


 Inhalt archiviert am 2024-06-18



# European Bus System of the Future

## Berichterstattung

### Projektinformationen

EBSF

ID Finanzhilfvereinbarung: 218647

[Projektwebsite](#)


Projekt abgeschlossen

Startdatum

1 September 2008

Enddatum

28 Februar 2013

Finanziert unter

Specific Programme "Cooperation": Transport  
(including Aeronautics)

Gesamtkosten

€ 25 687 247,65

EU-Beitrag

€ 15 810 606,00

Koordiniert durch

UNION INTERNATIONALE DES  
TRANSPORTS PUBLICS

 Belgium

Dieses Projekt findet Erwähnung in ...



## **Final Report Summary - EBSF (European Bus System of the Future)**

### Executive Summary:

The European Bus System of the Future project, EBSF, is conceived as a driver to increase the attractiveness and raise the image of the bus systems in urban and suburban areas, by means of developing new technologies on vehicles and infrastructures in combination with operational best practices.

Through the application of a "system approach", which looks to vehicle, infrastructure and operation as a whole, the project aims at setting up innovative high quality bus operating in the new generation of urban bus networks in Europe. This system approach also reflects the functional integration of the main bus system stakeholders: the organizing authorities and the municipalities, the operators and the bus manufacturing industry.

The final objective is:

- \* An intelligent system....making an intelligent use of information for passengers, drivers, operators, and a smart use of on-board energy
- \* ...with innovative vehicles and infrastructures... providing improved comfort also to drivers, accessibility to all the kind of passengers, allowing a flexible use of vehicle and its internal space by applying modularity concepts
- \* ...integrated in the European urban scenarios adapted to different European cities, mix of historical centers and modern areas.

Based on the needs of all the stakeholders and taking into account the new mobility trends and passengers' flow in innovative hubs, an intelligent bus system allows to offer new services for passengers and operators with new concepts for bus-stations as part of the whole transport network; therefore contributing to increase the modal shift.

Design, developments, simulation and test of key new technologies and operational concepts in real urban scenarios contribute to achieve such objectives.

During its 48 months lifetime, the project produced several outputs of two main families: Practical and Theoretical deliverables. The former include the results of activities aiming at technology development,

and their integration, whereas the latter include concepts, tools, simulations, specifications, and recommendations. From the research point of view, EBSF represents the backbone in the bus system research scenario, the "trunk" for growing European research activities like "branches". EBSF is a platform for the pursuit of the initiated research towards:

- an assessment of specific solutions, based on defined requirements and architecture;
- the development of specific aspects of the global system;
- testing the effect of changes, the exploitation of innovations or new technical enablers and the consolidation of the prioritized solutions.

Last but not least, EBSF set up the frame for the harmonisation and standardization of the solutions developed during the project

The EBSF project is a very important opportunity for local authorities, bus manufacturers and operators to change the image of the bus and passengers' perception by making buses an integrated part of the whole public transport systems.

Project Context and Objectives:

#### WHY A NEW PROJECT ON BUS SYSTEM

The EBSF is funded on the consideration that bus still remains the most universal solution for balanced and sustainable urban development from an economic, environmental and social standpoint.

Towns and cities across Europe are facing growing mobility challenges due to the need of satisfying a rising demand for accessibility within a context of growing sustainability concerns. Urban sprawl, transfer of activities to the outskirts, new mobility habits have resulted in chronic congestion throughout European urban areas, with the many adverse consequences that this entails in terms of air pollution, raise of accidents rates and accessibility problems. It is therefore vital, on one hand, to create a transport system which combines the individual's desire of mobility, and the economic requirement for the movement of people, with environmental needs and health concerns and, on the other hand, to improve the attractiveness of public transport systems for all types of stakeholders.

Since buses represent 80% of the total European Public Transport, with around 30 billion of passengers/year, they have a major role to play: they are in the front line in competing with private motorised transport for any travel and displacement of persons within the city.

As a matter of fact, bus systems are a powerful tool to answer to the new mobility needs in densely populated areas:

- buses are more environmental friendly than cars (saving fuel, reducing emissions and space occupancy)
- buses are flexible and tailored to the needs of end-customers both in terms of capacity and speed.
- bus systems not require heavy infrastructure to be put in service (are cheaper than other public transport solutions).

Nevertheless, between public transport modes bus is perceived today as a less attractive option, because of its performance in terms of regularity, speed, comfort, design, etc. Although genuine innovations have taken place in the field of bus manufacturing over recent years, they have mainly focused on technical performance and have not enabled users or local, national or European Authorities to change their perception of bus transport.

Bus system needs for a "renaissance" in the same way it happened to the Light Rail Transit and Tramways over the last few years. Such a "renaissance" can happen only by applying a comprehensive system approach looking at the vehicle, the infrastructure and the operation in an integrated way. The ideal

concept is represented by a vehicle that arises from the needs of the people that use bus services regularly, of the community defining the dispositions of public transport, of the company that manages and operates the fleet and of the vehicles manufacturers.

## THE SYSTEM APPROACH

The European Bus System of the Future project, EBSF, is conceived as a driver to increase the attractiveness and raise the image of bus systems in urban and suburban areas, by means of developing new technologies on vehicles and infrastructures in combination with operational best practices. As a result, the project doesn't look at the vehicle in isolation but as one of the elements integrated in the whole bus system together with infrastructure and operations.

Such a logic, called "the system approach" reflects also the functional integration of the main bus system stakeholders:

- the Organizing Authorities and the municipalities, who participate in the birth of bus systems with a high level of service
- the Operators
- the Bus Manufacturing Industry.

For the first time in European research, these concepts are fully endorsed by all stakeholders, with all major bus manufacturers joining their industrial capabilities along with operators and authorities pooling together in this pre-competitive research project.

## THE OVERALL PROJECT OBJECTIVES

Through the application of the "system approach", the project aimed at designing and validating a new breakthrough generation of urban bus systems, which will stimulate European cities to ensure a higher quality of the existing services and making public transport more attractive. Such a high-level objective has been achieved through the following steps:

- Defining and validating functionalities and architecture of a bus system which answer the needs of European bus stakeholders
- Developing new technologies on vehicles and infrastructure in combination with operational best practices
- Design, developments, simulation and test of key new technologies and operational concepts in real urban scenarios
- Set-up the frame for the harmonisation and standardization of the solutions developed during the project.

Moreover, in order to maintain or improve the competitive position of European bus manufacturers and operators, the project aimed at stimulating coordinated research on bus systems to find new solutions dealing with better effectiveness of investments, operation and production costs, future possibilities for bus environmental performances and smart use of energy sources

The final European Bus System of the Future project is:

An intelligent system...

making an intelligent use of information for passengers, drivers, operators, and a smart use of on-board energy;

...with innovative vehicles and infrastructures...

providing improved comfort also to drivers, accessibility to all the kind of passengers, allowing a flexible use of vehicle and its internal space (by applying modularity concepts)

...integrated in the European urban scenarios

adapted to different European cities, mix of historical centers and modern areas; featuring new services for passengers and operators (with new concepts for bus stations); based on the needs of all the stakeholders, and taking into account the new mobility trends and passengers' flow (in innovative hubs); part of the whole transport network (contributing then to increase the modal shift).

## THE LOGIC OF THE PROJECT

The EBSF Logic is composed of three major phases linked all together with a common strategy. These three phases are respectively, the System Definition, the Technological Development and the tests in the seven Use Cases. A graphical representation of the EBSF systems development lifecycle is through a V-scheme divided into three phases.

During the EBSF System Definition the requirements of the whole system and the subsystems (vehicle, infrastructure and operations) have been identified to design its architecture.

As a matter of fact, urban bus services, like Public Transport in general, contribute to meeting the mobility needs of citizens. One part of these needs is made up of quantifiable requirements, but another part is based on "perceptions" of the service itself. For this reason, the process followed for the holistic definition of the EBSF System is the result of a mixed top-down/ bottom-up approach. The top-down approach consisted of reflections performed by experts inside the consortium about existing trends in PT. The outcome of that work allows to achieve the EBSF Vision which presents how the bus system of the future should look like. The bottom-up approach was built on consolidated system engineering methodologies where the system requirements stem directly from the stakeholders' needs. Such activities were executed in the frame of the Sub-Project 1 mainly performed in the first year of the project.

This first stage in EBSF acted as the baseline of the second phase: the Technology Developments of the key concepts and elements of the global EBSF system for the vehicles and infrastructures, and the relative operational concept and practices. The sub-system design, the development of the equipments of the prototypes and the bus demonstrators' integration have been covered by the Sub-Projects 2 and 3. These activities, which started in the first year of EBSF, have been mainly executed in second and third years of project.

In the last phase of the project, the solutions developed were tested by seven Use Cases (Bremerhaven, Brunoy, Budapest, Gothenburg, Madrid, Rome and Rouen) in real operational scenarios in order to evaluate the added values of the new solutions vis-à-vis the existing status. The Paris bus stop demonstrator, which was not included in the EBSF project at the beginning and which was launched only in 2010, is the eighth and final operational test of the project: it is the only one exclusively focused on a station. Performed in the Sub-Project 4, these activities took place in the last year and half of the project. Strategic activities, including the dissemination of the results and the initial standardisation process of developed solutions, have complemented all the phases of EBSF in the view of increasing its visibility and acceptance in the Public Transport domain.

Project Results:

### 1. INTRODUCTION

The European Bus System of the Future project, EBSF, is conceived as a driver to increase the attractiveness and raise the image of bus systems in urban and suburban areas, by means of developing new technologies on vehicles and infrastructures in combination with operational best practices. As a result, the project doesn't look at the vehicle in isolation but as one of the elements integrated in the whole bus system together with infrastructural requirements and mobility concepts.

In addition to this technical system concept, such a logic, called "the system approach" reflects also the functional integration of the main bus system stakeholders, often symbolized as "the triangle" composed of :

- the Organizing Authorities and the municipalities, who participate in the birth of bus systems with a high level of service
- the Operators
- the Bus Manufacturing Industry.

For the first time in European research, these concepts are fully endorsed by all bus stakeholders, with major manufacturers (Evobus/Mercedes, Iveco Irisbus, MAN, Scania, Volvo) joining their industrial capabilities along with operators and authorities pooling together in this pre-competitive research project.

### 1.1.1 WHY A NEW PROJECT ON BUS SYSTEM

The EBSF is funded on the consideration that bus still remains the most universal solution for balanced and sustainable urban development from an economic, environmental and social standpoint.

Towns and cities across Europe are facing growing mobility challenges due to the need of satisfying a rising demand for accessibility within a context of growing sustainability concerns. Urban sprawl, transfer of activities to the outskirts, new mobility habits have resulted in chronic congestion throughout European urban areas, with the many adverse consequences that this entails in terms of air pollution, raise of accidents rates and accessibility problems. It is therefore vital, on one hand, to create a transport system which combines the individual's desire of mobility, and the economic requirement for the movement of people, with environmental needs and health concerns and, on the other hand, to improve the attractiveness of public transport systems for all types of stakeholders.

Since buses represent 80% of the total European Public Transport, with around 30 billion of passengers/year, they have a major role to play: they are in the front line in competing with private motorised transport for any travel and displacement of persons within the city.

As a matter of fact, bus systems are a powerful tool to answer to the new mobility needs in densely populated areas:

- buses are more environmental friendly than cars (saving fuel, reducing emissions and space occupancy)
- buses are flexible and tailored to the needs of end-customers both in terms of capacity and speed.
- bus systems not require heavy infrastructure to be put in service (are cheaper than other public transport solutions).

Nevertheless, between public transport modes bus is perceived today as a less attractive option, because of its performance in terms of regularity, speed, comfort, design, etc. Although genuine innovations have taken place in the field of bus manufacturing over recent years, they have mainly focused on technical performance and have not enabled users or local, national or European Authorities to change their perception of bus transport.

Bus systems need for a "renaissance" in the same way it happened to the Light Rail Transit and Tramways over the last few years. Such a "renaissance" can happen only by applying a comprehensive system approach looking at the vehicle, the infrastructure and the operation in an integrated way.

The ideal concept is represented by a vehicle that arises from the needs of the people that use bus services regularly, of the community defining the dispositions of public transport, of the company that manages and operates the fleet and of the vehicles manufacturers.

