DR9.12: Definition of Additional Use Cases for Closed-loop PLM

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ABSTRACT	This deliverable is a continuation of DR9.10 and describes further representative use cases that have as common topic the Closed Loop Product Data Management. Like in DR9.10, a major focus is the support of the Closed-loop PLM processes by the DSS and PDKM. While DR9.10 contains use cases from the PROMISE application scenarios A1, A8, and A10, this deliverable covers use cases from other application scenarios, namely A2, A4, A6, and A11.

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Abbreviations

BOL	Beginning of Life
CNC	Computerised Numerical Control
DfX	Design for X
DoW	PROMISE Description of Work
DSS	PROMISE Decision Support System
ECM	Engine Control Module
ELV	EOL Vehicle
EOL	End of Life
GUI	Graphical User Interface
LCC	Life Cycle Cost
MOL	Middle of Life
OEM	Original Equipment Manufacturer
PDKM	Product Data and Knowledge Management
PDM	Product Data Management
PEID	Product Embedded Information Device
PLM	Product Life-cycle Management
PROMISE	PROduct life cycle Management and Information tracking using Smart Embedded systems
RFID	Radio Frequency IDentification
UML	Unified Modelling Language
WP	Work package of PROMISE project
XML	eXtensible Mark-up Language

1 Introduction

1.1 Objectives of Task TR9.12 and scope of this deliverable

Task TR9.12 is the continuation of task TR9.10 that resulted in DR9.10 where a first set of PDKM use cases has been described. TR9.12 aims at identifying additional use cases to demonstrate the feasibility and value of Closed-loop PLM.

The objective of task TR9.12, and thus of deliverable DR9.12, is to provide descriptions for further BOL, MOL, and EOL use cases inspired/motivated by the PROMISE application scenarios and demonstrators. Hence, the document is structured according to application scenarios. However, it should be noted that the descriptions of the application scenarios available until now are most often DSS-centric; so until now, the usage of the PDKM in the application scenarios is very little described compared to the role of the DSS. Like the use cases previously presented in DR9.10, the use cases identified in TR9.12 should be representative in the sense that they support as many PROMISE application scenarios as possible, not necessarily restricted to the application scenarios covered by the PROMISE project's application cluster.

1.2 Overall modelling approach

Following the same modelling approach already taken in DR9.10, we use for most use cases UML (Unified Modelling Language) Use Case Diagrams (see [Coc01], [Fow04]) to present the use cases described in this deliverable. A UML Use Case Diagram is a graphical summary, potentially with reference to a given system, of the use cases and of the actors participating in each use case. The diagram also represents the relationships between use cases, if needed. For some use cases, we chose other graphical representations that seem to illustrate relevant aspects of the respective uses case better. In addition to these diagrams, detailed textual descriptions are needed for the system developers to implement the corresponding use cases. These descriptions are specified using the same set of terms already proposed in DR9.10. For the reader's convenience, the following table gives a brief explanation of the terms employed for the detailed description of the use cases.

Table 1: Template for the textual description of use cases

Actors	It is a *role* played by a user in relation with the system. The same user can sometimes play, depending on the case, different roles in different use cases. Moreover, sometimes, depending also on the specific case under study, the same role can be played by different users in a given use case.
Preconditions	It describes, which conditions must be satisfied, before the use case starts.
Triggers	It declares precisely, which event gives the starting shot to the use case.
Warranty	It describes what the system surely provides to the user at the end of the use case. The *main success scenario* (see next row) guarantees the arrival to the user's primary scope; anyway, it might sometimes be the case that "minor" results are achieved independently of, which alternative path was followed. These are called "*warranty*".
Main success scenario	It represents the sequence of user/system interactions in the case where the primary final scope of the user is achieved. No real standard for the enumeration of the different steps exists.
Alternative scenarios	It represents extensions to the *main success scenario*, describing deviations from the "primary flux" described by it. Again, no real standard for the enumeration of the different steps exists.

1.3 Brief document overview

The remainder of this document is structured as follows:

- Section 2 documents the use cases belonging to the A2 PROMISE application scenario and demonstrator (EOL/Recycling of heavy construction machines of Caterpillar).
- Section 3 documents the use cases belonging to the A4 PROMISE application scenario and demonstrator (MOL/Maintenance of vehicles of FIAT).
- Section 4 documents the use cases belonging to the A6 PROMISE application scenario and demonstrator (MOL/Maintenance of machine tools of FIDIA).
- Section 5 documents the use cases belonging to the A11 PROMISE application scenario and demonstrator (BOL information management for Adaptive Production of POLIMI).
- Finally, Section 6 concludes this report.

2 Use Cases for Application Scenario A2

2.1 General Description of A2

Using the product information captured by means of PEIDs, the A2 scenario demonstrates the capability of early determining the end of life of main engine components, in particular Engine blocks, Cylinder heads, Camshaft, Crankshaft, Turbocharger, and Pumps. Such information includes Bill of Materials (BOM) of the engine core, and Depreciation Status estimated on the main engine components. These kinds of information are constantly updated during service life of the engine: BOM is changed if components are replaced and the Depreciation Status is set according to the maintenance events and service operating conditions.

