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

SEE Specification - V1

D202.031

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V0.02	2014-01-14	Francesco Brunetti - POLITO
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CHANGE HISTORY

Version	Date	Reason for Change	Pages Affected
V0.01	2013-12-05	Initial Draft	-
V0.02	2014-01-14	Version for internal review	All
V0.03	2014-01-28	Version after internal review	Minor Changes
V1.00	2014-01-30	Version after external review	change in 3.1-3.x to describe better the approach and avoid misunderstandigs

CONTENT

1 Introduction

1.1 Role of deliverable

Starting from D202.010 and together with D202.021 this document has the major scope of detailing the use case description of the Preliminary Design for a new Regional TurboProp (private use case). In particular according to the DoW the main purposes of this deliverable are:

- To define the concepts of the dedicated SEE and involved tools;
- To define tool functionalities and services needed or to be implemented;
- To define an integration plan and the evaluation criteria

1.2 Relationship to other CRYSTAL Documents

This deliverable collects inputs directly from CRYSTAL D202.010 “Use Case Description” because can be considered the detailed refinement of it for what is regarding needed functionalities, tool chain and envisaged IT environment (SEE) supporting them. It has a strong relationship with D202.021 that is more focused in describing the requirements from the User Point of view. Moreover, as for D202.021 this deliverable tries to follow a common approach in describing the assets and requirements with the other “user requirement definition” deliverables under development in SP2.

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 overall approach of and give a “data model” of the information used to describe the scenarios and the use case and maps the relationship with D202.021
- Chapter 3 maps Engineering Activities with Tool Functionalities
- Chapter 4 contains the overview of the tool chains used in the different Engineering Methods
- Chapter 5 contains a brief example of the data that will be treated and produced in the Use Case
- Chapter 6 shows the envisaged architecture of the SEE platform for WP202

2 Overall Approach

2.1 WP202 data model

In order to avoid misunderstanding a data model of this approach has been prepared: it contains the objects used in the description of WP202 and the relationship among them. In the following schema the boundaries of the deliverables D202.021 in red and D202.031 in green have been pointed out.