## 2. PROJECT OBJECTIVES

Through the application of the “system approach”, the project aimed at designing and validating a new breakthrough generation of urban bus systems, which will stimulate European cities to ensure a higher quality of the existing services and making public transport more attractive. Such a high-level objective has been achieved through the following steps:

- Defining and validating functionalities and architecture of a bus system which answer the needs of European bus stakeholders
  - Developing new technologies on vehicles and infrastructure in combination with operational best practices
  - Design, developments, simulation and test of key new technologies and operational concepts in real urban scenarios
  - Set-up the frame for the harmonisation and standardization of the solutions developed during the project.
- Moreover, in order to maintain or improve the competitive position of European bus manufacturers and operators, the project aimed at stimulating coordinated research on bus systems to find new solutions dealing with better effectiveness of investments, operation and production costs, future possibilities for bus environmental performances and smart use of energy sources

The final European Bus System of the Future project is:

An intelligent system...making an intelligent use of information for passengers, drivers, operators, and a smart use of on-board energy;

...with innovative vehicles and infrastructures...providing improved comfort also to drivers, accessibility to all the kind of passengers, allowing a flexible use of vehicle and its internal space (by applying modularity concepts)

...integrated in the European urban scenarios, adapted to different European cities, mix of historical centers and modern areas; featuring new services for passengers and operators (with new concepts for bus stations); based on the needs of all the stakeholders, and taking into account the new mobility trends and passengers' flow (in innovative hubs); part of the whole transport network (contributing then to increase the modal shift).

## 3. LOGIC OF THE PROJECT

The EBSF Logic is composed of three major phases linked all together with a common strategy. These three phases are respectively, the System Definition, the Technological Development and the tests in the seven Use Cases.

During the EBSF System Definition the requirements of the whole system and the subsystems (vehicle, infrastructure and operations) have been identified to design the architecture of the system itself. Such activities were executed in the frame of the Sub-Project 1 mainly performed in the first year of the project. This first stage in EBSF acted as the baseline of the second phase: the Technology Developments of the key concepts and elements of the global EBSF system for the vehicles and infrastructures, and the relative operational concept and practices. The sub-system design, the development of the equipments of the prototypes and the bus demonstrators' integration will be covered by the Sub-Projects 2 and 3. These activities, which started in the first year of EBSF, have been mainly executed in second and third years of

project.

In the last phase of the project, the solutions developed were tested by seven Use Cases (Bremerhaven, Brunoy, Budapest, Gothenburg, Madrid, Rome and Rouen) in real operational scenarios in order to evaluate the added values of the new solutions vis-à-vis the existing status. The Paris bus stop demonstrator, which was not included in the EBSF project at the beginning and which was launched only in 2010, is the eighth and final operational test of the project: it is the only one exclusively focused on a station. Performed in the Sub-Project 4, these activities took place in the last year and half of the project. A factual description of the three phases is provided in the following sections.

## 4. THE SYSTEM DEFINITION

### 4.1 THE SYSTEM DEFINITION APPROACH

As a matter of fact, urban bus services, like Public Transport in general, contribute to meeting the mobility needs of citizens. One part of these needs is made up of quantifiable requirements, but another part is based on “perceptions” of the service itself. For this reason, the process followed for the holistic definition of the EBSF System is the result of a mixed top-down/bottom-up approach.

The former was based on a brainstorming involving European Public Transport experts aimed at identifying the main topics dealing with PT that represent the roots of the EBSF system definition, among them: vehicles and infrastructures accessibility, service performance, safety and security, environmental issues, maintenance, life on board, etc... Moreover, through the same approach, the experts of the Consortium have identified the main factors influencing the evolution of bus systems in Europe. These main factors have been translated in the six strategic concepts which define the EBSF vision:

- Responding to passengers’ needs
- Responding to social and environmental needs
- Responding to the needs of cities
- Promoting political support and relevant legislation
- Securing global leadership
- Call for strategic research agenda for urban bus systems.

The bottom-up approach was built on consolidated system engineering methodologies where the system requirements stem directly from the stakeholders’ needs. More than 500 user needs have been collected from all the stakeholders of the bus system (regular and non-regular users, operators, authorities, industries, and other road users) and then translated into precise statements with targets to be met by the EBSF. The user needs collected are qualitative expressions of missing or necessary functions, consequently the resulting 342 system requirements represent a coherent and consistent list of features that the whole EBSF has to include in order to satisfy the stakeholders’ “wish list”.

This detailed “wish list” have been the basis for clustering the identified system requirements into 17 Basic Functional Requirements, to define synthetic elements of the EBSF System Definition able to represent it in the most complete way and, then, for dividing them up in order to describe the 3 EBSF subsystems (vehicle, infrastructure and operation) and their interfaces in respect of the functionalities necessary to comply with the requirements themselves. In the following the features and functions identified as subsystem requirements are shortly presented.

#### 4.1.1 THE EBSF VEHICLE

The Vehicle Requirements are the basic features of a new generation of urban/suburban buses able to support the manufacturers in the development of their product. The identified functional specifications

represent huge potential innovations and are considered as crucial to reach innovation in the following topics:

- Driver Cabin

- ☐ Functional/Operating issue

- ☐ Ergonomic and comfort issues

- Passenger's area (on board journey)

- ☐ Internal layout and internal flow

- ☐ Attractive design

- ☐ Information

- Modularity

- ☐ Inside layout modularity

- ☐ Global geometry modularity

- ☐ Modular conception & building

- IT application on board

- ☐ Interface between the vehicle and functions/devices on board

- ☐ Interface between vehicle and back office/ground structure

- Guidance

- ☐ Guidance, external interaction and steering strategies

- ☐ Assisted guidance system

- Environment, energy saving

- Strategic sub components (fire, HVAC)

- Maintenance

#### 4.1.2 THE EBSF INFRASTRUCTURE

The Infrastructure Requirements are the specifications of the functional requirements of the infrastructural features that will serve the EBSF in urban and suburban areas. They are dealing with the following areas:

- Running-way

- Busway and lane

- Crossing

- Bus stop

- Interface bus stop

- Interchanges with other modes

- Depots and workshops

- Interface bus-city

Whilst some of the identified requirements are well known, and mentioned as a reminder for the state-of-the-art solutions, many others are strongly innovative compared to the current bus systems in operation. This is particularly true for the requirements dealing with busways and lanes, crossing, interface stop-bus and the interchange with other transport modes.

#### 4.1.3 EBSF OPERATIONAL REQUIREMENTS

The Operation Requirements are the main features of the EBSF bus operation system. They are classified

according to the operational phase of service, as follows:

- Preparation for service
- Entering in service
- Service
- Failures during the service
- Maintenance
- Depot management

Even if some of these requirements are well known, the EBSF has shown that they can be significantly improved by the use of the latest IT solutions and new technologies or by the use of solutions applied in industry. However, most of the requirements have a large innovation potential, especially those linked to information providing, integration of different transport means, as well as fare integration, communication between bus and ground station, or maintenance.

## 4.2 THE SYSTEM DEFINITION ELEMENTS

The EBSF System Definition is composed of five elements that together form EBSF:

- The EBSF Basic Functions
- The main associate trade-offs
- The core KPIs
- The axes of innovations of the bus-system solutions
- The EBSF reference architecture

The identified set of Basic Functions, represented by the 17 Basic Functional Requirements (BFR), can be seen as the first level of functional architecture of EBSF. In a functional way of looking to a bus system, these elements describe what the bus system should do, that is to say its system requirements necessary to meet user needs. Such complete, consistent and limited number of functions expresses the main topics of EBSF and identifies significant elements inherent to every public transport experience.

The main Trade-Offs are the system element in which the dimension of the multi-stakeholdership gets expressed. In EBSF, stakeholders' expectations and conflicting requirements at system level are detected and recorded all along the process. Making trade-offs is essential to find the optimal way to solve conflicting requirements when moving from the conceptual level to the level of solution. A short list of the main potential conflicts has been identified at system level and linked to the Basic Functional Requirements. They identify the choices to be taken while implementing the different functionalities of the EBSF. Potential conflicts have been also classified by category of stakeholders involved, keeping in mind that the identification of the suitable solution requires the endorsement of the impacted stakeholders, including the responsible local authorities.

The Reference Architecture refers to the construction of a theoretical bus system as composed of several types of bus services, including both the set of functions properly describing the coordination of the different bus system solutions between themselves and their integration with the other public transport systems (metro services, light rail services, etc), soft transport modes (walking and cycling) and private transport modes. The architecture, moreover, highlights the external functional interfaces of the bus system with the "outside world" (which includes material and non-material aspects, among them: policy, planning, laws/regulations and technology). The logic of the EBSF Reference Architecture can be worded as follows: we look at the role of PT in the total mobility and spatial design. Then we go via busses to the various solutions.

As well as identifying the sub-system requirements, it is important to identify the aspects driving innovation in the development of the relative solutions at system level. Thus, through the analysis of the system

requirements, a group of experts have identified for each Basic Function a set of key concepts strictly related to innovation. The Axes of Innovation specify in which areas of physical design and service design of the bus system there is most potential for innovation, which has been explored in the EBSF Use Cases. From function to solution and application is the angle of perspective put forward in this element.

Finally, in order to complete the support to the strategic decision to be taken in the implementation of the EBSF functions, a small set of single, specific and fundamental KPI have been identified. The Core Key Performance Indicators look at operational level and allow the strategic evaluation of EBSF, providing a way to measure performance improvements in bus system. The 5 core KPI are:

- Capacity use rate (use versus offer ratio)
- Average Commercial Speed
- Cost per km/passenger
- Punctuality and regularity
- Global city transit emissions (modal share)

It is worth highlighting that the set of core KPI is not a benchmarking tool to be used between cities, as local situations are too different to enable relevant comparisons and measuring methods can vary substantially. The EBSF Assessment Tool makes it possible to see through the Core Key Performance Indicators how an existing or intended bus system matches the innovative EBSF concept.

## 5. TECHNOLOGICAL DEVELOPMENT

The System Definition phase acted as the theoretical baseline of the second project phase: the technological development of key concepts of the global EBSF system for vehicles and infrastructures, in combination with the relative operational practices. In the following they are shortly illustrated.

### 5.1 DRIVER COMFORT

The project work has been oriented to adopt new ergonomic concepts to the design of the driver workplace, in order to improve comfort and access to the bus functions, and therefore the quality of the whole bus service. By the observation of many drivers working in different European cities, the applications of new ergonomic concepts along with detailed technical specifications have been produced and a driver-place has been fully designed.

EBSF proposed specific requirements on:

- Driver's Workplace in General
- H-Point
- Driver's Seat
- Pedals
- Steering
- Visibility
- Actuators, Control, Information
- Heating, Air Conditioning
- Interior Noise.

A mock-up of such cabin has been developed and tested by different bus-drivers coming from operators of different part of Europe, like Germany, Italy and Sweden. The results showed that the EBSF Driver Workplace improves safety and service performance and at the same time leads to a simpler and more intuitive driving style thanks to the improvements in usability and friendliness (in accordance with the

requirements).

## 5.2 ACCESSABILITY: LAYOUT, PASSENGER FLOW

The work focused on the development of new vehicle architectures to improve both the access of the passenger to the vehicle and the movement inside the vehicle. The main target was to reduce the waiting time at the bus stop.

A simulator has been developed, which reproduces the passengers' movement while accessing the vehicle and once inside it. Specific models representing different typologies of passengers (elder people, young boys, middle age businessmen...) have been developed, therefore modelling the attitude of such people in taking and moving inside the bus, also taking into account the urban context where they live. Such simulator has been validated through a mock-up, by involving 200 people, asking them to enter, exit and move into the bus, and comparing the movie taken of their movement to the results of the simulations. Such simulator has been used by MAN to test different dimensions for a fifth rear door to be implemented in its prototype for the Budapest Use Case, and by VOLVO to the Gothenburg Use Case for a bus with central driver position sited between the front wheels, folding seats and a double-wide door in the front of the bus.

