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Paris Area: Demo Description and Implementation Plan

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Coordinator: UITP – International Association of Public Transport

SUMMARY SHEET

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Abstract	Paris Area demo aims at improving maintenance of buses and availability of the fleet – thus quality of service to passengers – through 3 technological innovations: 1- Advanced telediagnostic back office systems (in multi-suppliers' environment), 2- Standard protocol for back office interoperability (telediagnostic and AVMS diagnostic), 3- Interoperability of on-board ITS & MADT implementation for maintenance. This document describes in details the above technological innovations and related design specifications, the implementation plan and responsibilities for each partner.
Keywords	Telediagnostic, Interoperability, IT Interface, IT Architecture, MADT, Maintenance

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
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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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40	Västtrafik AB - VTAB	Sweden
41	Commissariat à l'Energie Atomique et aux Energies Alternatives - CEA	France
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Entity	Short name	Country	Contact person
European Commission - INEA	EC INEA	-	Mr. Walter Mauritsch

DOCUMENT CHANGE LOG

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0.1	12/10/2015	Initial	DigiMobee	First draft for review
0.2	15/10/2015	Updates in chapters 5 and 6	DigiGroup Informatica	Partners review
0.3	20/10/2015	Updates in chapters 5 and 6	INEO, Metatronix	Partners review
0.4	21/10/2015	Updates in chapters 3, 5 and 6	IVECO, ACTIA	Partners review
0.5	27/10/2015	Final review	DigiMobee	Validation of partners feedback, cleaning of review marks
0.6	02/06/2016	All Document	UITP	Quality check
1.0	12/07/2016	All Document	DigiMobee	Reviewed version after quality check

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ACRONYMS

AVMS: Advanced Vehicle Monitoring System

CEN: European Committee for Standardisation

CMMS: Computerized Maintenance Management System

FEP: Front End Processor

FMS: Fleet Management System

IT: Information Technology

ITS: Intelligent Transport System

ITxPT: Information Technology for Public Transport

KPI: Key Parameter Indicator

OBU: On-Board Unit

MADT: Multi Application Driver Terminal

MM: Man Machine Interface

PT: Public Transport

PTA: Public Transport Authority

PTO: Public Transport Operator

STRAV : Société de Transport Automobile de Voyageurs (Transdev PT network)

TI: Technological Innovation

TRA: Transports Rapides Automobiles (Transdev PT network)

VO: Validation Objective

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1 Executive Summary

Maintenance of public transport vehicles is a key issue for public transport operators (PTO) and authorities (PTA). An efficient maintenance has a direct impact on the global quality of the service, and it is also a key economic criteria for the operators. Currently the maintenance of buses is managed using basic procedures and specific tools for different vehicle manufacturers. In the best case, dashboard lights are reported by the driver in operation when it occurs. Basically, diagnostic is very often performed once vehicle breakdown occurs without any anticipation.

EBSF project (2008-2012) paved the way for telediagnostic systems applied to public transport vehicles by demonstrating technical feasibility and efficiency of such systems for PTOs and PTAs. One of the main obstacles to the deployment of telediagnostic systems is the lack of interoperability to manage heterogeneous fleet of vehicles (different Original Equipment Manufacturers and On-Board Unit suppliers).

The objective of the EBSF_2 Paris Area demonstration is to build on the work done by the EBSF project and test a set of technological innovations in order to:

- demonstrate IT interoperability and sharing of maintenance data between telediagnostic systems in a multi-supplier environment, to offer a single telediagnostic interface for the PTO;
- validate advanced algorithms and filtering strategies to report relevant information (alerts and alarms) to the PTO in order to increase its operational performances;
- implement back office interoperability using defined standard protocol for telediagnostic systems in order to integrate vehicle data collected from on-board systems;
- validate on-board interoperability of telediagnostic systems and other IT systems (like multi-application driver terminal - MADT) using an IP network compliant with ITxPT architecture and the protocols based on the European standard EN13149; review vehicle Bus-FMS interface (standard vehicle technical data).

EBSF project has defined the first set of technical specifications of a standard interface for telediagnostic system. These specifications will be applied and validated in the present demo.

Paris Area demonstration relies on two vehicles fleets, each composed of 20 urban buses (multi brand – multi models) operating in Paris surrounding counties by two operators.

Deliverable 3.1 reports on the demo objectives, work-plan and responsibilities for each partner, design specification (focused on interfaces and data) and evaluation criteria.

2 BACKGROUND AND CONTEXT

2.1 Geographical and Urban Context

Two bus networks of TRANSDEV PTO are selected as demo sites:

- STRAV
- TRA

STRAV is the local PTO from Transdev group operating in Southeast Paris area (Figure 1).