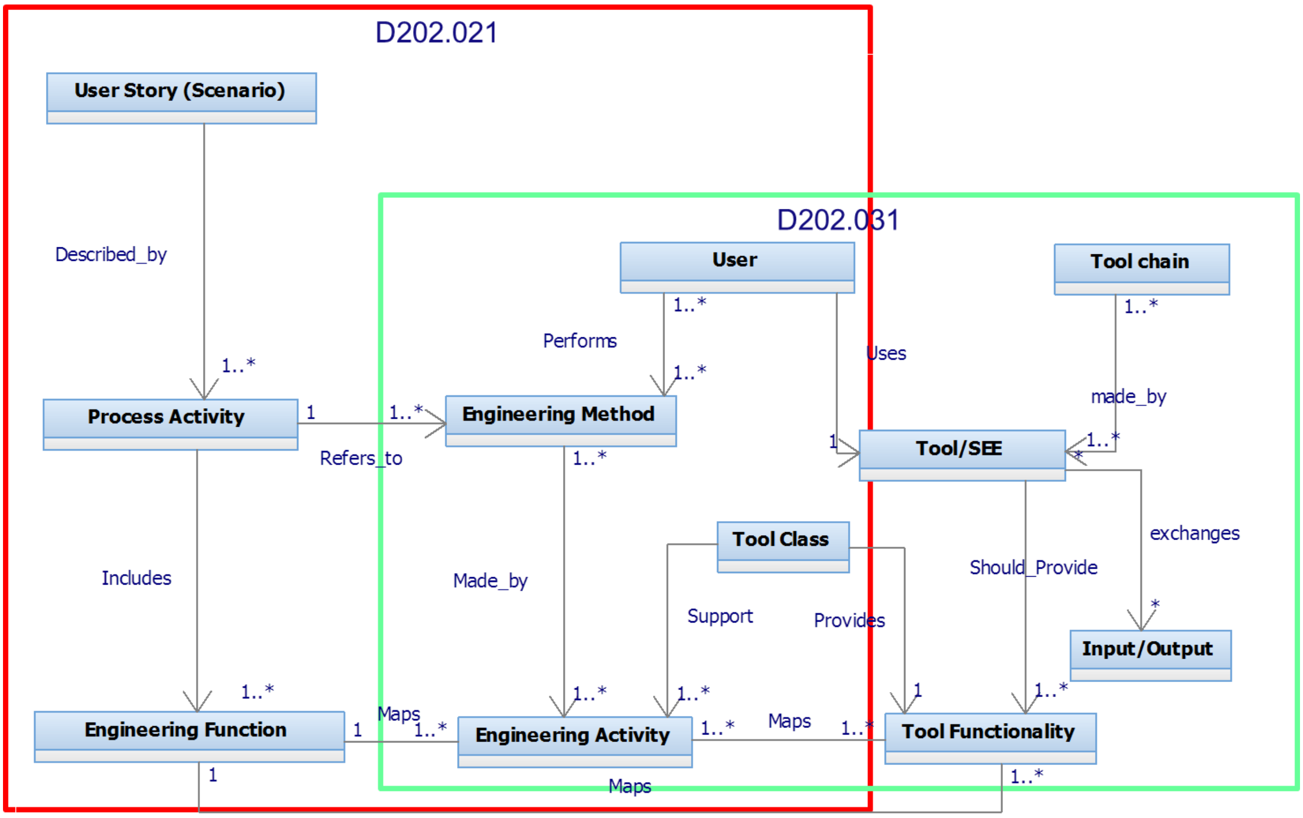

Figure 1: Approach data model and deliverables boundaries

Here below a short description of the objects shown in Figure 1

- User stories: the scenarios described in D202.010
- Process Activities: the main macro-activities that describe what to do in order to carry out the User Stories
- Engineering Function: each function that compose the flow chart or sequence that describe the macro–activity
- Engineering Method: it describes how the process activity is performed
- Engineering Activity: it describes each step of the Engineering Method
- Tool Class: the kind of tool used to support the engineering activity
- User: who is carrying out the engineering method
- Tool/SEE: the instantiation of the tool class that actually is used to perform the engineering activity

- Tool Functionality: the functionality given by the tool used to perform an engineering activity
- Tool chain: the tools used to perform a User story considering the link among them and the sequence in which they are used
- Input/Output: what is exchanged among the tools in the tool chain

The following steps have been made to link the Engineering Activities that compose the Engineering Methods with Tools/SEE and related Tool Functionalities:

1. To explicit the Process Activities that compose the User Story described in D202.010 scenarios
2. To describe Process Activities as flow charts or sequence of Engineering Function
3. To link Process Activities to Engineering Methods (EM) and Users and Tool Class
4. To link EM with Engineering Activity (IT Capability - what we expect a class of tools should be able to do in order to satisfy EM)

These first four step are described in D202.021 the following two are part of this deliverable

5. To link Engineering Activities to envisaged Tool Functionalities
6. To explicit the needed tool chain to satisfy the scenario (user story) and input and output among tools

3 Engineering Methods mapping

3.1 Engineering Activities vs. Tool Functionalities

In order to specify the SEE environment from the industrial user point of view in this chapter the links between Engineering Activities (that in sequence detail the Engineering Methods) with Tool Functionalities are depicted for each Engineering Method used in WP202 scenarios.

As “tool functionalities” here are considered the functionalities that the user expects to retrieve in the commercial tool (off the shelf, without customization) that instantiates a particular tool class (e.g. the commercial tool “DOORS” as “Requirement Manager” should provide “Requirement baseline management” functionality by default).

Figure 2 here below shows the mapping between WP202 User Stories (scenarios) and Engineering Methods: in each sub-chapter is described the relationship between Engineering Activities that compose the Engineering Method and the related Tool Functionalities.

		User Story (Scenario)			
		Functional Model Development	Functional Model Analysis	Functional View under Configuration Control	Physical Model Development
Engineering Method	Analyse Requirements				
	Verify Design against Requirements				
	Change Impact Analysis				
	Maintain Consistency between Multi-viewpoints Models				
	Provide Process Management				
	Provide configuration Control				
	Heterogeneous Simulation				

Figure 2:Engineering Method vs User Story mapping

The general schema of these tables shows the Engineering Activities in rows and the Tool Functionalities in columns. Tool Functionalities have been split in two main types:

Interoperability Tool Functionalities	functionalities that allow the tool to generally inter-operate and exchange information and data inside the chain tool.
Domain Tool Functionalities	typical functionalities of the domain in which the tool is used for.

