CRYSTAL

CRitical S**YST**em Enginieering **A**cce**L**eration

Use Case Description

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Contact	Claudio Pessa
Organization	ALA
Phone	+39 0117562678
E-Mail	claudio.pessa@alenia.it

AUTHORS TABLE

Name	Company	E-Mail
Fabio Bottiglieri	ALA	fabio.bottiglieri@alenia.it
Andrea Casagrande	ALA	andrea.casagrande@alenia.it
Luciana Lo Verde	ALA	Luciana.loverde@alenia.it
Roberto Luisi	ALA	roberto.luisi@alenia.it
Claudio Pessa	ALA	claudio.pessa@alenia.it
Laura Valacca	ALA	laura.valacca@alenia.it
Elena Valfrè	ALA	elena.valfre@alenia.it
Ivo Viglietti	ALA	Ivo.viglietti@alenia.it

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1 Introduction

1.1 Role of deliverable

This document has the following major purposes:

- To define the overall use case, including a detailed description of the underlying development processes and the set of involved process activities and engineering methods
- To provide inputs to WP601 (IOS Development) required to derive specific IOS-related requirements
- To provide inputs to WP602 (Platform Builder) required to derive adequate meta models
- To establish the technology baseline with respect to the use-case, and the expected progress beyond (existing functionalities vs. functionalities that are expected to be developed in CRYSTAL)

1.2 Relationship to other CRYSTAL Documents

This deliverable does not collect inputs from other CRYSTAL documents. The subject of the use case and the applicable process are derived from concrete product developments carried out by Alenia Aermacchi who is the use case leader.

It provides inputs to the following CRYSTAL deliverables:

- D202.021 – Requirements Specification V1
- D202.031 – SEE Specification V1
- D601.021 – Interoperability Specification V1
- D602.011 – Meta Model Specification V1

1.3 Structure of this document

This document is composed of four main chapters:

- Chapter 1 gives an overview of the scope of the deliverable, relationship with other CRYSTAL documents and this description of the document structure
- Chapter 2 describes the process for preliminary system design and a description of what is the system to be designed (more details are found in Annex III)
- Chapter 3 describes in detail the engineering environment of the Use Case
- Chapter 4 contains a concise description of the Engineering Methods used in the Use Case
- Annex I contains the detailed Engineering Method forms
- Annex II contains a table underlining the expected CRYSTAL benefit in using Engineering Methods
- Annex III defines the operational requirements of EIMSS System

2 Use Case Process Description

2.1 Preliminary System Design Approach

The approach is focused on the opportunity to define a complete traceability process starting from the preliminary design.

The process would imply the following activities:

- To support stakeholders in their daily activity to apply proper process and quality standards
- To define and structure the stakeholders and derived requirements in order to maintain the traceability
- To develop systems requirements, to validate the requirements by functional modelling, to build the related functional views according to the Harmony for Systems Engineering methodology.
- To support the system analysis.
- To perform RM&T analyses on the system architecture specification in order to identify the critical items and defects detection requirements.
- To support the definition of system test cases.
- To define system views under configuration control.

2.2 Use Case Description

The increasing complexity of the aeronautical products requires an evolution of the functionalities of the health and performance monitoring and related integration with ground systems for the flight data analysis and the resulting identification of the maintenance activity.

An Enhanced Integrated Monitoring and Support System (EIMSS) will be considered for the development of the Alenia Aermacchi use case.

The development will be at preliminary design level on a new turboprop regional aircraft.

The main objectives of this advanced system are:

- Support pilot operations by providing data in real time
- Support maintenance base operators by providing a subset of systems data and pilot's actions before the aircraft is landed in order to anticipate maintenance decisions and then minimize the down time of the system.
- Support maintenance ground operators with Off-line systems data availability

The following figure illustrates the most important relations among the EIMSS and other systems, where MC stands for "Maintenance Computer", MFD for "Multi-Functional Display" and GSS for "Ground Support System".

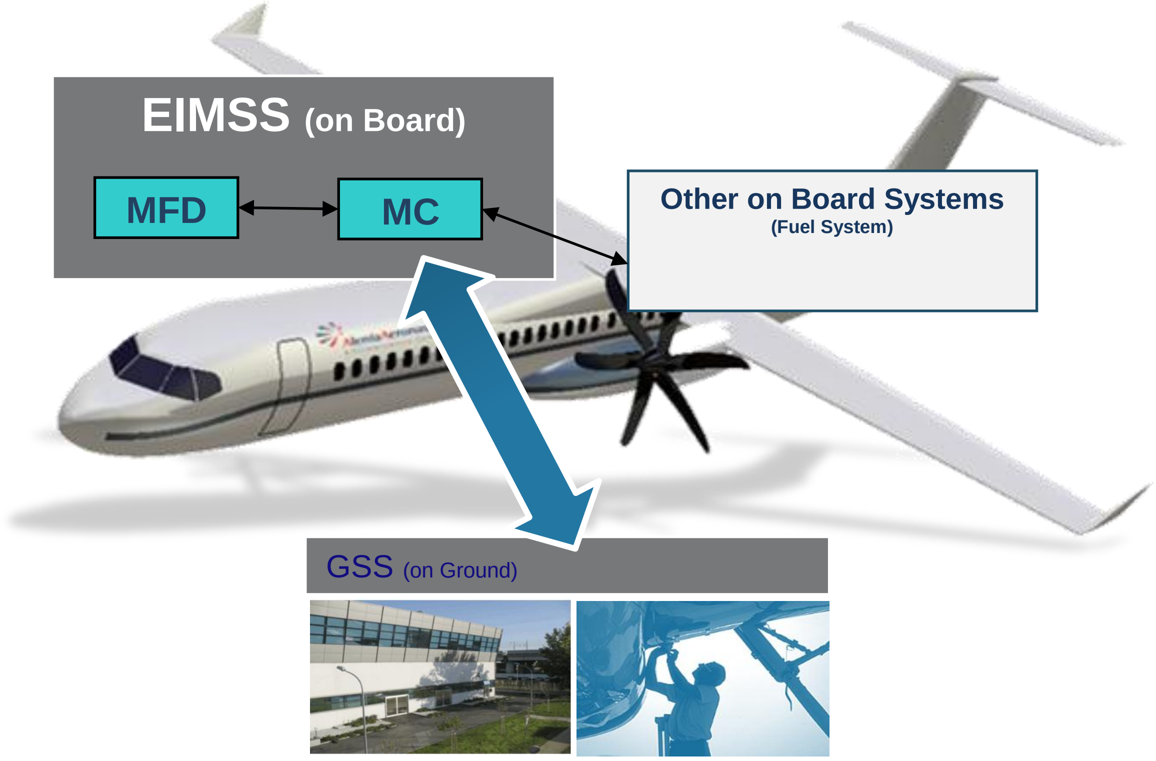

Figure 1: Interactions of EIMSS with other systems

In the proposed ALA use case, models will be developed by implementing the following functionalities:

- For the flight phases
  - The selected interfaces among systems (i.e. the Fuel System) shall send health data by via avionic bus to EIMSS.
  - EIMSS shall collect the health data from on board systems
  - EIMSS shall report to the pilot on flight events (e.g. ACAWS).
  - EIMSS shall provide the check list to the pilot in an interactive way, i.e. by suggesting the needed action to follow.
  - During the execution of the check list the EIMSS shall record pilot actions and system reactions.
- For the post flight phases
  - After each flight the relevant data are transferred to the Ground Support System (GSS).
  - The operator performs the debriefing of A/C and maintenance data.
  - The operator performs troubleshooting activities.
    - The GSS must connect each fault code with the relevant Technical Publications (Maintenance Manuals, IPC, Service Bulletin etc.).
    - The GSS must identify unscheduled maintenance task needs according to the troubleshooting results or flight data.

- The GSS must provide for each A/C of the fleet the updated status (single report for every A/C) of the scheduled maintenance operations and relevant alerts. The system must identify scheduled maintenance task needs based on the cumulated life of the A/C or the equipment.