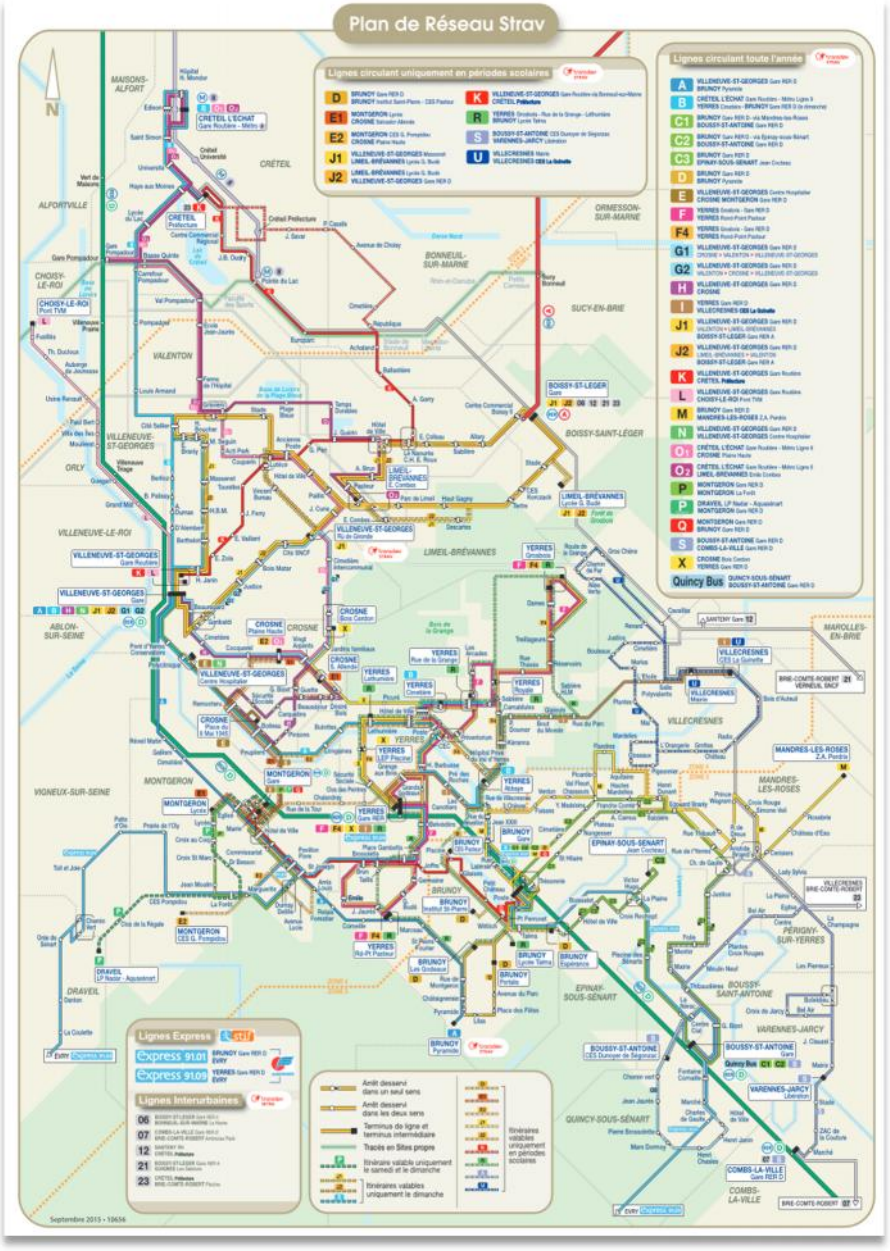

Figure 1 - STRAV network map

STRAV operates 30 lines all year long plus 9 during school times. STRAV is operating 175 buses with very strong operating condition: high traffic, high load during peak hours and very large timetables range (vehicles are operated from 4.00am to 1.00am).

In addition, STRAV is operating one of the largest fleet of articulated buses in outer suburbs of Paris and some hybrid vehicles since 2015.

TRA is the local PTO from Transdev group operating in Northern Paris area (**Error! Reference source not found.**).

TRA (Transdev group) operates 30 lines all year long, with a fleet of 215 buses running in a area of 20 cities located in the north of Paris and representing 720.000 habitants. The number of yearly passengers is 35 million.

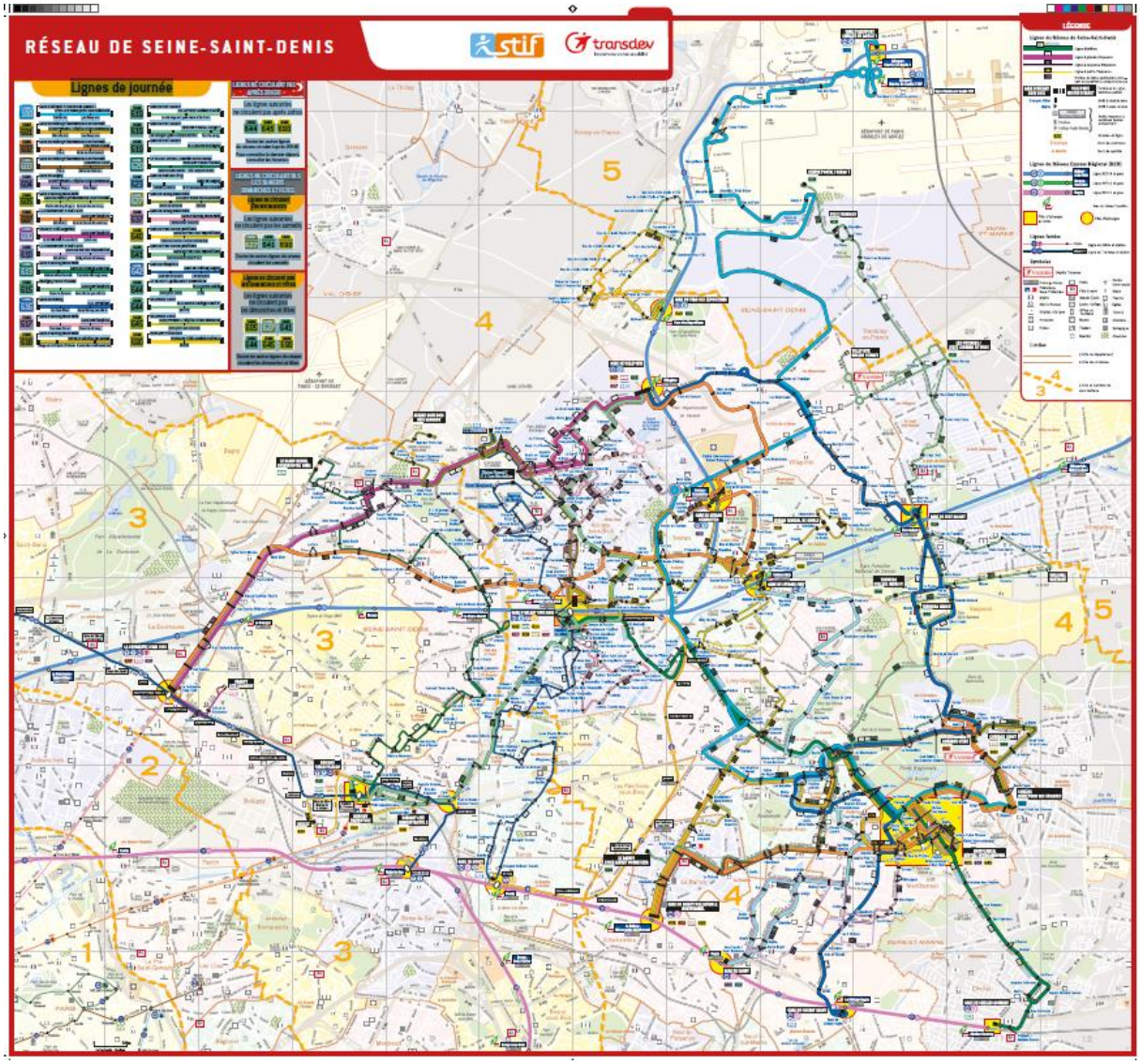

Figure 2 - TRA network map

2.2 PT Service Background and Context

In the given operational conditions, maintenance of PT vehicles is a key issue for PTOs and PTAs. It has a direct impact on the global quality of service. An efficient maintenance is also a key economic criteria for the PTO. Currently the maintenance of buses is managed using basic procedures.

PTO is operating heterogeneous fleets of vehicles, which include different brands and models of buses on several generations. A fleet with an average age of about 9 years can include more than 4 different brands and 40 types of vehicles. In these conditions a PTO cannot manage to use as many diagnostic tools as the number of bus types.

One of the main obstacles to the deployment of telediagnostic systems is the lack of interoperability between on-board equipment (Figure 3), and centralised back-office software, that needs to be open to manage vehicles of different manufacturers with a single standard interface and a single homogeneous tool.