3.2 Analyse Requirements

Interoperability Tool Functionality	Tool Functionality				
Domain Tool Functionality	IBM Rational DOORS				
Engineering Activity	Baseline Management	Project and directory Management	Discussion Management	Module Mangement	Data search
Structure and categorize requirements in requirement manager					
Establish quality policy for requirement types in requirement quality analyser					
Requirement quality analyser send request for requirement list import to Requirement Manager Tool					
Requirement Manager tool assembles the list of all requirements requested and send back to rqa tool					
rqa tool receives requirements					
in rqa tool requirements are analysed					
change needs arise from rqa, new requirement proposal are sent back to requirement manager					
in requirement manager are evaluated new requirement impact on overall requirement structure					

Table 1: Engineering Method "Analyse Requirements" mapping

Interoperability Tool Functionality	Tool Functionality				
Domain Tool Functionality	IBM Rational DOORS				
Engineering Activity	Data check and control	Link management and traceability	Import data	Export data	Change control
Structure and categorize requirements in requirement manager					
Establish quality policy for requirement types in requirement quality analyser					
Requirement quality analyser send request for requirement list import to Requirement Manager Tool					
Requirement Manager tool assembles the list of all requirements requested and send back to rqa tool					
rqa tool receives requirements					
in rqa tool requirements are analysed					
change needs arise from rqa, new requirement proposal are sent back to requirement manager					
in requirement manager are evaluated new requirement impact on overall requirement structure					

Table 2: Engineering Method "Analyse Requirements" mapping

Interoperability Tool Functionality	Tool Functionality				
Domain Tool Functionality	RQA				
Engineering Activity	Manage quality rules	Analyze Requirement	Change management	Import data	Export data
Structure and categorize requirements in requirement manager					
Establish quality policy for requirement types in requirement quality analyser					
Requirement quality analyser send request for requirement list import to Requirement Manager Tool					
Requirement Manager tool assembles the list of all requirements requested and send back to rqa tool					
rqa tool receives requirements					
in rqa tool requirements are analysed					
change needs arise from rqa, new requirement proposal are sent back to requirement manager					
in requirement manager are evaluated new requirement impact on overall requirement structure					

Table 3: Engineering Method "Analyse Requirements" mapping

3.3 Verify Design Against requirement

Interoperability Tool Functionality	Tool Functionality						
Domain Tool Functionality	PTC - Windchill QS						
Engineering Activity	Import of IBM Rhapsody Basic Model Elements	Import of IBM Rhapsody Simulation Scenarios Elements	Import of IBM Rhapsody (safety profile) RBD model elements	Develop a Logistic System breakdown	Allocate Preliminary Reliability Figures	Develop FMEA	RBD Evaluation
In RM&T Analysis Tool launch service «Get list of System Functional Architectural model basic elements (Use Case, Activities, BDD, IBD, Parts).							
In RM&T Analysis Tool modeller Functional Architectural elements are organised in Logistic Breakdown and ASD S1000D reference code is assigned to breakdown elements							
In RM&T Analysis Tool modeller preliminary reliability figures are allocated to basic System functional architectural model elements.							
In RM&T Analysis Tool modeller, main functional deviation (failure modes) are identified on basic System functional architectural model elements.							
In the functional modeller, launch service «Get list of System Functional Architectural model basic elements (BDD, IBD, parts)» updated with additional reliability information (ASD code, reliability figure, failure modes (including Failure Mode Id (FMI))							
In Functional modeller , Functional Architecture model is extended with dis-functional behaviour.							
In the Functional modeller , Functional Architecture model (including dis-functional behaviour) is extended with fault detection aspects in behavioural view.							
In the Functional modeller , Functional Architecture model (including dis-functional behaviour) is extended with Mission abort condition							
In the Functional modeller , single failure scenario simulation is performed							
In the Functional modeller , single failure sequence diagrams are renamed with Failure Mode Id (FMI)							
In the Functional modeller (safety profile), RBD models are developed.							
In RM&T Analysis Tool, launch service «Get list of Functional Architectural model simulation scenarios elements»							
In RM&T Analysis Tool, launch service «Get RBD models from Safety Profile»							
In RM&T Analysis Tool, FMEA table is completed with failure mode effects and detection from simulation scenario results							
In RM&T Analysis Tool, RBD diagrams are analysed							
In Requirements manager tool, launch service «Get Reliability & Testability Performance System Result (MOE)»							

Table 4: Engineering Method "Verify Design Against requirement"

