DA4.6: Implementation of the PLM Process model for the Demonstrator

Written by:
Francesca Bandera, Julien Mascolo (CRF)
Rosanna Fornasiero, Andrea Zangiacomi (ITIA)

DELIVERABLE NO	DA4.6: Implementation of the PLM Process model for the Demonstrator
DISSEMINATION LEVEL	**CONFIDENTIAL**
DATE	23.05.2008
WORK PACKAGE NO	WP A4: PROMISE EOL information management for predictive maintenance for trucks
VERSION NO.	V0.2
ELECTRONIC FILE CODE	DA4.6 v0.5.doc
CONTRACT NO	507100 PROMISE A Project of the 6th Framework Programme Information Society Technologies (IST)
ABSTRACT	This deliverable (DA4.6) summarises the implementation of the PLM process model for the demonstrator, in terms of scenes, PROMISE components and technology implemented, as described in DA4.3 and DA4.4. The motivation for eventual discrepancies is given, together with the detailed results of the activities performed for the implementation.

STATUS OF DELIVERABLE		
ACTION	**BY**	**DATE** (dd.mm.yyyy)
SUBMITTED (author(s))	Bandera, Fornasiero, Zangiacomi	15.05.2008
VU (WP Leader)	Julien Mascolo (CRF)	23.05.2008
APPROVED (QIM)	Dimitris Kiritsis	26.05.2008

Revision History

Date (dd.mm.yyyy)	Version	Author	Comments
24.01.2008	v0	Mascolo	Structure and overview of document
25.02.2008	v0.1	Mascolo	First version, with modified structure, snapshots from GUI
23.05.2008	v0.5	Bandera	Final version

Author(s)' contact information

Name	Organisation	E-mail	Tel	Fax
Julien Mascolo	CRF	julienetienne.mascolo@crf.it	00390119083911	00390119083083
Francesca Bandiera	CRF	francesca.bandera@crf.it	00390119080454	00390119083083
Rosanna Fornasiero	ITIA			
Andrea Zangiacomi	ITIA			

Table of Contents

List of figures

List of Tables

Abbreviations

Abbreviations used in this document:

CAN	*Controller Area Network*
DB	*Data Base*
DSS	*Decision Support System*
ECU	*Electronic Control Unit*
GPRS	*General Packet Radio Service*
GSM	*Global System for Mobile Communications*
LCC	*Life Cycle Cost*
LCRC	*Life Cycle Residual Cost*
MOL	*Middle Of Life*
OEM	*Original Equipment Manufacturer*
PDKM	*Product Data Knowledge Management*
PEID	*Product Embedded Information Device*
R&D	*Research and Development*

1 Introduction

1.1 Purpose of this deliverable

This deliverable (DA4.6) summarises the implementation of the PLM process model for the demonstrator, in terms of scenes, PROMISE components and technology implemented, as described in DA4.3 and DA4.4. The motivation for eventual discrepancies is given, together with the detailed results of the activities performed for the implementation.

1.2 Objective of demonstrator

The domain of the Application Scenario A4 is the Middle of Life (MOL) phase of the product lifecycle[1]. It specifically deals with the support the maintenance of a fleet of trucks, optimising the maintenance plan and increasing the overall availability of the trucks.
By closing the information loop using the Demonstrator "Information management for predictive maintenance", IVECO intends to improves the knowledge about the customer habits and the mission profile of the vehicle and finally enable to:

- Reduce the number of vehicle stops for maintenance
- Minimise the overall lifecycle costs of the components
- Avoid component breakdowns
- Take into account vehicle availability while planning maintenance interventions
- Take into account maintenance crew availability for performing maintenance

The idea behind predictive maintenance is the identification of slow degradation trends in the performance of specific systems in order to identify with reasonable warning the need of an intervention. This allows the optimisation of maintenance intervention with the implementation of a customised maintenance policy and contributes to make explicit the residual life of the component in order to better manage the total Life Cycle Cost (LCC).