It has to be highlighted that the main focus of the use case will be on the functionalities required for the flight phases. Therefore the main effort will be put on the development the EIMSS and of an A/C system that will allow to illustrate the capability of the EIMSS in collecting and elaborating different types of data (e.g. discrete / analogue inputs) coming from different types of sources (e.g. different types of sensors, control units, electronic circuitries,…).

Considering the relevance in terms of required reliability, maintainability and testability properties, the Fuel System has been selected as EIMSS interface system for the modelling activities.

In Annex III: EIMSS general requirements and a more detailed list of the operational logistic requirements has been provided for each phase of the flight.

2.3 Complexity and System Features

When designing and developing a complex system, the following topics are encountered:

- Complexity in mastering the applicable lifecycle and quality management processes.
- Complexity in modelling system components and health data packet transferred via avionic bus (ICD).
- Complexity in designing control laws and algorithms.
- High performance requirements for system simulation.
- Certification and safety requirements.

3 Detailed Description of the Use Case Process

3.1 Activities

The overall use case can be described as composed by different scenarios that emphasize different aspects of the problem. The figure below represents all the aspects of the overall use case considering:

- Activities related to engineering methods (in grey)
- Activities related to common methods (in white)
- Models in green (functional and physical)
- Black box (in black) considering just interfaces
- Tools in yellow

In this representation overlap between objects means direct interaction.

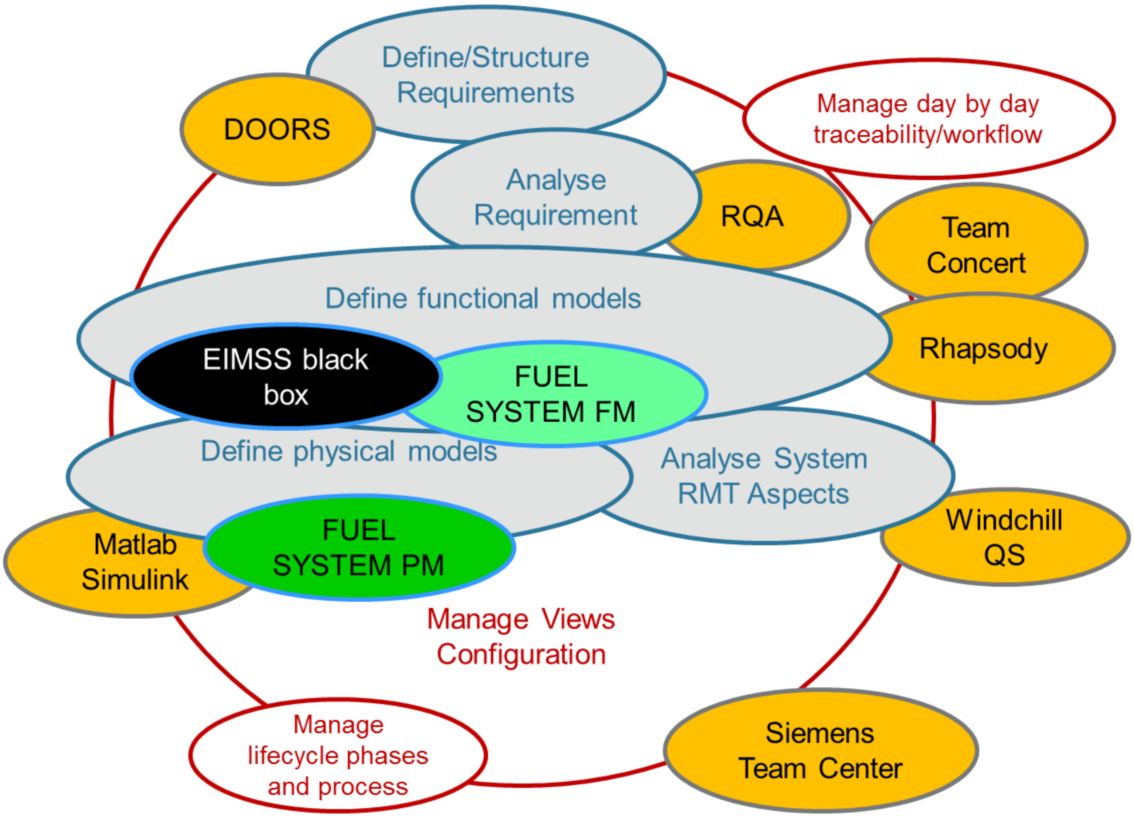

Figure 2: overall picture of assets involved in the use case

3.1.1 Scenario 1 – Functional Model Development

The scenario “Functional Model Development” foresees the interoperability between the following toolset:

- DOORS <-> Rhapsody;
- Rhapsody <-> Team Concert.

This scenario starts with the requirements written and specified in DOORS. When a consolidated baseline of the requirements is set up and ready to linked with Rhapsody objects, the design of the system architecture begins.
The design is a mix of several steps, according to the Harmony for SE phases. At the end of every phase some outputs are generated which must be linked with the requirements previously imported. Mutual traces between functional models and requirements modules in DOORS will be established. The definition of the system functions by Rhapsody model shall support specialists in developing the requirements at the lower level, therefore a “bi-directional” interface has to be foreseen. The Rhapsody model execution could be considered as one of the validation methods, so its outcomes shall be traced and linked to the related requirements. The Rhapsody model developed day by day from a requirements baseline needs to be versioned in order to maintain the traceability of the changes made by all the involved developers; for this reason this scenario also investigates the integration between Rhapsody and Team Concert.

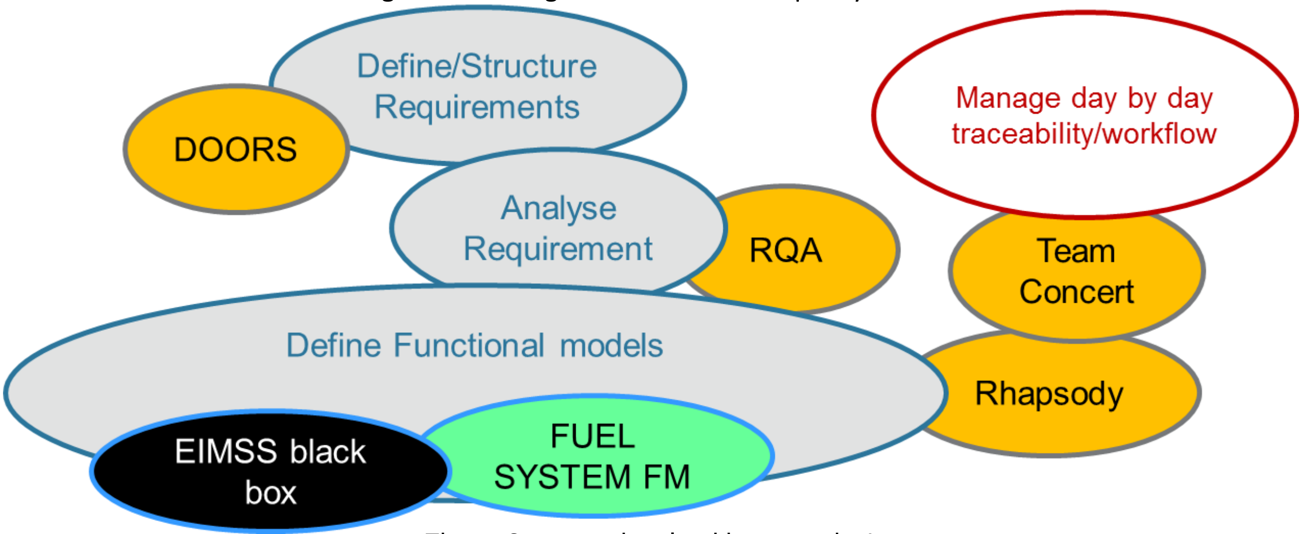

Figure 3: assets involved in scenario 1

Scenario 1 Challenges

The integrations between DOORS and Rhapsody, Rhapsody and Team Concert are already available, although some aspects make the customization very complicated and difficult, so the challenge of this scenario is to develop these integrations in a more customizable and user – friendly way. For example, a more simple integration between DOORS and Rhapsody can be used to return in DOORS module some information derived from the modelling phase and the subsequent verification and validation through Rhapsody model execution. The Rhapsody – Team Concert integration is still on initial integration and presents many difficulties in the merging activities between the various developer models. This scenario aims to investigate these aspects and improve them.