In addition, the simulation tool (BPST) has been enhanced with the following innovative features:

- Simulation of complete bus lines (i.e. simulation along successive bus stops)
- Simulation of passenger behaviour at the bus stop
- 3D playback animation of passenger behaviour at the bus stop.

Although BPST simulates passenger movement just in the horizontal plane, simulations take into account richer semantic information than purely 2D such as the presence of steps and particular behaviours like queuing, seating, standing, ticket validation, etc.

The 3D virtual environment features the EBSF bus stop and the EBSF capacity demonstrator bus, from VOLVO.

## 5.3 INFORMATION TECHNOLOGIES

In EBSF several bus equipment suppliers have developed an IT standard architecture and application platform for developing on-board information and communication systems. The work has been led by VEOLIA.

The main objective was to share key vehicle data by using IP standards on a common platform in order to improve equipment integration, avoiding being forced to rely on one single supplier for all the IT applications on-board.

A test-bench simulating two vehicles and different back-offices' architecture has been implemented in Paris and several applications have been developed by various suppliers and for different vehicles (tested also in the Use Cases). The test bench is a proof of concept for the EBSF IT architecture. The results validated the architecture's open-nature, which ensures compatibility with current hardware (through software updates) and allows that new EBSF compliant equipment can be automatically installed and configured. This streamlining and simplifying of IT installations will allow PT operators to become operational quickly with low 'integration' costs.

The key applications Dynamic Passenger Information (DPI); integration of Advanced Vehicle Monitoring System (AVMS); Multi Applications Driver Screen (MADT) and Remote Diagnostic have been validated by using the test bench and then tested in real operational scenarios in different cities (Bremerhaven, Brunoy, Rome, Madrid and Budapest), on different vehicles of EVOBUS, IRISBUS and MAN, and with equipment

developed by different suppliers. In particular, the coordination of three different back-offices through an AVMS integrator demonstrates that three different AVMS spread over Europe can work together to provide real-time integrated information.

On the Back-office side, a multi fleet coordination center with different telematic applications has been specified. Data acquired via Bus-FMS and pre-processed on-board can be transmitted to the back-office for real time analysis in case of red faults, telemetry for events & data logging for offline analysis, like life-time reports. In particular, remote diagnostic applications have been tested in Rome and Brunoy.

## 5.4 HANDLING SUPPORT SYSTEM

In the EBSF project the solution already successfully adopted by the TEOR system in Rouen has been further improved as a first step towards a solution independent by the optical guidance of the bus. The TEOR system is a bus system with optical guidance that helps the bus movements and docking, helping to reduce the stress of the driver, and improving the time in manoeuvring at the bus stop. Today the bus alignment is done only on the horizontal plane; therefore a gap remains to be solved for impaired people, like wheelchairs users.

In EBSF, two devices have been implemented: the first filling the gap between vehicle and dock; the second reducing the vertical gap by soft driving of the suspension, based on dock height detection by the vehicle, and developed using infrared sensors located near each door. The combined effect of the two devices will make the embarking similar to what happens today in modern tram lines. Two IRISBUS vehicles were already equipped and have started their test in Rouen, after having obtained the necessary homologation to perform the Use Case test during normal bus operation.

## 5.5 MODULARITY

### 5.5.1 External

Conceptual analysis of vehicle external modularity scenarios have been tested in a large set of simulations, performed by FRAUNHOFER university in order to derive the best vehicle configuration and operational conditions for external modular buses, both bustrailer and coupable configurations

Hailed from the previous operations, technical requirements that are normally not part of product specifications for conventional buses including existing solutions for bus-trailer combinations were established. In terms of operational conditions, the best results are obtained on lines in which the demand is changing significantly during the day, and for lines which merge and split during the path. In terms of potential benefits, operative personnel can be used more efficiently, and maintenance cost can be reduced: the marginal procurement costs calculated for the systems give the financial scope for manufacturers and operators. Limits are that such advantages depend on the line configuration and design, by the technical complexity of the solutions, and by legislations and rules today in place. A result of the project is a basic idea for a coupling/decoupling system with crossover. Based on the above a complete CAD model of a bus-trailer coupling system has been developed by HUBNER. The investigations show that important relevant practical features like good driving characteristics, an easy and fast coupling and decoupling procedure, secure safety facilities, an attractive inside layout, a comfortable parking process and agreeable costs can be achieved with a coupling-decoupling system, and the cost calculation clearly shows that this concept is economically valid.

The EBSF work focused also on the design of the trailers controls in order to obtain the so-called “monotrack steering” drive for an articulated bus in city urban scenarios. The study considered an articulated bus with a modular structure in order to permit a complete flexibility, either regarding the

number of transportable persons, or in order to allow a greater facilitation in the fulfilment of more difficult manoeuvres. The whole vehicle system is composed by one tractor and two trailers with two axles and is provided with a steering system, acting on all the wheels - for the tractor - and, on the rear wheels - for the trailers.

The original vehicle model of the articulated bus provided by Irisbus, was opportunely modified and tuned, in order to be as much as possible near the real vehicle. The control strategies were implemented in Matlab/Simulink environment. The analysis has shown the trailers controls are efficient both minimizing lateral error and stabilizing vehicle behaviour: in general, the reference trajectory error results less than 4 cm, so fulfilling the design specifics.

#### 5.5.2 Internal

For what concern internal modularity, new concept of sliding seat is developed and tested in EBSF, in order to develop the bus adaptability to the number of passengers.

The internal modularity design phase has defined:

- a self height alignment sliding seat, with possibilities of use manually or automatically: in the volume of one standard seat when closed, it can offer two standard seats when opened, with the same level of comfort
- new columns and handrails to follow the sliding seats modular movement and arrangement.

During the report period a CAD model was drawn and a prototype was built and after that sent to the Rome Use Case, where sliding seats and handrails prototypes have been implemented on the IRISBUS concept bus. This has provided feedback for adjustment of CAD Model.

### 5.6 ENERGY MANAGEMENT

Energy Control Strategies with positive effect on vehicle emissions and maintenance costs have been developed in the EBSF project. Predictive and adaptive energy management system for a conventional bus propulsion system has been developed and tested using modern optimization algorithms.

EBSF has been not dealing with the propulsion systems, but focusing on auxiliaries systems (Air conditioning, heating systems, IT equipments...) and vehicle components (structure, windows). Simplified heuristic strategies for fuel saving have been derived, and the results showed that the combined strategies can give a reduction of fuel consumption of up to 12.6%, depending on the driving profile and the measures implemented.

The modelling of climate inside bus and weather outside bus has been carried out. Also, statistics for weather parameters have been surveyed and Malaga, Dresden, Gothenburg and Kiruna are found to be representative for most climate types found in Europe. The experimental measurements on the MAN bus demonstrator in Budapest allowed to focus on the following topics: electrically powered doors; new air compressor; LED interior ceiling.

### 5.7 ENERGY EFFICIENCY

In EBSF, the primary objective dealing with Energy Efficiency in Bus System was to have a snapshot of the state-of-the art activities and trends that Public Transport companies have adopted or are going to adopt in the fields of energy efficiency and energy saving.

First part of the work focuses on the analysis of European legislation applicable to Public Transport for energy efficiency. In additions to analysis of the legislation of the Community, links between the policies of the Member States have been identified, going to study the rules dealing with plans for mobility,

concentration limits for the emission of pollutants from heavy-duty vehicles, energy plans specific to individual countries, the production of energy from renewable sources, the use of bio-fuels and the communication plans.

The analysed regulatory led to some general considerations. Firstly, general directives from the EU progressively turn into national regulations and laws, each revised according to local needs and political wills (from which derives a sort of never-ending amendment procedures). This causes a kind of fragmentation of the original directives, with a multiplication of local regulatory tools and lack of uniqueness. Some strategic areas as communication, education and participation still seem to be “unscathed”. It is undeniable that the quality of communication and information in the field of energy efficiency seems to be rather poor. No specific laws are available to support education (at any level) and research in the field of energy efficiency. Hence, a radical change towards dedicated sets of regulations for funding communications, educations and research in the field of energy efficiency is highly recommendable.

The second part of the work was devoted to a survey of the Public Transport Companies. The results of the survey were important and have brought to light a number of actions to be cutting edge and some worrying deficiencies in the world of Public Transport in terms of energy efficiency. A virtual path to achieve energy efficiency goals has been identified both for those Companies that have not yet moved any steps in terms of energy efficiency, and for those who have already done and they are going to do in the future, for the largest and the smallest, for those who can implement interventions more expensive and for those who, however, cannot afford large investments.

## 5.8 TRANSPORT AND TRAFFIC POLICIES

The first step has been the analysis and definition of urban areas structure and their characterization in terms of topography, activity, patronage, land availability and optimal transport modes, by the analysis of a high number of European examples. Then transport rules and traffic policies, which have an impact on urban structure, urban planning and on the effectiveness of a Bus System have been analysed especially to identify drivers and barriers for their implementation. Finally, some main recommendations concerning transport and traffic policies, also discussed with the members of the UITP Organising Authorities committee, have been developed. The main topics covered by the recommendations are:

- the power and role of the Public Transport Authorities
- the necessary link between transport policy and town/country planning on a larger area than the urban area
- the necessity to adapt fiscal and administrative national policies for supporting public transport organisation and use
- the needs to guarantee important, stable and long-term funding to Public Transport
- the complexity and the costs issue of the management of numerous different operators
- the quality and the duration of the partnership between the operator and the PT Authorities.

## 5.9 PASSENGER INFORMATION

User needs and functional requirements for travellers information have been identified and analysed according to the 3 EBSF sub-systems: vehicle (e.g. devices to be included in the bus design for exchanging information on PT services), infrastructure (e.g. types of information to be provided at bus stop and at interchanges with other nodes) and operation (e.g. availability of pre-trip information as planning, maps, stops, schedules etc...for all modes of transport necessary to make a single journey).

In addition, an in-depth analysis of the existing situation in Europe has allowed developing a model of real time information transmission to passenger that includes the state of the art of the operators and identifies the gap areas according to the user needs and requirements above mentioned. In particular the following aspects were considered in the model:

- The nature of the information to be transmitted to passengers
- The tool used to transmit the information to passengers
- Additional information that could be transmitted to passengers using real time information procedures.

The results achieved have been validated internally by the EBSF consortium, with special focus on the feed-backs from AVMS suppliers and integrators. This process allowed not only to consolidate the model, but was also used to assess those gaps areas that, following the matching activity, required being further developed within the recommendations.

The EBSF work focused also on the information needs and requirements of travellers with disabilities. One group of travellers which has been identified as requiring additional information is wheelchair users. As all travellers, those using a wheelchair require information on, e.g. how to travel from a to z, what route to take and at what time. The specific information needs of travellers using a wheelchair include information on which parts of the public transport system are accessible, e.g. which vehicles, bus stops and stations. Furthermore, they require information on the location of specific solutions, such as elevators, ramps, etc. as well as where information can be found that particularly target travellers using a wheelchair. The inventory of solutions has shown that information services exist specifically focusing travellers using a wheelchair. However, there is also room for improvements, e.g. regarding the level of details provided. A positive development would be if travel organisations involved travellers with disabilities in developing their own information. Web-based “crowdsourcing” could be one possibility to further involve travellers and use their experiences and suggestions to help other travellers use the PT network in an efficient and safe way.

## 5.10 INTERMODAL AND TRANSPORT HUBS

Intermodality has been studied in EBSF as a key factor to give shape to an efficient transport system, addressing the conditions of an optimal integration of the transport modes in order to ensure the bus system its best efficiency, and to contribute to a seamless mobility. The work started by capitalizing the experiences of Madrid.

One of the most important factors when conceiving an intermodal system is the conception of interchange or transfer points as main nodes of the transport network. These nodes must be optimised by making them maximally functional and pleasant, requiring thorough groundwork and planning, taking account of local characteristics, opportunities and constraints. According to this, four types of “connection points” have been defined: Long distances interchanges mainly used to connect long distance transport hubs with the urban centres; Metropolitan interchanges: to connect the outer/metropolitan area with the urban modes or rail network, or with ports and ferries; Urban interchanges (or intermodal area): to connect different urban modes (bus, metro, light rail, etc.); Points of connection: also located in the urban area and used for medium-short distance trips but with no specific infrastructure for the interchange, “natural” connections in the street network where several modes stop.