2 Description of the demonstrators

The following figure and table (from DA4.4) summarise the workflow, actors, events of processes of the A4 demonstrator. The scenes described in DA4.3 have been slightly modified into the processes described in DA4.4 and reported in the table below.

The following paragraphs will describe these scenes/ processes.

[1] The PROMISE A4 Demonstrator objectives has been fully described in Deliverable DA4.1 and DA4.4 (see References).

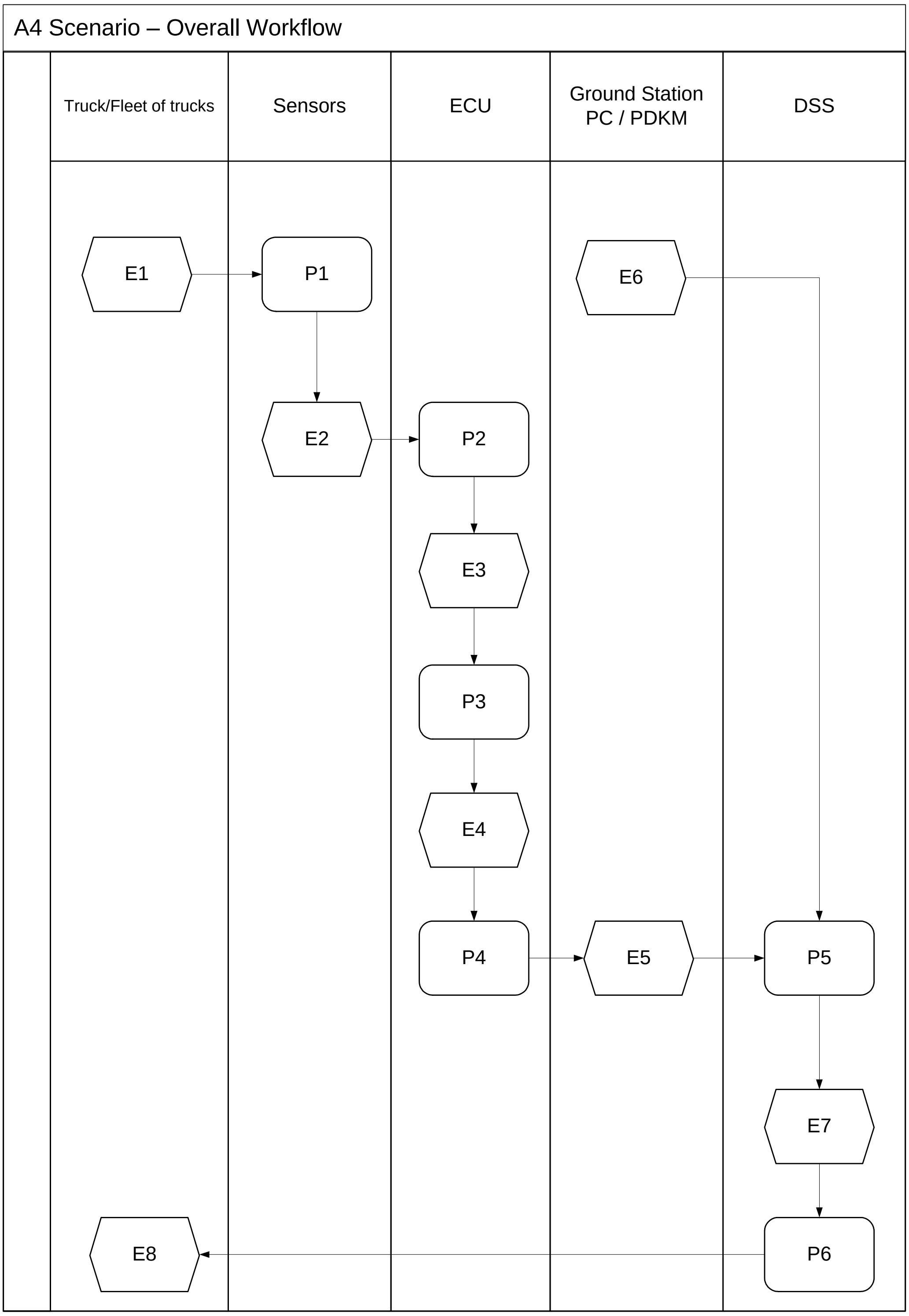

Figure 1: EPC Level-1 (overall workflow) diagram

Modelling components		Description	Remarks
Process	P1	Sensors measure specific vehicle values	
	P2	ECU stores data	
	P3	ECU analyses data	
	P4	ECU sends residual life to DSS	
	P5	DSS analyses data and defines calendar of maintenance operations for the fleet	
	P6	DSS sends info to the fleet manager and to trucks	

Table 1: EPC diagram (overall workflow) for decision support at MOL

2.1 Scenes implemented

The scenes have been implemented on a small fleet of four vehicles (2 IVECO Stralis and 2 IVECO Daily), a subset of the larger fleet of a logistics operator. The vehicles status has been assessed at the beginning of the tests and regularly during the 18 months of data recording.

In the following we report the discrepancies in the scenes implemented with respect to the plan.

Scene	**Discrepancy (None-L-M-H) with respect to**	Settings	Location	Actor	**Impact on relevance (None-L-M-H)**
Fleet of IVECO trucks (use of the vehicle)	None	None	None	None	None
Wireless communication (device communicates with central database)	None	None	None	None	None
Data storage in PDKM (knowledge stored in database)	None	None	None	None	None
Maintenance management in DSS (Computation of maintenance plan)	None	None	None	None	None

2.2 PROMISE components used

The components described in DA4.3 and DA4.4 have been used in the scenes presented above.

2.3 Eventual other modifications with respect to DA4.3 and DA4.4 (e.g. workflow)

No discrepancy.

3 Analysis of results obtained in the Activities in A4.6

In the following sections we report the activities for the implementation of the A4 demonstrator. The activities scheduled in the Dow in **Task TA4.6** are described, along with the technical problems and limitations encountered in each of these activities.