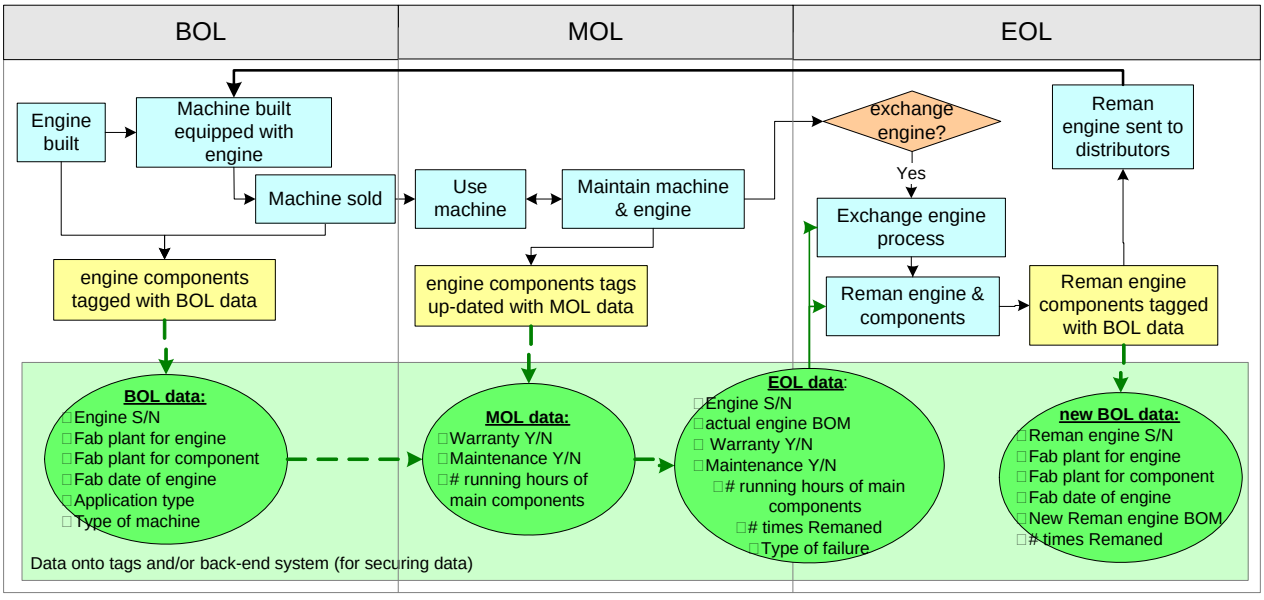

Figure 1: Overview of the A2 application scenario

The figure above from [DA2.3] describes the lifecycle phases of the engine components and the information flow between the phases:

- At BOL, i.e. when the components are assembled to a new engine, the BOL data is tagged to the components and written to the backend system
- During MOL, service maintenance and part change may occur, leading to updates of BOM data and maintenance information

- At EOL, decision is made on engine components reuse, remanufacturability or disposal/scrapping according to their wear status. If a component is selected for reuse or remanufacturing, it starts a new BOL as a CAT "Reman" product after the corresponding step.

Along these lifecycle phases of CATERPILLAR's engine components, we will present in the following four different use cases and describe how they are supported by the PDKM.

2.2 Use Case 1: Engine and Product Assembling

In this use case, BOL data, such as build date, location, and the Bill of Materials (BOM) for the engine, is collected and written into the PDKM and on tags to be attached to the engine components. This is performed first at an Engine Facility of CATERPILLAR, where engine components are manufactured or received from suppliers and then assembled into the engine core or complete engine, then at a Manufacturing Facility where the engine is put into a machine. The next figure illustrates the process flow in the use case:

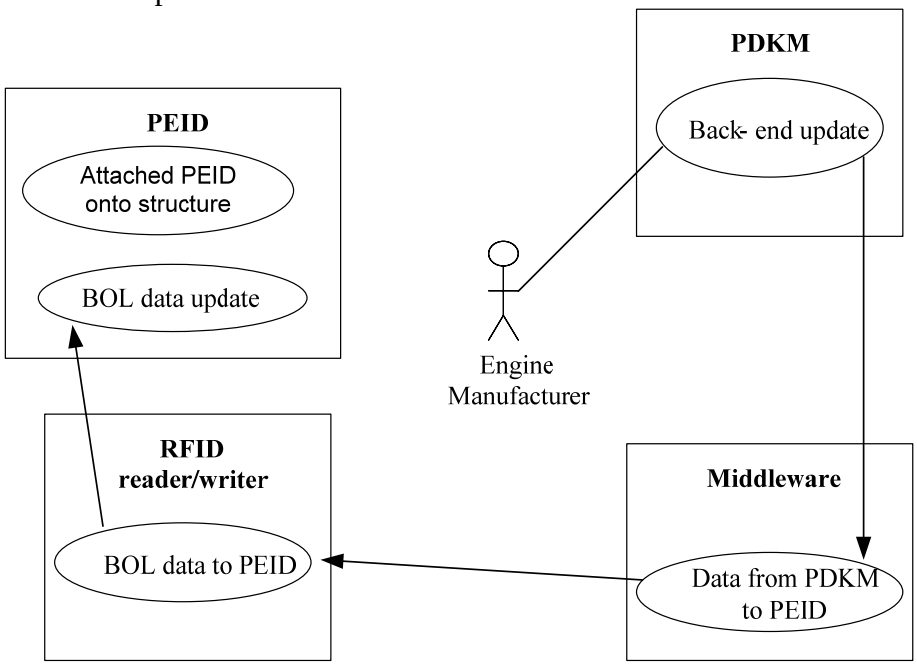

Figure 2: Diagram for the use case "Engine and Product Assembling"

Table 2: Textual description of the use case "Engine and Product Assembling"

Actors	Engine Manufacturer, Product Manufacturer
Preconditions	• The actor has logged into the PDKM system. • The actor has been recognized with one of the roles presented in the previous row.
Triggers	• The new engine and engine components are at an Engine or Manufacturing facility of CAT, which supports connection to the PDKM and PEID (via PROMISE Middleware). • The actor chooses the function "Backend Update for New Product" element from the BOL menu of the PDKM.
Warranty	The actor gets a synoptic view as well as a detailed view on the information items related to the corresponding engine components to be updated for the new engines.

