery list to the driver for goods distribution to the different shops/clients located in urban area.

4.7.4 Standardisation

Input was delivered to the CEN TC 278/WG3 workgroup on in-vehicle networks. The special requirements of DRT services for the messages between the IVT and other on-board devices for DRT services were extracted from D2 and D5, and were input to the CEN workgroup by Mr Pertti Peussa, the representative for Finland in the workgroup.

ATAF, ENEA and MemEx contributed to the Italian standardisation group on Telematics architecture for public transport. The activities developed and results obtained in INVETE provided a relevant contribution to the Reference European Architecture (FA) for what concerns the Main Functional Area 4 "Manage of the Public Transport Operation" with many interactions and feedback on the macro area "Provide Advanced Driver Assistance Systems". In particular INVETE provides the following results and contributions:

- Analysis and definition of the user requirements and functional architectures both for the level of definition details and for the level of bus/vehicle taking into account different service models and technological infrastructures and systems (AVM, Integrated Payment, TDC, Communication network, etc.) and in-vehicle device context.
- Development of a physical and communication architecture to be used as case reference for generalising the deployment / realisation approach
- Definition and identification of an organisational architecture that takes into account the real service scenario provided by the different transport services (Conventional, DRT, taxi, etc.) and the roles of the main actors involved in the service provision (passengers, drivers, centre operators, fleet operators, etc.)
- Identification of the related standards and the main characteristics of deployment process
- Demonstration and evaluation of the architectural solutions both from the functional and technological point of view and from the cost benefits analysis related not only to financial aspects but mainly to the service quality and efficiency

5. DELIVERABLES AND OTHER OUTPUTS

5.1. Project deliverables

| No | Title | Description |
|-----|---|---|
| D1 | Project Presentation | Description of the project objectives, approach and expected results |
| D2 | User Needs and Requirements for the In-Vehicle Terminal | Report on the work performed on user needs and requirements analysis. |
| D3 | Validation Plan | Plan describing the procedures and indicators used during the validation phase |
| D4 | Dissemination and Use Plan | Description of the plans for dissemination and exploitation |
| D5 | IVT Architecture and Specifications | Report on the work performed on the architecture and the specifications of the in-vehicle terminal |
| D6 | IVT platform | Report on the work performed in WP4 on the design of the in-vehicle terminal hardware and software platform |
| D7 | IVT Communications | Report on the work performed in WP5 on the communication gateways, and description of the IVT protocol. |
| D8 | IVT Applications | Report on the applications, which have been developed for the demonstrators, and the assessed technologies. |
| D9 | IVT prototype | Prototype, and short report describing the different modules and the applications. |
| D10 | IVT Verification results | Report describing the work performed in WP6 on the integration and the verification of the terminal |
| D11 | IVT Demonstration results | Report on the technical performance of the terminal during the demonstration phase |
| D12 | IVT Validation results | Report on the non-technical validation (user-acceptance, financial, socio-economic, open architecture assessment) |
| D13 | IVT Business Case | Review of the markets and analysis of exploitation possibilities of the INVETE terminal. |
| D14 | Project Conclusions and Recommendations | Overview of results and conclusions and recommendations for further research. The deliverable includes the detailed IVT protocol description. |
| D15 | Technology Implementation Plan | Specifications for the use, dissemination and exploitation of the project results |
| D16 | Final Report | this document |

5.2. Workshops organised by the project

Two Workshops have been organised, one in Florence on 29.5.2001 and in Tampere on 16.5.2002. The title of the workshop in Florence was: "Flexible Mobility Services: Motivations, Technologies and Current Experiences". About 140 participants participated to the Workshop in Florence, where also the INVETE prototypes were demonstrated. The workshop in Tampere has as title "Benefits of the use of advanced technologies in public transport services - Results of the INVETE project".

Local Workshops have been organised in Kuopio on 31.1.2001 and in Tampere on 14.3.2001, in order to get feedback of the operators involved in the demonstrations.

The programs of the Workshops are given in Annex A.

5.3. Articles & Conference presentations

Contribution to the book "Transport Flexible Services for Sustainable Mobility", to appear in June 2002, sponsored by the Italian Environment Ministry and ENEA, and edited by ENEA.

Conference papers:

- * Architecture for an intelligent in-vehicle terminal for Multimodal Collective Transport Services, Johan Scholliers, Marco Gorini, Ilkka Kaisto, Andrea Iacometti, 7th World Congress on Intelligent Transport Systems, 6-9.11.2000, Turin, Italy
- * The role of the Demand Responsive Transport Services in sustainable mobility: the experience in Florence, G. Valenti, A. Perugia, C. Binazzi, N. di Volo, G. Ambrosino, ECOMM 2001, Rome
- * An In-vehicle terminal for Flexible Collective Transport Systems, Johan Scholliers, Giorgio Ambrosino, ITS in Europe 2001 "The City at your fingertips", 20-23.6.2001, Bilbao
- * Development of an intelligent in-vehicle terminal for regular and flexible collective transport services, Johan Scholliers, Marco Gorini, Ilkka Kaisto, Pekka Eloranta, 8th World Congress on Intelligent Transport Systems, 30.9-4.10.2001, Sydney

Submitted papers:

- * Evaluation of an Intelligent in-vehicle terminal for regular and flexible Public transport services, J. Scholliers, IT Solutions for Safety and Security in Intelligent Transport, 16-18.9.2002, Lyon (accepted).
- * Evaluation of an Intelligent in-vehicle terminal for regular and flexible Public transport services, J. Scholliers, ITS World Congress Chicago (accepted).