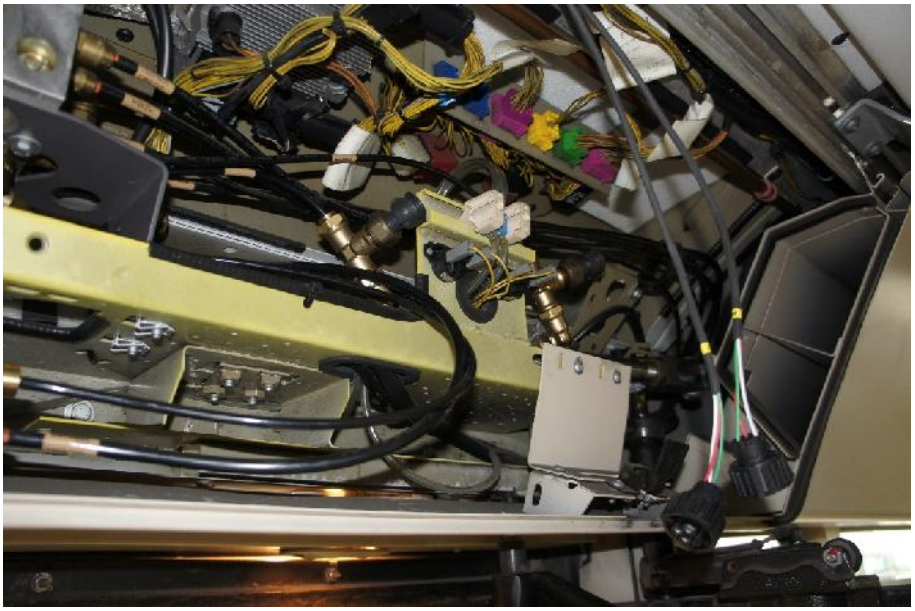

Figure 3 - On board equipment

In addition, PTOs operate fleets of vehicles equipped with heterogeneous ITS in a multi-supplier environment. Upgrading, maintaining or removing equipment from these buses is time consuming. Each of this supplier is implementing its own on-board data communication protocol. This is a key issue for PTO operation regarding maintenance of ITS.

Otherwise, driver reports for maintenance purpose are currently managed using paper supports filled when the bus is back to the depot.

2.2.1 STRAV

STRAV is operating a heterogeneous fleet of vehicles composed of two main vehicle brands (IVECO and HEULIEZ) including hybrids vehicles. In terms of devices for telediagnostic, currently vehicles are pre- equipped with telediagnostic OBU and back office software from IVECO BUS (supplied by METATRONIX) using proprietary communication protocol. Figure 4 shows as an example the maintenance activities at the STRAV depot.

Figure 4- Maintenance operation in STRAV depot

2.2.2 TRA

TRA is operating a heterogeneous fleet of vehicles which includes different brands and models of buses (HEULIEZ, EVOBUS, MAN, SOLARIS) on several generations and including hybrids vehicles. TRA vehicles are already equipped in after sales with telematics units connected to a telematics portal (supplied by ACTIA) providing eco-driving features.

2.2.3 PTO expectations

The PTO of STRAV and TRA (Transdev) has chosen didiDIAG® (supplied by DigiMobee and Digigroup Informatica) as single centralised maintenance back-office solution for Transdev group.

Tele-diagnostic feature is possible but requires the interoperability between the existing on-board equipment + their related data centre (supplied by METATRONIX and ACTIA), and the centralised maintenance back-office solution didiDIAG®. This interoperability demonstration (data collection from TRA and STRAV in a single telediagnostic solution) will be the core of the demo performed with this PTO.

3 DEMONSTRATION OBJECTIVES

By conducting this demonstration, the involved partners wish to take a significant step forward in achieving its goal of:

- avoiding dependency to systems suppliers and vehicle manufacturers,
- exchanging data between on-board IT systems, using single back office system for heterogeneous vehicles fleet equipped with on-board units from different suppliers,
- validating advance algorithms and filtering strategies to analyse vehicle technical data.

A review of Bus-FMS interface specifications (standard interface to access vehicle technical data) will identify the key needs for additional relevant data for telediagnostic system with a specific focus on hybrid vehicles data. The interface with the IT architecture (compliant with ITxPT) will demonstrate the interoperability with MADT and the implementation of CEN standard to share driver terminal for maintenance application (driver reports). This will be based on IT guidelines from 3iBS project[1] and will use ITxPT* platform (Figure 5) for testing on-board modules.

Figure 5 – ITxPT test bench

*ITxPT is an association gathering Public Transport stakeholders cooperating on the implementation of a working standard for plug-and-play IT-systems.

An integrated test-bench (Figure 5) offers services to specify, test, qualify and showcase IT solutions.

[1] *The intelligent, innovative, integrated Bus Systems, 2012-2015, www.3ibs.eu*

3.1 Validation Objectives

Paris Area demo is committed to work on two EBSF_2 priority topics: (i) IT standard introduction in existing fleets and (ii) Intelligent garage and predictive maintenance, by testing and evaluating the following technological innovations (TI):

- TI 1 – Advanced telediagnostic back office system (multi-suppliers environment)
- TI 2 – Standard protocol for back office interoperability (telediagnostic & AVMS diagnostic)
- TI 3 – Interoperability of on-board ITS & MADT implementation for driver daybook/driver alert connection to maintenance

The 3 TIs are extensively described in in section 5.1.

Coherently with the EBSF_2 evaluation methodology which applies to all the project demonstrations, a set of validation objectives have been identified according to the technological innovations (TI) to be implemented, and based on the overall objectives of the project.

These validation objectives are reported below according to the name and coding agreed with the project evaluation team:

VO6 Promoting retrofitting programs

Interoperability should not only apply to new buses, but must also be adapted for retrofitting of buses already in operation. The demonstration will show how the back-office and on-board systems can interoperate even on existing vehicles, using heterogeneous and ageing systems, as far as they comply with defined specifications.

VO16 Improving interoperability for ground operations

IT standard will unify language and treatment in a heterogeneous environment, allowing to unify processes and understanding at ground operations level. Tests on several operational buses from various manufacturers, using multi-supplier systems will illustrate the heterogeneity, which is a commonly shared concern for fleet maintenance.

VO17 Improving interoperability for IT systems

Recognition of IT standards enables the co-existence and independence of multi-suppliers IT solution in an existing fleet. The use of plug-and-play systems becomes possible.

VO18 Speeding up data management

Thanks to the use of a standard protocol, no more translation delays nor errors can occur. Data collection is facilitated, filters and algorithms can be added to keep relevant information only.

VO19 Reducing staff workload

Both preventive operations and real-time detected defects can be treated in one scheduled maintenance window, enabling to optimize staff workload for several operation during the vehicle planned downtime.

VO20 Minimizing operating and maintenance costs

As maintenance interventions can be scheduled, spare parts supply and work orders can be optimised. Further analysis of breakdowns 'data will provide factual data for discussing with suppliers and organise the fleet. Online breakdowns occurred in operation will be minimised and diagnostic time will be reduced.

VO22 Speeding up maintenance operations

Technicians can better identify at any time the source of the defects: the workshop can get organised accordingly and speed up the related maintenance operations so that breakdown severity does not raise up.

VO23 Reducing non-operational lifetime of vehicles

Intelligent garage should help planning vehicles downtime. As workshop staff will be able to monitor the fleet state in real-time, both pending priorities and operational constraints could be combined to improve vehicle maintenance scheduling, reducing vehicle immobilization time.

VO23 Improving staff qualification

Introduction of IT standard and innovative intelligent solution will boost together staff knowledge and motivation at the same time. The common language and standard applied to heterogeneous fleet will enhance the use of common language and shared knowledge, thus improving the overall qualification.

VO30 Increasing reliability

As each event will be recorded for each vehicle, each equipment and each subassembly recorded both technical and procurement teams evaluate the components reliability. The fleet reliability will be improved on a long term basis.

VO34 Increasing economic efficiency

Factual wear data should avoid preventive replacements. Best supplies could be ranked through reliability and durability statistics, helping to manage relationship with suppliers throughout factual data and leading to increased economic efficiency.