Main success scenario	1> The actor selects the function “Backend Update for New Product” from the BOL menu of the PDKM. 2> The actor uses the PDKM function to generate a serial number for the engine. 3> The actor browses from the synoptic to the detailed view on the information items to be filled in for the new engine and its components. 4> The actor uses the PDKM function to prepare BOL data for each relevant component, namely engine block, cylinder head, and crankshaft, of the engine using the same obtained serial number and enters the required information items: - Engine serial number - Component serial number - Build date - Fabrication plant - etc. 5> The actor uses the PDKM function to generate a Bill of Materials (BOM) or “as-produced product structure” for the engine. 6> The actor saves the “as-produced product structure” into the PDKM under the generated serial number of the engine. 7> The actor uses the PDKM function to successively write the prepared BOL data onto the PEID (tags) of all relevant engine component: - engine block - cylinder head - crankshaft 8> The actor attaches the PEID (tags) to each engine component and the engine itself.
Alternative scenarios	The actor changes the order of the write operations: 1> The BOL data is written onto the PEID for each engine component. 2> The PEID is attached to the corresponding engine component and the engine. 3> The BOM (“as-produced product structure”) is then generated and saved to the PDKM.

2.3 Use Case 2: Maintenance Recording

This use case deals with the MOL operation of CATERPILLAR machines. After being sold to a customer, a CATERPILLAR machine will regularly return to the dealer for repairs and maintenance. When a machine is brought in and engine maintenance work is done, the maintenance technician at the dealer’s garage will record what has been done in addition to the date of the event and the hours on the machine. This data will be written to the PDKM for later retrieval. The next figure illustrates the flow of the use case:

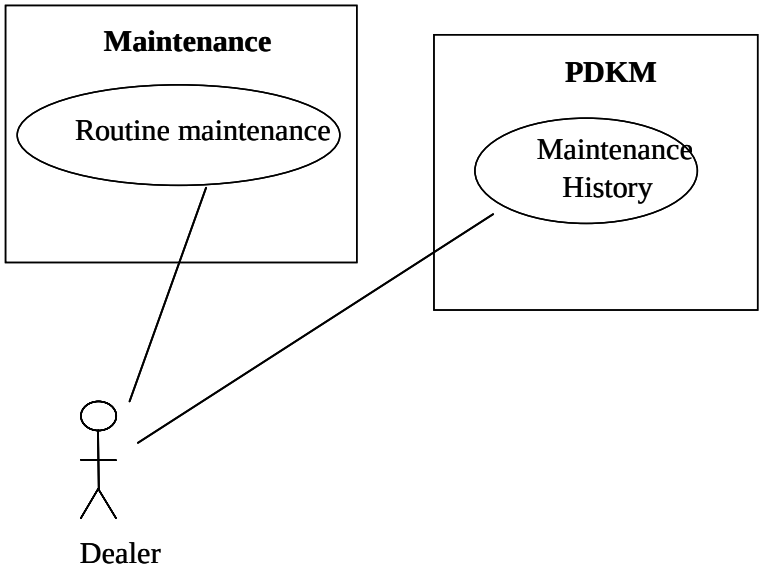

Figure 3: Diagram for the use case "Maintenance Recording"

Table 3: Textual description of the use case "Maintenance Recording"

Actors	Maintenance Technician of Dealer
Preconditions	• The garage supports connection to the PDKM and PEID on the machine (via PROMISE Middleware). • The actor has logged into the PDKM system. • The actor has been recognized with the role presented in the previous row.
Triggers	• The CATERPILLAR machine is at the garage of a CAT dealer for maintenance. • The actor chooses the function "Backend Update for Maintenance Information" element from the MOL menu of the PDKM.
Warranty	• The actor gets a synoptic view and a detailed view on the information items related to the maintenance of the engine and engine components. • Maintenance information and operation hours of the machine/engine will be updated in the PDKM with the new data read from the ECM.
Main success scenario	1> The actor uses a PDKM function to read the serial number of the machine and/or the engine from the ECM. 2> The actor uses a PDKM function to read operation hours, fuel consumption, etc., recorded in the ECM for all engine components. 3> The actor uses a PDKM function to update such information in the PDKM for the corresponding components. 4> The actor adds all performed maintenance activities to the maintenance history for the engine and machine. 5> The actor set the Maintenance (Y/N) flag as well as Warranty (Y/N) flag in the PDKM for the machine and the engine. 6> The actor uses a PDKM function to update the maintenance history as well as warranty information on the PEID of the engine (tag) and of the machine (ECM), which is done by a write operation through the PROMISE Middleware to the corresponding PEIDs.
Alternative scenarios	-

2.4 Use Case 3: Component Removal

In this use case, we describe the use of the PDKM to support the EOL process of components, i.e. component removal and replacement from a CATERPILLAR machine at a dealer site. This scenario complements Use Case 2 presented in the last section. In particular, when a tagged engine component, such as a crankshaft, is identified to be remanufacturable, the engine tag is to be updated with the new BOM with history of the part replacement. Furthermore, the PEID of the component will be updated with its EOL information (Operating hours, fuel consumption, warranty, core return credit, reason for failure, date of failure). The next figure illustrates the process flow in the use case:

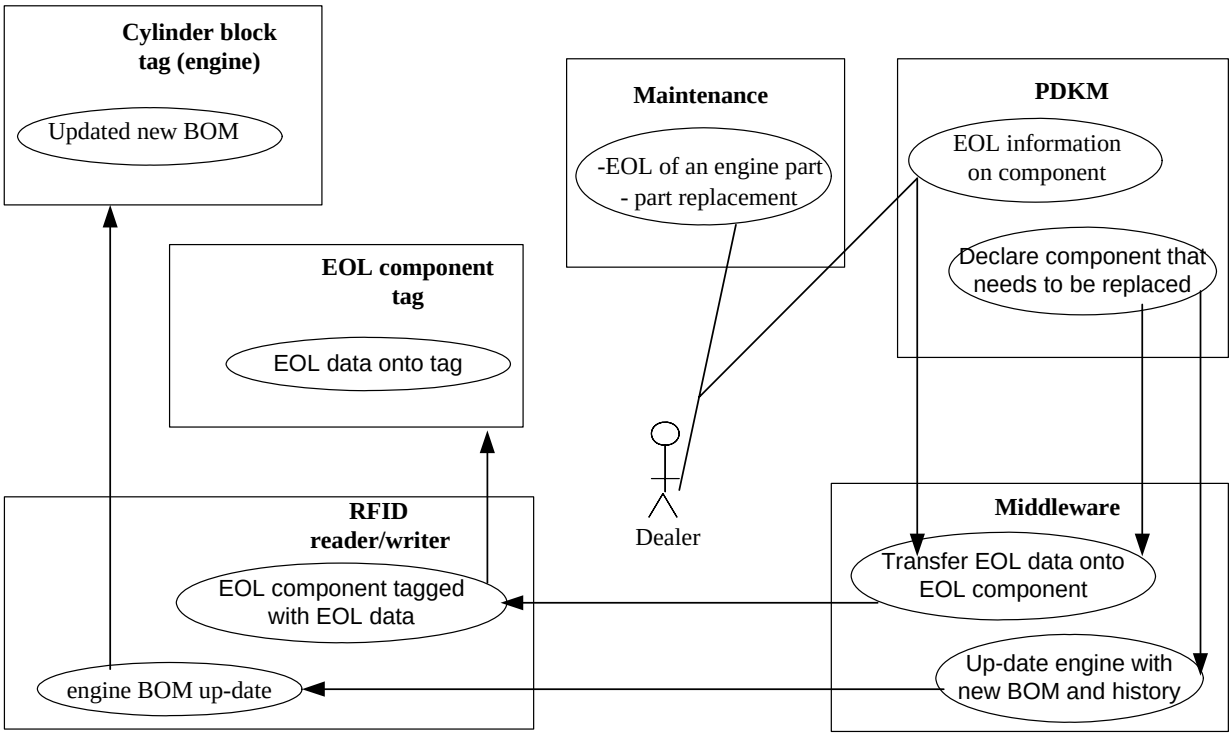

Figure 4: Diagram for the use case "Component Removal"

The new or replacement component will be entered into the PDKM, the date that the part was changed will be recorded, and the totalized ECM data will be stored for later use as BOL data in the DSS when it reaches its EOL. The information that must be put on the new or replacement components RFID tag will be written at this time.

Table 4: Textual description of the use case "Component Removal"

Actors	Maintenance Technician of Dealer
Preconditions	• The garage supports connection to the PDKM and PEID on the machine (via PROMISE Middleware). • The actor has logged into the PDKM system. • The actor has been recognized with the role presented in the previous row.
Triggers	• The CATERPILLAR machine is at the garage of a CAT dealer for maintenance. • The actor chooses the function "Backend Update for Maintenance Information" element from the MOL menu of the PDKM.

Warranty	• The actor gets a synoptic view and a detailed view on the information items to be updated on the engine and product. • The BOM of the machine and the engine is updated (by replacing the old components with the new components) in the PKDM as well as on the PEIDs of the products. • BOL information (operation hours, warranty) is initialized for new installed components. • EOL information (operation hours, fuel consumption, failure cause) is written onto PEIDs (tag) of the removed components.
Main success scenario	1> The actor uses a PDKM function to read the serial number of the machine and/or the engine from the ECM. 2> The actor uses the DSS functionality of the PDKM to identify components to be removed from the machine and/or engine. 3> The actor uses the PDKM functionality to identify the new components to be installed into the machine in order to replace those to-be-removed components. 4> The actor uses a PDKM function to initialize the operation hours and other data, such as, fuel consumption, warranty of the new components in the PDKM. 5> The actor uses a PDKM function to generate and store in the PDKM the new BOM for the machine and engine with the old components replaced by the new components. 6> The actor uses a PDKM function to update the BOM of the machine and engine on the PEID (Tag) of the engine and the ECM of the machine (the old BOM will be overwritten on the engine PEID and in ECM of the machine). 7> The actor uses a PDKM function to write total EOL data, namely operating hours, fuel consumption, warranty, core return credit, reason for failure, date of failure, onto the PEIDs (tags) of the to-be-removed components.
Alternative scenarios	Alternative for initializing the operation hours, fuel consumption, and warranty of the new components if they are used ones: 4a> The operation hours and fuel consumption of the new components are copied from the PDKM, if the new component is a used one and such information already has been captured for the component and stored in the PDKM.

3 Use Cases for Application Scenario A4

3.1 General Description of A4

The overall objective of the A4 demonstrator is to support the maintenance of a truck fleet, optimising the maintenance plan, and increasing the overall availability of trucks. Closing the information loop using the demonstrator “Information management for predictive maintenance” will improve the knowledge about the customer habits and the mission profile of the vehicles. The idea behind predictive maintenance is the identification of slow degradation trends in the performance of specific systems in order to identify with a reasonable advance the need of an intervention. This allows the optimisation of maintenance intervention with the implementation of a personalised intervention policy and contributes to make explicit the residual life of the component in order to manage the total life cycle cost (LCC) better.

3.2 Use Case Diagram

Figure 5 represents the use case diagram concerning the truck fleet management carried out by the actors fleet manager, design engineer, and garage crew. There is a high interrelationship between the represented use cases. There is no sequence order between the use cases, nevertheless the use case “Browse fleet structure“ provides a basis for other use cases.