Scenario 1 Tool Chain

- IBM Rational DOORS (initially v9.5.1);
- IBM Rational Rhapsody;
- IBM Rational Team Concert.

Scenario 1 Success Criteria

This scenario can be considered successful if the developer:

- can switch from requirements to design easily without losing any information;
- can customize the bridge between tools in order to import all the necessary information;
- can collaborate with the other developers (models merging);
- can perform day – by – day versioning.

3.1.2 Scenario 2 – Functional Model Analysis

The Scenario 2 “Functional Model Analysis” foresees the interoperability between the following toolset:

- IBM Rational Rhapsody <-> PTC Windchill Quality Solution
- PTC Windchill Quality solution -> IBM DOORS

Some features of the developed functional model in Rhapsody (e.g. functional blocks with relevant properties/description, interface data, main output parameters from simulation of different failure scenarios) will be imported in the PTC Windchill Quality Solution toolset to perform a set of RM&T analyses, for instance reliability prediction at functional / design level, reliability block diagram and evaluation of system reliability in different scenarios / phases, functional / preliminary design FMECA (Failure Modes, Effect and Criticality Analysis) including testability aspects (needs and means for failure detection).

Specific output of the RM&T analyses will be identified in order:

- to be integrated within the functional model specification in Rhapsody toolset (e.g. additional reliability properties allocated to functional blocks, additional failure condition and failure scenarios, list of data to be recoded and elaborated by EIMSS to highlights system malfunction both for flight operations and maintenance purposes),
- to give evidence about the verification of specific RM&T system requirements (direct link requirements in DOORS.

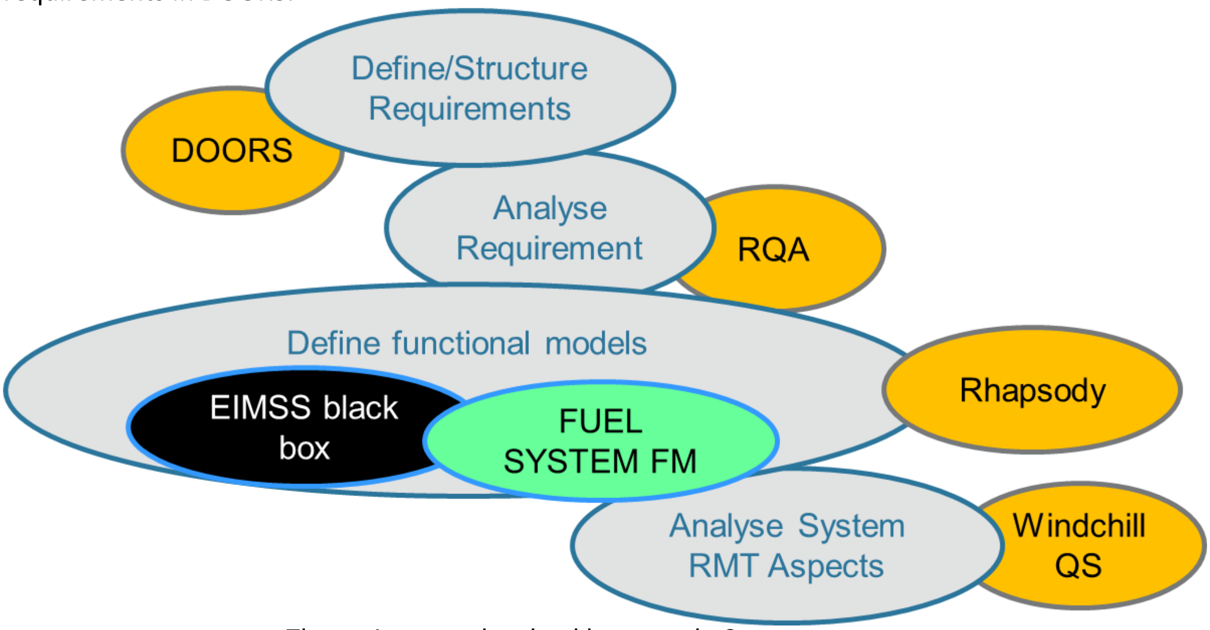

Figure 4: assets involved in scenario 2

Scenario 2 Challenges

The interoperability between IBM Rhapsody and PTC Windchill Quality Solution tools promotes the concurrent engineering approach between design and logistic / RM&T engineers being the logistic support / RM&T analyses directly linked to an executable model-based specification of the system instead of a static document based one.

The first challenge of this scenario is then to allow a more reactive design process (improvement of synchronisation among design and verification activities during the various iterations of the project) already starting from the early phases of project development.

Another challenge of this scenario is to connect in a more automated way the RM&T analysis world (PTC Windchill Quality Solution) and the requirement specification world (IBM DOORS) in order to obtain a more immediate evidence about the fulfilment of RM&T and logistic support requirements.

Scenario 2 Tool Chain

- PTC Windchill Quality solution;
- IBM Rational Rhapsody;
- IBM Rational DOORS;

Scenario 2 Success Criteria

This scenario can be considered successful if the developer:

- can import, in a customized way, specific data and information from the Rhapsody model within the RM&T analysis tool;
- can easily link and trace the results of RM&T analyses to: requirement and model based design

3.1.3 Scenario 3 – Functional View under Configuration Control

The scenario "Functional View under Configuration Control" foresees the interoperability between the following toolset:

- Rhapsody <-via Team Concert-> TeamCenter.
- PTC Windchill Quality Solution <-> Team Center

Product Lifecycle Management (**PLM**) is the process of managing the entire lifecycle of a product from its conception, through design and manufacture, to service and disposal. PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise. Even if the conception and design phases are included in the definition above, the current PLM tools in Alenia are not fully integrated and do not include the configuration management of the models developed in Rhapsody.

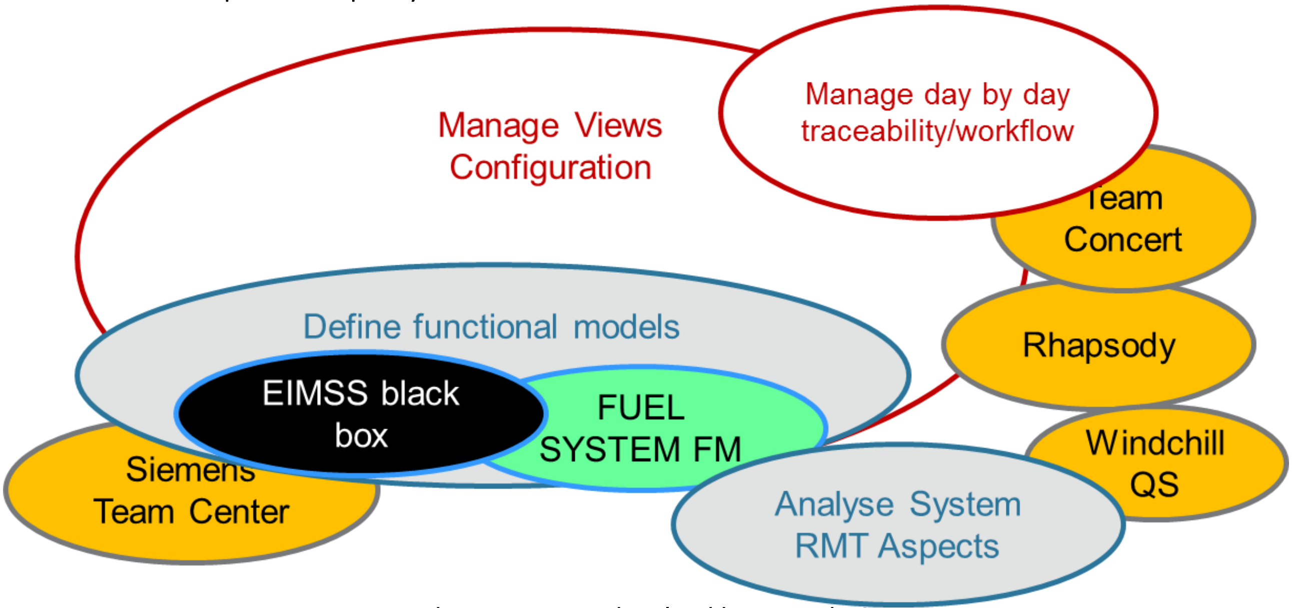

Figure 5: assets involved in scenario 3

This scenario aims to investigate the possibility to manage all the items related with the aeronautical product, including the main output of the engineering conceptual and design phase, in the PLM tools. More specifically the future PLM solutions will be able to manage requirements, functions, system elements, logical and physical architecture, engineering analysis, etc.. and their relationships under configuration control (As Required, As Conceived view) in an integrated way with the following already available PLM view (as Designed, As Planned).