The design criteria to be adopted must seek to avoid or reduce the disadvantages the transfer or break point may generate. To do so, the following success key factors have been identified:

- The location, the urban integration and the added activities for contributing to the attractiveness of the interchange itself

- The integration of all modes including private modes
- The design, the accessibility, the ticket purchase and validation system aiming to reduce and to make easy the transfer between modes
- The quality and reliability of the information which require a simple, fast and coherent system, with efficient data exchange mean
- The environment quality and comfort of waiting area, so as its safety and security
- The accessibility of all groups of users to be considered from the very beginning of the design process
- A well coordinated and powerful management of the place including an User-Oriented Services Plan and an Environmental Management Plan

The work has highlighted that the standardization of the information channels and tools would be an important way for improving the reliability of multimodal information.

Furthermore to improve the coordination in bus network and between transport modes dedicated control room and technical standards for AVMS are the main operative tools.

### 5.11 ELECTRIFICATION OF URBAN BUS SYSTEMS

The work focused on comparing promising options for realisation of fully electric operation of line-service buses and recommending goal-oriented pilot projects for the near future in consideration of technical, operational and cost aspects. The options of exchange of batteries, fast charging of batteries and fast charging of high-performance capacitors (ultracaps) have been analysed.

No system was found that offers the best possible starting position for all applications. It is only possible to make recommendations oriented towards the respective line characteristics and the specific use: the (preferably automatic) exchange of battery trailers is a goal-oriented system for diameter lines with long distances between the terminal stops. Moreover, it would be possible to upgrade the present hybrid buses to electric buses by way of battery trailers.

Fast charging of batteries via a partial catenary is recommended for loop lines. As an alternative to or to reduce the partial catenary the batteries can be charged via docking.

The other variants examined in respect of fully electric operation are less goal-oriented as they have clear disadvantages compared with the above mentioned systems.

A study on the opportunity of using DC traction systems of public transport for charging battery-powered vehicles has been performed. Metro, light rail, tram and trolleybus networks with electric power supply installations offer options for rapid and slow charging of other electric vehicles such as electric buses or (shared) e-cars, e-bikes, e-taxis, often at very interesting locations such as park-and-ride facilities. The analyses performed showed that existing European public transport energy distribution network is a very low-cost basis to set-up a large (and even fast) charging infrastructure for urban passenger and freight transport. As a matter of fact, power supply infrastructure of a light rail system is suited for covering the high power demand needed for fast charging of battery buses and rectifier stations can be used as charging station positions for all kinds of electric vehicles.

### 5.12 BUS STOP

The work on bus stops dealt with the design of different bus stations adapted to different urban contexts, featuring new services (e.g. comfortable waiting time, real time bus system information) and new facilities (e.g. local life information, temporary shops, parking for bikes). The work has been funded on the consideration that the “bus stop” is the first component of the “bus system” that the customers meet. It serves three functions directly connected to the use of the bus and public transport:

- Firstly it must be considered as a rallying point: it is at this spot that usual and/or occasional customers get together to access to the bus system. That induces it must be recognizable and accessible.
- Secondly: it concurs to the waiting conditions of the customers. It is seldom not to have to wait before getting on the bus. The quality of this waiting time strongly impacts the decision to take or not the bus. That induces it must be comfortable, clean, and the waiting time must be announced for reducing the feeling of uncertainty.
- Thirdly it is a physical support for delivering the information on the bus service use.

As a result, the bus stop plays a prominent part in the attractiveness process to the bus and transport system; an unsuitable station can bar the way for the use or dissuade from the use of the Bus System. The EBSF project has included an advanced design sub-project about an enhanced bus station for heavy traffic bus stops. The RATP has managed this sub-project with the designer Marc Aurel, committed and specialized in urban furniture and public space. An original station, well adapted to the cityscape, has been designed and installed in Paris in the Gare de Lyon hub, at a station used by almost 15 000 passengers per day.

For the RATP the operation has been a complete success. For its users, for its institutional partners, for its corporate reputation, this EBSF bus station demonstrator has appeared as a really innovative operation, contributing with optimism to the future of urban life. Moreover such a realization has received two French design awards (Janus de l'Innovation 2012 and Etoile de l'Observateur 13) and has been noticed in the design world because of its accuracy: far from a spectacular realization, this station has been understood as an innovative service touching directly the urban citizens.

## 6. USE CASES

The main objective of the seven EBSF Use Cases was to produce practical and physical results of the solutions imagined and developed in the project. The concepts of EBSF have been tested in real operational conditions or, where not possible, in mock conditions, in order to evaluate the added values of the proposed new solutions in the context of their local conditions and then transferred to a larger European scale. Each city tested specific solutions to specific problems.

The Paris bus stop demonstrator, which was not included in the EBSF project at the beginning and which was launched only in 2010, is the eighth and final operational test of the project: it is the only one exclusively focused on a station.

Together with test benches and mock-ups, the UCs represent the ideal means to strengthen and show the application of the system approach to improve the attractiveness of bus services in real cities. UCs in fact aim at conveying the project outputs into a practical, tangible and assessable dimension and are intended as a combination of demonstration vehicles, running in operational conditions, and system and infrastructure features.

### 6.1. BUDAPEST

In Budapest, urban buses are the daily choice of two million users amongst all modes provided by the public transport network (bus, tram, metro, suburban railway and trolleybus). Increasing the flow of bus passengers and the bus system efficiency in terms of operational costs, while improving comfort, space and security, has been the challenge tested in the EBSF Use Case.

A new type of vehicle was tested in real operational conditions: the MAN Lion's City GL, which is an innovative urban bus that offers passengers all kind of facilities to make journeys as enjoyable and

comfortable as possible:

- five doors shorten the time spent at stops and offer better comfort and accessibility to passengers;
- new interior design and seat arrangements allow the best possible passenger flow, flexibility and comfort;
- innovative systems guarantee, specially conceived for large passenger volumes, guarantee a safe trip to all, even when the capacity is at its maximum.

Moreover the bus is powered by a modern engine reducing energy consumption. In terms of exhaust gases, it complies with the voluntary EEV standards (Enhanced Environmentally Friendly Vehicle), which set more demanding requirements for particulate emissions than the current Euro 5 emission standard.

Testing the specially modified MAN Lion's City GL on Budapest's 11 kilometer inner-city route 86, a line with high-passenger volumes, has been a great opportunity to test pioneering concepts in practice and to compare the results with the existing infrastructure.

The test phase has delivered findings on the optimisation of the boarding, the passenger flow at bus stops has been improved, time at stops has been reduced and thereby the time required for each circuit of the route has been decreased. Shorter journey times supported by traffic light influence have increased the number of circuits per day and therefore optimized the passenger offer.

## 6.2 MADRID

The Madrid Use Case looked at the metropolitan bus lines between the Majadahonda municipality and the city of Madrid. Majadahonda is a town located to the west of Madrid, 18 km from the capital's centre. In this area with high income level and high motorization rate, many citizens travel to Madrid everyday, what causes high level of congestion during peak times. Trying to solve this situation, this corridor was provided in 1995 with a BUS-HOV (Bus and High Occupancy Vehicles) lane what favours the use of Public Transport, accounting with 30% share of the mechanized trips in Majadahonda.

Between Madrid and Majadahonda, the EBSF project has tested innovative, multimodal and real time information to provide users with more information via various means (web, SMS, displays, Bluetooth, etc.). The integrated real time information allows the user to choose the best mode depending on the real situation of the network. For example, a passenger riding a bus getting to the railway station (right before entering the highway corridor), can choose to get off and ride the train in case there is a problem in the HOV lane, and accident or congestion; or stay in the bus to get to Madrid. Or the opposite situation, a passenger riding the train, finds there is a breakdown in the rails, he can change to ride the bus. That information has to be supplied to the driver, on-board the bus, on-board the train, in the train station, in the bus stop, at home, etc. This was really innovative for buses, because it is not only "voice information" (through speakers), but panels and screens on board the buses and on the stops and stations.

Real time multimodal information already in operation in rail and metro networks, has been made possible for buses thanks to another major innovation brought by EBSF: a new architecture able to manage the information coming from different operators / modes, communicating and integrating very different Automatic Vehicle Monitoring Systems (AVMS) — one for each operator — in the Integrated Public Transport Management Centre. Moreover through Radio Frequency system on the EBSF lines has been possible to guarantee communications between the operators and the busses also when vehicles enter underground interchange stations like the Moncloa station.

All improvements make the bus system more attractive, and the innovative infrastructure offers a new way of travelling adapted to passengers' needs. Tests carried out on lines with a high demand during rush hour provided a good example for the rest of the regional network, where the same system will be applied. As a result, the high quality service and real time information offered throughout the public transport network in

the region promoted a modal shift to public transport.

### 6.3 ROUEN

The TEOR lines - a BRT network - in Rouen already offered significant improvements in terms of accessibility thanks to the optical guidance system making it easier to align the bus at the station; a few more centimeters are needed to fill the gap completely, particularly for the vertical gap. The EBSF innovations in Rouen are a further step forward to granting easy access to all, including those with special needs.

Two Irisbus Iveco Buses, one articulated Citelis and one articulated Agora, both with optical guidance system have been equipped with two enhanced systems:

- a suspension electronic control for vertical gap filling;
- a gap filler installation for horizontal gap filling.

The former is based on an electric system which detects the height of the dock thanks to infrared cells and regulates automatically the vehicle's height with an automatic suspension system, placing the bus at the same level than the dock. The latter is a retractable step installed on the second door of an Agora bus which is deployed automatically as soon as the door is open and retracts once the door is completely closed.

The new system enables simultaneously to bridge over the lateral and the vertical gaps between the bus and the dock, offering an optimized accessibility for every kind of passengers. In this way, this enhanced solution reduces completely the step due to residual vertical gap and fill in fully the horizontal gap. The system is linked with a RFID recognition system of the dock for safety with RFID transponder installed in the ground just few meters before the station and RFID reader installed on the vehicle frame.

The gap filler and height regulation systems have been proved to make the bus more accessible for everyone, which is an essential condition for users to choose the bus as the optimal transportation system and improve more generally the quality perception of passengers and potential users. Special consideration has been given to the requirements of reduced mobility people including elderly people or parents with prams.

### 6.4 GOTHENBURG

The Gothenburg Use Case is divided into two parts: The first part consists of the Volvo Demonstrator bus and the second one is dealing with improvements on the existing bus route where bus drivers will be trained and helped to dock to the stops.

Following the example of the trams, the EBSF Volvo demonstrator bus has developed a new central driver cabin by placing the front wheels in the front corners of the bus and positioning the driver between them in the centre. Drivers thus feel safer and have a better view of the traffic situation. The use case allowed to highlight the following findings:

- By putting the wheels in the front next to the driver, there are more possibilities for the interior layout of the bus.
- With the absence of the wheelhouse between the first and second doors wheelchairs access in the front door is improved.
- The passenger flow inside and outside the bus is enhanced thanks to the double doors with large door blades.
- The semi-transparent articulation bellow ensures a high level of comfort inside the bus to make journeys more pleasant for passengers.

More space can be dedicated to standing passengers and the folding seats can be blocked or released

according to the passenger flow. This together with higher accessibility can reduce the dwell time at stops. In the Gothenburg UC line all buses are built with low floor and all stops are equipped with a special 17 cm high curb stone. The idea is that the driver should be able to get as close as possible to the stone by steering the bus wheel against it. This is not the behaviour of all drivers and at some stops it is not easy to find the right track to get close enough. The UC helped the drivers to dock to the curb stone by painting on the streets and by special training.

Passenger and driver well-being has been central to the Use Case of Gothenburg. The EBSF Volvo demonstrator bus, with a centred driver workplace offers new internal layout possibilities boosting the comfort of passengers, improving the accessibility of all and reducing dwell time at stops. Drivers feel safer and have a better view of the traffic situation. The training of drivers has shown what can be achieved by adapting knowledge and skills to existing infrastructure.

## 6.5 BREMERHAVEN

Multiple public transport information and links to public communication services can help to overcome the “information barrier” to using public transport and provide more effective marketing tools to provide:

- seamless journeys with a high level of on-board comfort and safety, attractiveness, in-time operation and consistent level of information service;
- better e-public services through dedicated IT systems on-board and at selected bus stops.

