D6.1

Paris City: Demo Description and Implementation Plan

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SUMMARY SHEET

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Abstract	The EBSF2 project aims to test, evaluate and validate innovative technological solutions and/or strategies for urban and sub-urban bus systems through demonstrations in real service. Six key research areas have been identified to have the highest potential to impact: Energy Strategy and Auxiliaries; Green Driver Assistance Systems; IT Standards introduction in existing fleet; Vehicle Design (capacity, accessibility, modularity); Intelligent Garage and Predictive Maintenance; and Interface between Bus and Urban infrastructure. These areas are to be further investigated in demonstrations in altogether 12 sites of which Paris City is one. The Paris City demonstration is committed to implement and test three (3) technological innovations (TIs): Automation of a bus in a bus parking (TIParc1); Bus terminal co-design method (TIParc2) and Bus terminal architectural simulator (TIParc3). This deliverable is intended to enlighten the Technical Innovations to be demonstrated in Paris City, including the plans for implementation of the demonstrations, the Validation Objectives identified coherently with the methodology developed by the EBSF_2 Evaluation team and the test scenarios, as the test environments in which the EBSF_2 TIs will take place.
Keywords	Bus system, Bus Terminal, Bus Parking, Automation

INTERNAL DISTRIBUTION

Participant N°	Participant organisation name	Country
1 Coordinator	Union Internationale des Transports Publics - UITP	Belgium
2	Régie Autonome des Transports Parisiens - RATP	France
3	Iveco France SA - IVECO	France
4	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. - FRAUNHOFER	Germany
5	Hübner Gummi- und Kunststoff GMBH - HUEBNER	Germany
6	DigiMobee SAS - DIGIMOBEE	France
7	Centro de Estudios e Investigaciones Técnicas - CEIT	Spain
8	Chalmers Tekniska Hoegskola AB - CHALMERS	Sweden
9	Compañía del Tranvía de San Sebastián, SA (CTSS) – DBUS	Spain
10	IRIZAR S Coop - IRIZAR	Spain
11	D'Appolonia S.p.A. - DAPP	Italy
12	EvoBus GmbH - EVOBUS	Germany
13	Volvo Bus Corporation - VBC	Sweden
14	Pluservice srl - PLUSERVICE	Italy
15	Universidad Politécnica de Madrid - UPM	Spain
16	Actia S.A. - ACTIA	France
17	Teknologian Tutkimuskeskus - VTT	Finland
18	MEL-SYSTEM	Italy
19	Ineo Systrans – INEO	France
20	Stuttgarter Strassenbahnen AG - SSB	Germany
21	Associazione Trasporti - ASSTRA	Italy
22	Pilotfish Networks AB - PILOTFISH	Sweden
23	Start Romagna SpA - START ROMAGNA	Italy
24	FIT Consulting Srl - FIT	Italy
25	Hogia Public Transport Systems AB - HOGIA	Sweden
26	Trapeze ITS UK Limited - TRAPEZE	Switzerland
27	Digigroup Informatica srl - DIGIGROUP	Italy
28	Transports de Barcelona SA - TMB	Spain
29	TIS PT, Consultores em Transportes, Inovação e Sistemas, SA - TISPT	Portugal
30	Rupprecht Consult - Forschung & Beratung GmbH - RUPPRECHT	Germany
31	Keolis SA - KEOLIS	France
32	Syndicat Mixte des Transports pourle Rhone et l agglomeration Lyonnaise - SYTRAL	France
33	Transport for London – TFL	UK
34	Università degli Studi di Roma La Sapienza – UNIROMA1	Italy
35	Verband Deutscher Verkehrsunternehmen - VDV	Germany
36	Promotion of Operational Links with Integrated Services, Association Internationale - POLIS	Belgium
37	Tekia Consultores Tecnologicos S.L - TEKIA	Spain
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39	Union des Transports Publics - UTP	France
40	Västtrafik AB - VTAB	Sweden
41	Commissariat à l'Energie Atomique et aux Energies Alternatives - CEA	France
42	Consorcio Regional de Transportes de Madrid - CRTM	Spain