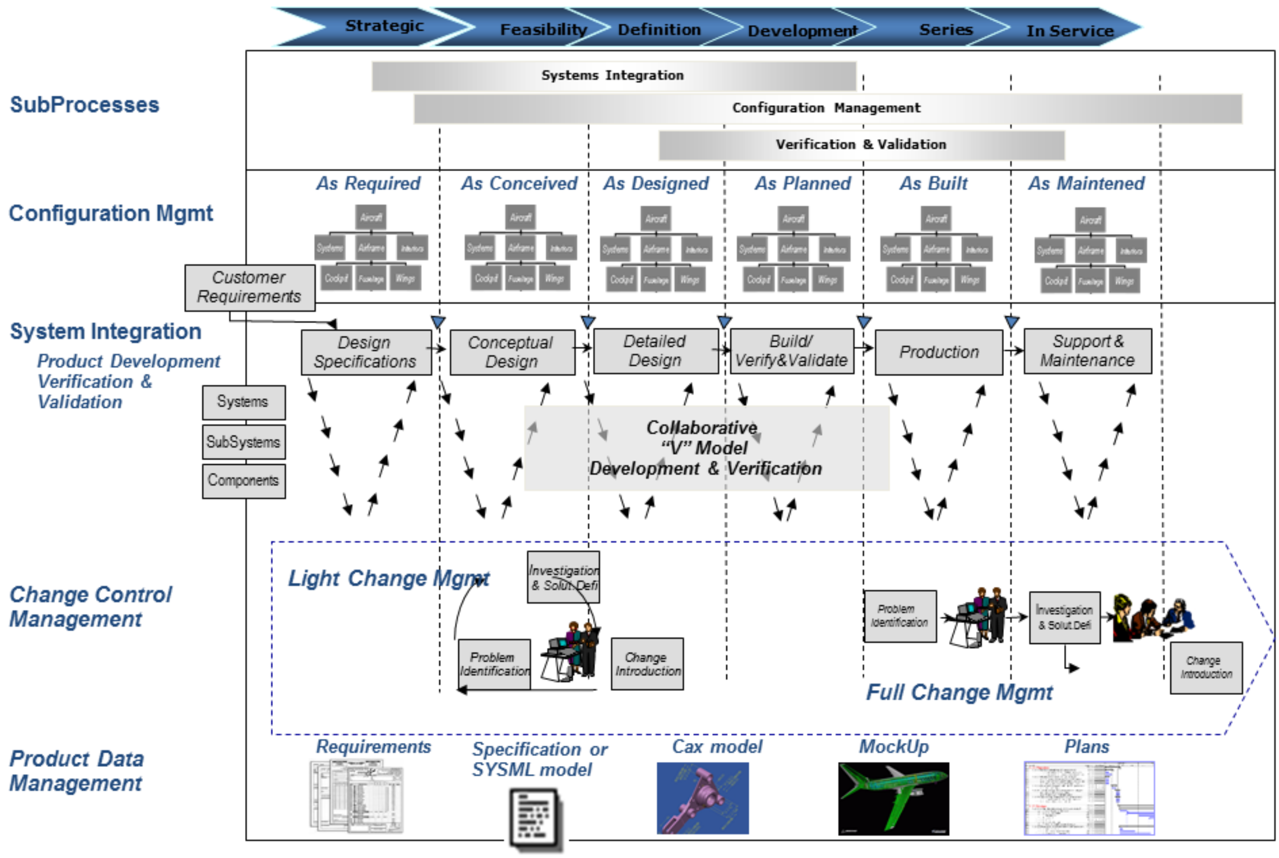

Figure 6: involved views and impacted environment processes

Scenario 3 Challenges

The challenge of this scenario is to connect, in an automatic way, the engineering and production worlds.

Scenario 3 Tool Chain

- IBM Rational Rhapsody;
- PTC Windchill Quality Solution
- Siemens TeamCenter.

Scenario 3 Success Criteria

This scenario can be considered successful if:

- The developer can import the entire Rhapsody Model in TeamCenter automatically;
- The developer can import specific data and information (e.g. activities mapped with functions, blocks mapped with systems) from the Rhapsody model to be managed under configuration control and to support traceability all along the Product Life Cycle;
- The developer can trace the configured results of RMT analysis in Team Center;
- The user can consult/visualize the entire or part of the Rhapsody Model inside TeamCenter by applying particular query criteria.

3.1.4 Scenario 1b: Physical Model Development

The Scenario 1b "Physical Model Development" foresees the interoperability between the following toolset:

- IBM Rational Rhapsody <-> Matlab – Simulink
- IBM Rational DOORS <-> Matlab - Simulink;

The definition of the system blocks in the Rhapsody model (step of the design synthesis phase) is the starting point to define the components also of the monitored system. At this stage it is recommended to guarantee a link between the functional model built in Rhapsody and the physical model of the monitored system (i.e. fuel system) built in Matlab-Simulink.
In particular the fuel system parameters (tank and feed pressure lines, fuel level…) will be used as inputs for the definition of the related functional interfaces between the EIMSS and the fuel system.
The physical model execution could be considered as one of the methods to identify the parameters and the related ranges of values to be monitored, as they could indicate system malfunctioning or failure events.
In addition the outputs of the physical model in terms of achieved performance parameters will be linked to the related DOORS module to register compliance evidence or requirements validation.

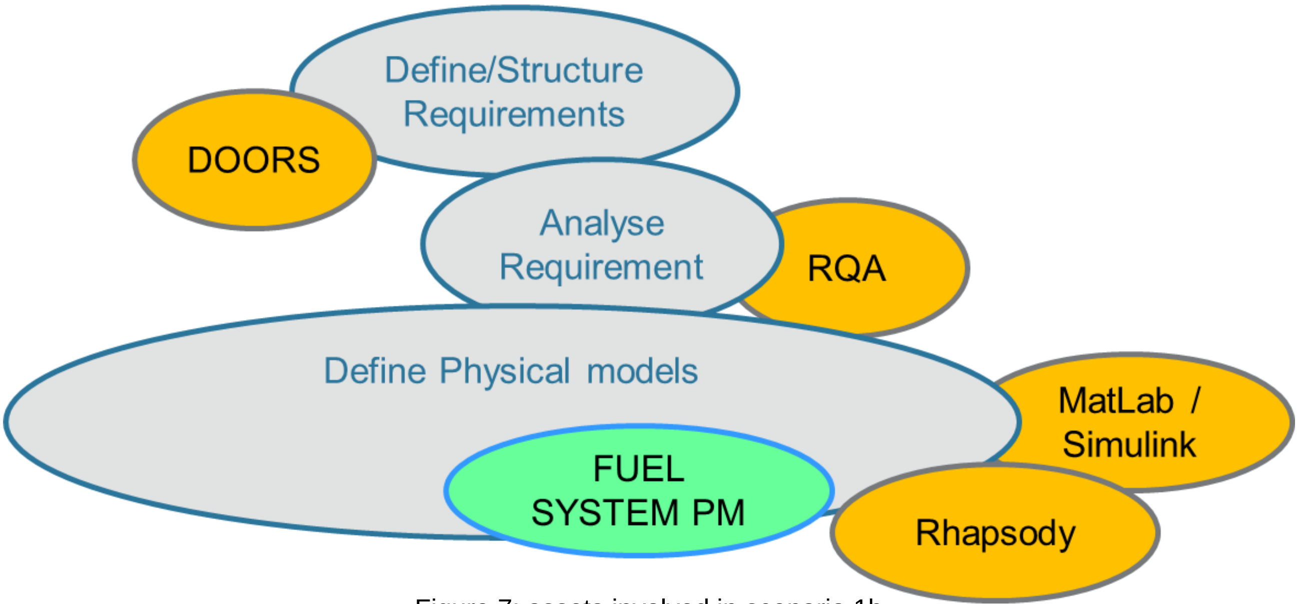

Figure 7: assets involved in scenario 1b

Scenario 1b Challenges

The interoperability between IBM Rhapsody and Matlab-Simulink tools promotes the concurrent engineering approach between functional analysis and design synthesis phase (in particular the detailed architectural design as described by Harmony for SE methodology). The first challenge of this scenario is then to allow a physical model coherent to the functional model. Another challenge of this scenario is to synchronize in a more automated way the physical analysis world (Matlab - Simulink) and the requirement specification world (IBM Rational DOORS) in order to obtain a more immediate rationale about the validation of derived performance requirements.