VO36 Making the debt service coverage more affordable

Each vehicle and each component will be monitored according to its real state, enabling to increase vehicle lifetime, improve spare parts procurement, and even reduce reserve fleet with improved return on investment.

Validation objectives can be indeed related to several TIs, as shown in Table 1.

Validation Objectives		IT standard introduction in existing fleets	Intelligent garage and predictive maintenance
VO6	Promoting retrofitting programs	TI-2/3	TI-2/3
VO16	Improving interoperability for ground operations	TI-2	TI-2
VO17	Improving interoperability for IT systems	TI-2/3	TI-2/3
VO18	Speeding up data management	TI-2	TI-2
VO19	Reducing staff workload		TI-1
VO20	Minimizing operating and maintenance costs		TI-1
VO22	Speeding up maintenance operations		TI-1/3
VO23	Reducing non-operational lifetime of vehicles		TI-1/3
VO23bis	Improving staff qualification	TI-3	TI-1/3
VO30	Increasing reliability		TI-1
VO34	Increasing economic efficiency		TI-1/2/3
VO36	Making the debt service coverage more affordable		TI-1

Table 1 – Link Validation Objectives – Technological Innovations

3.2 Key to TIs

The Paris Area demo will evaluate its Technical Innovations through key data measurements. Data will be compliant with the requirements defined in WP2 “Setting the scenarios” to feed the technical as well as economic and financial evaluation of the innovations.

- Data collection of EBSF_2 core Key Performance Indicators relevant for the predictive diagnostic topic
- Evaluation of success of back office interfaces and Front End Processor (including implementation time)

- Evaluation of success of on-board AVMS diagnostic messages sent over the IP network
- Evaluation of success of strategies for predictive diagnostics
- Evaluation of success of on-board daybook/driver alert

4 DEMONSTRATION DESCRIPTION

The Paris Area demonstration Team (Digimobee, METATRONIX, IVECO, INEO, ACTIA, UITP representing ITXPT) is committed to implement and test during the project lifetime 3 technological innovations (Figure 6):

- TI 1 – Advanced telediagnostic back office system (multi-suppliers environment)
- TI 2 – Standard protocol for back office interoperability (telediagnostic & AVMS diagnostic)
- TI 3 – Interoperability of on-board ITS & MADT implementation for maintenance

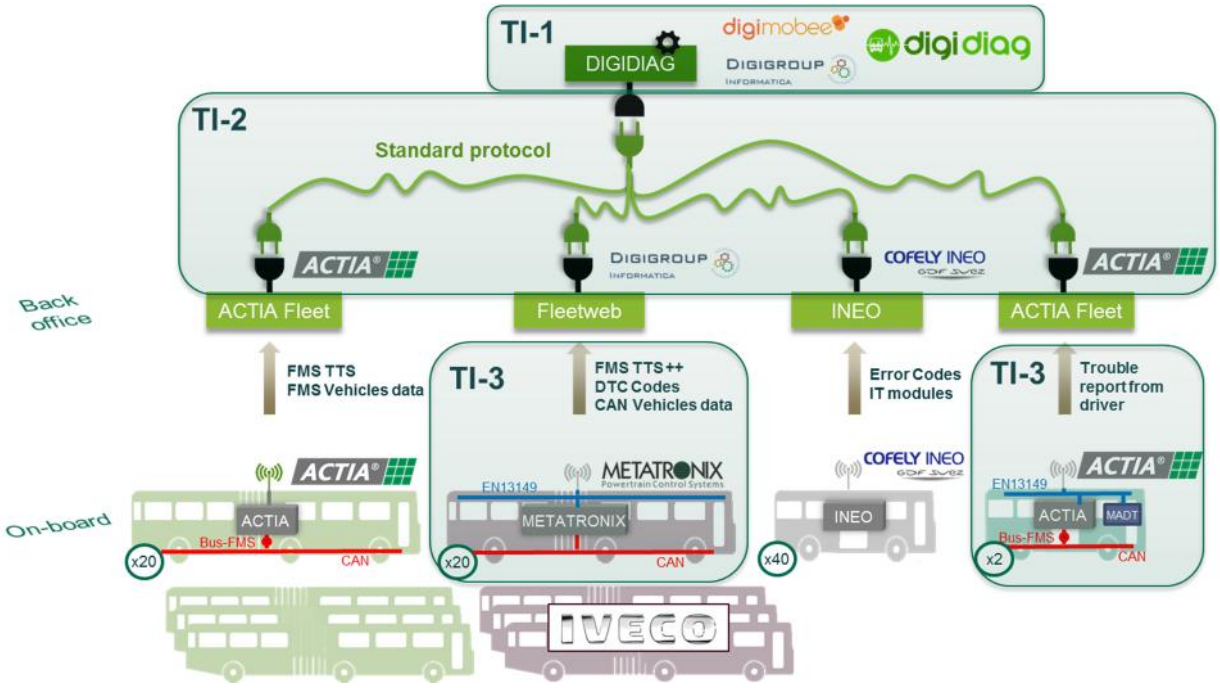

Figure 6- Paris Area architecture for IT systems and telediagnostic back office

4.1 Goals of the TIs and how they can be achieved

4.1.1 TI 1 Advanced telediagnostic back office system (multi-suppliers environment)

EBSF project paved the way for telediagnostic systems applied to public transport vehicles demonstrating technical feasibility and efficiency of such systems for PTOs and PTAs. The development of predictive diagnostics for key sub-systems such as drivetrains or doors requires proprietary know-how of the component's suppliers, which need to be integrated in the overall diagnostics system in an open and harmonized way.

An evaluation of the interface with CMMS (Computerized Maintenance Management System) will be evaluated to analyse the technical feasibility of a fully integrated system connected with the operating maintenance tool used by the PTO.

The PTO will identify strategies for predictive maintenance of critical vehicle components.

4.1.2 TI 2 Standard protocol for back office interoperability (telediagnostic & AVMS diagnostic)

In the EBSF project, a sub-group of the IT work-package defined the technical specifications of an open interface for telediagnostic system. It includes a reference model to be applied to the data acquisition, analysis and processing. These specifications will be applied in the demo and will be enriched with additional features to offer a full back-office interoperability.

4.1.3 TI 3 Interoperability of on-board ITS & MADT implementation for maintenance

In the EBSF project, more than 20 Public Transport stakeholders defined the technical specifications for an open IT systems architecture and within the 3iBS project, the relative guidelines. This work contributed to the development of the European standard: the EN13149 for IT systems in Public Transport paving the way to cost effective, reusable, scalable, modularised and sustainable PT systems in an approach that is compatible with continuing open competition and innovation in digital technology. Now ITxPT association supports the deployment of such IT standards.

ITxPT architecture will be implemented in the demo to demonstrate on-board standard communication to report ITS diagnostic faults from VIDAC OBU using specified EBSF service (today supported in ITxPT). In addition, a MADT (Multi-Application Driver Terminal) concept dedicated to maintenance report (daybook) from drivers will be demonstrated.

A review of Bus-FMS interface will permit to evaluate data availability for both ICE and hybrid vehicles and collect additional user needs for telediagnostic features.