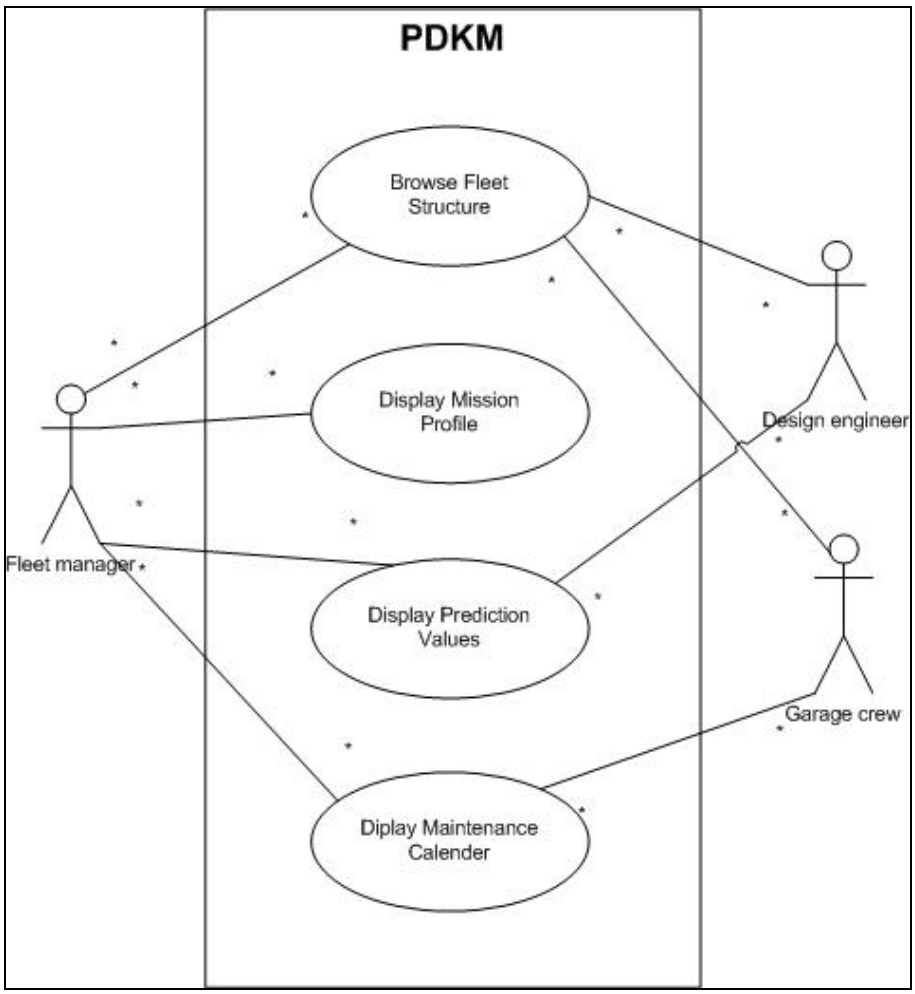

Figure 5: Use Case diagram for the A4 demonstrator

3.3 Use Case 1: Browse fleet structure

Table 5: Textual description of the use case “Browse fleet structure”

Actors	Fleet manager, design engineer, garage crew
Preconditions	• The user has logged into the system. • The fleet structure has been initialised and changes have been updated.
Triggers	The PDKM user chooses the functionality to browse the product structure in the MOL functions menu.
Warranty	The user is able to browse through the product structure.
Main success scenario	1> The user is able to select a truck type. 2> The user will be presented with all the product instances with the specified product type. 3> The user can select a product instance and detailed information regarding this instance will be displayed in the PDKM window.

Alternative scenarios	1> The user is able to enter a fleet number. 2> The user will be presented with all the truck instances that belong to the specified fleet. 3> The user can select a truck instance and detailed information regarding this instance will be displayed in the PDKM window.

3.4 Use Case 2: Display mission profile

Table 6: Textual description of the use case "Display mission profile"

Actors	Fleet manager
Preconditions	The fleet manager has specified a truck instance.
Triggers	The fleet manager chooses functionality to display the mission history for the selected truck instance.
Warranty	The fleet manager is able to view the mission history for the selected truck instance.
Main success scenario	1> The fleet manager will be presented with a list containing the mission information for the respective truck instance. 2> Mission information could consist of a description, mission ID, start date, end date, and range.
Alternative scenarios	-

3.5 Use Case 3: Display prediction values

Table 8: Textual description of the use case "Display prediction values"

Actors	Fleet manager, design engineer
Preconditions	The user has specified a truck instance.
Triggers	The user chooses functionality to display the prediction values for the selected truck instance.
Warranty	The user is able to view the prediction values for the selected truck instance.
Main success scenario	1> The user will be presented with a list containing the prediction values for the respective truck instance. 2> Prediction values include residual lifetime estimations and other values.
Alternative scenarios	-

3.6 Use Case 4: Display maintenance calendar

Table 9: Textual description of the use case "Display maintenance calendar"

Actors	Fleet manager, garage crew
Preconditions	The user has specified a truck instance.
Triggers	The user chooses functionality to display the maintenance calendar for the selected truck instance.
Warranty	The user is able to view the suggested maintenance dates for the selected truck instance.

Main success scenario	1> The user will be presented with the decision support information calculated in the DSS based on the information regarding garage availability and estimated residual lifetime values. 2> Maintenance dates for the selected truck instance will be suggested.
Alternative scenarios	-

4 Use Cases for Application Scenario A6

4.1 General Description of A6

The main objective of the A6 application is to develop a Predictive Maintenance solution for their milling machines. FIDIA machines are often customised according to the needs of each individual customer. Because of this, high costs are usually incurred in production losses due to machinery breakdown, customers' 'on-site' assistance during the set-up stages, as well as during the later stages of the life cycle of the machine whenever maintenance work is needed. This holds especially in the frequent case where the user site is several hundreds or thousands of kilometres from the supplier site. Modern Information Technologies offer the opportunity of dramatically reducing machine unavailability by enhancing their diagnostic performances.

Due to the complexity of the scenario, several solutions have been proposed by the support of the technology providers. Currently, the solution that best fits the FIDIA demonstrator uses the PROMISE Middleware, which is the essential communication infrastructure between PEIDs, PDKM, and DSS, at a FIDIA central location and treats the CNC machine as a top-level PEID and RFID tags as low-level PEIDs. This means that the CNC machine would be treated as PEID and managed by the remote Middleware.
PROMISE DSS can be found locally on the customer's CNC machine in a simplified version as well as on the FIDIA central server. Predictive maintenance actions could be done in both sites. PDKM resides in a central server.