Presentation with slides (in addition to the presentations at the Workshops organised by the INVETE project):

- * Location technologies in collective transport services, Johan Scholliers, Mobile Location Workshop, 7-8.6.2001, Espoo, <http://location.vtt.fi/mlw2001/source/Scholliers.pdf>
- * Telematic services for public transport and the INVETE project, Johan Scholliers, Automotive Forum, 20-21.11.2000, Lille
- * Johan Scholliers, IMAGE Clustering Event 26.3.2002, Tampere

White Paper on INVETE Web site: "The IVT Protocol: an Ethernet Protocol for Distributed Architectures applied to Collective Transport".

5.4. Participation in industrial exhibitions

Instrumentointi has distributed a brochure on the project at their stand at CeBit 2000 and 2001 and Innotrans 2000, Berlin.

The INVETE project was shown at the stands of Softeco and Mobisoft at ITS 2000 Exhibition, and at the INVETE Workshops in Florence and Tampere.

6. PROJECT MANAGEMENT AND CO-ORDINATION ASPECTS

6.1. Project Management issues

Project management has ensured that all activities and project partners are working towards the objectives of the project. Johan Scholliers (VTT) has acted as Project Co-ordinator. The INVETE Project Office is located at the premises of VTT Automation in Tampere and is headed by the Project Co-ordinator. The Project Office has performed administrative work such as reporting to the Commission.

Individual Workpackage leaders have been responsible for the management of Workpackage activities. For WP1, WP2, WP6 and WP8: Johan Scholliers (VTT), WP3 Dirk Engels (Tritel), WP4 Ilkka Kaisto (Instrumentointi), WP5 Pekka Eloranta (Mobisoft), WP6 Marco Boero (Softeco) and WP7 Giorgio Ambrosino (ATAF).

The INVETE Steering Committee (ISC) consist of representatives of the principal contractors, and has held 8 meetings during the reporting period (4.2.2000 (Florence), 5.5.2000 (Mechelen), 30.6.2000 (Tampere), 9.11.2000 (Genoa), 15.3.2001 (Tampere), 28.5.2001 (Livorno), 5.9.2001 (Tampere) and 17.1.2002 (Rome)), always in connection with Consortium Meetings on the technical progress of the project.

In Finland, monthly meetings were held between the project partners, and in Florence, three monthly meetings of the Italian partners.

The Consortium Agreement has been drawn up between the partners, based on the Unified Consortium Agreement for FP5 projects during the first months of the project.

The Co-ordinator has built up the Quarterly Management Reports and Periodic Reports based on Monthly Management Reports, provided by the different partners. The division of the project in two contracts, one for R&D (IST-1999-10311) and one for Demonstration (IST-1999-70311), caused additional bureaucratic work for the partners. The demonstration part consisted of WP7 and Task T8.2. For administrative reporting, WP8 was split in two parts: Task 8.1+8.3 (R&D) and Task 8.2 (Demonstration). The Co-ordinator has gathered the Cost Statements from the different partners and distributed the amounts according to the guidelines of the Commission.

Each deliverable, which has been submitted to the Commission, has been subjected to Peer Review by at least two experts, one from outside the project and another from inside the project, who has not been involved in the production of the deliverable. Brendan Finn (ETTS) functioned as external Peer Reviewer for all the deliverables produced during the reporting period. Dr Bernd Wild, Intarsys, acted as second external Peer Reviewer for D5. As peer reviewers from inside the project acted Mr Stephen King (Instrumentointi UK) for D1 and D9, Mr Neri Di Volo (ATAF) for D2, Dr Juha Luoma (VTT) for D3 and D10, Dr Gaetano Valenti (ENEA) for D4 and D5, Mr Leo Weyns (De Lijn) for D6, Mr Albin Van Walle (De Lijn) for D7, Mrs Lea Ceulemans (De Lijn) for D8 and Mr Jeff. Duffell (Mobisoft UK) for D9.

An internal Website has been used for distribution of meeting minutes, document templates, draft deliverables and internal documents in the Consortium. The Extranet service for the internal website is provided by VTT Internal Services and maintained by the Co-ordinator. A mailing list has been set up for distributing information between the project participants.

At the beginning of the project, the Project Handbook was developed, including guidelines for deliverable production and management procedures.

6.2. Performance and dedication of the consortium and individual partners

All partners were duly committed to the project.

6.3. Problems encountered and solved

In the first year, Koiviston Auto withdrew from the project. Koiviston Auto had not actively participated the project. The regular public transport demonstration site was moved from Lahti to Tampere on vehicles of Väinö Paunu Oy, who acted as subcontractor to Instrumentointi Oy. A request for amendment was submitted and approved.

Due to the delay in the production of the prototypes and the start of the demonstration, a request for Amendment was submitted in November 2001, to prolong the project with two months.

7. OUTLOOK

7.1. VTT

7.1.1 Benefits

VTT has acted as Co-ordinator, during the project, and contributed to the architecture and specifications of the terminal, and to the development of the in-vehicle interface, has developed the IVT testing device and has been responsible for the Bluetooth assessment. During the project, VTT has gained expertise in the management of European projects, with Bluetooth communication and CAN-interfacing. The expertises related to the technologies and the procedures used during the project will be used in VTT's other projects related to wireless communications and with public transport.