Scenario 1b Tool Chain

- IBM Rational Rhapsody;
- IBM Rational DOORS
- Matlab - Simulink;

Scenario 1b Success Criteria

This scenario can be considered successful if the developer:

- can import, in a customized way, specific data and information (blocks/components) from the Rhapsody model within the Matlab – Simulink model;
- can check the consistency between the logical interfaces built in Rhapsody and the interfaces of the parametric model of the system in Matlab Simulink.
- can easily link and trace the results of physical simulation to the requirement

3.1.5 Scenario 2b: Physical Model Analysis

The Scenario 2b "Physical Model Analysis" foresees the interoperability between the following toolset:

- Matlab – Simulink <-> PTC Windchill Quality Solution

Some features of the developed physical model in Matlab - Simulink (main output parameters from simulation of different scenarios) will be imported in PTC Windchill Quality Solution toolset to perform a set of RM&T analyses, for instance preliminary design FMECA (Failure Modes, Effect and Criticality Analysis) including testability aspects (needs and means for failure detection).
Some outcomes of the RM&T analysis (e.g. failure conditions, effects, detection means) could be transferred to Matlab-Simulink in order to integrate the physical model with some failure behaviour.

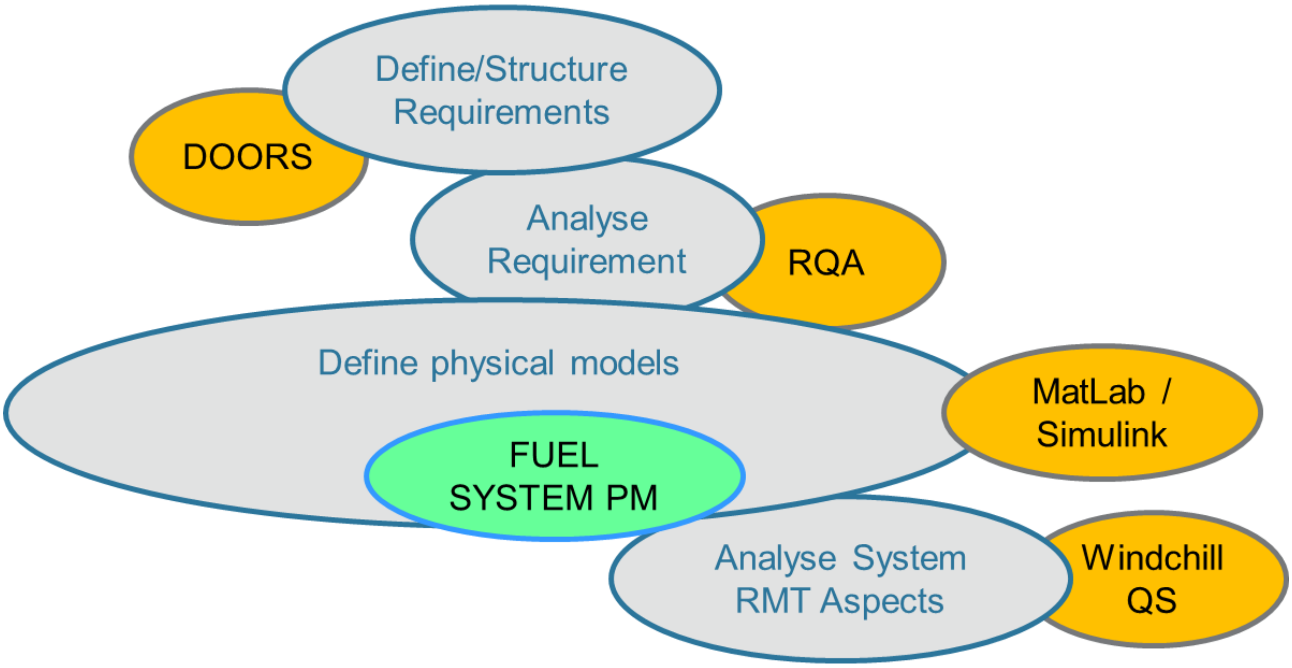

Figure 8: assets involved in scenario 2b

Scenario 2b Challenges

The first challenge of this scenario is then to allow a RM&T analysis consistent with the physical model.

Scenario 2b Tool Chain

- PTC Windchill Quality Solution;
- Matlab - Simulink;

Scenario 2b Success Criteria

This scenario can be considered successful if the developer:

- can export in a customized way, specific output data and information from the Matlab-Simulink model simulation to the RM&T analysis tool;
- can check the consistency of the physical behaviour built in Matlab – Simulink to the failure modes analysis carried out in PTC Windchill Quality Solution.

3.2 Stakeholders & Roles

Stakeholder	Role
Configuration manager	To manage as required, as conceived and as designed views
Domain expert	To analyse domain requirements and to define/execute domain models
Project manager	To ensure proper workflow and program control
Requirement analyst	To ensure requirements quality and harmonization
RM &T expert	To analyse RM & T domain requirements and to define/execute RM & T domain models
System integrator	To analyse system requirement and to harmonise input in an integrated system model

Table 1: involved stakeholders

3.3 Overall Use Case Success Criteria

The possibility to better define a complete traceability process starting from the preliminary design will be reflected in a:

- Better definition of the requirements, the functional model and the RM&T analysis.

  The RM&T analysis will be performed from the earliest stages and directly linked with a model based system specification, making easier and less costly to define a complete set of product support requirements.

Generally the Use Case Success Criteria is the accomplishment of the activities listed in 2.1 paragraph

An integrated table of expected benefits of the application of engineering methods is displayed in Annex II: Technology Baseline & Progress Beyond.

4 Identification of Engineering Methods

The engineering methods for this use case have been identified starting from the WP208 ones considering their applicability on WP202 too.