One EVOBUS demonstrator and 15 retrofitted buses have been equipped with a driver terminal and on-board AVMS computer dynamic passenger information components; real time information is displayed on the screens allowing passengers to see, e.g. the real departure time from the next stop, interruptions to service, alternative routes, tourist and public service related information. Info-terminals displaying public transport and public service related information have been further developed at ten bus stops strategically situated in the city.

About 56% of the population is living along the Use Case line (n° 502). This line connects densely populated districts in the outskirts of the city, the main tourist attraction area “Havenwelten”, the city centre and the main station. The test phase extended the information offer from any place in the city (home, redesigned bus stop, vehicle, public space), to other means of transport (e.g. regional trains) and to other online information sources (e.g. e-public and tourism services).

The EBSF innovations in the EVOBUS demonstrator bus have facilitated passengers’ journeys and in the redesigned bus stops, waiting time didn’t act as a barrier to choosing the bus as a transportation mode. The new solutions have improved the quality level of the bus service for all passengers, in particular for visually and hearing impaired people.

## 6.6 BRUNOY

Today, the activities dealing with the bus maintenance are mainly divided in two parts:

- periodic activities: technical controls, fluids change, etc;
- corrective activities: fixing of vehicle failures.

For a public transport fleet operator, the main maintenance issues are linked to the technical failures which appear on line during the service. This type of failure has an impact on the service quality and on operation costs both for passengers (change of vehicle during the trip and delay) and for the operator (replacement of the vehicle during operation, immobilizing and repair of failing vehicle).

In Brunoy, the EBSF Use Case tested a new telediagnostic and remote maintenance system based on new information and communication technologies.

Ten CITELIS buses from IRISBUS have been equipped with a new embedded system based on an innovative technical architecture, allowing specific information to be extracted from vehicles' subsystems (multiplex network for vehicle alarms and alerts including dashboard lights, Control Area Network and additional specific sensors for three key components: the doors, battery and brake system). Two communication channels are used to download data to the workshop; once the data are collected, all information is transmitted to the workshop, where it is analysed using specialised advanced algorithms. Data is available for consultation on a website and can be requested according to different parameters (bus number, time period, type of alert, etc). Moreover, alarms, alerts and events are associated with a map, which allows events to be correlated with the line.

Specific software related to the three key components (doors, brake system and battery) has been developed for predictive maintenance purposes. The objective is to anticipate the technical failures and associated serious fallouts like technical failures during the service. This specific software is based on advanced algorithms developed using data fusion, sampling and signal processing.

The global technical architecture of the telediagnostic system tested in the Brunoy Use Case is integrated and compliant with the EBSF telematic architecture which has been developed by twenty-two partners of the project and has been validated on a test bench (see 5.3). This architecture is based on existing standards at interface and communication protocol levels.

The Brunoy Use Case impacted on the:

- reduction of number of reserved vehicles;
- immobilisation of vehicles for maintenance actions;
- reduction of technical failures during operation service.

Advanced data analyses enable monitoring of all events and problems affecting vehicles with automatic processes, and therefore allow the implementation of efficient and optimized preventive and predictive maintenance applications, which could be integrated into the telediagnostic system. These analyses improve the reliability of vehicle maintenance.

Finally, the compliant architecture of the telediagnostic solution with the standard telematic EBSF test bench has provided a solution which can be included in integrated architectures and allowed it to be part of the system overview.

## 6.7 ROME

The ESBF Use Case in Rome was aimed at developing innovations in three different fields:

- internal layout (Irisbus bus demonstrator);
- driver workplace (test bench)
- remote maintenance (full service)

The bus demonstrator has been based on the Hynovis concept bus developed by Irisbus Iveco. This bus offers a very innovative passenger compartment providing comfort and well being to passengers:

- easy access to the seats: no steps of the first 10 meters of the bus (out of 12);
- a central aisle brought to 1,2 m (instead of 0,9 m) to ease the passenger movement inside the vehicle;
- a glazed surfaced increased by 20 %, to open the vehicle on the city and to bring light into the vehicle.

A new modular layout of seats has been developed to enable to adjust the capacity of the vehicle to the needs, and to optimize the amount of seats and the comfort offered to the passengers. The system consists in a sliding seat, aligning the two seats to the same level for a better comfort. The seats arrangement is made by the driver itself, depending of the affluence during the day. This arrangement can

be done at the terminal station. The process can be manual or fully automatic.

The smart internal layout modularity of the EBSF Demonstrator is able to enhance the level of the bus service, in particular in peak hour conditions: the new solutions avoiding big affluence to harm the comfort of the passengers.

The improvement of work conditions for driver is a key issue for better service, performance and industrial relations between company and employees. The driver's cabin is the place where the driver spends 6 to 8 hours of his life every day, and for this reason it has to be comfortable, ergonomic, safe and should assure the best microclimatic conditions. Nowadays in Europe, the cabin guide is extremely not homogenous, the extremely variable typology of buses. A static mock-up of a future European driver's workplace has been especially produced for tests in the driving simulator at the IVI-Fraunhofer Gesellschaft in Dresden (Germany). The ergonomic quality of the mock up in the driving simulator (reproducing two bus lines in Rome and Dresden) has been tested by drivers of different European cities (Dresden, Gothenburg and Rome).

In Rome, EBSF focused also on the maintenance needs of the methane buses exploited by ATAC; needs which are different from the maintenance requirements for diesel or electric buses. 50 existing IRISBUS CNG buses have been equipped with a new diagnostic on-board system (DIGIGROUP i-Diag system), which collects vehicle's information from specifically installed sensors and bus Control Area Network (CAN). These collected data are sent to the back-office application by the GPRS network. ATAC Maintenance Engineers adapted the maintenance program for each vehicle on the basis of the real life and stress of the vehicle, by means of collected data analysis.

Innovations on remote maintenance system impacted positively on the general fleet of the vehicle, on the service reliability as well as on the maintenance and operating costs for the operator.

## 6.8 PARIS

An original bus station, well adapted to the cityscape, has been designed and installed in Paris in the Gare de Lyon hub, at the existing "Gare de Lyon – Diderot" bus stop (17 Boulevard Diderot) in the Paris 12th district. The traffic measured at this bus stop reaches 8.500 boarding passengers by weekdays. Including the alighting passengers, this stop sees around 15.000 passengers per weekday.

The station has two parts: on the bus side the features are dramatically enhanced in comfort, information and atmosphere, and on the city side some new services are offered to the passers-by and the neighbourhood. Passages between the front side and the rear side allow passengers to enter in the station by the back side and the extremities: these passages are very important for a big station to create porosity between the buildings' façades and the front of the station.

The bus station was installed in May 2012 and the experiment lasted 6 months, showing a highly successful product creating comfort and pleasure, and bringing services to the passengers and also to the neighbourhood. The operation to dismount the station was launched in December 2012 but the Paris City Council services asked to keep it, which is a testimony of a big success. Therefore, the RATP is now studying how this station can be kept as "living lab" and maintained until a new generation of station will be installed in 2014-2015.

The station has been evaluated very positively by its users. In a spontaneous or assisted way, 98 % of the users quoted a positive element of the station. They correctly identified the different functions of the station and its physical features (design of the station, information systems, additional services) have been identified as enhancing the quality of the station: the space design is positively quoted at 65 %, the services are well identified at 59 %, the modernity and the image of the station is quoted at 40 %.

Finally, the conclusions of this services exploration will be implemented in the enhanced stations resulting from the new tender, and the EBSF bus station demonstrator will be replaced by a definitive solution. The EBSF project will have strategically contributed to improve dramatically the quality of the urban bus stations.

## 7. TRANSFERABILITY OF THE FINDINGS

The main objective of this task was to perform a Transferability Exercise (TE) to outline which are the possible drivers and barriers which could endorse/prevent the transferability of the EBSF measures across Europe.

The TE has been developed through a specific methodology, based on an in-depth study of the general contents of transferability processes, according to methodologies already developed in previous EC-funded research projects (TRANSPLUS, LEDA, CIVITAS). Specific requirements to adjust such methodologies to the EBSF UCs have then been elaborated by the WP 4.2 Evaluation partners; the proposed amendments provided a simplified, but effective, operational sequence to assess the exportability of EBSF measures, considering the specific aspects of the project in hand:

- the implementation of test measures in the UCs;
- the availability of no-consolidated results, due to the restricted timeframe the EBSF measures are implemented within.

The proposed methodology for transferability is based on a six-step process:

- Step 1- Selection of candidate UCs
- Step 2 - Cluster of origin cities
- Step 3- Selection of target cities
- Step 4 - Cluster of target cities
- Step 5 – Transferability exercise
- Step 6 – Assessment of transferability

and decisions taken at every step are to be assumed as pre-requisites to the development of the next.

The core of the Transferability Exercise is the Complementarity Matrix, where a panel of respondents called for expertise had to score how much crucial have been the performance levels achieved within each EBSF Use case, to successfully transfer the EBSF outcomes to his/her own city. Scores and resulting findings have been analysed at site level and, for each UC, the most effective performance, in terms of transferability, outlined. Then, such scores and findings have been cross-analysed to find out among the UCs which are the possible common potentials and gaps to transfer the EBSF measures; eventually, a sensitivity analysis has been developed to find out how much is likely to replicate such performance level outside the EBSF experience.

Each UC experience provided clear directions for the transfer of the tested measures and showed that no barriers seem to prevent the TE respondents from theoretically transferring the EBSF measures to their own context, although with different degrees. At general level, since it is difficult to synthesize results at site level, two specific directions for transferability have been identified:

- to successfully transfer measures, even very different one from the other as those of Budapest, Gothenburg or Madrid, the priority is to ensure a faster, more frequent, attractive, and reliable travel supply, whereas issues as comfort, information accessibility, safety, look and inclusiveness may come after;
- innovative measures can be transferred provided not to raise the overall costs, in fact, they should be

compensated by benefits as the improved service efficiency or the reduced fuel consumption. This leads to consider the only real gap detected by this TE: in general the environmental concern is not a priority (none of the respondents select the Urban environment area for visioning); it is not surprising, then, that issues as the fuel consumption has been considered only in terms of savings rather than of how it may affect the environment. The need to develop a “greener” awareness among operators and decision makers is the only way to fill this gap.

Finally, the results of the TE allowed to highlight which elements can be more likely to be transferred from one urban context to the other. The first basic consideration was that most interesting results had to be achieved in case of a mix of tests/measures rather than a very specifically-focused trial of a single measure. The experience of UC, e.g. Brunoy seems to confirm this: a measure testing only a remote maintenance system resulted of no interest for none of the respondents of the TE light application session.

The second element to consider was the more modest acknowledgment of the environmental issues if compared to the relevance given to other aspects as comfort, cleanness and quality. The lesson learned within EBSF is that TE respondents’ sensitivity seemed to be closer to problems like social inclusion than to the environmental care and that the environmental concern cannot be considered a driver for the transfer of none of the EBSF measures (also because of the contrasting results collected in this field). The success of issues as comfort, quality, cleanness, according to the patrons’ assessments during the evaluation phase, may be increased by the perception of innovations. A third factor to consider was, then, whether innovation per se could be considered a more appealing factor than effective but well-known technical measures. The analysis performed stressed that innovation of single components is not a sufficient condition to start a transfer, and that innovative factors to import do have to affect costs in a modest way and guarantee reliability of operations.

The last point was on the observation that measures affecting aspects such as commercial policies, economic and operational issues call for long time and wide scale of implementation to be real effective; this could turn into barrier for all those contexts that look for fast solutions to improve the PT overall productivity. It has been largely observed that for some EBSF experiences more lasting tests or enlarged test conditions would have provided more consolidated and/or comprehensive data and therefore less contrasting results. There is no doubt that in some TEs, uncertainty of results was behind the assessment of one or more KPIs in complementarity matrixes and that this could have affected the theoretical exportability of the measures.

## 8. THE EBSF SYSTEM ASSESSMENT TOOL

The EBSF Assessment Tool (ESAT) is a simple, small and smart tool that makes it possible to see how an existing or intended bus solution matches the innovative EBSF concept. The tool, in other words, allows answering to the question: how much a bus solution is in line with the EBSF concepts according to the EBSF Vision and the System Definition?