7.1.2 Use and exploitation of the results

VTT is a research institute, and will use the expertise - related to project management, product development, validation, and with Bluetooth and CAN technologies - in other projects with Finnish and European industries. The testing device, developed for the IVT, will be attempted to be used as much as possible in other projects related to wireless automation. The experience in managing European projects will be exploited in other European projects, such as APOLLO.

7.2. ATAF

7.2.1 Benefits

ATAF was responsible for the Florence Trial and Demonstration site, further to participate to horizontal task in system requirements definition and in carrying out the verification and evaluation of the results. By participating in INVETE, ATAF has gained and consolidated an expertise in the following areas:

- analysis and setting of the requirements and needs with respect to the overall fleet monitoring and control scenario and in particular for what concerns the on board equipments and their level of integration
- understanding the organisational and operational levels needed for the functioning of technological devices and guaranteeing an adequate service quality level

The experience gained in INVETE supported ATAF at the national level in acting as a local site for the Italian demonstration of innovative AVM System under different activities related to the Italian ITS Architecture definition.

7.2.2 Use and exploitation of the results

On the basis of the experience gained in the project, ATAF will implement the INVETE approach and results at different levels of the service provision:

- realising an agency for the co-ordination and management of different Flexible Transport services currently operated by ATAF. The INVETE terminal will be the base device for integrating the different fleet operators under the agency;
- using the main INVETE specifications and functions for answering the requirements of quality service contract requested by the Regional Authority;
- consolidation of the E&D services by the co-ordination of the services of the different operators by the introduction of an onboard terminal on the basis of the INVETE specifications.

Finally, the consolidation of ATAF expertise in European Project Participation was acknowledged by the Commission with the approval of the FAMS Project co-ordinated by ATAF.

7.3. ENEA

ENEA's experience gained from the development and demonstration of the IVT is extremely useful and advantageous for carrying out current and forthcoming demonstration and research activities aimed at improving sustainability of transport in urban areas.

At present ENEA has an agreement with the Italian Ministry of Environment to support the development in a number of Italian cities of alternative transport services, characterized by flexible routing and scheduling of relatively small vehicles, with the final aim to counteract the use of private car. In this perspective the IVT developed in INVETE can be considered as a means of increasing services through increased efficiency of operations.

Another positive fallout from INVETE experience is on the current activities promoted by the Italian Ministry of Infrastructures and Transport, which aim at defining the National Transport Telematics Architecture. As for this, ENEA is involved in the definition of the architectural aspect in the context of the Public Transport Services including flexible and fixed route schemes as well as on board and on ground technologies and functions.

7.4. DE LIJN

7.4.1 Benefits

De Lijn participated in the INVETE project to contribute to the definition of the user needs and system requirements and to evaluate the transferability of the INVETE developments to other technical and operational environments. In this way the conceptual development of the INVETE terminal takes also into account the needs of a public transport operator as De Lijn with different type of services and a large fleet of vehicles equipped with different ITS systems supporting the operations.

By participating in the project further De Lijn gained a good knowledge of the possible schemes of integrating and extending the different subsystems towards a more performing supporting system for the driver and the operator:

- the requirements and user needs for the monitoring and passenger information system in addition to the current radio and ticketing driver interfaces
- a view on new features and a more integrated system to support the demand responsive services

7.4.2 Use and exploitation of the results

Using the experience of the INVETE project, De Lijn will be able to define in a better way the most appropriate and feasible technological evolution of the supporting systems taking into account the emerging European standards.

Based on the INVETE specifications and functions De Lijn will define a new driver interface for the on-board functions of the Monitoring and Passenger Information system. Taking into account the 3 level implementation schemes, an efficient evaluation will be made to decide on the best cost-efficient way to implement such a terminal. If the evaluation proves to be positive a fleet of around 2500 buses and trams will be equipped with such a terminal.

For the Demand Responsive Vehicles (a growing number of Demand Responsive Services is actually put in place in the context of the “basic mobility” initiative of the Flemish Government), the INVETE architecture will allow to come to a better integrated system and a new driver interface.

7.5. Tritel

7.5.1 Benefits

Tritel did participate in the INVETE project co-ordinating the definition of the user needs and user requirements of the INVETE terminal and supporting De Lijn in their participation in the project.

In this way Tritel consolidated and extended its experience in the development of the system specifications for ITS systems to support public transport operations. Looking to the evolution of these supporting systems, Tritel realised the emerging need to integrate the different on-board systems in an open way to allow different suppliers but simplify the work of the driver. The INVETE project presented a strong approach for this, showing possible future evolutions and objectives and demonstrating the feasibility of technical solutions.

7.5.2 Use and exploitation of the results

Tritel will use the results of the INVETE project as direct input and background in its advisory work towards public transport companies on the development and implementation of new supporting systems. The system requirements set up in the INVETE project can be the base for the requirements in calls for tenders for these systems as far as the on-board devices concerns. Also in a future European project on the definition of the further research and development needs for ITS systems for public transport, the conclusions of INVETE will be taken into account.

7.6. Instrumentointi

7.6.1 Benefits

Instrumentointi has been the provider of the IVT Platform consisting of the Base Module (BSM) with the supported IVT Protocol services, provider of the Application Modules both for the DRT and AVL applications and the Application developer for regular PT intercity application by providing both vehicle software to the AVL Application Module and the depot software for a standard PC. Also the Finnish test site in Tampere has been on the responsibility of Instrumentointi.