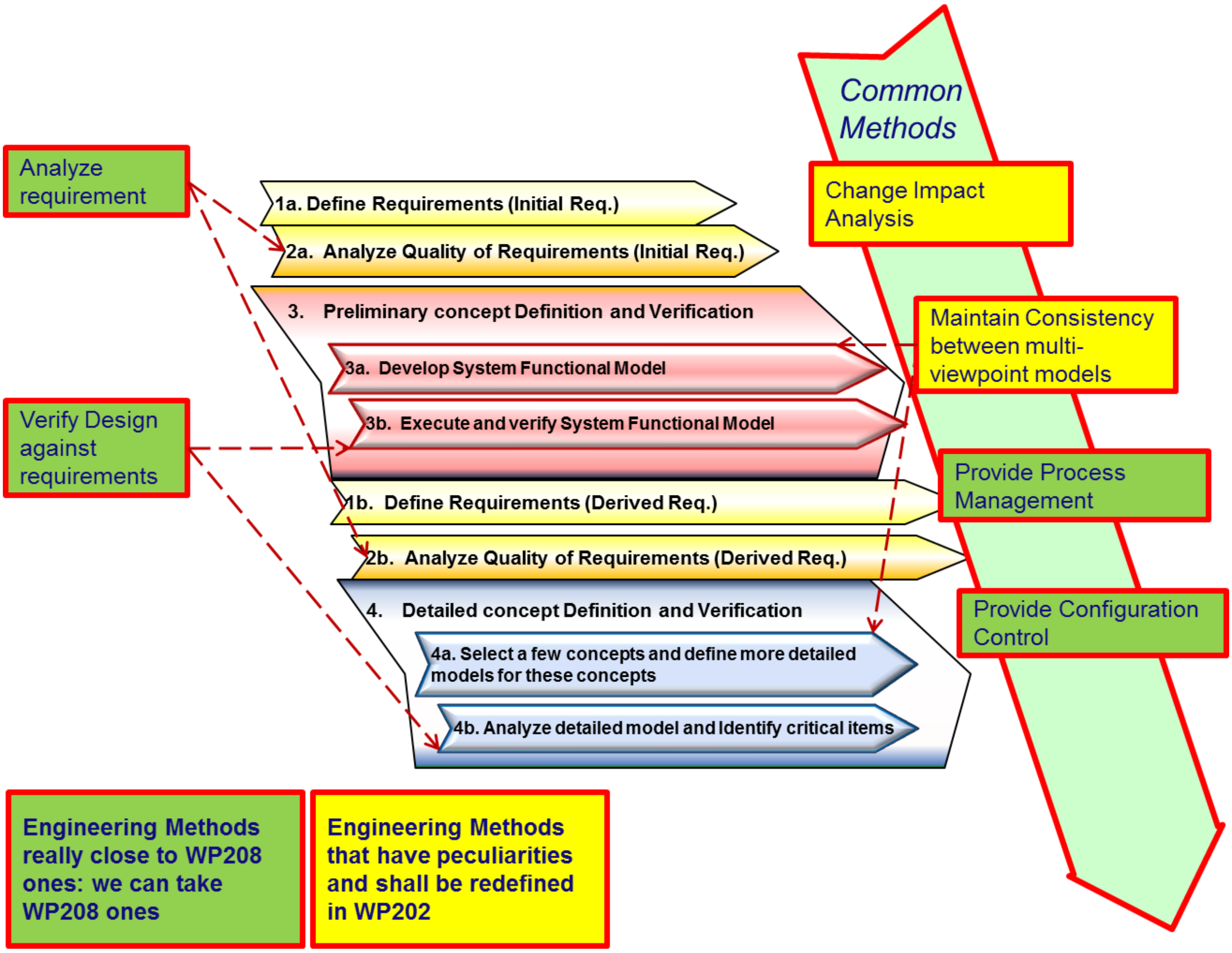

Figure 9: application of the engineering methods on the life-cycle

During the Preliminary Design and the Development of a system, the following engineering methods areas are typically adopted:

Analyse Requirement: The system / subsystems specifications are written using DOORS (IBM Rational) tool and are linked using the linking feature typical of this tool. The quality of requirements is checked via the RQA tool and the checked information is stored in a database.

Verify Design against Requirements: Once the development has started, the designer, at different level of maturity, is able to check (verify) if the driving requirements have been satisfied by the design of the system. In this engineering method the discipline specialists will retrieve structured information from functional models and on a discipline requirements basis, the domain models will be built using dedicated software tools, generating qualitative and quantitative information that will be used as feedback on the preliminary design for further design iterations as well as evidence for requirements verification.

Change Impact Analysis and Traceability: when a change needs to be investigated the environment is able to show the links to impacted items (at different levels, in different views) and to show which data and models need to be updated. To support the change impact analysis the environment shall be able to show the traceability between all data produced in the views of the different involved domains.

Maintain Consistency between Multi-viewpoints Models: the system/subsystems architecture and behaviour models are defined using Rhapsody toolset (IBM Rational) and the Harmony for SE methodology (IBM Rational). This phase produces an executable system model that can be used for the preliminary requirements verification and validation. The functional model supports the reliability analysis (i.e. FMECA, FTA, RBD), the strong connection between different models is achieved by a continuous data exchange between Rhapsody and the dedicated RM&T tool.

Provide Process Management: A process management is built up in order to support the involved stakeholders in their activities and to trace its maturity progress.

There is a need to monitor the system concept development status and the quality of identified solution through a requirement based criteria. The "as conceived" configuration is approved and baselined. Stakeholders are supported in their monitoring and assessment activities by the process enactment service and PLM solution.

During system functional design, models and data are versioned in a lighter way using Team Concert (IBM Rational) in order to track changes and share projects between multiple developers. Provide configuration control: once the system architecture is defined, any function and performance is allocated to the physical component with the related model, validation reports and taxonomy. The "functional view" is managed and versioned using Team Center (Siemens). All data are under configuration control.

Tables with structured information about engineering methods are displayed in Annex I: Detailed Descriptions of the Engineering Methods.

5 Terms, Abbreviations and Definitions

Please add additional terms, abbreviations and definitions for your deliverable.

A/C	Aircraft
ACAWS	Advisory, Caution, And Warning System
debrief event	A session in which all the involved actors examine how a mission or an event has been dealt with
EIMSS	Enhanced Integrated Monitoring and Support System
GSS	Ground Support System
FTA	Fault Tree Analysis
KPI	Key Performance Indicator
Log Book	Mean for recording the sequences of events
Log Card	Mean for recording the sequences of events for one mission
MBSE	Model Based Systems Engineering
MC	Maintenance Computer
MFD	Multi-Functional Display
MoC	Mean of Compliance
MoE	Mean of Evidence
MWO	Maintenance Work Order
PLM	Product Life Cycle Manager
RM&T	Reliability, Maintainability & Testability
SE	Systems Engineering

Table 2: Terms, Abbreviations and Definitions

6 References

CRYSTAL consortium; 2013	Annex I - "Description of Work"

Annex I: Detailed Descriptions of the Engineering Methods

Engineering Method: Analyse Requirement		
Purpose: to provide an engineered method to evaluate quality, consistency and coverage of the system / subsystems requirements		
Pre-Condition Requirement is stored in Doors D/B Requirement quality information is stored in other D/B	**Engineering Activity** 1. In RQA, launch service "Get List of requirements" 2. Request is forwarded to Doors D/B 3. List of all requirements is assembled and send back to RQA tool 4. In RQA, receive requirements 5. In RQA, select the requirement to be analysed in detail, and launch service "Get Requirement" 6. Request is forwarded to Doors D/B 7. Identify and send Requirement to RQA 8. In RQA, analyse requirement. Afterwards, send back (service "send requirement") 9. In RQA, select the new created requirement to be sent and stored in DOORS, and launch service "Send Requirement"	**Post-Condition** Requirements quality, consistency and coverage are checked and evaluated, results are traced according the degree of formalization (formal review baseline, peer review baseline, working baseline)
Artefacts provided as input of the activity 1. requirement list 2. quality metrics	**Artefacts** produced during the activity 1. requirement list	**Artefacts** which are the result of the activity 1. new requirement list 2. evaluation report (metric)
Additional Comments: N/A		

Engineering Method: Verify Design against Requirements

Purpose: The aim of this method is to verify via different CAE solutions, at different level of detail and from different viewpoints (functionalities, performances, -abilities, etc.) the compliance of the solution against the requirements.

Pre-Condition	**Engineering Activity**	**Post-Condition**
requirement list available functional model available physical model available reliability model available	1. define Means of Compliance (MoC) for each requirement 2. link requirements to model elements 3. automate/simulate model 4. evaluate/check model automation/simulation vs. requirements 5. create report (MoE – means of evidence) 6. link MoE to requirements 7. create verification report	list of MoE available verification report available (coverage report)
Artefacts provided as input of the activity 1. requirement list 2. functional model 3. physical model 4. reliability model	**Artefacts** produced during the activity 1. list of MoC (requirement view)	**Artefacts** which are the result of the activity 1. List of MoE (requirement view) 2. coverage metrics

Additional Comments: the availability of the model as pre-condition depends on requirements type to be verified (functional requirement – functional model, performance requirement – physical model, reliability requirement - reliability model).). In particular, at the begin of the requirements verification process, the availability of reliability models is derived from the availability of functional / physical models (including both nominal and failed behaviour).