3.1 Development and test of the stand-alone DSS

The development and tests of the stand-alone DSS are reported extensively in deliverable DR8.8 and DR8.9. The integrated DSS is presented in DR8.11 The reader should refer to these documents for any detail on the DSS. The following paragraph recalls the components integrated in the demonstrator and presents some snapshots of the final system.

3.2 Provide suitable data for the integration Middleware, PDKM and DSS

Sample data has been provided to test the algorithms, to test the models and to test the interfaces. Furthermore a PMI has been developed by CRF to ease the data upload towards the PDKM. Annex A reports the structure of the PMI xml file, including a data sample.

3.3 Integration Middleware – PDKM – DSS

In addition to the initial objectives of the Task 4.6, a dedicated middleware has been developed to automate the data upload form the vehicles (see Annexe A).

Integration of the following components (in bold the components specifically developed in PROMISE) has been performed:

1. Data busses on-board of vehicles (B-CAN): collect on-board data on the real use of the vehicle, which enable to compute the residual life of the components;
2. A4-specific **algorithms for residual life**, developed by CRF;
3. Convergence®, the proprietary telematics platform of the FIAT Group: acts as a repository for lifecycle data; aggregates data; calculates residual life of components using the algorithms mentioned in point 2 above;
4. A4-specific **database** developed by and hosted in CRF: collects data coming from the vehicle during lifecycle;
5. A4-specific **PMI** developed by CRF: transfers data towards PDKM;
6. **PDKM**, developed by Inmediasp and hosted by SAP: acts as a repository of lifecycle data, enables computations in DSS;
7. **Algorithms for maintenance plan calculation**, developed by ITIA: calculates the optimal maintenance plan;
8. **DSS**, developed by Cognidata and hosted by SAP: integrates the algorithms mentioned in point 8 above;
9. DSS and PDKM **GUI** developed by SAP: creates the interface with the user.