The possibility to participate the user requirements and specification process of the IVT from the beginning of the INVETE influenced deeply to the product concept, according to which the Instrumentointi will develop the products in the future. The Base Module specification – open platform having the services supporting the IVT protocol – has brought new co-operation possibilities, which were also trained with Softeco and Mobisoft, for the IVT. The modular approach of the Base Module will make a large scale of applications possible, and thus provide the possibility to have a sufficient volume for the vehicle computer. The experience gained also from the application modules – the large colour screen with possibilities to show a map and the small black and white to text and icon information – will be most valuable in the further development of the user interfaces.

Technologically during the INVETE project the critical areas – processors, CAN, displays like TFT-LCD and LCD, touch screens, operating systems like Windows NT Embedded and Linux – were developed to next stage and in IVT concept the new approaches could be taken into account.

On the application areas, the experience of the AVM systems was enlarged to intercity PT and also the needs and approaches in the DRT applications were clarified together with the general market view of the IVT, especially from Belgium and Italy.

7.6.2 Use and exploitation of the results

Instrumentointi is the system integrator and equipment manufacturer of PIS for vehicles like trains and buses in Finland. The results of the INVETE have had a direct impact to the development of the products for the PT and a trademark of AVMi for the autonomous vehicle fleet management has been decided to launch. The marketing steps abroad will start and in the development of the business, the experiences and contacts through the INVETE project are most valuable.

The market size for an IVT type product is approximated to be hundreds of units in Finland and thousands of units in Europe per year. In the exploitation the co-operation with the application developers Mobisoft and Softeco will be continued, as suitable business cases will appear. For the marketing of the IVT platform the network of system integrators/application developers has to be created.

7.7. Softeco

7.7.1 Benefits

Softeco has participated as an IT solutions provider to the application and demonstration of the INVETE terminal in Florence. Specifically, they have developed and on-site validated the DRT-IVT application for the INVETE site in Italy. This consists of a number of software services embedded on an IVT platform with full graphical capabilities and supporting various DRT operations on-board: presentation and management of updated trip information, vehicle location and navigation, advanced interaction with the driver, communication with the DRT Travel Dispatch Centre, etc.

The main benefits for Softeco include greatly enlarged market potentials for their current DRT system (PersonalBus™). The Florence INVETE application has provided a major test-bed for system components related to on-board driver support services and a show case for further development and marketing of DRT architecture solutions.

7.7.2 Use and exploitation of the results

Softeco is an IT solutions provider in the field of info-mobility systems and applications. The company is currently the main provider of DRT management systems in Italy and has started marketing activities in other European countries. The further use and exploitation of the INVETE results and achievements can be summarised as follows:

- Enhancement of the portfolio of solutions for DRT management architectures. With the DRT-IVT developed in INVETE, the current DRT management system (PersonalBus™) will be extended to cover real-time management of dynamic DRT and similar services. Thanks to the modularity and scalability of the INVETE IVT architecture, the potentials of current Softeco solutions are enlarged in terms of types and characteristics of the applications addressed, including:

- small DRT services, with no or little IVT requirements (low-end IVT's, with little graphical capabilities, vehicle location and communication services);
- large DRT applications in urban, peri-urban and rural areas (high-end IVT's, with full graphical capabilities, navigation and driver support, vehicle location, communication, etc.);
- dual-mode extra-urban/rural regular services with the possibility of operating DRT services in particular areas or time periods.
- Application of DRT-IVT solutions in related transportation fields such as urban logistics and goods distribution (especially operated according to demand-responsive schemes), pick-up/delivery systems, freight-taxi services, etc.
- Exploitation of developed knowledge for further RTD activities. Specifically, two new IST projects have recently started in the field of flexible mobility services (FAMS, IST-2001-34347) and e-logistics (eDRUL, IST-2001-34241)

7.8. MemEx

7.8.1 Benefits

MemEx, was involved in INVETE co-ordinating the IVT requirements specification activities and supporting the Italian INVETE application and demonstration both from technical and system side and the operational one. In the context of INVETE, MemEx had the opportunity to consolidate its background on transit company needs and objectives analysis techniques towards ITS system and on the assessment methodology developed to verify the related impacts at the organizational and operational levels. Moreover the participation in INVETE enhanced the specific competence of MemEx on the Communication network and on the real opportunities given by the different networks.

7.8.2 Use and exploitation of the results

MemEx, is an engineering consultancy company specialised in supporting public authorities and fleet operators in the ITS sector. Specifically, MemEx often acts as advisor at the setting stage of tenders for AVM System and ITS devices to be installed on board of public vehicles (bus, tram, etc). The INVETE approach and results will be therefore used as base requirements for setting the bid and for the technical offers of on board devices evaluation both from the technical point of view (functions, HW requirements, communication, etc.) and from the standardization one.

7.9. Mobisoft

7.9.1 Benefits

Mobisoft has been the provider of the GSM gateway & protocol that provide the interface between a GSM modem and the applications, running at the in-vehicle terminal. At the TDC side, a similar gateway to the gateway at the IVT side can be used, since the protocol to transmit messages between the TDC software and the gateway is the same as in the IVT.

Mobisoft has also developed the Finnish DRT software to be used for DRT services with the IVT. The Finnish DRT application in the IVT is used together with an existing DRT System, in this case MobiRouter™ in the Kuopio region. The Travel Dispatch Centre (TDC) in Kuopio will take the orders/bookings and communicate with the vehicles using the IVT's for DRT. The system has a comprehensive description of the transport services available for the customers. The DRT vehicle drivers will use the IVT and related DRT software to receive and send information related to the service provision. Thus for the IVT the DRT software will be developed and suitability of the IVT for DRT will be assessed and experiences

gained. The TDC delivers information to the driver, who uses the IVT DRT services, and receives messages from him/her.