4.2 Workflow Diagram

Figure 6 represents the workflow diagram concerning the FIDIA scenario. Table 7 contains information about the elements used in this diagram. Further details about the A6 workflow can be found in [DA6.4], from which also this figure and table have been taken from. The details of the process steps P3 to P6 make up the use cases described in the following sections.

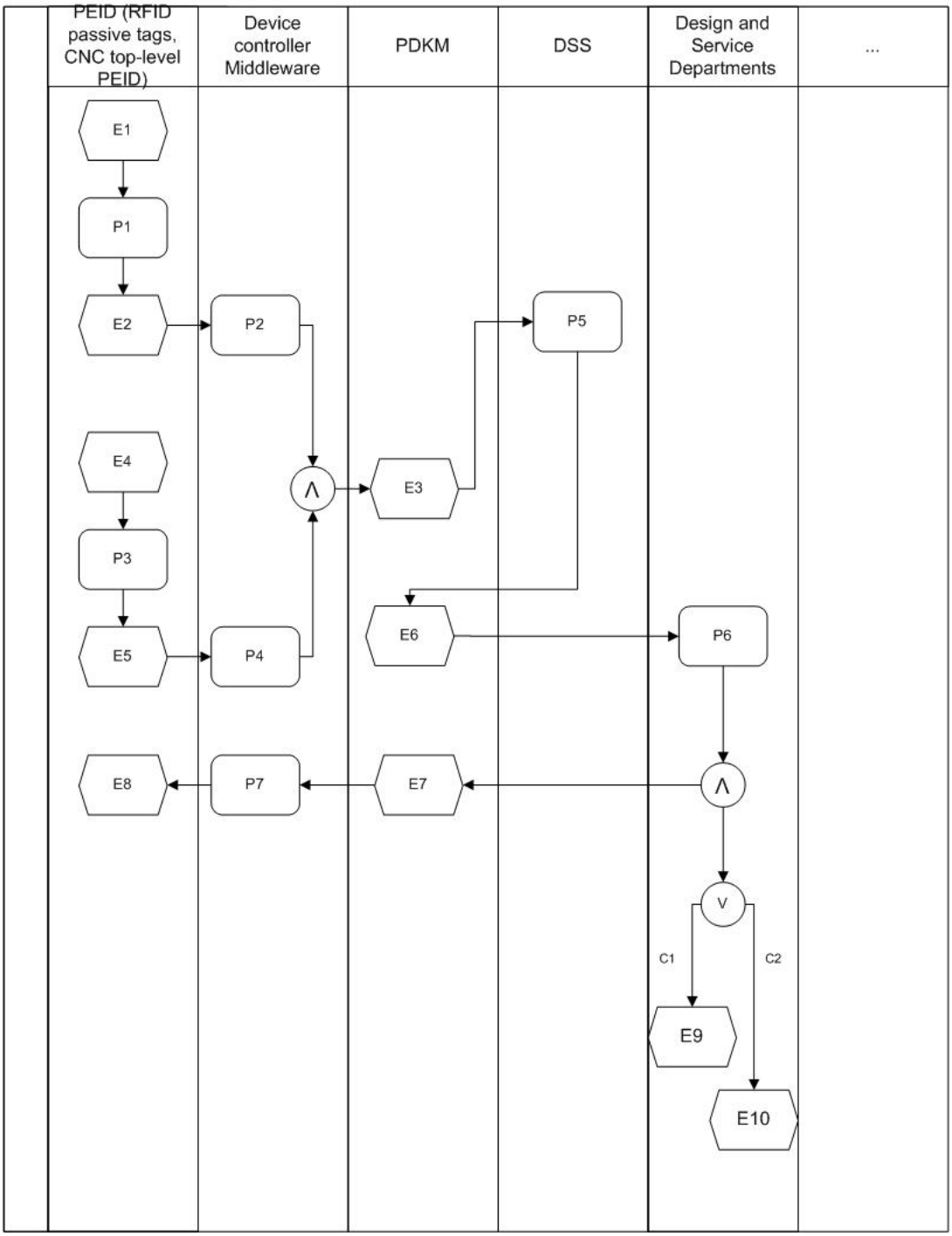

Figure 6: Workflow diagram for the A6 demonstrator

Table 7: Information flow description for the workflow diagram

Modelling components		Description
Process	P1	Updating process of BOL data
	P2	Transfer process of BOL data onto PDKM by Middleware
	P3	Process of execution of Predictive Maintenance Tests
	P4	Transfer process of MOL data onto PDKM by Middleware

	P5	DSS Predictive Maintenance Analysis; the FIDIA Predictive Maintenance DSS is divided into: 1) ageing module 2) maintenance cost management module
	P6	Evaluation of maintenance actions, planning of service interventions, updating the PDKM
	P7	Transfer process of MOL data onto PEIDs by middleware
Event	E1	RFID tags are applied on the mechanically critical components
	E2	RFID tags are updated with BOL data
	E3	PDKM is updated with all BOL and MOL data
	E4	Scheduled maintenance test on the machine
	E5	CNC stores Predictive Maintenance test results
	E6	DSS results are available on PDKM
	E7	PDKM is updated
	E8	PEIDs are updated
	E9	Maintenance instruction transmission to the service personnel
	E10	Maintenance program transmission to the service personnel and/or the customer
Condition (at branching and merging)	C1	Immediate action
	C2	Scheduled action

4.3 Use Case {P3, P4, P5}: Process of execution of Predictive Maintenance Tests

Table 8: Description of the use case "Predictive Maintenance Tests"