4.2 Test scenarios

Test Scenarios (TS) describe the test environments in which the EBSF_2 TIs take place. The test environment includes the entire set of conditions under which the EBSF_2 demonstrations are developed or, in other words, the detailed description of what is going to be tested, when, where, how, etc. Test scenarios have been divided into the following test categories:

a) simulations;
b) tests in controlled environment;
c) tests under real operational conditions;
d) technological concepts, code of practice and specifications.

Paris Area demo focuses on categories b) and c).

Test Scenarios are also based on comparative analyses of results, at local level and cross-site. This general evaluation approach is based on the assessment of the “no EBSF_2 situation” vs the “EBSF_2 situation” at each demo site and for each TI. This comparative study allows a univocal, objective and independent assessment of the outcomes of the innovations tested.

Regarding Paris area demo, tests for TI 1 [Advanced telediagnostic back office system (multi-suppliers environment)] will be operated according to "**before vs during**" and "**control vs test**" methods, in real operational conditions (see Table 2).

PARIS AREA TI-1	Tests under real operational conditions	Before	During
Vehicles involved (units)		40	40 +5 hybrid vehicles
Lines involved (units)		5	5
Routes involved (units)		5	5
Time span (data collection)		January 2014 March 2015	Begins May 2016 Ends March 2017
Time span (testing activities)		-	Begins May 2016 Ends March 2017
Staff involved (units)		3	4

Table 2 –TI 1 tests under real operational conditions

Tests for TI 2 [Standard protocol for back office interoperability (telediagnostic & AVMS diagnostic)] will be operated according to "**before vs during**" method, in both a controlled environment and real operational conditions.

Tests in controlled environment will be performed in 0216 on the ITxPT testbench located in Paris. Staff involved in this test consist of 4 persons.

Tests in real operational conditions are detailed in Table3.

PARIS AREA TI-2	Tests under real operational conditions	Before	During
Vehicles involved (units)		40	40 (potentially all vehicles of the fleet for AVMS interface)
Lines involved (units)		5	5
Routes involved (units)		5	5
Time span (data collection)		Begins January 2015 Ends September 2015	Begins May 2016 Ends March 2017
Time span (testing activities)		-	Begins May 2016 Ends March 2017
Staff involved (units)		1	4

Table 3 – TI 2 tests under real operational conditions

Tests for TI 3 [Interoperability of on-board ITS & MADT implementation for maintenance] will be operated according to "**before vs during**" and "**control vs test**" methods, in both controlled environment and real operational conditions.

Tests in controlled environment will be performed in 2016 on the ITxPT testbench located in Paris. Staff involved in this test consist of 4 persons.

Concerning tests in real operational conditions (see Table 4), vehicles involved in the tests include:

- 1 vehicle with telediagnostic OBU using EN13149 standard;
- 2 vehicles with MADT for maintenance.

PARIS AREA TI-3	Tests under real operational conditions	Before	During
Vehicles involved (units)		20	3
Lines involved (units)		5	5
Routes involved (units)		5	5
Time span (data collection)		Begins March 2015 Ends September 2015	Begins May 2016 Ends March 2017
Time span (testing activities)		-	Begins May 2016 Ends March 2017
Staff involved (units)		1	4

Table 4 – TI 3 tests under real operational conditions

4.3 Fleets, vehicles and lines involved

The Paris Area demo relies on two vehicles fleets, each composed of 20 in-service urban buses operating in Paris surrounding counties:

- one fleet equipped with ACTIA on-board units ("TGU1A" model connected to Bus-FMS interface enabling to transmit geotagged FMS data via SIM card in real-time);
- one fleet equipped with METATRONIX on-board units ("VIDAC" model connected to CAN bus enabling to transmit geotagged enriched vehicle technical data via SIM card in real-time).

Both fleets are equipped with on-board INEO AVMS interfaced with ticketing and CCT systems. Such OBU will feed digiDIAG® with IT system diagnostic data.

For the objectives of the demonstration, digiDIAG® telediagnostic back office system (delivered by DIGIMOBEE and DIGIGROUP INFORMATICA) will be deployed on both fleets, to manage data coming from data systems suppliers back office. In addition, one vehicle will be equipped

with an IP-based VIDAC OBU compliant with EN13149 standards and plugged on the IT network. This interface will feed digiDIAG® with IT system diagnostic data (VIDAC OBU).

Telediagnostic OBUs will collect relevant diagnostic and maintenance vehicle data from Bus-FMS interface, dashboard or multiplex system. In addition AVMS OBU will collect relevant AVMS and IT diagnostic data. These data are processed by each on-board system and downloaded to the related back office using different communication media: Wifi or 3G depending of the data type and criticality.

digiDIAG® back office system will collect data using standard IT interfaces or / and FEP (Front End Processor) to merge all information in a single back office tool.

ITxPT platform will be used to validate the integration of on-board systems: the OBUs used in the demo will first be installed on the testbench for testing their ability to exchange data

Based on this telediagnostic system and related filtering strategy and algorithms, the PTO will apply strategies for predictive diagnostics of "maintenance critical" vehicle components. The PTO will use telediagnostic system for daily operational management of fleets (real-time alerts and workshop management) and specific data analyses when relevant (fault report, statistical report on a period, legal visit preparation, etc…).

4.4 Qualitative description of “no EBSF_2 scenario” vs “EBSF_2 scenario”

Description of “no EBSF2_situation”	Description of “EBSF2_situation”
Maintenance of PT vehicles is managed using specific tool from each vehicle manufacturer. In the best case, a dashboard light is reported by the driver in operation when it occurs. Basically, diagnostic is performed once vehicle breakdown occurs without any anticipation. Only some periodic maintenance actions are planned in annually (oil change, legal visit…).	Observation of the data will permit to identify dysfunction signals or abnormal pattern of key subsystem: engine, gearbox, doors… Based on it, warning and / or automatic trace files can be managed by the back office tool. An interface with the CCMS system will be realized to integrate the reports directly in the PTO system and to demonstrate the use of telediagnostic solution in an intelligent workshop environment. Based on this telediagnostic system, the PTO will specify specific strategies for predictive diagnostics of "maintenance critical" vehicle component to be used in daily operational management of fleets.
Telediagnostic OBU are using their own communication protocol to download technical data from the vehicle to their proprietary back office. There is no interoperability between the tools and the result is that it doesn’t fit with PTO expectations to monitor fleets of heterogeneous vehicles equipped with multi-suppliers systems. In addition AVMS OBU is downloading its own diagnostic data (ITS technical data) using its own communication protocol and its own back office.	The demonstration will consist of two fleets, each composed of around 20 in-service urban buses operating in Paris surrounding counties: one fleet equipped with ACTIA systems and one fleet equipped with METATRONIX systems. And both are equipped with INEO AVMS. In addition 5 hybrid vehicles will be monitored in the scope of the demo. Telediagnostic OBU will collect relevant diagnostic and maintenance vehicle data from Bus-FMS interface, dashboard, or multiplex system. In addition AVMS OBU will collect relevant AVMS diagnostic data. These data are processed by the on-board system and downloaded to the back office using different communication media: Wi-Fi or 3G depending of the data type and criticality. The back office system will centralize data using standard IT interfaces and FEP (Front End Processor) to merge all information in a single back office tool.