The main benefits for Mobisoft consist of increased markets for the GSM gateway/protocol and the MobiRouter™ software for DRT. The DRT application used in the Kuopio region has provided Mobisoft with experiences of new innovative combination of the existing DRT application and an advanced modular in vehicle terminal. The feedback from the users has been very positive and the DRT system has worked very well in the INVETE terminal. INVETE has provided Mobisoft with a new technological alternative to be used in DRT services.

7.9.2 Use and exploitation of the results

Mobisoft is a provider of advanced software mobile communication applications. Mobisoft is the main DRT management system provider in Finland and in the UK. Mobisoft is going to start activities also in other European countries. DRT services have strong market potential not only in Finland but also throughout Europe. The sustainability, mobility and environmental issues have made DRT also politically attractive. There are thousands of communities, municipalities, towns and cities in Europe looking for new kind of transport service concepts. Naturally these service concepts cannot be developed without proper telematics equipment including IVT's. The market for this equipment is remarkable in DRT services. The amount of potential users of IVT's will increase, when the DRT concepts and services will become widely used in Europe. Most likely this will happen in few years. Naturally the INVETE IVT has to be competitive to be able to gain the markets. For Mobisoft it is naturally important to have different kind of technological alternatives, for different kind of users and customers. If there is a potential for thousands of DRT service concepts in Europe, there accordingly will be market for perhaps tens of thousands of IVT's.

The results of the DRT software development and experience of the DRT software in IVT's will be used as soon as possible. Mobisoft will exploit the INVETE results actively in the future, especially if/when the IVT proves to be useful and valuable in DRT operations.

Every DRT application needs a communication channel to the TDC. GSM network is especially suitable when either a reasonably small amount of vehicles is involved or the fleet operates on a geographically wide area. If a large fleet operates on a small area, it may be more cost efficient to use own PRN, but this has to be evaluated case by case. GSM works fine with big fleets as well, but then it is a matter of price structure of the GSM operator and the characteristics of the communication needs. Mobisoft has developed the GSM communication between the IVT and the TDC. GSM-data has been used successfully with MobiRouter together with the INVETE terminal and the feedback from the users (drivers) has been extremely positive

When the IVT is used for instance in low demand areas (rural etc.) the private radio network is normally out of question and something else is needed. Small transport operators may be reluctant to invest in PRN's and are looking for something else. The European Commission has also encouraged the use of GSM. There are thousands, maybe more, operators who are potential users of new IVT's and GSM communication. However the emerging new technologies have be taken into account, when estimating the market size.

The experience of GSM communication with the IVT's in DRT has already been used by Mobisoft and they will continue intensively. There are for instance three new IST projects in which Mobisoft is actively taking part in the field of flexible mobility services (FAMS, IST-

2001-34347 & EMIRES IST-2001-32591) and e-logistics (eDRUL, IST-2001-34241). These projects will also be of great interest and importance for the INVETE project.

8. CONCLUSIONS

The main aim of the INVETE project has been to specify, develop and validate a modular intelligent in-vehicle terminal (IVT), which can be used for different transport services (regular and flexible collective transport) and different transport modes (bus, taxi), and which operates in different environments (GSM, private radio network).

The INVETE project developed a modular in-vehicle terminal, which has been demonstrated in different transport services in different test sites. Modularity was realised both at hardware level (separate modules for interfacing functionalities and for the interface to the driver; modular construction of the terminals), and at software level, through the use of socket-based services and the development of a TCP/IP based protocol. The modularity of the terminal allows adapting the terminal more easily to the requirements of the operators and the services.

Starting from the same platform, three different test sites have been set up at the same time. The different test sites are characterised by different operating environments and transport services (regular public transport, DRT), different vehicles (bus, minibus, maxi-taxi) and different physical IVT interfaces and terminal options (GSM, PRN, voice interfaces).

The overall conclusion from INVETE is that the in vehicle terminal developed, with its open and modular platform based on a general-purpose Base Module (BSM) and an application-oriented Application module (ASM), provide valuable support and advance to both regular public transport and demand responsive transport services operations. The results of the INVETE evaluation process showed that it is possible to provide services that are accepted by the operators, and that good levels of technical performance could be achieved. When considering overall costs and impacts, all demonstration sites considered that the demonstrations systems and services were justified and viable.

The INVETE consortium members each aim to exploit the results of the experimental project in a number of key areas. The authorities and operators are encouraged to continue to operate and develop the services and systems utilising INVETE results. They expect that project results can especially help to satisfy obligations for personal mobility and participation in society at lower cost through more widespread deployment of DRT service concepts and related telematics.

Technology providers and developers in INVETE expect to be able to market and sell the core and value-added technology products such as communications devices, in-vehicle terminals, location devices, and in-vehicle software services. During project development, they were already able to get feedback from the experiences in the INVETE tests-sites providing valuable input and feedback.

Integration of public transport (regular and DRT) services (within national transportation policies) is a particular exploitation goal for some partners who have participated in INVETE. For instance without DRT there are no possibilities for seamless public transport outside public transport corridors. When implementing or updating monitoring systems for regular and flexible collective transport, authorities and public transport operators are advised to take the complete life cycle of the system into account. For this reason, they should take the following criteria, which were addressed in the INVETE project, into consideration: openness, modularity, compliance to standards and updatability.