Actors	Service technician
Preconditions	• The user has logged into the system. • The machine has carried out a "health state" test. • The on-CNC-DSS has analysed the test results. • All data has been stored in the PDKM.
Triggers	The machine periodically executes "heath state" tests.
Warranty	The user is able to browse through the product structure.
Main success scenario	1> The user is able to select a machine. 2> The user will be presented with all the test data generated by the tests. 3> The user can see the best decision for the respective machine as suggested by the DSS. 4> The user is able to change the decision of the PDKM system's DSS.
Alternative scenarios	-

4.4 Use Case P4: Transfer process of MOL data onto PDKM by middleware

Table 9: Description of the use case "Data Transfer into PDKM (manually triggered)"

Actors	Service technician

Preconditions	• There is a Middleware connection to the CNC machine. • Since the service technician wants to control the data flows, the system is configured in way that he has to start data transfer from the CNC machine to the PDKM manually[1].
Triggers	The on-CNC-DSS has displayed an alert to the CNC-user informing about critical conditions and the CNC-user has informed the Service technician about that circumstance.
Warranty	The user is able to transfer data from the CNC machine to the PDKM.
Main success scenario	1> The service technician logs into the PDKM and selects the PDKM's representation of the CNC machine. 2> The service technician starts PDKM functionality to transfer all relevant data from the CNC machine to the PDKM. 3> The service technician browses the received data.
Alternative scenarios	-

4.5 Use Case P5: Predictive Maintenance Analysis

Table 10: Description of the use case "Predictive Maintenance Analysis"

Actors	Service technician
Preconditions	• The user has logged into the system. • New Predictive Maintenance Test results have been transferred to the PDKM.
Triggers	The on-CNC-DSS has displayed an alert to the CNC-user informing about critical conditions and the CNC-user has informed the Service technician about that circumstance.
Warranty	The user is able to browse through the product structure.
Main success scenario	1> The service technician checks different data such as maintenance history and compares the respective machine with others.
Alternative scenarios	2> Supported by the DSS, the service technician is doing ageing analysis and cost estimations for different maintenance actions and judges about alternative measures.

4.6 Use Case {P5, P6}: Evaluation of maintenance actions, planning of service interventions

Table 11: Description of the use case "Maintenance actions and service interventions"

Actors	Service technician
Preconditions	• The user has logged into the system. • New Predictive Maintenance Test results have been transferred to the PDKM.
Triggers	Periodically
Warranty	The user is able to browse through the product structure.

[1] The PROMISE System offers also functionality to support automatic data transfers. However, in some situations, as e.g. the system's set up phase, the manual triggering of data transfer is preferred by users.

Main success scenario	1> Analysis of critical conditions; collection of all useful data from PDKM 2> Identification and planning of required maintenance activities by using the DSS 3> Integration of these activities into the current maintenance schedule
Alternative scenarios	-

5 Use Cases for Application Scenario A11

5.1 General Description of A11

The PROMISE A11 application scenario basically concerns, in the PROMISE PDKM viewpoint, the management of information on product types and of a number of related documents. These pieces of information are in most cases contained in appropriate documents, which are represented by files of different formats (.pdf, .doc, .dwg, .dxf, etc.).

The A11 document types to be managed by the PROMISE PDKM, in the context of the PROMISE A11 Demonstrator, are listed in the following:

- **RPM**: Request of Product Modification
- **TO**: Technical Offer
- **FO**: Final Offer
- **OPM**: Order of Product Modification
- **IM**: Implemented Modification
- **D**: Drawing
- **PS**: Process Specification
- **SS**: System Specification

The creation of these documents happens in most cases outside of the PDKM system, sometimes in the PROMISE DSS, except for the RPM, TO, and FO documents, where the creation of these documents happens in the PDKM (see details below).

Summarising the use cases described in the following sections, the requirements on PDKM functionalities for the A11 application scenario with respect to document management are the following:

- Insert/create a new document (of a given type) related to a given product type. This should be possible, depending on the document type:
  - By compiling a form (RPM, TO, and FO documents), and then by saving what has been inserted into a new file of a pre-specified extension, depending on the document type
  - By selecting the file (OPM, IM, D, PS, and SS documents) of interest from an appropriate directory/location in the file system
- Modify an existing document (only for the RPM, TO, and FO documents) related to a given product type and save the modifications either in the same file or in a new file of the same type. The rest of the document types can only be modified by appropriate DSS functionalities or other software systems.
- Delete an existing document (of any given type) related to a given product type.
- Browse existing documents for a given product type

Restricting to the use cases described here, the single requirement on PDKM functionalities for the A11 application scenario not concerning document management is:

- Browse existing product types and the related product structures

5.2 Use Case Diagram of the A11 Demonstrator

The next figure presents the use case diagram for the A11 demonstrator. This is intended to provide a synoptic view of the different functionalities requested by each user. The core portion of the use cases description is then contained in the following sections, where each use case is described in detail.