Engineering Method: Change Impact Analysis		
Purpose: the purpose is to support the analysis of the impact of a change of a CI on all correlated models, providing a traceability table/matrix		
Pre-Condition requirement list available functional model available physical model available reliability model available Models are managed as Configuration Items (CI) Relationships between CI of System View and As Designed View are managed in PLM (a function is allocated to a system or logical equipment, a system or logical equipment implement a set of functions, a logical equipment is traced to a physical part (Equipment installation/assembly/part)	**Engineering Activity** 1. A Change of a CI arises 2. In PLM, select the SYSTEM under analysis 3. In PLM navigate As Designed CI impacted (equipment) through TRACE relationships 4. Modelling tools are providing the list of impacted models 5. In MBSE and domain tool identify diagrams to be involved in the change	**Post-Condition** Traceability Table/Matrix available Navigation of TRACE relationships and visualization
Artefacts provided as input of the activity 1. requirement list 2. functional model 3. physical model 4. reliability model	**Artefacts** produced during the activity 1. Domain Data list 2. Traceability Matrix/Table	**Artefacts** which are the result of the activity 1. Traceability Matrix/Table
Additional Comments: N/A		

Engineering Method: Maintain Consistency between Multi-viewpoint Models

Purpose: the aim of this method is to ensure that the different models in development during the preliminary phases of a project are consistent with each other. The information contained in the models shall not be incongruent and any time a modification that impacts on other model will be made a notification of mismatch shall be sent to proper users.

Pre-Condition	**Engineering Activity**	**Post-Condition**
requirement list available functional model available physical model available reliability model available (all models are considered configured)	1. change authorized 2. model A change 3. send data update notification to all impacted models 4. change embodied in other models 5. manage and trace models baselines	1. updated and consistent models available
Artefacts provided as input of the activity 1. requirement list 2. functional model 3. physical model 4. reliability model	**Artefacts** produced during the activity 1. authorized change 2. change notification 3. change impact report 4. models baselines	**Artefacts** which are the result of the activity 1. Updated models

Relevant to link between reliability models and functional / physical models, the steps 3. and 4. of Engineering Activity have to be considered in bidirectional way during the requirements analysis process, i.e. changes in functional / physical models (coming from analysis of functional / performance requirements) will generate update of reliability models and, vice versa, changes in reliability models (induced by analysis and verification of reliability requirements) will generate updated of functional / physical models (e.g. integration of new failed behaviour / scenarios, detection means, etc.)

Engineering Method: Provide Process Management

Purpose: The aim of this method is to provide the involved stakeholders with support about the activities and the process they have to apply within their daily activity. It also aims to define an approach for establishing a "single point" tool neutral access to the information about the systems under development, including process monitoring

Pre-Condition	**Engineering Activity**	**Post-Condition**
Requirements list is available in PLM System view is available in PLM Applicable process specifications are available to the tool chain	1. In PLM establish the traces among requirements, models and analysis reports 2. Display relevant process to the stakeholder 3. Display current (to do) activity 4. Display available monitor information 5. Stakeholder asks for system information and progress 6. Process management retrieves system information and traces from PLM 7. Process management evaluates progress information 8. System information are displayed to stakeholder	1. Stakeholders got support in their monitoring and assessment activities 2. Integrated views about system design and development progress are built 3. Integrated views are built according to stakeholder's need to know 4. System design summary assessed
Artefacts provided as input of the activity 1. Relevant process specification formalized through SPEM 2. Relevant enactable process formalized through BPMN2 or equivalent 3. Selected requirements list 4. System views data 5. Analysis reports	**Artefacts** produced during the activity 1. Process monitoring data 2. Integrated system view for display 3. OSLC (RM, QM, …) service requests toward RM and PLM tools	**Artefacts** which are the result of the activity 3. Updated progress data

Additional Comments

Process Management services shall comply with recognized process specification standards. Currently envisaged standards are SPEM (specification) and BPMN2 (enactment).

Engineering Method: Provide Configuration Control		
Purpose: provide configuration control not only of the physical views but also of requirement and functional views in order to manage and reuse these artifacts for similar product/capability classes		
Pre-Condition Functions are managed as Activities of Activity Diagrams in MBSE Tool (SysML modeling). Systems/Sub-Systems/Logical Equipment are managed by Blocks in MBSE tool (SysML modeling). Systems/Subsystems/Logical Equipment/ Functions are managed as Configuration Item in PLM Tool. A Functional Specification defined in a SysML Model has been frozen as Baseline at the end of Functional Analysis (Black box activity diagram) applicable to a specific configuration A Functional Specification defined in a SysML Model has been frozen as Baseline at the end of Design Synthesis (White box activity diagrams) applicable to a specific configuration	**Engineering Activity** 1. In PLM, select the SYSTEM under analysis 2. In PLM, launch service "Get List of System Functionalities" 3. Request is forwarded to MBSE Tool (SysML modeling) 4. List of all functions is assembled and sent back to the PLM tool 5. In PLM, receive functions 6. In PLM, the developer associates information related to applicability to the imported Functions 7. In PLM, correlate System View CI to As-Designed View CI 8. In PLM, select the SYSTEM under analysis 9. In PLM, launch service "Get List of All Syb-system Functionalities" 10. Request is forwarded to MBSE (SysML modeling) 11. For each SUBSYSTEM the List of allocated functions is assembled and send back to PLM tool 12. In PLM, receive SUBSYSTEM functions 13. In PLM, the developer associates information related to applicability to the imported functions	**Post-Condition** Systems View Management in PLM tool with Applicability management of Functionalities defined in MBSE tool (SysML modelling). Management of Commonalities and Comparison of different Functional Configuration in PLM. Management of traceability from System View CI to As-Designed View CI (e.g. Function to Part Number) in the PLM tool.
Artefacts provided as input of the activity 1. Activity Diagrams (SysML) 2. Internal Block Diagrams (SysML) 3. Functional Specification Baseline	**Artefacts** produced during of the activity 1. System Functionalities List 2. Sub-System Functionalities List	**Artefacts** which are the result of the activity 1. System View 2. System View links to other views
Additional Comments: N/A		

Annex II: Technology Baseline & Progress Beyond

Engineering Method	Current Functionality	Expected Progress in Crystal
Analyse Requirement	Requirements are analysed without automated support. Quality assured via direct assessment, consistency is enabled via requirements organization.	Automated support of tool checking quality, consistency, and redundancy of requirement. Tool shows to the operators requirements issues that can be accepted or rejected.
Verify Design against Requirements	Requirements are verified only in advanced life cycle phases, with poor traceability in the first phases.	Functional requirement can be verified directly through functional model execution assessing if the functionality provided by the system model satisfies the requirements.
Change Impact Analysis and Traceability	The impact of a change cannot be linked automatically anytime the information is split in different tool/environment	Tool interconnection and interoperability provide seamless information flow that enables change impact analysis in a federated environment.
Maintain Consistency between Multi-viewpoint Models	When a change is made on a model there is no other way than through a formal change process to align all the impacted models that share some information with each other	When a model change is made all models that share information are advised that some upgrade/mod is available and can be embodied in the model.
Provide Process Management	Early lifecycle phases follow very iterative activities that are coordinated via formal reviews and baselines.	Early lifecycle phases processes can be managed with a more fine granularity guaranteeing a better consistency.
Provide Configuration Control	Configuration control is confined in physical views	Configuration control is extended to requirement, functional and in general CAE views.

Annex III: EIMSS general requirements

Airspace Logistics Operational Scenarios

This section contains a system requirements set defined by Alenia Aermacchi' s "Customer Support &Service" division.

The selected operation will be divided in four main operational scenarios:

- ✓ Pre Flight Phase (Mission Planning)
- ✓ Flight Phase
- ✓ Post Flight Phase
- ✓ Maintenance Execution

Pre Flight Phase

Scenario Summary (Mission)

This scenario describes the Pre Flight activities for a general flight of an airline for business or commercial professional purposes. The scenario is written in very general terms such to cover both the "sunny-day" (where no major unplanned events affect the flight) and the "rainy day" (where adverse and/or degraded conditions occur) perspectives.