The results of the INVETE project will be exploited in the short term at through upgrading and full deployment at the test sites, through collaboration between consortium partners in tenders for public transport services. On the long term, dissemination has to be targeted towards the organisations responsible for the call for tenders, in order to motivate them to add the innovative features of the INVETE approach (modularity, updatability...) as selection criteria in calls for tenders.

The INVETE platform is also planned to be exploited in two starting IST projects: FAMS (on an agency for flexible transport services) and in eDRUL, on the management of freight distribution and logistics in urban areas. The interoperability of the INVETE platform with on-board devices, complying with the coming EN13149-6 standard, is tested in the Finnish BusLAN project. Further paths for developments are the use of Ethernet for new telematic applications (e.g. related to security) in public transport, and alternative physical architectures for the terminal,

As such, the project has reached the objectives of the research. Demonstration in the test sites will continue until November 2002, allowing the operators to get enough experience with the INVETE terminal.

REFERENCES

- [1] European Conference of Ministers of Transport, Council of Ministers, Consolidated Resolution No 2001/3 on Accessible Transport, CEMT/CM(2001)15/FINAL/CORR1

LIST OF ABBREVIATIONS

| | |
|------|--|
| ASM | Application Service Module |
| AVL | Automatic Vehicle Location |
| AVM | Automatic Vehicle Monitoring |
| BSM | Base Service Module |
| CAN | Controlled Area Network |
| DRT | Demand Responsive Transport |
| ECMT | European Council of the Ministers of Transport |
| GIS | Geographical Information System |
| GPRS | General Packet Radio Service |
| GPS | Global Positioning System |
| GSM | Global System for Mobile Communications |
| HW | Hardware |
| ISO | International Organisation for Standardization |
| ITS | Intelligent Transport Systems |
| IVT | In-Vehicle Terminal |
| LAN | Local Area Network |
| PIS | Passenger Information System |
| PRN | Private Radio Network |
| PT | Public Transport |
| SW | Software |
| TDC | Travel Dispatch Centre |

ANNEX A. PROGRAMMES OF THE WORKSHOPS

The following pages contains the programmes of the Workshops:

- Flexible Mobility Services: Motivations, Technologies and Current Experiences, 29.5.2001, Florence
- Benefits of the Use of Advanced Technologies in Public Transport Services, Tampere, 16.5.2002
- Local Workshop, Kuopio, 31.1.2001 (in Finnish)
- Local Workshop, Tampere, 14.3.2001 (in Finnish)

REGISTRATION FORM

Name

Prenome

Society

Address

City

Country.....ZIP Code

Tel

Fax

E-Mail.....@

VAT Number

Registration fee Lit. 150.000
(The fee includes coffee breaks, buffet, VAT)
Dead line 15 may 2001

The terms of payment

Money transfer registered:
Banca Toscana Agenzia n.19 Via Cavour, 82/a Firenze
Current account n. 69504/50 registered at ATAF S.p.A.
ABI = 03400 CAB = 02999



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INVETE
EUROPE PROJECT
IST-1999-10311/70311



Workshop

FLEXIBLE MOBILITY
SERVICES :
Motivations,
Technologies
and
Current Experiences

29 May 2001

Florence
Business Palace
P.zza Adua

ATAF
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INFORMATION SOCIETY TECHNOLOGIES
(IST) PROGRAMME



**FLEXIBLE MOBILITY SERVICES :
Motivations, Technologies and Current Experiences**

The changes in life and work style, the accessibility and organisation of services in urban and metropolitan areas, combined with substantial variations in mobility indicators (high decrease in home-work trips, about 25% of trips are shorter than 2 Km, 40% are home-based, high rate of elderly and citizens with mobility impairments, etc.) are resulting in changed mobility needs and requirements (spread travel patterns, low demand areas/time periods, city - peripheral journeys, special users, etc.), for which conventional collective transport cannot give an adequate answer in terms of service quality and cost effectiveness. This kind of mobility has the potential to account for up to 30% of the overall trips in urban areas.

Moreover the fast and well consolidated technological developments in telecommunication and information (WWW, WAP, GPRS, UMTS, etc.) allow collective transport to provide flexible mobility services (from car sharing and shared taxi to demand responsive and door to door service etc.), which can be adapted to the user needs and complementary to conventional transport. Recently, the interest for these services has grown up in the Local Authorities, causing a strong development of the Demand Responsive Transport services (DRTs).

These services have been developed and demonstrated in several trans-national projects funded by the EU (SAMPO, SAMPLUS, SIPTS, VIRGIL, etc.), which involved transport operators, public administrations and IT industries of different countries (UK, Ireland, Finland, Sweden, Italy, Belgium, etc.) and at national level (Firenze, Livorno, Milano, Trieste, Fano, Napoli, etc.).

In this context, the European Project INVETE aims at realising and demonstrating an in-vehicle terminal to support drivers in managing Flexible Transport services (Shared Taxi and DRTs).

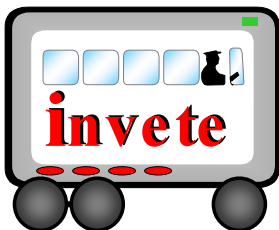
The results of these first pilot applications have been already analysed in order to evaluate the role to be played by flexible services in collective transport and the related impacts on the overall mobility management strategies, and to identify both the operational/organisational aspects and the real support provided by the IST technologies.