Interoperability Tool Functionality	Tool Functionality							
Domain Tool Functionality	IBM Rhapsody						IBM DOORS	
Engineering Activity	Import of Windchill PTC QS Logistic breakdown code on Basic Model Elements	Import of Windchill PTC QS Reliability data on Basic Model Elements	Import of Windchill PTC QS Failure Mode data on Basic Model Elements	Modelling of Functional / Dis-functional behaviour	Simulate Functional / Dis-functional Models	Create RBD model	Import of Windchill PTC QS Reliability & Testability performance results	Manage requirements and relevant MOE traceability
In RM&T Analysis Tool launch service «Get list of System Functional Architectural model basic elements (Use Case, Activities, BDD, IBD, Parts).								
In RM&T Analysis Tool modeller Functional Architectural elements are organised in Logistic Breakdown and ASD S1000D reference code is assigned to breakdown elements								
In RM&T Analysis Tool modeller preliminary reliability figures are allocated to basic System functional architectural model elements.								
In RM&T Analysis Tool modeller, main functional deviation (failure modes) are identified on basic System functional architectural model elements.								
In the functional modeller, launch service «Get list of System Functional Architectural model basic elements (BDD, IBD, parts)» updated with additional reliability information (ASD code, reliability figure, failure modes (including Failure Mode Id (FMI))								
In Functional modeller , Functional Architecture model is extended with dis-functional behaviour.								
In the Functional modeller , Functional Architecture model (including dis-functional behaviour) is extended with fault detection aspects in behavioural view.								
In the Functional modeller , Functional Architecture model (including dis-functional behaviour) is extended with Mission abort condition								
In the Functional modeller , single failure scenario simulation is performed								
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In RM&T Analysis Tool, launch service «Get RBD models from Safety Profile»								
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In RM&T Analysis Tool, RBD diagrams are analysed								
In Requirements manager tool, launch service «Get Reliability & Testability Performance System Result (MOE)»								

Table 5: Engineering Method "Verify Design Against requirement"

3.4 Change Impact Analysis

Interoperability Tool Functionality	Tool Functionality				
Domain Tool Functionality	DOORS			Rhapsody	
Engineering Activity	Change Control	Link management and traceability	Change Analysis	Modify model	Model Analysis
A Change of a requirement, a functionality or a CI arises					
Find all impacted items in the tool chain through SEE environment					
In PLM retrieve all CI that are impacted considering the different view					
For each impacted domain specialist considers how the change impact the different objects in the models.					
Discipline domain specialist modifies local functional and physical domain models according to change requirements					

Table 6: Engineering Method "Change Impact Analysis"

Interoperability Tool Functionality	Tool Functionality			
Domain Tool Functionality	Team Concert		TeamCenter	
Engineering Activity	Display, track , monitor information	Retrieve information	Change Management	Search
A Change of a requirement, a functionality or a CI arises				
Find all impacted items in the tool chain through SEE environment				
In PLM retrieve all CI that are impacted considering the different view				
For each impacted domain specialist considers how the change impact the different objects in the models.				
Discipline domain specialist modifies local functional and physical domain models according to change requirements				

Table 7: Engineering Method "Change Impact Analysis"

3.5 Maintain Consistency between Multi-viewpoints Models

Interoperability Tool Functionality	Tool Functionality			
Domain Tool Functionality	Rhapsody		Mathworks Simulink	
Engineering Activity	Modify model	Model Analysis	Modify model	Model Analysis
change authorized				
model change in a specific domain (Functional and Physical)				
send data update notification to all impacted models				
impacts are evaluated and harmonized				
change embodied in other models				
manage and trace models baselines				

Table 8: Engineering Method "Maintain Consistency between Multi-viewpoints Models"

Interoperability Tool Functionality	Tool Functionality			
Domain Tool Functionality	Team Concert		TeamCenter	
Engineering Activity	Display, track , monitor information	Manage information	Manage Configuration and effectivity	Change Management
change authorized				
model change in a specific domain (Functional and Physical)				
send data update notification to all impacted models				
impacts are evaluated and harmonized				
change embodied in other models				
manage and trace models baselines				

Table 9:Engineering Method "Maintain Consistency between Multi-viewpoints Models"

3.6 Provide Process Management

Interoperability Tool Functionality	Tool Functionality					
Domain Tool Functionality	IBM Rational Team Concert					
Engineering Activity	Manage Plans	Manage Task	Manage workflow	Manage Report	Display, track , monitor information	Retrieve information
Configure the Workflow Manager platform through the desired “formal” process specification. (model transformation may be needed).						
Invite stakeholders to join the project.						
Inform the stakeholders about their current task to be performed.						
On the work bench, provide relevant (context aware) task details to the stakeholders (on demand)						
Display updated list of task related events						
Display available process (progress) monitor information in the tracking task-board.						
Stakeholder asks for system information and links to development data through proper queries issued through the dedicated interface.						
Workflow management retrieves system information and traces from ALM platform through the established links (OSLC linked data)						
Workflow management evaluates progress information						
Task relevant (updated) information are displayed to stakeholders through dedicated work item perspectives of the work bench.						