EXTERNAL DISTRIBUTION

Entity	Short name	Country	Contact person
European Commission - INEA	EC INEA	-	Mr. Walter Mauritsch

DOCUMENT CHANGE LOG

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0.2	31/08/2016	Section 3 and 4	RATP	Completion Review of content
0.3	01/12/2016	Section 4	RATP	Update Review of content
0.4	14/12/2016	Whole Document	UITP	Quality check
1.0	16/12/2016	Final Version	RATP	Modification based on UITP review

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ACRONYMS

EBSF – European Bus system of the Future

BIGS – Bus Intelligent Garage System

KPI – Key Performance Indicator

ITxPT – Information Technology for Public Transport

PTA – Public Transit Authority

PTO – Public Transit Operator4

TI – Technological Innovation

VO – Validation Objective

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1 Executive Summary

The European Bus Systems of the Future 2 (EBSF 2) is an Innovation Action co-funded by the European Union within the Horizon 2020 Research and Innovation programme. The project aims to test, evaluate and validate innovative technological solutions and/or strategies for urban and sub-urban bus systems through demonstrations in real service. Six key research areas have been identified to have the highest potential to impact:

- Energy Strategy and Auxiliaries;
- Green Driver Assistance Systems;
- IT Standards introduction in existing fleet;
- Vehicle Design (capacity, accessibility, modularity);
- Intelligent Garage and predictive maintenance; and
- Interface between Bus and Urban infrastructure

These areas are to be further investigated in demonstrations in altogether 12 demo sites of which Paris City is one. The Paris City demonstration team is committed to implement and test three (3) technological innovations (TIs), listed below according to the name and coding agreed with the EBSF_2 evaluation team, namely:

- Automation of a bus in bus parking (TIParc1)
- Bus terminal co-design method (TIParc2)
- Bus terminal architectural simulator (TIParc3).

TIParc1 belongs to the EBSF_2 topical area “Intelligent Garage and predictive maintenance”, while the TIParc2 and 3 belong to the EBSF_2 topical area “Interface between Bus and Urban infrastructure”.

This deliverable, D6.1 – Paris City: Demo Description and Implementation Plan**,** provides a description of the innovations to be demonstrated, including the relevant objectives to be achieved, the test environments in which the TIs will take place and the conditions under which the demonstrations are developed. A preliminary overview of the implementation plan and data to be collected is provided as well.

2 Introduction

The European Bus Systems of the Future 2 (EBSF 2) is an Innovation Action co-funded by the European Union within the Horizon 2020 Research and Innovation programme and coordinated by UITP – the International Association of Public Transport. The project, which runs between May 2015 and April 2018, capitalizes on the results of the previous EBSF project (2008-2013) and, as the former, aims to develop a new generation of urban bus systems by means of new vehicle technologies and infrastructures in combination with operational best practices, and test them in operating scenarios within several European bus networks.

The need for more cost-effective and energy efficient bus systems has led to the identification of a set of technological innovations (TIs) and strategies with a strong potential to optimize mainly energy and thermal management of buses (in particular auxiliaries such as climate systems), green driver (eco driving) assistance systems, intelligent garage and maintenance processes, IT standard equipment and services. Moreover, to effectively address the need to move quickly from laboratory research to actual innovation of the bus fleets in operation in Europe, the technologies to be tested have been selected according to their technological maturity (and not only because of their potential) in order to ensure a short step to commercialisation once the project ends. The use of simulators and prototypes has been conceived as a preliminary step for the validation of the innovations in real operational scenarios, performed within the project as well, or as a necessary task to prove the potential of more futuristic solutions currently implemented at early stage of development (e.g. modular bus).

2.1 Organisation of deliverable

This deliverable, D6.1 – Paris City: Demo Description and Implementation Plan**,** provides a description of the innovations to be demonstrated, plans for implementation of the demonstrations, relevant validation objectives, and data to be collected.