The ESAT can be used by e.g. authorities or operators to assess both present and future bus solutions in early phases (feasibility, planning, specification...) or by researchers to understand to which extend the innovative concepts developed in the frame of EBSF are considered and implemented in real bus solutions.

The tool focuses on the assessment of innovative and evolutionary aspects of the System Definition

elements, dealing with 4 Bus System Solutions (BSS):

- Bus with High Level of Service (BHLS);
- Bus with High Level of Service Lite;
- Classic Lines;
- Local Lines.

Since a variety of bus system solutions exists today (created to meet the priority needs coming from specific user categories or behaviours) and they could vary greatly from city to city, the classification of bus solutions in 4 levels is more descriptive than prescriptive and aims at reflecting one of the most recent observed trends i.e. the “hierarchisation” of the lines according to local contexts and to the level of customers approach and expectations.

To make clear the role of the above mentioned BSS in the network, as defined in the EBSF project for the functional classification the tool is based on, a “reference” definition is provided below.

BHLS is an enhanced bus system that operates on bus lanes or other transit-ways in order to combine the flexibility of buses with the efficiency of rail. By doing so, BHLS meets a set of efficiency and performance criteria; operates at faster speeds, provides greater service reliability and increased customer convenience. It utilizes a combination of advanced technologies (ITS), infrastructure and operational investments that provide significantly better service than more traditional bus services.

BHLS LITE is similar to BHLS but has less stringent requirements on Vehicle, Infrastructure and Operations. With this the medium high capacity service the stations are less widely spread (up to 500m) and not all infrastructure is fully dedicated. Nevertheless IT-solutions as priority at traffic lights guarantee an efficient and frequent service with standard, articulated and bi-articulated buses. BHLS LITE can be perceived as a (strong) improvement of the classic lines or a forerunner of a full BHLS, depending on the implementation approach and strategy.

CLASSIC LINES are mostly urban and sub-urban lines with a rather high capacity but lower frequency. The main or secondary network performs mostly in mixed traffic with a few dedicated right-of-ways. The bus system solution is characterized by both pre- and on-board ticketing and makes use of ITS according to the specific needs. The spacing between the stations is half of this of BHLS (Lite).

The most common LOCAL LINES offers short and local services into a district. The low capacity and low frequency solution is featured by standard buses and limited ITS solutions.

### 8.1.1 HOW IT WORKS

The ESAT tool is based on a simple methodology which provide a twofold assessment:

- The assessment of the bus system solution on a system level, which answer to the question: how the BSS matches the EBSF on a system level? The assessment provides the understanding of how real BSSs answer to the identified needs and requirements of the EBSF users and stakeholders.
- The assessment of the bus system solution according to its main potential areas of innovation, which answer to the question: how improving the BSS potentially act on influencing the KPI?

Both assessments are based on a simple calculation module; regarding to the first one, the person performing the assessment indicates, for each BFR, how relevant the EBSF concepts are/have been in the implementation of the BSS to assess, by a relevancy grade between 0 and 3. The relevancy input is then multiplied by the corresponding KPI weight assigned by experts to the BFR; such a weight quantifies to which extent the EBSF concept potentially influence the bus system in terms of the 5 KPIs

The ESAT then shows the outcomes in radar diagrams, that illustrate the footprint of the analysed BSS through the 5 Core Key Performance Indicators, so that the more filled the diagrams are the more the bus

system solution is in line with the EBSF concepts according to both the assessment levels:

#### Potential Impact:

In terms of dissemination, EBSF generated a very effective flow of information and publicity about its objectives and results all along the lifetime of the project. EBSF shared its message about improving the image of the bus in the urban environment by addressing a very broad range of audiences: scientific, technical, bus and public transport experts, institutional and governmental, urban planners, business, citizens...

The dissemination activities took place through a wide scale of communication channels: events (local, national, international, European), working groups (EBSF User Group, UITP Commissions and Committees), media (newspapers, magazines, TV, radio).

The EBSF logo and website defined the identity of the project and aim at raising attention and curiosity from all kinds of public.

As an expert audience, the EBSF User Group was conceived as a tool to support specific project's activities through external expertise. The mission of the User Group was to enlarge the review of results by following the progress and validating the results of EBSF. The User Group brought an independent perspective on the project's activities and provided constructive outputs which endowed the Consortium with a fresh approach. The work of this excellent sounded board facilitated a larger acceptance of the project's outcomes. Another success was certainly the setting out of a framework which lists some lines of reflection and actions for decision-makers to implement a long term bus transport policy in an integrated urban environment.

UITP, the International Association for Public Transport is the international network for public transport authorities and operators, policy decision-makers, scientific institutes and the public transport supply and service industry. UITP covers all modes of public transport (metro, bus, light rail, regional and suburban rail, and waterborne transport) and acts as a platform for worldwide co-operation, business development and the sharing of know-how between our 3400 members from 92 countries on all continents. Therefore, the UITP platform is an excellent opportunity to disseminate the project amongst international and European experts. Regularly EBSF took part in some UITP dedicated Committees and Commissions, as well as in UITP events like the Bus Conference, UITP Congress and Exhibition, IT-Trans ...

The "classic" online tools include the EBSF website ([www.ebsf.eu](http://www.ebsf.eu)) which is externally oriented and offers static and dynamic information. The EBSF Website is easy to use allowing a good navigation with a clear, well-spaced, illustrated and colourful layout. A strong effort is dedicated to the quality of the texts and general presentation. Keeping the public informed about the major EBSF developments and maintaining their good level of interest towards the project are high priorities for the Consortium. The website has been constantly improved, also offering the user to download some EBSF specifications, EBSF publications and presentations. The access to the EBSF IT Specifications and EBSF Driver Cabin Specifications are tracked to help keeping contact for discussion. The website has evolved accordingly to the real needs of the project, it is an information and a networking tool as it also allows to create and to develop contact with the external world. Through the "contact tool" of the website, the project coordinator is regularly contacted by citizens who provide suggestions or ideas. Many students willing to include the EBSF project within their thesis or dissertation are asking for further information. Also public bus drivers share their opinions and recommendations with the project coordinator. This correspondence proves that external interest has

been rising all long the project's life.

The periodic Newsletter, entitled The Roadmap of EBSF reports on the main on-going developments of the project. The Newsletter is circulated four times per year internally to the members of the Consortium and externally to more than 800 readers. An online registration tool is available on the EBSF website. The articles developed by the project coordinator and contributions sent by the partners are briefly publicised in the Newsletter and linked to the EBSF website where a full description can be found. The EBSF Newsletter refers to bus news at EU and worldwide level using the same sources as for the News section of the website. The texts of the EBSF Newsletter are simple, short and attractive. Humour can be used, like for example in the Horoscope which is composed of three sub-sections: love, vitality and work. The objective is to maintain a good level of readership and to permanently raise the curiosity of the readers. Euractiv, the European Union Information website, is an independent website specialised in European Union affairs. Euractiv website is well-known for covering all EU news and promoting job offers in EU affairs. It allows setting up an advertising campaign which is a rotating banner with a direct link to the event. The EBSF IT Architecture was presented in Paris on 18th November 2011 and we chose to publicise the event via the Euractiv campaign.

## Publications

The EBSF leaflet is the document of reference to anchor the project status and its key elements. The information available in the EBSF leaflet is related to: the project status and main achievements, EU funding, coordinator and partners, main objectives, overall presentation of the sub-projects, EBSF website and main contact. Used to disseminate the project description, the EBSF leaflet avoids also the circulation of wrong information about the project.

The EBSF Vision is a sixteen-page brochure containing the common message of the Consortium about an ideal Bus System for the Future of European society. Produced in the first months of the project, this strategic document introduces a new level of urban bus transport services and introduces to the readers a new generation of bus systems that are adapted to European cities. Published in 2,500 copies, the EBSF Vision is a major tool to disseminate the project. The dissemination added-value of the EBSF Vision is to deeply present the cornerstones of the project on which any activity is going to be built during four years. The Vision document is divided in six chapters analyzing the six main factors influencing bus systems:

1. Responding to passengers' needs
2. Responding to social and environmental needs
3. Responding to the needs of cities
4. Promoting political support and relevant legislation
5. Securing global leadership
6. Strategic Research Agenda for urban bus systems

The EBSF Compendium is a fundamental dissemination tool written at the end of the first year of the project and updated at the end of each year of the project. This document is more than a sum up of the ongoing or just achieved activities. The Compendium explains the methodology applied by the partners, describes the most important results reached for the period and underlines their main inputs for the following activities. All the concepts included in the Compendium are supported by detailed analysis: the specific EBSF source documents are always indicated in the presentation of these results and are

available for further details. The EBSF Compendium has been issued at the end of the first EBSF stage “SP1” offering to the public a deep understanding of the EBSF system definition.

Leaflets dedicated to each Use Case (UC) have been developed during the implementation of the UC. One leaflet per UC city/ region has been produced:

- Bremerhaven
- Brunoy
- Budapest
- Gothenburg
- Madrid Region
- Rome
- Rouen

The common graphic chart (template) defined by UITP ensures the harmonization of all Use Cases’ leaflets. They can be individualized (per city/ region) or put together in a common brochure: The European Bus System of the Future Use Cases brochure which later became the European Bus System of the Future Demonstrations brochure. This will offer at the end of the project, an “EBSF Literature Collection” comprising all Use Cases leaflets and demonstrations also including the leaflets about the EBSF Bus Station demonstrator in Paris, the EBSF IT Platform in Nanterre/Paris and the EBSF Driver Cabin in Dresden for which individual leaflets were also produced.

All the above publications are also available digitally thanks to their web version which is downloadable from the EBSF website (Section Publications).

The EBSF Poster is used in events and gives a clear picture of the main project information. The poster provides brief information about: the main objectives of the project, EU funding, coordinator and partners, main objectives, overall presentation of the sub-projects, EBSF website and main contact.

## Events

On top of the events organised by the UITP platform, EBSF participated to numerous international events: conferences, exhibitions, seminars, workshops... The EBSF Consortium made the most out of the opportunities to disseminate the project in events all over Europe but also beyond the Old Continent. The Coordinator acted as the spokesperson with the support of the Sub-project leaders when necessary. The EBSF representatives were often invited to international events but they also kept on looking at great international dissemination opportunities by submitting papers and abstracts to be selected and participate in sessions. Most EBSF partners were also very active during local and national events. Some partners of EBSF have become key ambassadors to speak about specific EBSF topics (technical, specialized, etc...). The EBSF presentations are lively, illustrated with images of the main technological developments, pictures of the Use Cases or videos of the tests and keep the public eager to know about the project’s evolution and its results. At the European level, EBSF is disseminated in all relevant events organized by the European institutions or other organizations.

### The Use Cases’ events

One event at least is organized for each Use Case. Most of the events officially launch the start of the Use Cases or close the Use Cases by presenting its results. All Use Cases events involve the partners of the Use Cases, the host city and bring visibility to the project Consortium and to the European Commission. Additionally to the presentations, focusing particularly on the technical development of the Use Cases, a

“technical visit” (it can be a ride of the participants in the bus) and a press conference are organized. Articles are collected afterwards by UITP and the partners. Following the annual VDV Akademie of April 2011 in Bremerhaven, the VDV Study led within the scope of EBSF was presented to the stakeholders at the occasion of two different workshops. The first part of the study entitled “Options for Line-Service Bus Systems with Fully Electric Operation for Complete Circulations” was presented during the Workshop on Electrified Public Transport Bus Systems on 2nd April 2012 in Brussels. The second part of the study entitled “Use of DC Traction Systems of Public Transport for DC Charging of Battery-Powered Vehicles” was presented during the Workshop “Infrastructure and business models for electric mobility in cities – what role for public transport?” on 5th March 2013 in Brussels.

Towards the end of the project, the interest outside of the EU has risen significantly. EBSF started to interact with a public from Singapore, Australia, USA, South Africa, Nigeria, Latin America and Canada.

### The EBSF Final Event

The Final EBSF conference & exhibition has been organized on 15th October 2012 in order to disseminate the projects results among the bus transport and urban mobility stakeholders. To ensure the highest European visibility of EBSF, the Final Event is organised in Brussels.