Table 10: Engineering Method "Provide Process Management"

3.7 Provide Configuration Control

Interoperability Tool Functionality	Tool Functionality						
Domain Tool Functionality	**Siemens TeamCenter**						
Engineering Activity	Views Management	Product Structure Management	item Relation Management	Search	Product Link Management	Manage Configuration and effectivity	Import data
In PLM select the SYSTEM under analysis							
In PLM ask for List of System Functionalities							
Request is forwarded by SEE environment to functional modeller							
In the SEE environment, the List of all functions is assembled and sent back to the PLM tool							
In PLM receive functions							
In PLM the developer associates information related to applicability to the imported Functions							
In PLM correlate System View CI to As-Designed View CI							
In PLM , select the SYSTEM under analysis							
In PLM , launch service "Get List of All Sub-system Functionalities"							
Request is forwarded by SEE environment to Functional Modeller							
In the SEE Environment, for each SUBSYSTEM the List of allocated functions is assembled and send back to PLM tool							
In PLM , receive SUBSYSTEM functions							
In PLM, the developer associates information related to applicability to the imported functions							

Table 11: Engineering Method "Provide Configuration Control"

Interoperability Tool Functionality	Tool Functionality			
Domain Tool Functionality	IBM Rational Team Concert			
Engineering Activity	Display, track , monitor information	Retrieve information	Manage information	Exchange information
In PLM select the SYSTEM under analysis				
In PLM ask for List of System Functionalities				
Request is forwarded by SEE environment to functional modeller				
In the SEE environment, the List of all functions is assembled and sent back to the PLM tool				
In PLM receive functions				
In PLM the developer associates information related to applicability to the imported Functions				
In PLM correlate System View CI to As-Designed View CI				
In PLM , select the SYSTEM under analysis				
In PLM , launch service "Get List of All Sub-system Functionalities"				
Request is forwarded by SEE environment to Functional Modeller				
In the SEE Environment, for each SUBSYSTEM the List of allocated functions is assembled and send back to PLM tool				
In PLM , receive SUBSYSTEM functions				
In PLM, the developer associates information related to applicability to the imported functions				

Table 12: Engineering Method "Provide Configuration Control"

3.8 Heterogeneous Simulation

Interoperability Tool Functionality				
Domain Tool Functionality	Team Concert		DOORS	
Engineering Activity	Display, track , monitor information	Manage information	Baseline Management	Data search
The analyst engineer requests the list of the available requirements				
The analyst engineer request the list of the available physical models related to Fuel System				
The analyst engineer request the list of the available Functional models related to Fuel System				
The analyst engineer analyses the architectural and functional models, and select the allocated pre-defined set of requirements				
The analyst engineer launches the Simulation tool and analyses components and system performances				
The analyst engineer verifies the requirements means of compliance against the calculated performances				
The analyst engineer releases the new physical model				
The analyst engineer requests the list of the updated physical model				
The analyst engineer can run combined simulation using two different simulation models				

Table 13: Engineering Method "Heterogeneous Simulation"