Description of “no EBSF2_situation”	Description of “EBSF2_situation”
Nowadays public transport vehicles are usually equipped with a first generation of IT systems installed in after sale. These systems are proprietary and are still related to the choice of on-board hardware. Moreover, they are expensive to maintain, configure and are not scalable. ITS are using proprietary IT interfaces to exchange information like AVMS, location data and ITS diagnostic fault codes. The result is a redundancy of features. For examples, the driver obtains information coming from the different applications thought many displays and multiple communication gateways are installed for each application with proprietary back office features. Each data flow are linked to each supplier without any interoperability and modular features. It means that a single supplier provides all the components of a system without any alternative.	One vehicle will be equipped with an IP-based telediagnostic OBU (VIDAC) compliant with EN13149 part 7/8/9 standards (i.e. “inventory service” based on EBSF AVMS specifications) and plugged on the IT network. This interface will enrich the telediagnostic database with ITS diagnostic data. In addition two vehicles will be equipped with an IP-based MADT for driver daybook function connected maintenance compliant with EN13149 part 7/8/9 (and based on EBSF technical specifications) standards and plugged on the IT network.

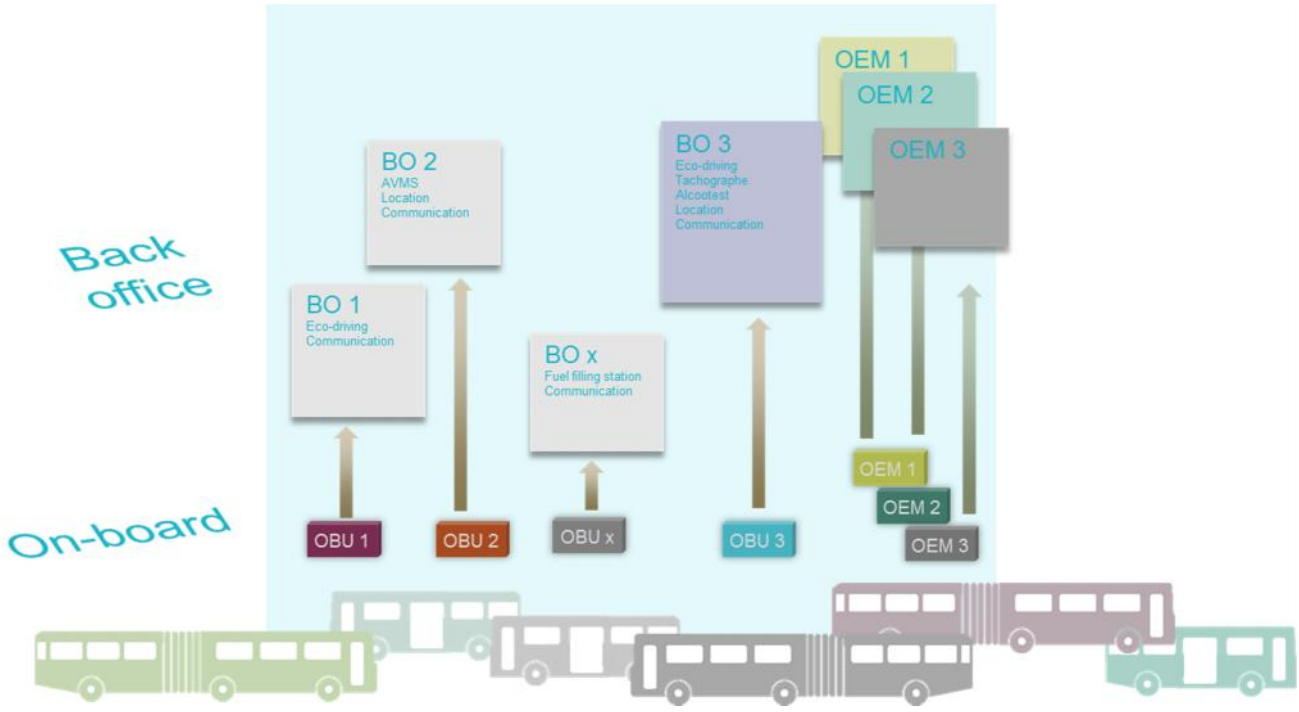

Figure 7- Today situation of on-board IT systems and related back offices

4.5 Risks which may affect the test quality and mitigation actions

Risks are limited thanks to tests in controlled environment (using ITxPT platform) before tests under real operational conditions. The success of the demo is dependent on the different supplier developments and the implementation of related IT standards and MADT concept. As data comes from multi suppliers OBU and/or back office systems, standard protocol has to be used to feed the back office tool.

In addition, a strong support to introduce the tool in the PTO organisation will be performed to ensure the most efficiency of the telediagnostic system.

Performance of the interface needs to be evaluated to guaranty efficient “real-time” information with minimum additional transmission delay due to post-processing operations.

4.6 Preliminary information about the data collection plan

4.6.1 TI 1: Advanced telediagnostic back office system (multi-supplier environment)

Periodically, a report from the local PTO will permit to identify the number of breakdowns in operation occurred for each vehicle monitored in the scope of the demo.

In addition, for each real-time alert/fault collected by the telediagnostic system, a double check with the local PTO CMMS (Computerized Maintenance Management System) will offer complementary information regarding the impact of the fault on PTO operation and maintenance process.

CMMS tool will also be used to collect maintenance costs for all the vehicles monitored in the scope of the demo.

Results from both tools will permit to assess specific KPI s such as:

- Number of breakdown on line (during operation)
- Time to diagnose a fault
- Evaluation of success of strategies for predictive diagnostics
- Maintenance costs, such as : warehouse costs, work costs, diagnostic costs, vehicle immobilization costs.

4.6.2 TI 2: Standard protocol for back office interoperability (vehicle platform & AVMS diagnostic)

For each alert/alarm occurring in the monitored vehicles, a check at the level of the global back office system will permit to validate the interoperability of each telediagnostic system. It means that periodic reports will monitor alert/alarm occurred in the vehicles and reported to dedicated back office vs. alert/alarm collected by the global PTO back office system. As a result, an evaluation of the success of the back office interfaces and FEP will be possible.

4.6.3 TI 3: Interoperability of on-board ITS & MADT implementation for maintenance (Driver daybook & alert)

On-board ITxPT compliant network tools (OBU logs, IP packet monitoring, IP services validation) will be used to monitor IP messages published on the IP network. Based on this, the evaluation of the success of the on-board ITS diagnostic and MADT message sent on the IP network will be possible.

5 DEMONSTRATION IMPLEMENTATION PLAN

The demonstration is planned over a period of 36 months, starting beginning of May 2015 (Figure 8). The first 6 months are dedicated to the description and implementation plan, the last 6 months focus on demo results. Core demonstration will take place in-between, from Project Month 6 to 24, for a18-month phase split into 2 main activities: preparation and execution of the demonstration, as detailed in sections 5.1 and 5.2.