Tactical Planning Phase

1. The Pilot and the Platform Operator shall plan the mission.
2. The Pilot and the Platform Operator shall identify the resources necessary to the mission.
3. The Platform Operator and the Ground Crew Operator shall check the Platform availability in accordance with planned mission

Standing – Pushback/Towing

4. The Ground Crew Operator shall perform the Pre Flight Platform Activities in accordance with planned mission (refuelling, SW loading, etc.)
5. The Ground Crew Operator shall perform the Pre Flight Checks

Flight Phase

This scenario describes the specific flight activities of an airline for business or commercial professional purposes. The operations are analysed during all flight phases involved, starting from the engine start-up till engine shut down. The scenario is written in very general terms such to cover both the “sunny-day” (where no major unplanned events affect the flight) and the “rainy day” (where adverse and/or degraded conditions occur) perspectives.

Engine Start-up

6. The System shall collect all the health data.
7. The System shall detect and highlight each fatal or critical failure.
8. The System shall show correct check list for each detected failure, taking into account the warning priority.
    a. EIMSS must show electronic check list on MFD
    b. Each check list must be structured in a step by step workflow
    c. Each impacted system must interact with the check list tool
9. Each operation shall be checked and ticked by the pilot.
    a. If applicable, integration between A/C and EIMSS shall be automatic.
    b. Switch on next step must be authorized by pilot.
10. Each operation shall be recorded to MC

Taxi out (departure)

11. The System shall collect all the health data.
12. The System shall detect and highlight each fatal or critical failure.
13. The System shall show correct check list for each detected failure, taking into account the warning priority.
    a. EIMSS must show electronic check list on MFD
    b. Each check list must be structured in a step by step workflow
    c. Each impacted system must interact with the check list tool
14. Each operation shall be checked and ticked by the pilot.
    a. If applicable, integration between A/C and EIMSS shall be automatic.
    b. Switch on next step must be authorized by pilot.
15. Each operation shall be recorded to MC

Take-off /Climb

16. The System shall collect all the health data.
17. The System shall detect and highlight each fatal or critical failure.
18. The System shall show correct check list for each detected failure, taking into account the warning priority.
    a. EIMSS must show electronic check list on MFD
    b. Each check list must be structured in a step by step workflow
    c. Each impacted system must interact with the check list tool
19. Each operation shall be checked and ticked by the pilot.
    a. If applicable, integration between A/C and EIMSS shall be automatic.
    b. Switch on next step must be authorized by pilot.
20. Each operation shall be recorded to MC

Cruise

21. The System shall collect all the health data.
22. The System shall detect and highlight each fatal or critical failure.
23. The System shall show correct check list for each detected failure, taking into account the warning priority.
    a. EIMSS must show electronic check list on MFD
    b. Each check list must be structured in a step by step workflow
    c. Each impacted system must interact with the check list tool
24. Each operation shall be checked and ticked by the pilot.
    a. If applicable, integration between A/C and EIMSS shall be automatic.
    b. Switch on next step must be authorized by pilot.
25. Each operation shall be recorded to MC and transmitted to GSS for further activities

Approach – Landing

26. The System shall collect all the health data.
27. The System shall detect and highlight each fatal or critical failure.
28. The System shall show correct check list for each detected failure, taking into account the warning priority.
    a. EIMSS must show electronic check list on MFD
    b. Each check list must be structured in a step by step workflow
    c. Each impacted system must interact with the check list tool
29. Each operation shall be checked and ticked by the pilot.

a. If applicable, integration between A/C and EIMSS shall be automatic.

b. Switch on next step must be authorized by pilot.

30. Each operation shall be recorded to MC

Taxi in (arrival)

31. The System shall collect all the health data.
32. The System shall detect and highlight each fatal or critical failure.
33. The System shall show correct check list for each detected failure, taking into account the warning priority.
    a. EIMSS must show electronic check list on MFD
    b. Each check list must be structured in a step by step workflow
    c. Each impacted system must interact with the check list tool
34. Each operation shall be checked and ticked by the pilot.
    a. If applicable, integration between A/C and EIMSS shall be automatic.
    b. Switch on next step must be authorized by pilot.
35. Each operation shall be recorded to MC and transmitted to GSS for further activities

Engine Shut-Down

36. The System shall collect all the health data.
37. The System shall detect and highlight each fatal or critical failure.
38. The Platform transmit all the health and flight data.
39. Each operation shall be recorded to MC and transmitted to GSS for further activities

Post Flight Phase

This scenario describes the specific Post flight activities of an airline for business or commercial professional purposes. The operations are analysed during all post flight phases and in particular debriefing, troubleshooting and reporting. The scenario is written in very general terms such to cover both the "sunny-day" (where no major unplanned events affect the flight) and the "rainy day" (where adverse and/or degraded conditions occur) perspectives.

Debrief

2. If flight's data was not transmitted before, they shall be transferred by the on board platform to the Ground Support System (GSS)
3. The GSS must manage each debrief event separately.
4. The GSS must elaborate for maintenance purpose each data calculated on board
5. The GSS analyses trend data to calculate: Sortie number, full stop landing number, touch and go number, missions phase and speed, g factors, accelerations (on each axes).

6. For each data calculated the GSS must show trend data.
7. It can be possible to insert the manual debrief in all cause in which the saved data in not available.
8. The Logistic Operator performs the analyses of the failures.
9. The Logistic Operator set an aircraft status.
10. The Logistic Operator identify troubleshooting procedure applicable to the failure and integrate or analyse the data manually.
11. the GSS shall save the data in a common database for all the fleet.
12. The GSS shall provide the possibility to show A/C condition (e.g. surfaces angle, speed etc).

Troubleshooting

13. The GSS shall report to the Pilot and Logistic Operator on flight's events (e.g. ACAWS etc…).
14. The Logistic Operator can analyse health and failure data performing Troubleshooting procedure.
15. The GSS must visualize all fault codes.
16. The GSS must connect each fault code with the relevant Technical Publications (Maintenance Manuals, IPC, Service Bulletin etc.).
17. The GSS must provide for each A/C of the fleet the updated status (single report for every A/C) of the scheduled Maintenance Operations and relevant Alerts. The System must identify scheduled maintenance task need based on the cumulated life of fleet or equipment.
18. The GSS must identify unscheduled maintenance task need according to Troubleshooting results or flight data.

Reporting

19. The GSS must provide information about Fleet or Aircraft System Status (ex. System efficient, System efficient with limitation, System on ground for non-scheduled maintenance, System on-ground for missing parts, System on ground for service bulletin implementation, System in preservation status and no data available).
20. The GSS must provide information about the daily Platform (or relevant subsystem) activity.
21. The GSS must provide the fleet location showing the map with the Platform present position.
22. The GSS must provide all the events of a system in chronological order.
23. The GSS must provide the Installative Configuration of each Platform limited to the Traceable Items.
24. The GSS must provide a fault distribution analysis for Fleet, Platform, Items, Customer.
25. The GSS must provide to the Logistic Operator the Troubleshooting results.

Maintenance Execution phase

This scenario describes the Maintenance activities of an airline for business or commercial professional purposes. The scenario is written in very general terms such to cover both the "sunny-day" (where no major unplanned events affect the flight) and the "rainy day" (where adverse and/or degraded conditions occur) perspectives.

MWO Plan

26. The GSS shall manage the Maintenance Plan and the resources needed in accordance with the Flight Operation System

MWO Identification

27. The Logistic Operator shall create all the MWO relevant to scheduled or unscheduled maintenance.

28. The Logistic Operator shall be able to identify all the resources (skills, spares, AGE and consumable) necessary to the MWOs

29. The Logistic Operator shall be able to identify the priority of the MWO execution modifying the maintenance plan

30. The Maintenance Operator shall be able to reserve the resources from the Maintenance System and the Warehouse System (or Customer Maintenance System)

MWO Execution

31. The Maintenance Operator shall prepare the resources

32. The Maintenance Operator shall prepare the Platform or the Systems involved to the Maintenance

33. The Maintenance Operator shall execute the MWO

34. The Quality Operator shall validate the MWO

35. The Quality Operator shall compile the Log Card and Log Book

MWO Account

36. The Maintenance Operator account all the MWO activities, reporting the relevant time and data

MWO Report

37. The System shall be able to provide the resources consumption for a single MWO, month, year, Customer, Platform etc

38. The System must provide a verification of MWO KPIs