We report some snapshots of the integrated system.

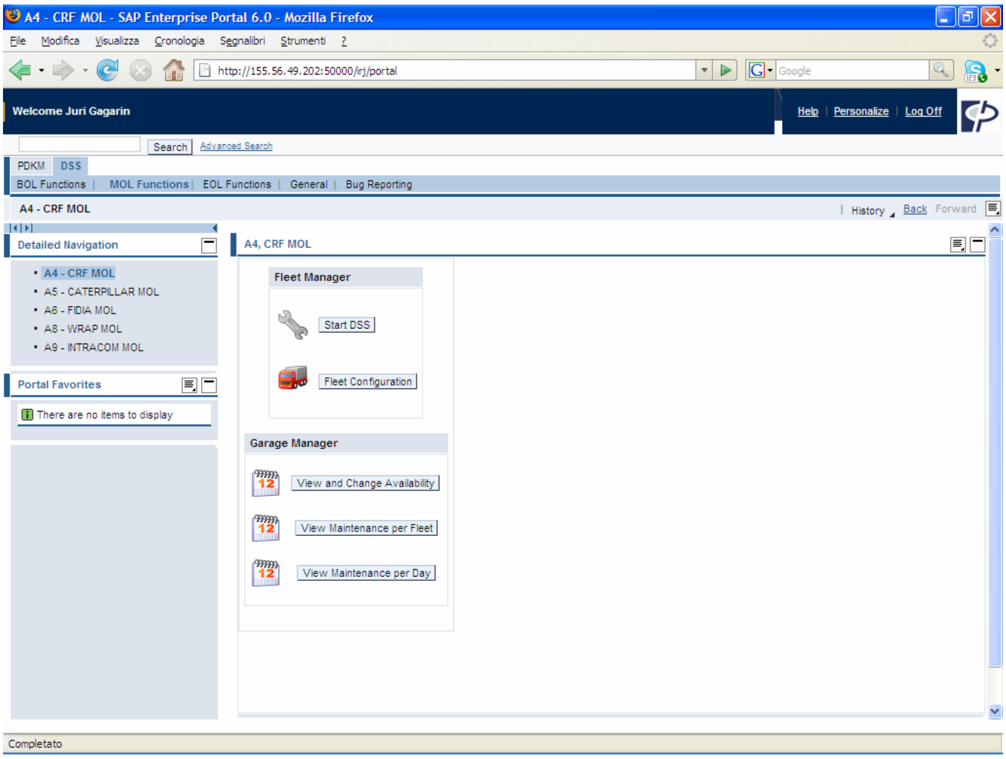

Figure 2: Starting the DSS

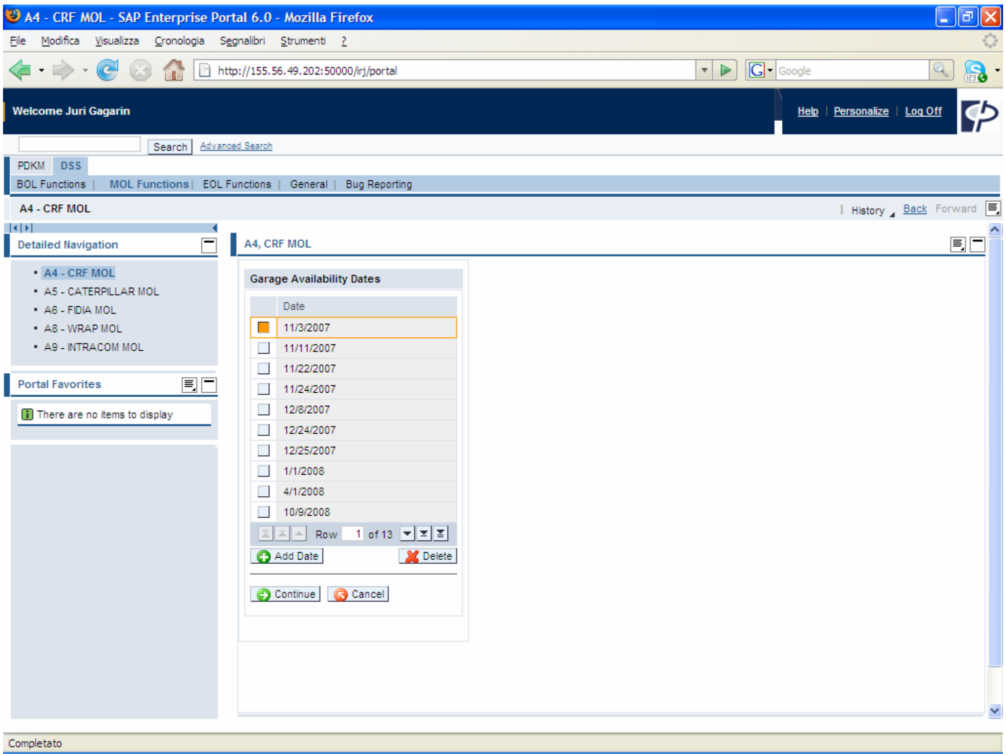

Figure 3: Modifying the garage availability

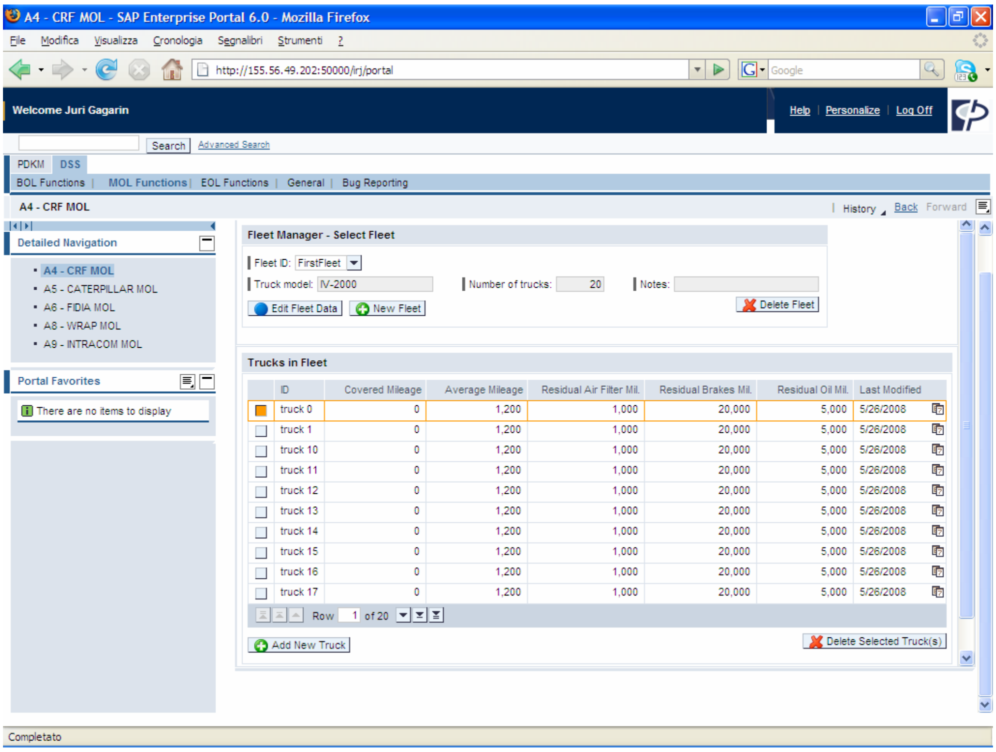

Figure 4: Defining the fleet

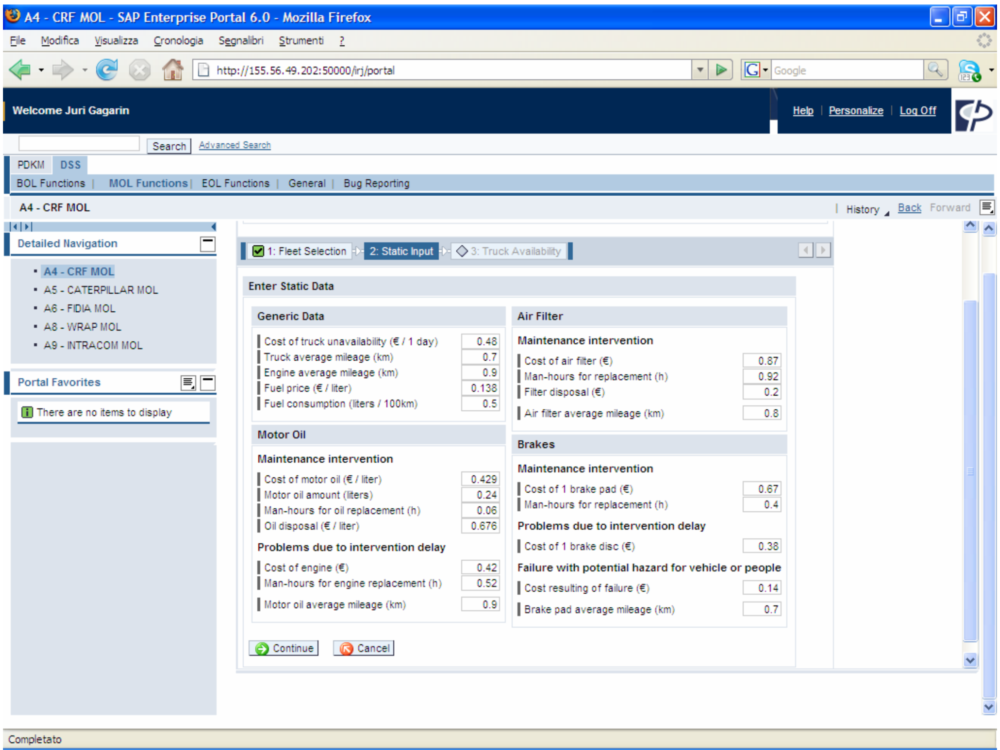

Figure 5: Specifying the static input

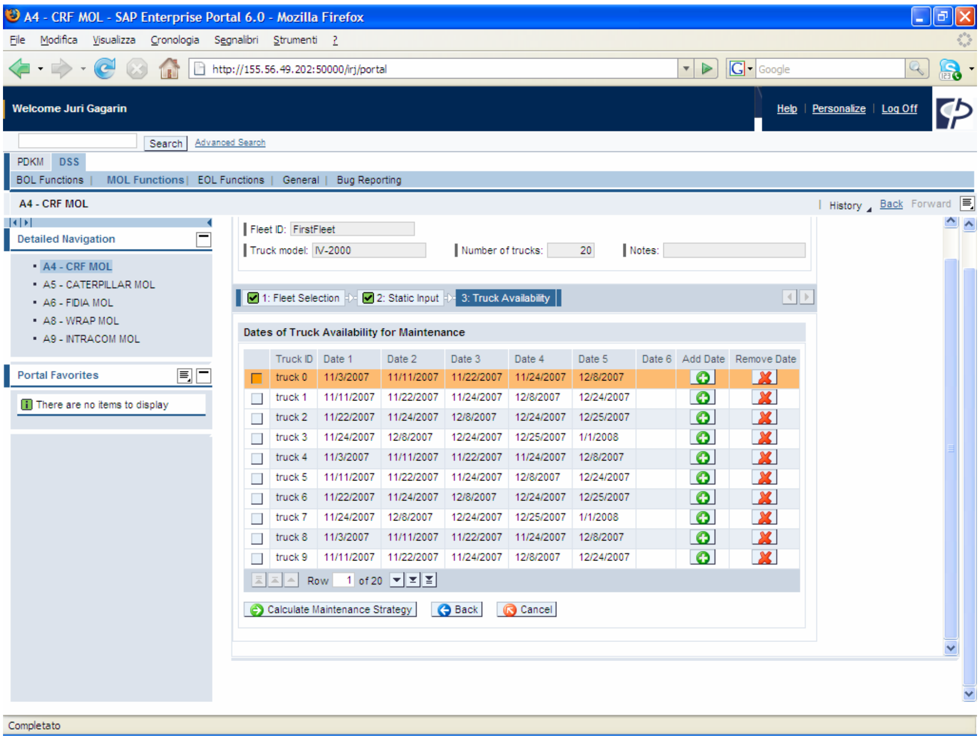

Figure 6: Calendar of maintenance

4 Conclusion

The present deliverable report the results obtained in implementing the PROMISE A4 demonstrator. The demonstrator shows the integration of all PROMISE components in order to solve the issue at stake: the decision support for maintenance of trucks during the Middle-of-Life.