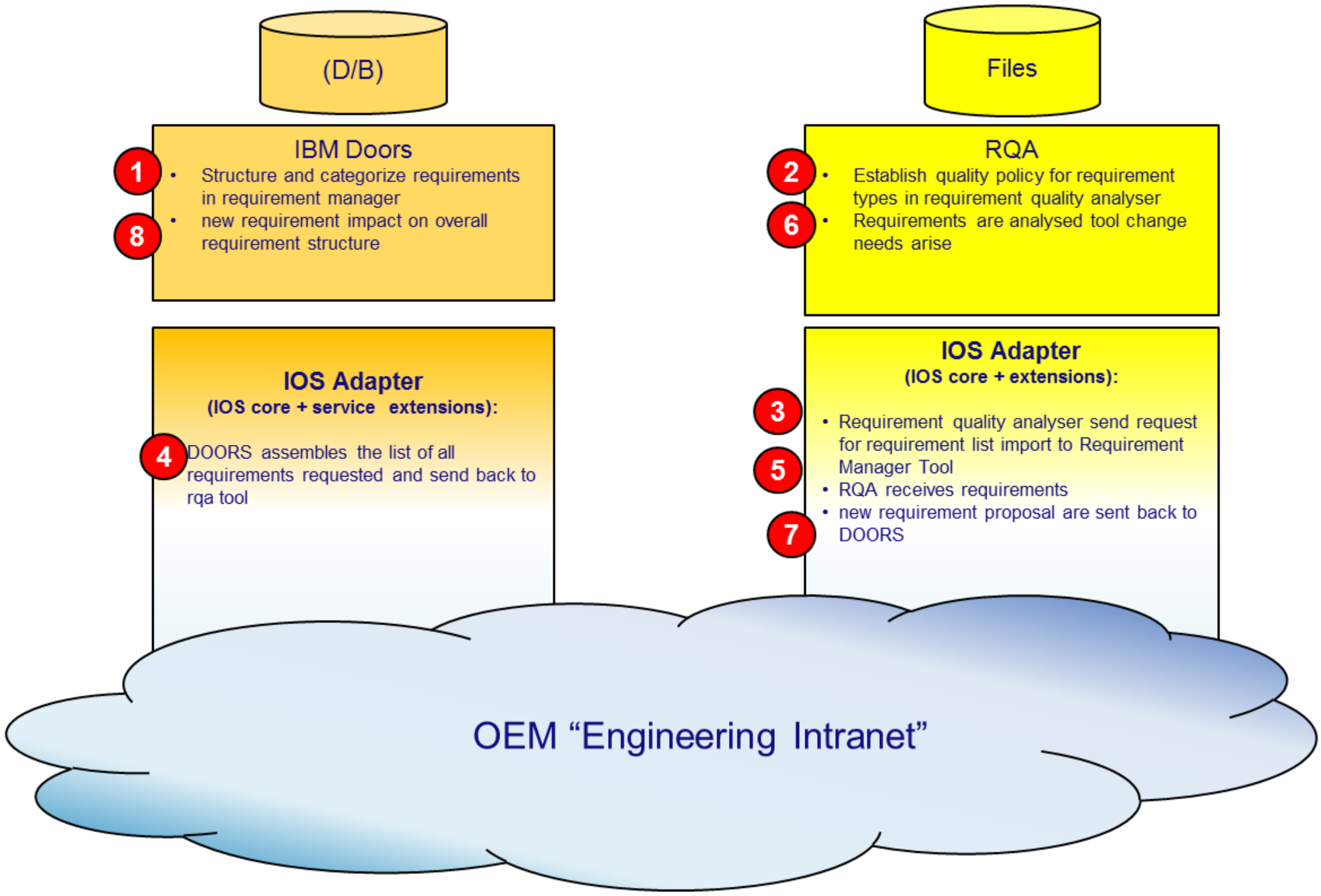
Interoperability Tool Functionality	Tool Functionality			
Domain Tool Functionality	Rhapsody		Mathworks Simulink	
Engineering Activity	Modify model	Model Analysis	Modify model	Model Analysis
The analyst engineer requests the list of the available requirements				
The analyst engineer request the list of the available physical models related to Fuel System				
The analyst engineer request the list of the available Functional models related to Fuel System				
The analyst engineer analyses the architectural and functional models, and select the allocated pre-defined set of requirements				
The analyst engineer launches the Simulation tool and analyses components and system performances				
The analyst engineer verifies the requirements means of compliance against the calculated performances				
The analyst engineer releases the new physical model				
The analyst engineer requests the list of the updated physical model				
The analyst engineer can run combined simulation using two different simulation models				

Table 14: Engineering Method "Heterogeneous Simulation"