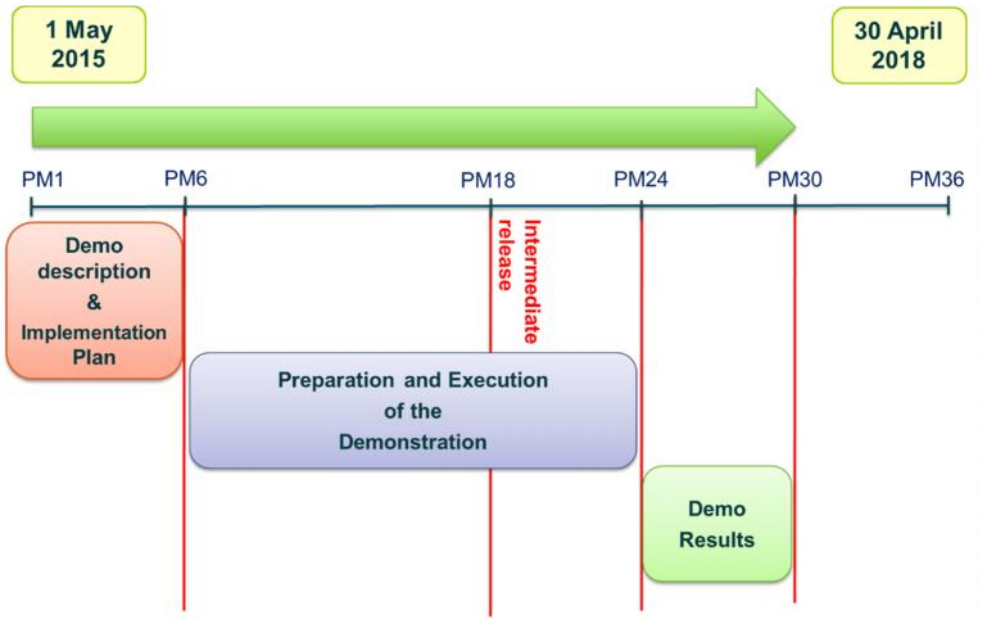

Figure 8- EBSF_2 overview workplan and related deliverables

5.1 Preparation of the demonstration

The first task required as preliminary activity for the implementation of the Paris Area demonstration consists in collecting the users' needs for telediagnostic software (TI-1) and for Bus-FMS requirements (TI-3).

A list of Bus-FMS data available on Hybrid vehicles (in addition to ICE vehicles) must also be established at the same time (TI-3), followed by an evaluation of technical feasibility and the update of related Bus-FMS interfaces. In addition, the preparation of TI-2 (standard protocol) relies on the writing of technical specifications of the back office interface (as a web service).

Evaluation of CMMS interface is part also of preparatory works in order to check the technical feasibility of interface with the telediagnostic back office (TI-1/2). Based on this, any further implementation could be agreed if relevant (e.g. interfacing CMMS and telediagnostic for maintenance orders and acknowledgement of the faults, *not defined at this stage in the work plan*).

5.2 Execution of the demonstration

Once the preparation phase has been started, iterative implementations can begin for each of the following features grouped by technological innovation:

- TI-1
  - improvement of telediagnostic software step A (with standard back office interface / TI-2)
  - improvement of telediagnostic software step B (with IT systems error codes management and MADT driver daybook events report / TI-3)
- TI-2:
  - Development of back office Interface Step A.1
- TI-3:
  - Implementation on demo vehicles, with updated Bus-FMS interfaces
  - Implementation of EN13149 part 7/8/9 standards for IT system error code management
  - Implementation of back office Interface compliant for IT system error code management
  - Implementation of MADT for daybook events reports with back office Interface compliant for driver events report

Once implemented, some elements require further iterative tests (part 6.3.1) and related iterative updates:

- TI-2:
  - Update of back office Interface Step A.2
  - Update of back office Interface Step B

Based on implementation outcomes, some validation tests of OBU compliance for TI-3 will be performed on ITxPT platform to check the compliance of development with IT standard and on the field to validate the interface with telediagnostic back office.

- TI-2:
  - tests of back office Interface step A.1
  - tests of back office Interface step A.2
  - tests of back office Interface step B
- TI-3:
  - test on ITxPT platform of EN13149 part 7/8/9 standards for IT system error code management
  - test on ITxPT platform of MADT for maintenance

5.3 Demo Gantt Chart

WP3 Paris Area Demonstration		2015								2016											
Deliverables (blue) & Technological Innovations (green)	Who ?	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
D3.1 - Paris Area: Demo Description and Implementation Plan	Consortium						6														
D3.2 - Preparation and Execution of the demonstration - intermediate release	Consortium																		18		
D3.3 - Preparation and Execution of the demonstration	Consortium																				
D3.4 - Paris Area: Demonstration Results	Consortium																				
TI-1 : Advanced telediagnostic backoffice system (multi-suppliers environment)																					
User Needs Collection for telediagnostic software	DigiMobee																				
Improvement of telediagnostic software step A (with standard backoffice interface / TI-2)	DigiGroup Informatica																				
tests of telediagnostic software step A	DigiMobee																				
Improvement of telediagnostic software step B (with IT systems error codes management and MADT driver events report / TI-3)	DigiGroup Informatica																				
tests of telediagnostic software step B	DigiMobee																				
Data analysis	DigiMobee																				
TI-2 : Standard protocol for backoffice interoperability (telediagnostic & AVMS)																					
Technical Specification of backoffice Interface (web service)	DigiGroup Informatica / Actia / DigiMobee																				
Developement of backoffice Interface Step A.1	DigiGroup Informatica / Actia																				
tests of backoffice Interface step A.1	DigiMobee																				
Update of backoffice Interface Step A.2	DigiGroup Informatica / Actia																				
tests of backoffice Interface step A.2	DigiMobee																				
Update of backoffice Interface Step B	DigiGroup Informatica																				
tests of backoffice Interface step B	DigiMobee																				
Definition of guidelines for standardization of CMMS interface	DigiGroup Informatica / DigiMobee																				
TI-3 : Interoperability of on-board ITS & MADT implementation for maintenance																					
User Needs Collection for Bus-FMS requirements	DigiMobee / Actia																				
List of Bus-FMS 3 data available on Urbanway and GX Heuliez ICE Vehicles																					
List of Bus-FMS 3 data available on **Hybrid** Urbanway and GX Heuliez **Hybrid** Vehicles	Iveco																				
Evaluation of technical faisability & Bus-FMS interfaces update	Iveco																				
Implementation on demo vehicles with updated Bus-FMS interfaces	Iveco																				
Implementation of EN13149 part 7/8/9 standards for IT system error code management + test on ITxPT platform	Metatronix																				
Implementation of backoffice Interface compliant for IT system error code management	INEO																				
Implementation of MADT for maintenance with backoffice Interface compliant for driver events report + test on ITxPT platform	ACTIA																				