The main issues to be solved were the development of statistical models for residual life evaluation, for calculation of the maintenance plan, taking into account the many variables (availability of the maintenance crew, cost of unavailability of the vehicle, of the components…). All these issues were solved in time, with innovative approaches, ahead of the IVECO competitors.

Regarding communication, no major problems were expected, as it relies on the existing architecture (Convergence, vehicle busses).

From a business point of view (which is further elaborated in DA4.7) the integration with the existing Blue&Me Fleet architecture is a major advantage of the approach and is key for a quick industrialisation of the demonstrator.

In synthesis, the objectives of the demonstrator have been fully met.

5 References

DA4.3: Design of the A4 Demonstrator on Predictive Maintenance for Trucks, N. Francone, J. Mascolo, CRF, May 12th 2006.

DA4.4: Process model workflow description for the demonstrator, Julien Mascolo, Francesca Bandera, CRF, Celal Dikici, BIBA, Nov 20th 2006.

DR8.9. Testing and Evaluation of the DSS demonstrator (Version 3), Coordinator COGNIDATA, March 15th 2008.

DR8.11. Refinement and Improvement of the decision support demonstrator (Final version), Coordinator COGNIDATA, May 15th 2008.

Annexe A PMI for A4 – Sample of data


```
  <?xml version="1.0" encoding="UTF-8" ?>
- <pmiEnvelope type="dataResponse" version="2.0">
- <dataResult type="read">
- <result>
- <targetDevices>
- <targetDevice>
  <id>10000505</id>
- <infoItems>
- <infoItem>
  <id>TRUCK_COV_MIL</id>
  <value timestamp="2007-02-10T12:00:00">60000</value>
    </infoItem>
- <infoItem>
  <id>KILOMETERS_PER_DAY</id>
  <value timestamp="2007-02-10T12:00:00">250</value>
    </infoItem>
    </infoItems>
    </targetDevice>
- <targetDevice>
  <id>10000517</id>
- <infoItems>
- <infoItem>
  <id>AIR_FILTER_RES_MIL</id>
  <value timestamp="2007-02-10T12:00:00">50000</value>
    </infoItem>
    </infoItems>
    </targetDevice>
- <targetDevice>
  <id>10000518</id>
- <infoItems>
- <infoItem>
  <id>BRAKES_RES_MIL</id>
  <value timestamp="2007-02-10T12:00:00">30000</value>
    </infoItem>
    </infoItems>
    </targetDevice>
- <targetDevice>
  <id>10000519</id>
- <infoItems>
- <infoItem>
  <id>MOTOR_OIL_RES_MIL</id>
  <value timestamp="2007-02-10T12:00:00">40000</value>
    </infoItem>
    </infoItems>
    </targetDevice>
    </targetDevices>
    </result>
    </dataResult>
    </pmiEnvelope>
```