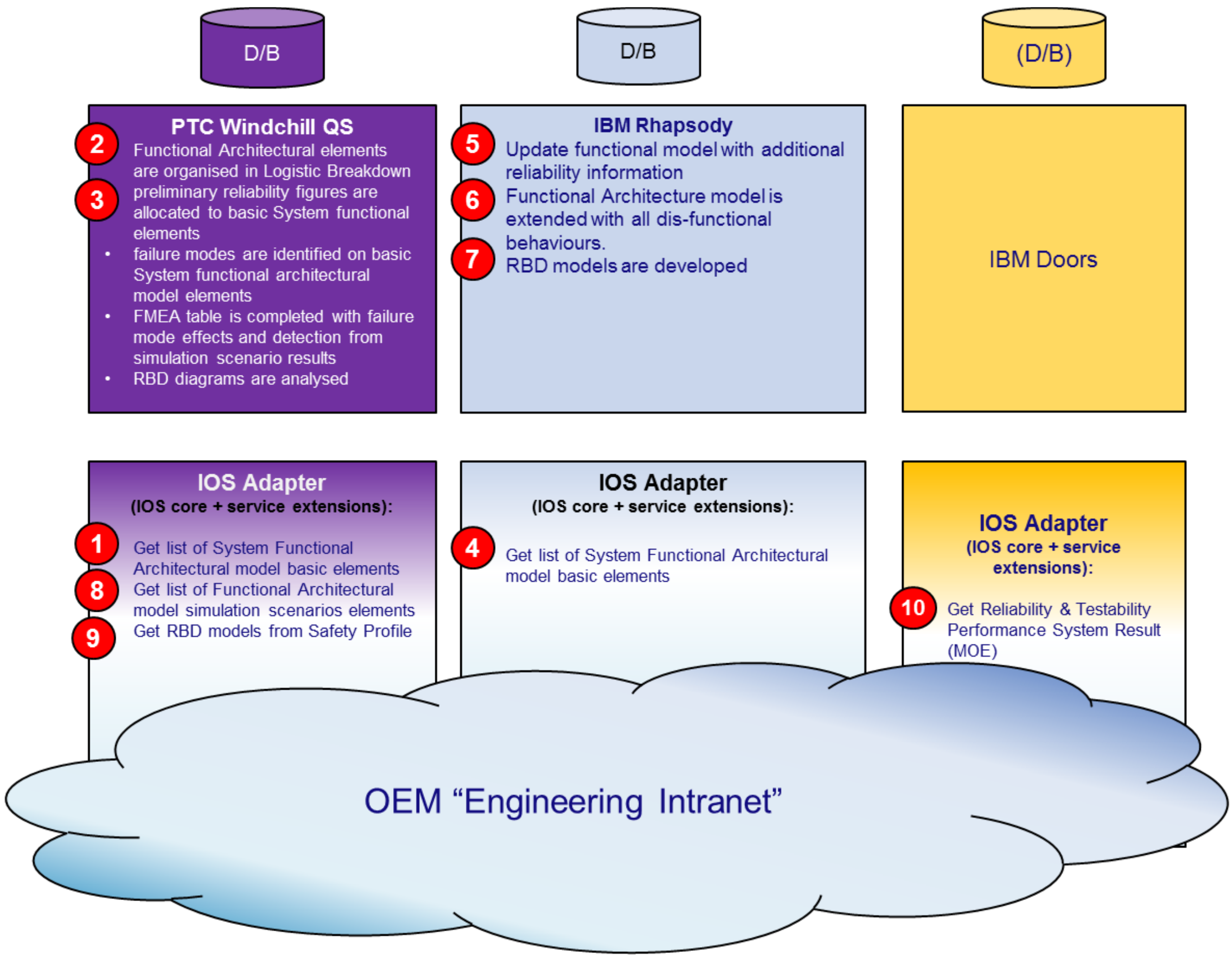
4 Engineering method envisaged Tool chain

In this section the focus is on the sequence of activity mapped on the tool chain: these activities are considered performed inside the tool or via the IOS Adaptor, the sequence is given by numbers in red.