The INVETE workshop aims at focusing these flexible mobility solutions and to have an open discussion both on the results of current applications (from the service motivations to the cost/benefits analysis) and the barriers to be faced by the communities and transport operators in the provision of these services within a sustainable transport framework. In particular, a general overview of the role of telematics in Transport systems, Flexible Mobility and Transport service concepts and evolution at European level will be presented. Therefore the main motivations from the different user needs and from the point of view of Transport operators requirements will be provided (when, where and why), outlining the system architecture and the main involved technological options. The Invete Project and the different applications operated in Italy, Finland and Belgium will be presented, with a specific presentation of the main organisational, institutional and juridical aspects. Finally, the overview of National support policy for Flexible Transport services will be provided.

The workshop is targeted both to Communities and Transport Companies technicians together with sector experts and IT suppliers which aim at a diversification of their core business. During the workshop a demonstration corner will be active for the presentation of different DRT systems and the INVETE Project technologies.

The Workshop is organised also with the support of Working Group Flexible Mobility Services of Car free Cities Network

| | |
|-------|--|
| | Agenda |
| 9.30 | Opening session : A.Frangioni, ATAF Spa President R.Brunetti, ATAF Spa General Manager D.Malosti, ENEA, Roma |
| 10.00 | The EU approach to transport telematics Mr.Minarini, EU-DG IST Transport and Tourism |
| 10.20 | Flexible transport service: concepts and evolution D.Engels, Tritel, Belgio |
| 10.40 | DRT services : needs, typologies and deployment P.Sassoli, ATAF Spa |
| 11.00 | Coffee break |
| 11.30 | DRTs Architecture and technologies G.Ambrosino, G.A.Consultancy, C.Binazzi, ATAF Spa |
| 11.50 | The European INVETE project J.Scholliers, VTT, Finland |
| 12.00 | <i>Some DRTs in operation in Europe</i> "Ring" in Limburg & Flanders, L.Weyns, De Lijn, Belgium Experiences in Finland, P. Eloranta, Mobisoft , Finland |
| 13.00 | Buffet |
| 14.30 | <i>Some DRTs in operation in Italy</i> "PersonalBus" in Firenze, F. Pettinelli, N. di Volo, ATAF Spa Experiences in Trieste , R.Gerin, Trieste Trasporti "ProntoBus" in Livorno, P.Balestrini, ATL "My Bus" in Fano, M.Benedetti, M.Misuriello, ASET trasporti |
| 15.15 | <i>The Supplier point of view</i> System architectures, M.Boero, Softeco Sismat, Genova HW platform and network, I.Kaisto, INSTA, Finland |
| 16.00 | Organisational and Institutional aspects, P. Eloranta |
| 16.20 | The support policy of Environment Ministry G. Silvestrini, Environment Ministry |
| 16.40 | Presentation the book "Transport Flexible Service for sustainable Mobility", M.Romanazzo, ENEA |
| 17.00 | Discussion and conclusions |



Benefits of the use of advanced technologies in public transport services



Results of the INVETE project

UKK Institute, Kaupinpuistonkatu 1, Tampere, Finland
Thursday 16 May 2002, 10:00-17:00

The aim of the workshop is to discuss the benefits of the use of advanced technologies, such as wireless communication and positioning (GPS) techniques in public transport. The workshop will discuss how these techniques can improve the quality and cost-effectiveness of the public transport service, and how with these techniques new services can be developed, such as real-time public transport information or traffic light priority.

In order to assure public transport accessibility to all citizens, including elderly and disabled, Demand Responsive Transport services are developed all over Europe. For effective deployment of these services, advanced communication, positioning and optimisation techniques are required. The workshop will discuss the use of Intelligent Transport techniques in Demand Responsive Transport.

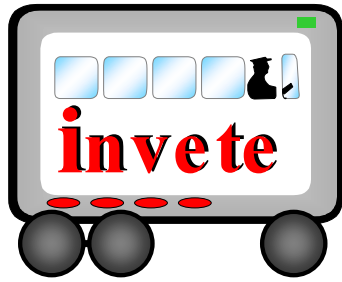
An important element is the terminal for the driver. The EU-funded INVETE project has developed a terminal for both regular and Demand Responsive Transport services. The INVETE platform is modular and easily adaptable to the needs of the operators. The INVETE terminal has been demonstrated in different test sites in Finland and Italy. The workshop will present the terminal and the results of the evaluation. The workshop will finish with an overview of other important projects in the public transport field in Finland and elsewhere.

Agenda:

- 09:30 **Registration** and morning coffee
10:00 **Opening of the Workshop**
10:05 **Welcome**, Sabina Lindström, Ministry of Transport and Communications, Finland
10:15 **Keynote speech: ITS for public transport**, Fabrizio Minarini, European Commission
10:45 **Automatic Vehicle Monitoring Systems**
 The operator point of view, Piero Sassoli, ATAF spa, Italy
 The manufacturer's point of view, Kimmo Leskinen, Instrumentointi oy, Finland
11:15 **An example of an AVM system: Tampere PARAS**, Olli Kanerva, Tampere City Transport, Finland
11:35 **Demand Responsive Transport Systems: possibilities of ITS**, Brendan Finn, ETTS, Ireland
12:05 **The INVETE terminal**
 The INVETE project and the terminal architecture, Johan Scholliers, VTT, Finland
 The INVETE platform, Ilkka Kaisto, Instrumentointi oy, Finland
12:35 **Lunch**
13:30 **The INVETE test sites and evaluation results**
 Florence, Claudia Binazzi, ATAF spa, Finland
 Kuopio, Tiia Oksanen, City of Kuopio, Finland
 Tampere, Jani Frantsila, Väinö Paunu oy, Finland
 Belgium, Dirk Engels, Tritel nv, Belgium
15:00 **Coffee break**
15:20 **Conclusions of the INVETE project**, Johan Scholliers, VTT, Finland
15:50 **Activities related to the INVETE project**
 BusLAN, Pertti Peussa, VTT, Finland
 FAMS & eDRUL, Giorgio Ambrosino, ATAF spa, Italy
16:30 **Discussion**