The deliverable is organized as follows:

- Chapter 3 presents a description of the context where the demonstrations will take place;
- Chapter 4 describes the three innovations to be demonstrated in Paris City, including the relevant objectives to be achieved, the test environments in which the TIs will take place and the conditions under which the demonstrations are developed. A preliminary overview of the implementation plan and data to be collected is provided as well.
- Chapter 5 presents the demo team;
- Chapter 6 describes the contribution of the partners to the deliverable.

3 Paris City Context

Paris city is located within the Ile-de-France Region, which has a population of almost 12 Million inhabitants. Its transport authority, STIF, refers to the Regional Council and the 8 Departments' Councils, and coordinates all the public transport modes in the region. RATP is the main operator for the public transport by bus, serving almost 300 lines in the central area of the region. Other operators gathered under the Optile brand serve the suburbs and some additional express lines.

The Paris City demo refers to the bus network operated by the RATP, almost 200 lines served by 4500 vehicles, covering the French capital and its inner outskirts, which will be impacted by the RATP global modernization plan, called BUS 2025.

Bus 2025 is a strategic program based on three core elements:

1. The global energy transition towards a non-diesel fleet to be achieved by 2025 (4500 vehicles with 80 % full electric and 20 % biogas for the longest and most difficult lines). As a result, all the 25 maintenance yards must be completely transformed to allow night electric loading operations, and several final bus terminal stations must be fitted with complementary loading equipment. This technical transformation is also the opportunity to radically modify the design of the vehicles in order to generate a status upgrade for the urban bus mode.
2. This major change in the bus fleet must be accompanied by innovative actions about the bus stations in the cityscapes, especially with the bus terminals' modernization, which must be more integrated in urban fabrics.
3. The bus service is also expected be transformed through new digital information systems, allowing public transport by bus to become more flexible and tailored to the passengers' needs.

For the RATP, the Bus 2025 plan means a commitment in specific innovative researches to feed innovation in many parts of the bus system.
Among these research areas, two of them have been chosen when the EBSF_2 project opportunity was announced:

- The initiation of automation tests in bus depots for parking operations (before later experiments about automated buses in urban contexts),
- The experiment of new design management methods for urban bus terminals, based on co-design processes gathering local authorities, transport players (operators and transport authority) and other local players.

Therefore the involvement in the EBSF_2 Project is related to a key modernization strategy: the success of the Paris City demonstration is expected to generate further researches and developments to transform the urban bus ecosystem.

4 Demo Description

The Paris City demonstration team is committed to implement and test three (3) technological innovations (TIs), listed below according to the name and coding agreed with the EBSF_2 evaluation team and described in the following sections, namely:

- Automation of a bus in a bus parking (TIParc1)
- Bus terminal co-design method (TIParc2)
- Bus terminal architectural simulator (TIParc3).

4.1 Automation of a bus in a bus parking

In Paris city, urban pressure has lead RATP to reduce the surface area of bus depots while keeping this necessary activity in the urban area of Paris. A possible solution, already investigated and experienced by RATP, is to make the bus depot evolve underground.

Moreover, in line with the EBSF_2 objective to promote more cost-effective bus systems, one way to reduce the operating costs of a bus line is to reduce the time needed to park buses.

The automation of bus parking will have 2 beneficial consequences:

- Reducing the time needed for bus parking;
- Making the parking spaces smaller thus reducing the size of the bus depot.

The demonstration of TIParc1 will take place in the bus depot of Lagny in the 20th arrondissement in Paris. It's an underground bus depot of 30 000 m² with a capacity of 190 buses.

4.1.1 Goals

The goal of this project is to test the technical feasibility of automation of bus parking (i.e. unmanned vehicle movement) in a bus depot as well as evaluate the impacts of such innovation on the overall performances of the system. The project leans on the fleet management system that already exists and advanced technologies such as sensors and bus embedded autonomous motion control.

4.1.2 Validation objectives

For each Technological Innovation (TI) a set of Validation Objectives has been identified coherently with the methodology developed by the EBSF_2 Evaluation team in Task 2.2. Table 1 presents the Validation Objectives related to the Technological Innovations TIPArc1.