To announce the Final Event, a flyer was produced and distributed to all participants at former events and meetings. Moreover, a dedicated website was also created for people to get specific information about the event and to ease the registration process. The event and its own website were publicised on the homepage of the EBSF website.

The Final Conference encountered a great success with over 300 participants from 29 different countries worldwide. Such Final Conference was an opportunity to present the innovative results of four years of intensive research and development. After a welcoming session by UITP Secretary General Alain Flausch and Andràs Siegler, Director of Transport Directorate (DG R&I), the programme comes in different lively sessions. Each session offered an overview of different aspects and innovations: EBSF system definition, driver comfort, accessibility, passenger flow, energy sustainability, modularity and so on...

UITP is leading the event preparation and partners were deeply involved in the presentations and exhibitions. Indeed, this final conference comprised the exhibition of the project prototypes and mock-ups in addition to a set of presentations demonstrating the EBSF results. The EBSF results have been shown in the conference through lively presentations enhanced with the exhibition of some of the greatest EBSF achievements: four bus demonstrators and prototype (Volvo, MAN, Irisbus, Evobus), the EBSF driver cabin and the IT architecture test bench. During the course of the conference, delegates were able to attend technical visits at their favourite time or to walk freely in the exhibition areas (inside and outside). In order to promote all the EBSF results, the exhibition was completed with videos of demonstrations and explanatory posters.

The Conference was closed by Alain Flausch, UITP Secretary General and Siim Kallas, Vice-President of the European Commission and Commissioner responsible for Transport. After the Final Event, the Conference’s presentations were made available for download on the EBSF website and UITP followed up all the individual and media requests.

Press and Media were widely invited, in particular through UITP’s and EBSF partners’ contacts. After

receiving a media advisory message, all interested journalists were required to register with the EBSF team. Such process allows us to keep track of the media interest in EBSF. A press conference took place as a parallel session to allow journalists a special dedicated time to hear about the project from UITP, the European Commission and the 5 bus manufacturers taking part in the EBSF project. Then, a technical visit of the bus demonstrators, EBSF Driver cabin and IT test bench was organised especially for the press. Finally, journalists were also able to follow the conference from their dedicated seats as well as on the screens installed in the EBSF exhibition area of the conference centre.

#### New tools of communication

On 19th September 2011, EBSF in collaboration with Y4PT has launched the worldwide KALIDEOBUS photo contest, opened until September 2012. The KALIDEOBUS photo contest is an initiative to involve the general public in the EBSF project by challenging their creativity. Targeting young people as well as anybody interested in photography and/or art, the contest is a way for its contributors to enhance the exercise of citizenship as it is an opportunity to support UITP's objective of doubling the market share of public transport worldwide by 2025. The participants will have to capture the picture(s) of urban bus(es) and use their imagination to rethink the bus as a public transport in order to produce an original piece of art. Very accessible, the KALIDEOBUS photo contest is within everybody's reach as the contestant just needs a camera before sending his/her creation to us. Publicised through Y4PT and EBSF websites, the contest is widely taken up by the social media like Facebook and Twitter. Such contest is a stimulating event for the media which is interested in reporting the photo competition and its results. Thus this photo competition is likely to arouse interest among the general public in a trans-generational way as photography can be enjoyed by the youth as well as by older people. Publicising this contest is a great opportunity to put the project EBSF in the spotlight.

This contest was a large success with the reception of many pictures from 8 countries worldwide. The 3 winners were assigned through a democratic vote by the bus experts present during the Closing Reception of the Final Conference.

Social media is a new way for communication and interaction. It offers an opportunity to open a dialogue with the general public, allowing interaction and providing opportunities to raise awareness of the public towards EBSF. The target audience is different from other means of communication: younger personality and well-suited for short-term and immediate communications. Social media is part of the EBSF dissemination strategy as a well-used mean to provide original, exciting and real-time information for a really low cost.

- Facebook: 250 people today "like EBSF"! The objective is to communicate more proactively with the youth. The EBSF Facebook page is animated by UITP and gives the possibility to the public to follow the project and react easily
- Twitter: EBSF is twitted for events, news, etc... EBSF counts 174 followers for over 900 tweets!
- Youtube: several videos taken in some of the EBSF demonstrator buses (in particular in Budapest) have been published on Youtube. Over 20 videos are dedicated to EBSF.
- Blogs: EBSF was the main topic of articles on over 50 blogs from different parts of the world!

As a snow ball effect, the impact of these new ways of communication can be extremely fast, but until now for EBSF only positive reactions resulted from a wide international public. Interaction with citizens has increased through the new social media and especially via Facebook and Twitter.

## Very large media coverage

Media are a powerful medium to disseminate a project. During the project's lifetime, EBSF has been covered by TV, radio, Internet and the printed Press. EBSF kept raising the interest of both specialised and general press as well as other media. The consortium takes, as often as possible, the advantage of the opportunities offered by editorial coverage in international, European and local press. Most of the time press articles or interviews reach the bus sector audience but dissemination also reaches the citizens through national and local press. The UITP platform brings a lot of benefits for getting and maintaining contacts with the Media, in particular with international magazines specialized in public transport issues. Thanks to the UITP international network, editorial invitations are regularly sent to the EBSF consortium. In addition, the UITP-Direct newsletter and the UITP-Public Transport International magazine are particularly used to disseminate EBSF through short or long articles. In addition to regular articles published in the UITP-Public Transport International magazine, the September/October 2012 issue was entirely dedicated to EBSF. This full issue focuses on the presentation of EBSF activities and results. The publishing of this issue was synchronised with the EBSF Final Event. The communication channels of the partners are also explored. Regularly, articles about EBSF are published in national and local press. The Use Cases' events strongly contributed to this wider general dissemination as it was the case for the unveiling of the EBSF Bus Station Demonstrator in Paris. Close to 70 press articles or TV/radio reports worldwide were dedicated to EBSF for this Use Case only!

Short movies were produced for the Bremerhaven, Madrid, Brunoy, Gothenburg, Budapest Use Cases. They aim at showing the prototypes, bus demonstrators or all EBSF implementations in operational conditions in their local environment with a special focus on the innovative aspects brought by the EBSF project.

The Use Cases of Madrid and Rouen were broadcasted on Green transport TV. Some videos have also been broadcasted on Euronews (Gothenburg), national and local channels (Madrid and Budapest) and Youtube (Budapest). All those videos are accessible online.

## EURONEWS

Media coverage included the Futuris programme of Euronews TV, which is still available on Euronews website as well as on Youtube. The report was rebroadcasted in summer 2012 and could reach many people as the channel broadcasts in 11 different languages. All European public television and the main private ones received the 9-minutes report via a Eurovision exchange. The report focused on Gothenburg Use Case, as well as the test bench and the driver cabin.

## Greentransport TV

The strategic objective of GREENTRANSPORT-TV is to contribute to the development of public awareness on the European research on greening transport in all European countries through the professional use of television media. By presenting the Use Cases of Rouen and Madrid, the Greentransport TV report focused on EBSF new vision for bus systems in Europe and included interesting highlights about punctuality, comfortable travelling and efficient exchange of vehicles. The report focused on Rouen and Madrid Use Cases.

Radio interviews and TV coverage of events in which EBSF took part like the Transports Publics

Exhibition 2012 and the unveiling of the EBSF Bus Station Demonstrator in Paris informed citizens about the EBSF project, its activities, tests in real operational scenarios and results.

Press releases were prepared in order to deliver a maximum of relevant information to the journalists who need information about EBSF or who will attend a Press conference organized for an EBSF event. An EBSF Press release gathers complete and self-contained information about the project and is always completed by relevant figures, illustrations or publication provided by the communication department of UITP. Press conferences are organized to mark major EBSF events. They are generally organized on the same spot as the event, at its start or at its end. Journalists are invited in advance by UITP communication department or directly by the partners. They are provided with a “Press Kit” including the Press release, Press factsheets, relevant publications, handout versions of the presentation slides, agenda of the event, CV of relevant people, key figures, diagrams, pictures, etc... Journalists are asked to send copies of their articles, reports, or the references of their contribution to the project coordinator. By regularly emailing and broadly sending invitations to events to the press contacts, EBSF kept the interest of the journalists at a high level throughout the whole project’s lifetime. In return, journalists were widely present during EBSF events, covering the UC events, the Final Event, EBSF activities and results.

Clearly, the interest in EBSF among the public and the bus sector has continued to grow throughout the project at local, national, European and international level. With EBSF, the general recognition of the value of collaboration at the EU scale demonstrated EBSF benefits to EU citizens who were reached through many channels of communication all along the project’s lifetime.

#### EBSF Impacts on Bus System domain

The EBSF project also complies with clear targets set by the European Commission in the White Paper: the cities of tomorrow must be more fluid, greener, smarter, safer and more accessible.

Innovation, new concepts of mobility, as well as substantial investment are essential to meet a wide range of issues and challenges facing bus systems:

- ☐ environmental challenges like air and noise pollution
- ☐ accessibility for all, everywhere in the city, and for all kind of activities
- ☐ flexibility and adaptation of the service to stakeholder’s needs
- ☐ safety and security inside and outside the bus
- ☐ cost of bus operations versus efficiency

EBSF contributed to demonstrate that the bus is the most versatile urban transport solution to deal with such new challenges faced by European cities.

Without doubts, it can be said that EBSF has been a breakdown project in the urban Bus domain. It has been an efficient open platform for dialogue between urban all bus transport stakeholders throughout Europe. EBSF has generated a substantial improvement in the relationship between actors.

Amongst the major achievements, by a global point of view EBSF has strongly contributed to 3 major breakthroughs:

1. Create a very efficient open platform for dialogue between all public transport shareholders throughout Europe:

It has been the first time than the first five big European bus manufacturers have joint resources for pre-competitive research. While bus demonstrators have been developed independently by each manufacturer, the specification work (for the driver cabin, for the IT platform...) have been produced by large set of project partners working together. Industries have been strongly committed to the project, by

providing large co-funding contributions despite industrial crisis.

It has fostered an open dialogue between different stakeholders (operators, authorities, manufacturers, passengers) not bounded or limited by commercial relationships, then improving the mutual understanding of constraints and expectations. This has facilitated EBSF both developing original ideas and achievements, but also making a “cherry picking” of the best ideas coming from the members of the consortium and from external partners, like the members of the EBSF Users Group and other entities, like the UITP Bus Committee. It has been achieved thanks to the high commitment from partners inside and outside the consortium.

It has developed a “global thinking” through a system approach. City and mobility challenges are complex problems that require an analysis which goes beyond the specific domain (for example, mobility issues have to be faced considering also the economy structure of the city). Such “global thinking” is at every level: In terms of time: make compatible long term vision and short term action; in terms of scope: bus systems are part of a public mobility. EBSF considers interfaces with all modes; in terms of space, seen at European level, exchanging views on practices and expectations all throughout Europe, while recognizing the need to respect local cultures and peculiarities; in terms of space at the City level, considering nodes, zones of activity, urban development...

## 2. Strongly contribute to the bus image improvement

EBSF project has enhanced the perception of bus opportunities by operators and authorities, thanks to the enormous networking, dissemination and awareness activities performed in the 54 months of the project, in Europe and worldwide (thanks also to the involvement of the 8 UITP Regional Offices spread around the world)

Project has proven that with good quality of service (passengers information, network restructuration, hierarchy of lines...), bus could be easy to use, attractive and efficient.

Obviously the rapid change on perception and mentalities was not generated only by EBSF, but EBSF has been clearly at the leading edge of the change, all over Europe. But this contribution to the “Bus Revival” comes at the best appropriate time, since the current restrictions on public transport infrastructures funding are promoting the search for efficient less expensive solutions...

## 3. EBSF has paved the way for the future

For the first time a comprehensive roadmap for further research has been finalized, including all aspects: technological, societal, systems, integration on urban scenarios...

Approved by all major stakeholders, the roadmap will allow coordinating and stimulating further research at European and even National levels.