For more information, please contact: Johan Scholliers, VTT Industrial Systems, P.O. Box 1302, 33101 Tampere, Finland, tel. +358 3 316 3642, fax +358 3 316 3494; email: Johan.Scholliers@vtt.fi





INVETE Work Shop
Kuopiossa 31.1.2001
Kivelän talon juhlasali
klo 12-15.30

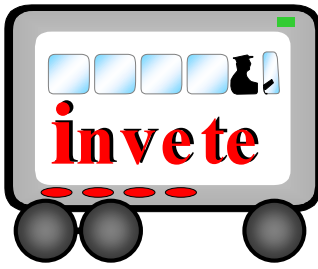


IST-1999-10311, IST-1999-70311

Ennen Work Shopin alkua suoritetaan 'autojen katselmus', jossa Instrumentointi Oy:n edustajat käyvät läpi invataksiyrittäjä Juha Tabellin ja taksiyrittäjä Risto Liljan kanssa ne ajoneuvot, joita tullaan keväämmällä käyttämään pilottilaitteiden kokeilussa. Tämä katselmus tapahtuu klo 09.00 alkaen Kuopion Yliopistollisen sairaalan pihapiirissä ennen varsinaista Work Shopia

Ohjelma

- | | |
|----------------------|--|
| 12.00 - 12.15 | Kokoontuminen ja kahvit |
| 12.15 - 12.45 | INVETE-projektin suomalaisten osapuolten esittely; <i>VTT, Instrumentointi Oy, Mobisoft Oy, Tampereen Viatek Oy</i> |
| 12.45 - 13.30 | INVETE-projektin tausta, tavoitteet ja tähänastiset saavutukset, <i>Projektin koordinaattori Johan Scholliers, VTT Automaatio</i> |
| 13.30 - 13.45 | INVETE-terminaalin esittely ja kehittämisen vaiheistus, <i>Programme Manager Timo Ahokanto, Instrumentointi Oy</i> |
| 13.45 - 14.00 | Tauko |
| 14.00 - 14.30 | Kuopion MYK ja INVETE-projekti; tavoitteet ja toimenpiteet <i>Myyntipäällikkö Pekka Eloranta, Mobisoft Oy</i> |
| 14.30 - 15.00 | Kuopion MYK:n nykytilanne ja tulevaisuuden näkymät <i>Osastopäällikkö Kauko Pursiainen, Kuopion kaupunki</i> |
| 15.00 - 15.30 | Keskustelu |
| 15.30 | Lopetus |



EUROPEAN COMMISSION
INFORMATION SOCIETIES TECHNOLOGY (IST)
PROGRAMME



INVETE

IST-1999-10311, IST-1999-70311

INTELLIGENT IN-VEHICLE TERMINAL FOR
MULTIMODAL FLEXIBLE COLLECTIVE
TRANSPORT SERVICES

INVETE Workshop

Tampere, Tekniikankatu 1 (VTT-talo)

Keskiviikko 14.3.2001, 13:00 - 17:30

INVETE-projektissa kehitetään ja kokeillaan/demonstroidaan modulaarista, älykästä ajoneuvoterminaalialia (IVT), jota voidaan käyttää eri joukkoliikennepalveluissa (säännöllinen ja kutsujoukkoliikenne) ja eri liikennevälineissä (bussi, taksi), ja joka toimii eri ympäristöissä (GSM, paikallisradioverkko). Ajoneuvoterminaalieja ja palveluja demonstroidaan oikeissa käyttöolosuhteissa testialueilla Italiassa ja Suomessa sekä kutsujoukkoliikennettä että säännöllisessä liikenteessä. Projektin osallistujat ovat VTT, Instrumentointi Oy, Mobisoft Oy, ATAF (IT), Softeco Sismat (IT), Memex (IT), De Lijn (BE) ja Tritel (BE).

INVETE-terminaalien suunnittelu loppuillaan, ja nyt haluamme kutsua teidät Workshopiin, jossa teille esitetään terminaalialia ja terminaalien sovelluksia. Workshopin esitykset pidetään englanniksi. Workshopin yhteydessä on mahdollista keskustella suomalaisten suunnittelijoiden kanssa.

Ohjelma:

| | |
|---------------|--|
| 13:00 - 13:30 | <i>Welcome and Overview of the INVETE Project</i> J. Scholliers, VTT Automation |
| 13:30 - 14:15 | <i>Presentation Of The Terminal,</i> Instrumentointi Oy |
| 14:15 - 14:45 | <i>Presentation Of The AVL Application Finland</i> Instrumentointi Oy |
| 14:45 - 15:15 | Coffee Break |
| 15:15 - 16:00 | <i>Presentation Of The DRT Application Finland</i> Mobisoft Oy |
| 16:00 - 16:45 | <i>Presentation Of The DRT Application Italy,</i> Softeco Sismat SpA |
| 16:45 - 17:15 | <i>Discussion</i> |

Lisätietoja:

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E-mail Johan.Scholliers@vtt.fi