Validation Objective n.	Description
VO 16	Reducing staff workload
VO 17	Minimizing operating and maintenance costs

Validation Objective n.	Description
VO 19	Speeding up maintenance operations
VO 28	Increasing economic efficiency
VO 40	Minimizing the size of parking spot

Table 1 – Validation objectives of TIParc1 demonstration

4.1.3 Test scenarios

The demonstration includes both simulations, which will include the dynamic model of the bus, the bus depot and all the needed sensors, as well as tests in the bus depot as a controlled environment.

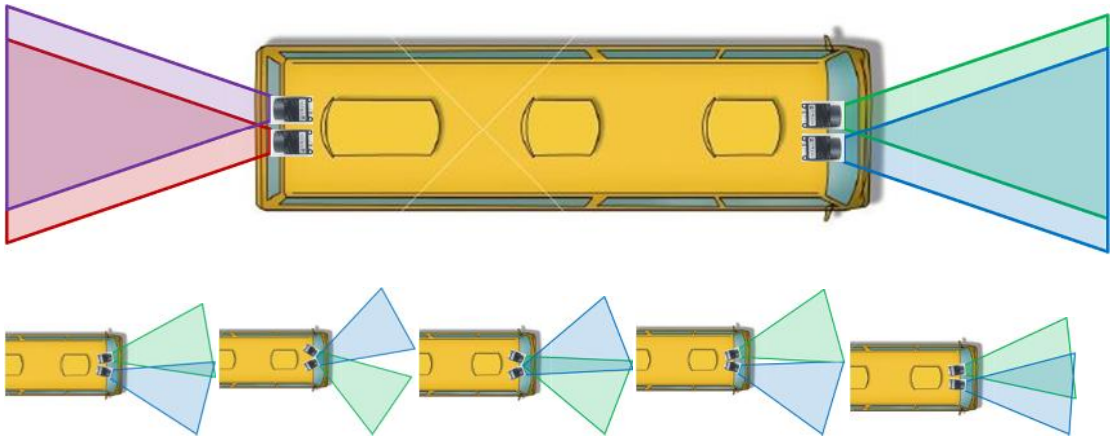

Figure 1 – data captures of the cameras to be installed on the bus for the test

4.1.4 Description of the no ebsf2 scenario vs ebsf2 scenario

At present (no EBSF_2 scenario), at the end of service, when a bus arrives at a bus depot, the fleet management system allocates the bus driver a parking space through the driver/system interface. The bus driver refuels and washes the bus, and then drives the bus to the specified parking space.

When service starts, the bus driver takes note of the localization of his bus which is given by the fleet management system, then goes to the space (at level -2 or -3) and starts service.

In the EBSF_2 scenario, at the end of service, when a bus arrives at the bus depot, the fleet management system allocates the bus driver a parking space through the driver/system interface. The driver leaves the bus at a drop zone at the entrance. Then, the fleet management system communicates an available parking space to the bus intelligence garage system (BIGS). The BIGS acknowledges the request, and autonomously drives the bus to the allocated space.

On arrival at the bus depot, the driver summons the bus with a HMI. The BIGS autonomously drives the bus from its space to the drop zone where the driver is waiting.

4.1.5 Preliminary data collection plan

Data on motion of the bus will be collected and analyzed. Several values needed for the assessment of the KPIS will be based on a theoretical evaluation.

4.1.6 Implementation plan

Preparations for the demonstration on Intelligent Garage include several tasks, namely:

- Specification of needs;
- Software: localization, perception, supervision, planning, bus routes;
- Development of simulator;
- Development of bus navigation supervisory control;
- Development of safety functions;
- Interface between embedded controller and the bus.

The preliminary time plan is provided in Table 2.

	2016			2017				2018	
Specifications									
Simulation									
Integration									
Demonstration									
Analysis									

Table 2 - Gantt chart for TIParc1demonstration

4.1.7 Risk assessment

An assessment of the risk associated with the demontration of TIParc1 is provided in Table 3.

Risk	Probability Assessment	Consequences	Comments
Obstacle detection / collision	Moderate	High	An obstacle may not be detected
Localization	Moderate	High	A higher security margin could lead to the immobilization of the bus.
Unwanted speeding up of the bus	Moderate	High	It could lead to collision or people falling on board

Table 3 - Risk identification and assessment of TIParc1 demonstration.