EBSF’s accomplishments go beyond the technological innovations defined: it is widely recognised as one of the “lighthouse” projects in the Public transport domain, and is the reference activity for urban Bus System research in Europe

How EBSF will concretely impact the Bus System domain

Successful research project, especially when focused on complex systems and rich of technology developments, put the base in two set of further activity categories. On one side, they put the base for New Research on Bus Systems, on the other side they produce concrete outputs that, having taken advantage by a research phase (to demonstrate feasibility and benefits) are ready for Exploitation to introduce innovation in the market domain. EBSF is characterised by key activities in both areas.

### 1. Application and Consolidation of solutions, concepts, approaches

EBSF has identified a set of key innovative solutions and concepts for the bus system and its components; the exploitation of such solutions depends on their level of maturity: some concepts (technical or

conceptual like requirements) are ready to be introduced in the urban bus system domain.

Already during the project execution, several achievements (specifications, requirements, solutions...) have been translated into actions (tenders, recommendations, further industrial steps...) like:

- ☐ EBSF Vehicle requirements included in new ASSTRA guidelines for bus operators tenders;

- ☐ Extension of IT specifications to the tender of all the HOV buses in Madrid

- ☐ Development of equipments compatible to the EBSF IT standard and implementation of the protocol and the architecture on some bus lines and services in Sweden

- ☐ Application of some solutions developed on the driver workplace to the a recent model of commercial driver cabin

It is of course important to underline that the standardization, of valid and suitable solutions can speed-up the efficient and economic introduction of innovation in the domain.

The project has determined a list of topics ready for CEN or ISO standardisation (e.g. in the field of on-board and back-office IT) and established the key activities needed to follow this in CEN or ISO technical committees.

The selection of topics resulted by criteria ensuring:

- ☐ Consensus between participants on this topic which allows an easy production of CEN or ISO work item.

- ☐ A good level of specification which will ease the production of a first CEN or ISO draft document on the topic.

- ☐ Positive economical impacts on the mode bus operations

Two where the EBSF developments with higher impact on standardisation, even if at very different level:  
EBSF IT Standard

The importance of IT standards has been discussed lengthly in the transport domain and also in the EBSF project. Today's IT systems installed in bus fleets are mostly proprietary and difficult to extend, as developed as tailored solutions for specific applications.

Developments are logically quite expensive for the authority / operator, not only in terms of application development costs, but also in terms of new equipment installation / upgrade. For example a bus fleet for a mega-city requires men-years of effort just to cable entirely new equipments in all the vehicles of the fleet. But lack of standard is becoming difficult to sustain also by bus manufacturers, as the differences and peculiarities of each installations, tailored to customer specific application and supplier specific platform, create difficulties in the maintenance and in the analysis of guarantee aspects. Standardisation of vehicle physical interface (connector, power...) done in EBSF facilitate these actions.

Then, the IT scenario it is also becoming complex to maintain by the suppliers, as they are forced to keep active application platforms not anymore state-of-art, but still installed. In fact, as IT domain is an high technology one, lifetime of IT systems and applications is development very short respect the normal lifetime of a vehicle. This means that different updates and changes would happen in the vehicle-back office systems, in order to install and run state-of-art solutions.

In addition, the presence of different (and often partially redundant) system on board create, a part logical issues of energy consumption, also concerns for the driver, forced to consider different systems that present not-harmonised ergonomic design and different working functions.

A scenario like this makes very difficult (or very expensive) the interoperability between systems and then the implementation of the service liberalisation. And this would not be the case with standardised protocols for networking between vehicle and back-office.

For this reason, IT standardisation has been a key topic to follow by project partners, together with the

development of:

- Overall architecture (definition of the architecture, principles, concepts)
- Onboard and backoffice detailed specifications (description of all mechanisms, services subscription)
- Installation requirements (hardware requirements and power consumption rules)
- Testbench located in France.
- Set of tools and validation test

#### EBSF Driver Workplace

Another key innovation area of EBSF suitable of standardisation according to the principles introduced at the beginning, is the Driver Cabin design.

As seen, in the EBSF for the first time, joint research effort has been put by manufacturers, operators and researchers for the development of a driver workplace. It produced a high number of observations, use of state-of-art ergonomic concepts, development of specifications and test of drivers on an ergonomically optimised and adjustable driver workspace for improved driver comfort.

The result is a set of recommendations for a code of practice of driver's cabin, applicable to the different guidelines and recommendations about driver workplace existing in the different European Countries. In fact, the European scenario of driver cabin specification see many different specifications and guidelines developed at national level; only the German VDV specifications looks to be a bit more adopted than the others, but very often with specific changes done at national level.

The recommendation produced within EBSF, freely available on the project website [www.ebsf.eu](http://www.ebsf.eu) offered as first step towards a possible definition of a common European standard for driver work place, after discussion and harmonization with all the relevant stakeholders.

In fact, it has to be considered that the EBSF project activities were pure research activities, and then produced some mostly-technical-based recommendations for standard update. But moving from such recommendations to real development requires a longer process that was not in the scope of EBSF, and that of course would require the stable involvement of key stakeholders necessary to transform the results of research work in real innovation on board, providing great advantages to the bus drivers.

Some small steps in this direction have been made: manufacturers have already requested and discussed the specifications, so as European Transport Federation (ETF) and some National Driver Unions.

At level of implementation, some of the concepts have been already applied on commercial driver workplace of the last generation of urban buses from manufacturer. And some very specific and technical topics have been presented in the frame of relevant ISO groups, like the new recommendations for pedals developed by the bus manufacturers involved in EBSF.

#### EBSF IT Consolidation

One of the key developments of EBSF project is the EBSF IT standard and architecture. It can produce a real breakthrough in the domain; its development has seen the contribution of more than 20 bus system stakeholders including suppliers but also authorities, operators, manufacturers.

As already mentioned, today the specification is publicly available on project website [www.ebsf.eu](http://www.ebsf.eu) for download. It is possible to get on-board / back-office specifications, so as the on-board installation requirements. Around 300 downloads have been counted until today, from worldwide countries, and from all types of stakeholders. The test-bench is sited in Paris, and is available for visit by contacting the EBSF team through the website.

The European Bus System of the Future (EBSF) specifications on Information Technology (IT) architecture have paved the way to cost effective deployment of digital systems on board Public Transport (PT) vehicles and for back-office applications, securing open environment & constant competition. This

standard IT architecture for Public Transport specifies communication protocols and hardware interfaces to offer a full interoperability of IT systems in PT applications. Based on open technology, it gives the possibility to operators and organizing authorities to use public transport data anywhere in Europe through common mechanisms, standard rules and protocols. As from now, parts of these IT architecture specifications are included in EN13149 standard which is in the scope of CEN TC278WG3SG1 standardization group. This IT architecture is suitable for buses and is under extension to other means of PT

Today collaboration with operators and authorities out of the project has started, the standardisation process is on-going (see following).

The team that have developed the IT platform strongly believe that this is the most credible tentative to develop a standard solution for vehicle – back-office communication protocol standardization, and for this reason they have built on the EBSF IT specifications, ITxPT. ITxPT is an IT platform reproducing on board IT systems with associated back-offices. It complements the technical specifications by including a test bench and tools for monitoring and testing solutions, in a standardized, multi-suppliers interoperable environment.

The ITxPT platform is the unique integrated European IT platform to specify, test, qualify and showcase IT solutions. The ITxPT platform is hosted in the center of Paris offering an easy access to all European PT stakeholders.

The goal of ITxPT consortium is to support, maintain and promote a working standard for plug-and-play IT-systems applied to Public Transport.

Such consortium works on the capitalization on EBSF IT work by completing, maintaining and evolving the EBSF Platform into the ITxPT Platform through: new additional services and other means enlargement, the update of the specifications for a wider PT community; the maintenance and evolution of the test-bench; the promotion and the support to the adoption of a ITxPT Standard architecture; the development of a credible business and marketing plan; the provision of support to integration & validation of new systems. The long term objective is to set certification processes and the relative certification entity.

#### Urban Bus Systems Exploitation Platform

EBSF started as a project to further strengthen discussions within UITP about future possibilities to improve public transport according to long term targets. Within EBSF, the main European PT stakeholders have delivered a lot of new ideas that can support those long term targets, like concept vehicles but also IT-solutions, specifications, recommendations and others.

EBSF has built excellent foundations to take bus systems forward in Europe and even beyond, moving them one step closer to taking up the prominent place they deserve in our cities.

EBSF is the platform to support and anchor all European stakeholders in worldwide competitiveness. EBSF provided food for thought on bus systems to the stakeholders: the examples of accomplishments you saw today are innovations for bus systems as a whole: vehicle, infrastructure, operations. The concept of European Bus System is a great strategy to adopt in a global environment. And is the right approach for the next great innovation challenges like Electrification of bus systems, Intermodal information management. They are within the strategic objectives of UITP.

EBSF comes on top of other experiences to add further weight to argumentation towards decision-makers. It has identified a set of key innovative solutions and concepts for the system, and its components. Already during the project execution, some of the specifications and requirements identified have been adopted in tender processes.

With the project at its end, it is necessary to ensure that these key research results are effectively

transformed into innovations. To this purpose, is going to be created an Urban Bus Systems Exploitation Platform to follow the passage from research to innovation.

Such platform identifies the best way to ensure that key research results are effectively transformed into innovations. In such a way it ensures that new ideas and innovations performed in the EBSF project that can lead to realization in new products, techniques or IT-solutions to support the main strategies about Public Transport and urban mobility.

In particular, the main concepts to be included in the terms of reference of the Urban Bus Systems Exploitation Platform would be:

- develop exploitation strategies facing together EC White Paper and different sector strategy (like the UITP Public Transport x 2 and the joint Position Paper about decarbonisation of PT);
- promote use of solutions and approaches developed within EBSF and other projects with high potential of standardisation such as the requirements, specifications, solutions, recommendations;
- create a “quality label” for transport efficiency for the most innovative and performing solutions/ research achievements, in order to facilitate commercial processes in tenders and negotiations.

On this purpose, at the end of the EBSF project, a specific logo has been developed to indicate the developments based on EBSF outcomes. In fact, while EBSF indicated a project, with a start and an end, it was necessary to define a brand for a “product” that would indicate all the innovations implemented and derived by the EBSF project concepts and developments. The logo is based on the mission statement “how is the bus system of the future”, developed at the beginning of the project, and stating that the Urban Bus System of the Future is Intelligent, Innovative, Integrated.

From such concept, it is derived the brand “IBS” where it is left to the reader to imagine if the “i” stands for “intelligent” “innovative” or “integrated”.

The Urban Bus Systems Exploitation Platform is going to capitalise and extend the experience of the EBSF Steering Board. It will work also beyond the completion of the EBSF project.

### Innovative Bus Systems Roadmap

Research and innovation in urban bus domain requires large investment, while the corresponding market is a niche market. The return of investment is always complex and becoming more difficult in the present financial situation. But the impact of innovation on Public Transport on the quality of life of European citizens is very high.

In a similar scenario, research fundings from European, Regional and National institutions are the welcome support for sharing the financial risks linked to innovation.

On this regard, EBSF project has operated a breakthrough, showing that European Manufacturers can join their effort for pre-competitive research in a successful way. And creating a platform for open dialogue between operators and manufacturers improving understanding of constraints and expectations. The model of collaboration launched by EBSF has demonstrated to be efficient.

EBSF is the foundation stone for the future of bus systems in Europe and also beyond the European boundaries. EBSF as a great model for the Public Transport research; project partners, key PT stakeholders, industry, so as UITP and its members, feel the importance of continuing research and are ready for further efforts.

In these years, the EBSF system has been designed in its basic characteristics and functionalities. In addition, some related key new technologies and operational concepts have been developed, simulated and tested in real urban scenarios. Last but not least, EBSF has set-up the initial frame for the

harmonisation and standardization of the solutions developed.

List of Websites:

[www.ebsf.eu](http://www.ebsf.eu)

For any questions or comments regarding EBSF, please contact Pauline Bruge, EU Projects Junior Manager ([info@ebsf.eu](mailto:info@ebsf.eu))

## Verwandte Dokumente



[final1-ebsf-final-report.pdf](#)

**Letzte Aktualisierung:** 7 August 2014

**Permalink:** <https://cordis.europa.eu/project/id/218647/reporting/de>

European Union, 2025