Figure 9 – Demo Gantt Chart 2015 and 2016

WP3 Paris Area Demonstration		2017												2018			
Deliverables (blue) & Technological Innovations (green)	Who ?	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
D3.1 - Paris Area: Demo Description and Implementation Plan	Consortium																
D3.2 - Preparation and Execution of the demonstration - intermediate release	Consortium																
D3.3 - Preparation and Execution of the demonstration	Consortium				**24**												
D3.4 - Paris Area: Demonstration Results	Consortium										**30**						
TI-1 : Advanced telediagnostic backoffice system (multi-suppliers environment)																	
User Needs Collection for telediagnostic software	DigiMobee																
Improvement of telediagnostic software step A (with standard backoffice interface / TI-2)	DigiGroup Informatica																
tests of telediagnostic software step A	DigiMobee																
Improvement of telediagnostic software step B (with IT systems error codes management and MADT driver events report / TI-3)	DigiGroup Informatica																
tests of telediagnostic software step B	DigiMobee																
Data analysis	DigiMobee																
TI-2 : Standard protocol for backoffice interoperability (telediagnostic & AVMS)																	
Technical Specification of backoffice Interface (web service)	DigiGroup Informatica / Actia / DigiMobee																
Developement of backoffice Interface Step A.1	DigiGroup Informatica / Actia																
tests of backoffice Interface step A.1	DigiMobee																
Update of backoffice Interface Step A.2	DigiGroup Informatica / Actia																
tests of backoffice Interface step A.2	DigiMobee																
Update of backoffice Interface Step B	DigiGroup Informatica																
tests of backoffice Interface step B	DigiMobee																
Definition of guidelines for standardization of CMMS interface	DigiGroup Informatica / DigiMobee																
TI-3 : Interoperability of on-board ITS & MADT implementation for maintenance																	
User Needs Collection for Bus-FMS requirements	DigiMobee / Actia																
List of Bus-FMS 3 data available on Urbanway and GX Heuliez ICE Vehicles																	
List of Bus-FMS 3 data available on **Hybrid** Urbanway and GX Heuliez **Hybrid** Vehicles	Iveco																
Evaluation of technical faisability & Bus-FMS interfaces update	Iveco																
Implementation on demo vehicles with updated Bus-FMS interfaces	Iveco																
Implementation of EN13149 part 7/8/9 standards for IT system error code management + test on ITxPT platform	Metatronix																
Implementation of backoffice Interface compliant for IT system error code management	INEO																
Implementation of MADT for maintenance with backoffice Interface compliant for driver events report + test on ITxPT platform	ACTIA																

Figure 10 – Demo Gantt Chart 2017 and 2018

6 CONCLUSIONS

By conducting this demonstration, the involved partners wish to take a significant step forward in achieving the goal of: (i) avoiding dependency to systems suppliers and vehicle manufacturers, (ii) exchanging data between on-board IT systems and (iii) using a single back office system for heterogeneous vehicles fleet equipped with on-board units from different suppliers. A review of Bus-FMS interface specifications will also help identifying the key relevant data for telediagnostic system with a special focus on hybrid vehicles.

The interface with the IT architecture will demonstrate the interoperability and implementation of MADT for maintenance by means of the ITxPT test-bench to test on-board modules and validate the systems integration together with the IT guidelines developed in the frame of the 3iBS project.

In the preliminary activities for the implementation of the demo, a set of key tasks and related responsible partners has been identified as follow:

- digiDIAG® telediagnostic back office system will be delivered by DIGIMOBEE and DIGIGROUP INFORMATICA to manage data coming from systems suppliers back offices using standard IT interfaces or FEP (Front End Processor) to merge all information in a single back office tool.
- IVECO will ensure that vehicles are equipped with updated Bus-FMS interface
- All demo vehicles are equipped with an AVMS which will report to digiDIAG® some IT system error codes. INEO will implement back office interface compliant for IT system error code management.
- Vehicles equipped with METATRONIX onboard units (VIDAC) will also report IT system error codes to digiDIAG®.
- ACTIA will develop back office interface for its on-board units and MADT
- digiDIAG® back office system will analyse the vehicle and IT technical data with advanced algorithms and filtering strategy to report relevant outcomes to the PTO.
- In addition, two vehicles will be equipped with an IP-based MADT compliant with EN13149 part 7/8/9 standards to log events from drivers report. This interface will feed digiDIAG® with drivers report data.

Coherently with the project timing of the different work packages and their components, the - implementation and execution of the Paris Area demonstration will take place between October 2015 and April 2017 , with the TI 3 being implemented by October 2016. The data collection and the local evaluation is supposed to start in May 2016 and being completed by October 2017.

7 PARTNERS' CONTRIBUTION

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

Company	Sections	Description of the partner contribution
DIGIMOBEE	ALL	Writing of the first draft for partners review based on demo kick-off meeting and WP2 outcomes. Coordination of partners review process.
METATRONIX	ALL	Review of the first draft. TI-3: Analysis, Data definition, Development of the firmware on telediagnostic OBU for integration with AVMS information. Testing of solution on test-bench. Installation and testing on demo vehicle
IVECO	ALL	Review of the first draft. Minor change in the 6.3.5
INEO	ALL	Review of the first draft. Focus on TI-3 : send different breakdowns occurred with AVMS to telediagnostic systems
ACTIA	ALL	Review of the first draft.
UITP	ALL	Review of document

8 ANNEXES

Demo Team

Team members are involved in different steps of the demonstration, depending on their respective specialties, as shown in the table below

Actia

Due date		Item	Task
2015	oct	TI-2	Development of back office Interface Step A.1
	nov	TI-3	User Needs Collection for Bus-FMS requirements
	dec	TI-2	Technical Specification of back office Interface (web service)
2016	may	TI-3	Implementation of MADT for maintenance with back office Interface compliant for driver events report + test on ITxPT platform
2017	jan	TI-2	Update of back office Interface Step A.2

DigiGroup Informatica

Due date		Item	Task
2015	oct	TI-2	Development of back office Interface Step A.1
	dec	TI-2	Technical Specification of back office Interface (web service)
2016	mars	TI-1	Improvement of telediagnostic software step A (with standard back office interface / TI-2)
	sept	TI-1	Improvement of telediagnostic software step B (with IT systems error codes management and MADT driver events report / TI-3)
2017	Jan	TI-2	Update of back office Interface Step A.2
	may	TI-2	Definition of guidelines for standardization of CMMS interface
	juin	TI-2	Update of back office Interface Step B

Digimobee

Due date		Item	Task
2015	nov	TI-2	tests of back office Interface step A.1
		TI-3	User Needs Collection for Bus-FMS requirements
	Dec	TI-1	User Needs Collection for telediagnostic software
		TI-2	Technical Specification of back office Interface (web service)
2016	may	TI-1	tests of telediagnostic software step A
	nov	TI-1	tests of telediagnostic software step B
2017	feb	TI-2	tests of back office Interface step A.2
	may	TI-1	Data analysis
		TI-2	Definition of guidelines for standardization of CMMS interface
	jul	TI-2	tests of back office Interface step B
2016	avr	TI-3	Implementation of back office Interface compliant for IT system error code management

Ineo

Due date		Item	Task
2016	may	TI-3	Implementation of back office Interface compliant for IT system error code management

Iveco

Due date		Item	Task
2015	nov	TI-3	List of Bus-FMS 3 data available on Urbanway and GX Heuliez ICE Vehicles
2015	dec	TI-3	List of Bus-FMS 3 data available on **Hybrid** Urbanway and GX Heuliez **Hybrid** Vehicles
2016	mars	TI-3	Evaluation of technical feasibility & Bus-FMS interfaces update
	juin	TI-3	Implementation on demo vehicles with updated Bus-FMS interfaces

Metatronix

Due date		Item	Task
2016	mars	TI-3	Implementation of EN13149 part 7/8/9 standards for IT system error code management + test on ITxPT platform

End of the Document