4.2 Bus terminal co-design method

Due to the Grand Paris Express new orbital metro network in preparation, more than 60 interchanges will be created from scratch, rebuilt from the existing ones, or simply refreshed, with openings scheduled between 2022 and 2030. More than 10 other locations independent to this Grand Paris Express network are also under study, and some of them can have nearer deadlines before 2022.

The aim of Bus terminal co-design method (TIParc2) is to obtain bus terminals which could really be considered as urban platforms shared between a transport operational function (i.e. vehicles departures, arrivals, and storages, passengers areas, services for the transport operators' staff) and an urban function (services for passengers and for the neighborhood, enhancement of the cityscape, creation of urban spots positively assumed by the local authorities).

This Technological Innovation is intimately linked to the awareness that new co-design methods can only be based on new tools as an architectural simulator, allowing the stakeholders to visually perceive the effects of the choices they are doing in the process of planning a new bus terminal. Therefore TIParc2 is complementary to TIParc3 - Bus terminal architectural simulator, described in section 4.3.

4.2.1 Goals

The RATP is committed to test new co-design methods inspired by new design processes which are today used for products or services, but they have never been applied to buildings or city planning subjects and especially to bus terminals. The principle is to gather all the stakeholders in a session composed of a few co-design meetings, to share all the necessary data and create a collective awareness of the different possible configurations of a bus terminal. As a result, the suggested approach is aimed at facilitating the final decision-making process with a reliable result.

Several unsatisfying results of bus terminal design process have been recently assessed by the demo team, with too long projects processes (almost 10 years), generating obsolete results. Therefore another goal is to shorten dramatically the global period of study, preparation and realization of a bus terminal.

4.2.2 Validation objectives

Table 4 presents the Validation Objectives related to the Technological Innovations TIParc2.

Validation Objective n.	Description
VO 33	Improving urban interface with the bus
VO 37	Getting the local authorities positively involved in bus terminals
VO 38	Improving the bus terminals' design management process

Table 4 – Validation objectives of TIParc2 demonstration

4.2.3 Test scenarios

The demonstration includes:

- A simulation on a test site without stakeholders, to adjust the method and the tool.
- Two experimental sessions for two real sites where new bus terminals are expected to be built.

4.2.4 Description of the no ebsf2 scenario vs ebsf2 scenario

The no ebsf2 scenario can be described as a classical bus terminal preparation scheme, made of a sequence of exchange steps between the responsible of the project ("maître d'ouvrage") and all the relevant stakeholders. The traditional transport projects investments rules will follow, starting from summarized specifications and sketches, which are progressively deepened until a detailed specifications final document and a finalized designed project are produced.

Even with precautions, some rejections can occur at the end of the design process, generating delays and additional costs. These inconsistent results can make the process unreliable.

In the ebsf2 scenario the period of study is shortened and the design work should be done through a few co-design meetings with all the needed stakeholders, after a careful preparation of the material. The last meeting should be conclusive.

4.2.5 Data collection plan

The co-design meetings will be recorded. The preparatory elements and the last conclusions will also be also taken into consideration for the assessment phase, to allow an analysis of the decision-making process and a later improvement of the method.

4.2.6 Implementation plans

The demonstrations will be prepared in several steps:

- Specifications writing and procurement process for the design management methods consulting team (linked to the architectural simulator specification and procurement process – see 4.3.6.)
- Choice of the test site and of the two experimental sites among all the possible locations in the RATP projects agenda (criteria: adaptation to the schedule, to the status of progress, and compatibility with the stakeholders)
- Design of the co-design methods and preparation of the materials for the test site and the experimental sites

The Gantt chart in Table 5 shows the main steps of the implementation plan for the activity on Bus terminal co-design method.

	2016				2017				2018	
Specifications										
Preparation & test										
Experimentation										
Analysis										
Communication										

Table 5 - Gantt chart for TIParc2 demonstration

4.2.7 Risks assessment

An assessment of the risk associated with the demontration of TIParc2 is provided in Table 6.