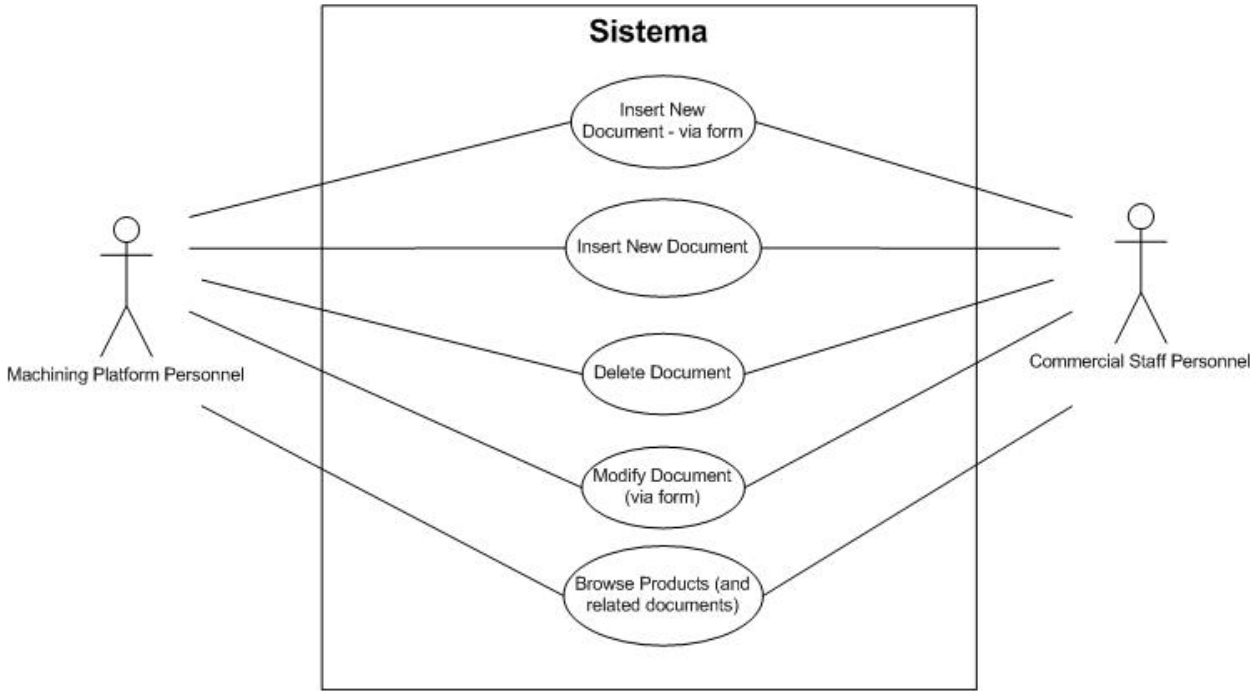

Figure 7: Use Case diagram for the A11 demonstrator

5.3 Use Case 1: Insert New Document (via form)

Table 12: Description of the use case "Insert New Document via form"

Actors	Machining Platform Personnel, Commercial Staff
Preconditions	• The actor has logged into the system. • The document to be modified is of one of the following document types: RPM, TO, FO.
Triggers	The actor wants to insert a new RPM/TO/FO document.
Warranty	-
Main success scenario	1> The actor selects the functionality to insert a new document via form. 2> The actor is presented with the related form, which is empty if the actor starts from scratch, or which is pre-compiled with some information if the actor starts from an existing document of the same type. 3> If the actor owns the required access rights, he can finalize the insertion of the new document.
Alternative scenarios	3.1> If the actor does not own the required access rights, he is prompted not to attempt to insert the new file and the insertion is aborted.

5.4 Use Case 2: Insert New Document

Table 13: Description of the use case "Insert New Document"

Actors	Machining Platform Personnel, Commercial Staff
Preconditions	• The actor has logged into the system. • The document to be modified is of one of the following document types: OPM, IM, D, PS, SS.
Triggers	The actor wants to insert a new OPM/IM/D/PS/SS document.
Warranty	-
Main success scenario	1> The actor selects the functionality to insert a new document from file. 2> The file is selected from the file systems. 3> The file is saved into the system and linked to the related product type.
Alternative scenarios	-

5.5 Use Case 3: Modify Document (via form)

Table 14: Description of the use case "Modify Document"

Actors	Machining Platform Personnel, Commercial Staff
Preconditions	• The actor has logged into the system. • The document to be modified is of one of the following document types: RPM, TO, FO.
Triggers	The actor wants to modify at least part of an RPM/TO/FO document.
Warranty	-
Main success scenario	1> The actor selects a specific document he wants to modify. 2> The actor is presented with the related form, pre-compiled with the current status of information in the document. 3> If the actor owns the required access rights, he can modify the document and save the modifications.
Alternative scenarios	3.1> If the actor does not own the required access rights, he is prompted not to attempt to modify the file and the modification is aborted.

5.6 Use Case 4: Delete Document

Table 15: Description of the use case "Delete Document"

Actors	Machining Platform Personnel, Commercial Staff
Preconditions	The actor has logged into the system.
Triggers	The actor wants to delete a certain document.
Warranty	-
Main success scenario	1> The actor selects a specific document he wants to delete. 2> If the actor owns the required access rights, he can delete the document.
Alternative scenarios	2.1>If the actor does not own the required access rights, he is prompted not to attempt to delete the file and the deletion is aborted.

5.7 Use Case 5: Browse Products (and related documents)

Table 16: Description of the use case "Browse Products and Related Documents"

Actors	Machining Platform Personnel, Commercial Staff
Preconditions	The actor has logged into the system.
Triggers	The actor wants to gather some kind of information on a specific product type and/or on its related documents.
Warranty	The actor is able to browse all available information on the selected product type.
Main success scenario	1> The actor either selects from the web-GUI a specific product type or inserts via the web-GUI, the name of a known product type. 2> The actor browses the available documents on the product type (Drawings, RPMs, etc. – see list in section 5.1). 3> The actor browses the product structure, in case of complex products, and can select to move to the information at the components level.
Alternative scenarios	-

6 Conclusions

In this deliverable, we continued the approach presented in the deliverable DR9.10 to identify and describe use cases that are of relevance for Closed-loop product lifecycle management. We selected several application scenarios provided by PROMISE application partners, namely A2, A4, A6, and A11 to develop the corresponding use cases. The use cases will support the design and development of further PDKM and DSS functionalities.

7 References

[DA2.3] Cécile Corcelle, Erin Wilmoth, DA2.3: Design of the A2 Demonstrator on information management for heavy load vehicles decommissioning, PROMISE Deliverable

[Coc01] Alistair Cockburn, Writing Effective Use Cases, Addison Wesley, 2001

[Fow04] Martin Fowler, UML Distilled (Third Edition, compliant with UML 2.0), Addison Wesley, 2004

[DA6.4] Daniele Panarese, Fabrizio Meo, DA6.4: Process model workflow description for the demonstrator, PROMISE Deliverable