Risk	Probability Assessment	Consequences	Comments
Difficulties in the choice of the experimental sites	Low	High	The studied locations should be chosen arbitrarily
Non convergence after a co-design meeting session	Moderate	High	Additional co-design meetings could be organized later than the EBSF_2 schedule deadlines, in order to conclude

Table 6 - Risk identification and assessment of TIParc2 demonstration.

4.3 Bus terminal architectural simulator

This TI is intimately linked to the previous one, in fact the simulator will be used for implementing the new co-design methods.

4.3.1 Goals

To make co-design meetings possible and reliable, a simulator is needed to allow the stakeholders to share a collective understanding of the different possible configurations of the studied bus terminal.

The simulator should be developed or adapted from existing products, respecting the dedicated specifications of this research.

The ways a bus terminal configuration should be represented thanks to the simulator are ground plans, augmented reality renderings, visual perspective screenshots.

4.3.2 Validation objectives

Table 7 presents the Validation Objectives related to the Technological Innovations TIParc3.

Validation Objective n.	Description
VO 37	Getting the local authorities positively involved in bus terminals
VO 38	Improving the bus terminals' design management process

Table 7 – Validation objectives of TIParc3 demonstration

4.3.3 Test scenarios

Coupled to the bus terminal co-design method experiment, the simulator will be validated and used in two steps:

- The use on the simulated test site will allow the validation and adjustment of the tool, if needed,
- The experiment in real-life situation with stakeholders for two different studied sites.

For all the locations the simulator should allow the production of several configurations versions in real time, to help the participants understanding the consequences of their wills and finally of their decision.

4.3.4 Description of the "no ebsf2 scenario" vs "ebsf2 scenario"

The "no ebsf2 scenario" represents a classical work process, where the bus terminals projects are shown on plans, visual perspective renderings and short videos, which can't be modified during the presentation meetings. Each new version needs a working period and additional meetings, generating delays.

In the "ebsf2 scenario", the configuration of the planned bus terminal should be adapted in real time and the immediate understanding of the results should help the gathered stakeholders to share a collective understanding of each option and to take quicker and more reliable decisions after necessary adjustments.

4.3.5 Data collection plan

Relevant features of each configuration version will be collected.

4.3.6 Implementation plans

To allow the simulator to be operational, the following tasks (also shown in Table 8) are needed:

- Specifications writing and procurement process for the architectural simulator;
- Collection of all the data needed site by site;
- Preparation of the simulation for each studied site.

	2016				2017				2018	
Specifications										
Preparation & test										
Experimentation										
Analysis										
Communication										

Table 8 - Gantt chart of TIParc3 implementation plan

4.3.7 Risks assessment

An assessment of the risks associated with the demonstration of TIParc3 is provided in Table 9.

Risk	Probability Assessment	Consequences	Comments
Lack of flexibility of the simulator tool	Moderate	High	The method will be adapted to the possibilities of the simulator
Bad understanding of the configurations by the participants	Moderate	High	Additional representations in additional meetings

Table 9 - Risk identification and assessment of TIParc3 demonstration

5 Demo Team

The Paris City demonstration team consists of the following persons:

- Francisco Sanchez, innovation responsible at IVECO
- François-Xavier Russotto, research engineer in robotics at CEA LIST
- Clément Lucchesi, project manager at RATP. Responsible for the TIParc1 demonstration.
- Yo Kaminagai, head of design at RATP, responsible for the TIParc2 and TI Parc3

Other persons will be included as soon as the procurement processes will be finished and the locations for the bus terminal design experimental sessions will be selected.

6 Partner Contribution

The following partners have contributed to completion of the deliverable as specified below.

Institution/Company	Sections	Description of the partner contribution
RATP	Whole Document	A draft version of the deliverable, including all chapters and sections, as well as several reviews of the document based on input from partners.
CEA	4	Contribution to TIParc, Review of content
IVECO	4	Contribution to TIParc1, Review of content
UITP	Whole document	Document quality check

End of the Document