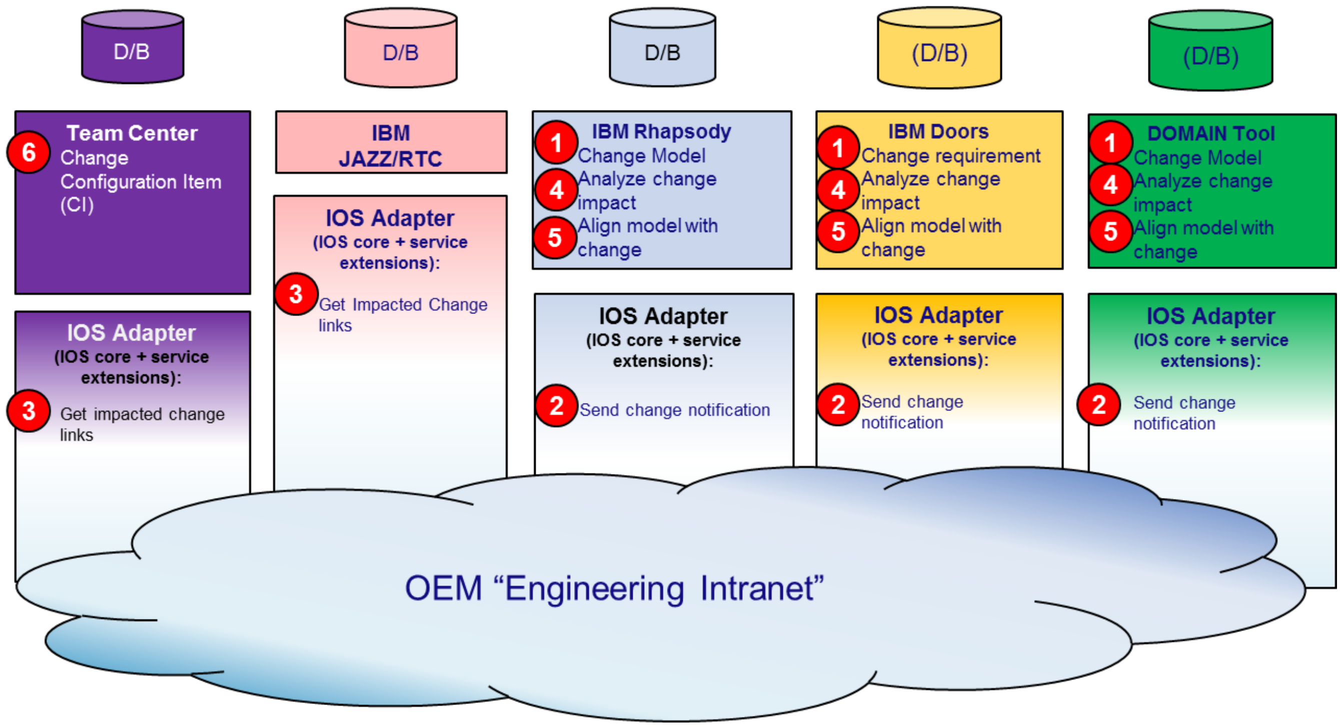
4.1 Analyse Requirements



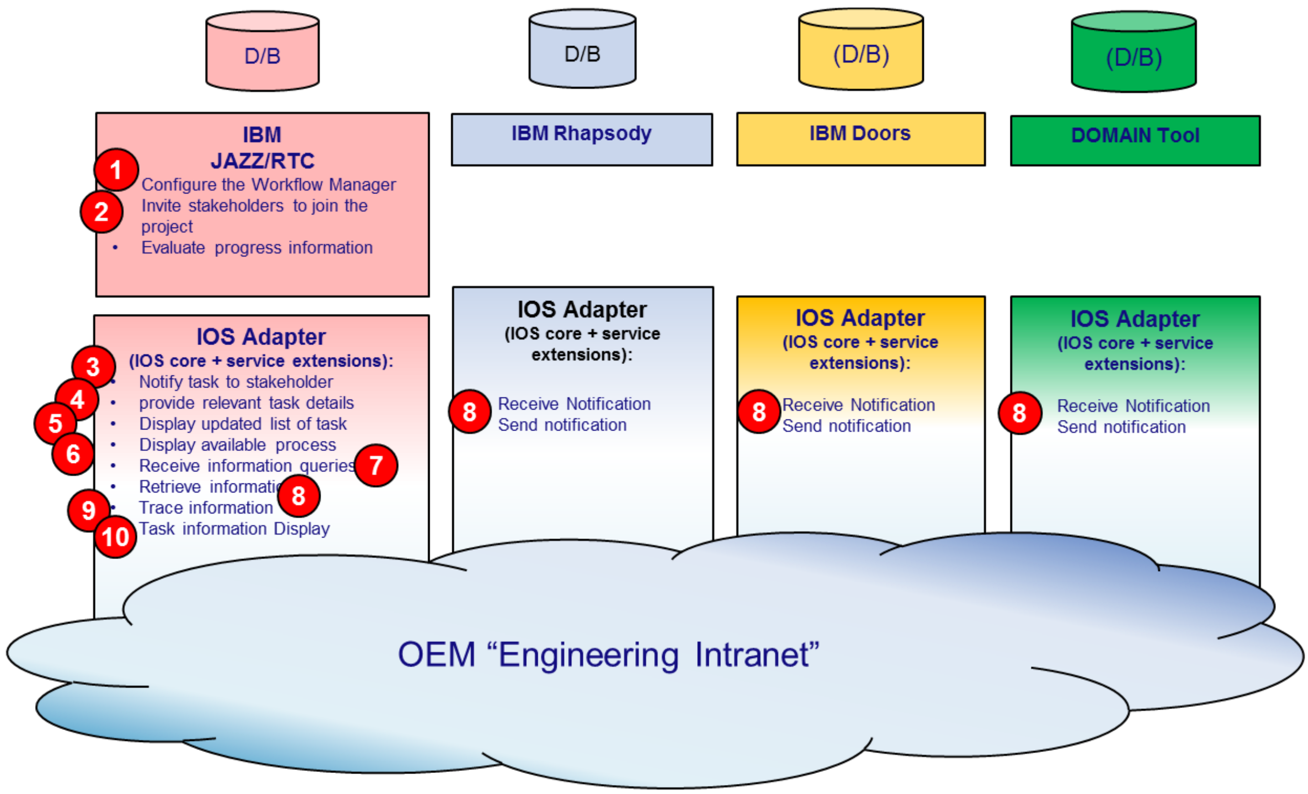
4.2 Verify Design Against requirements



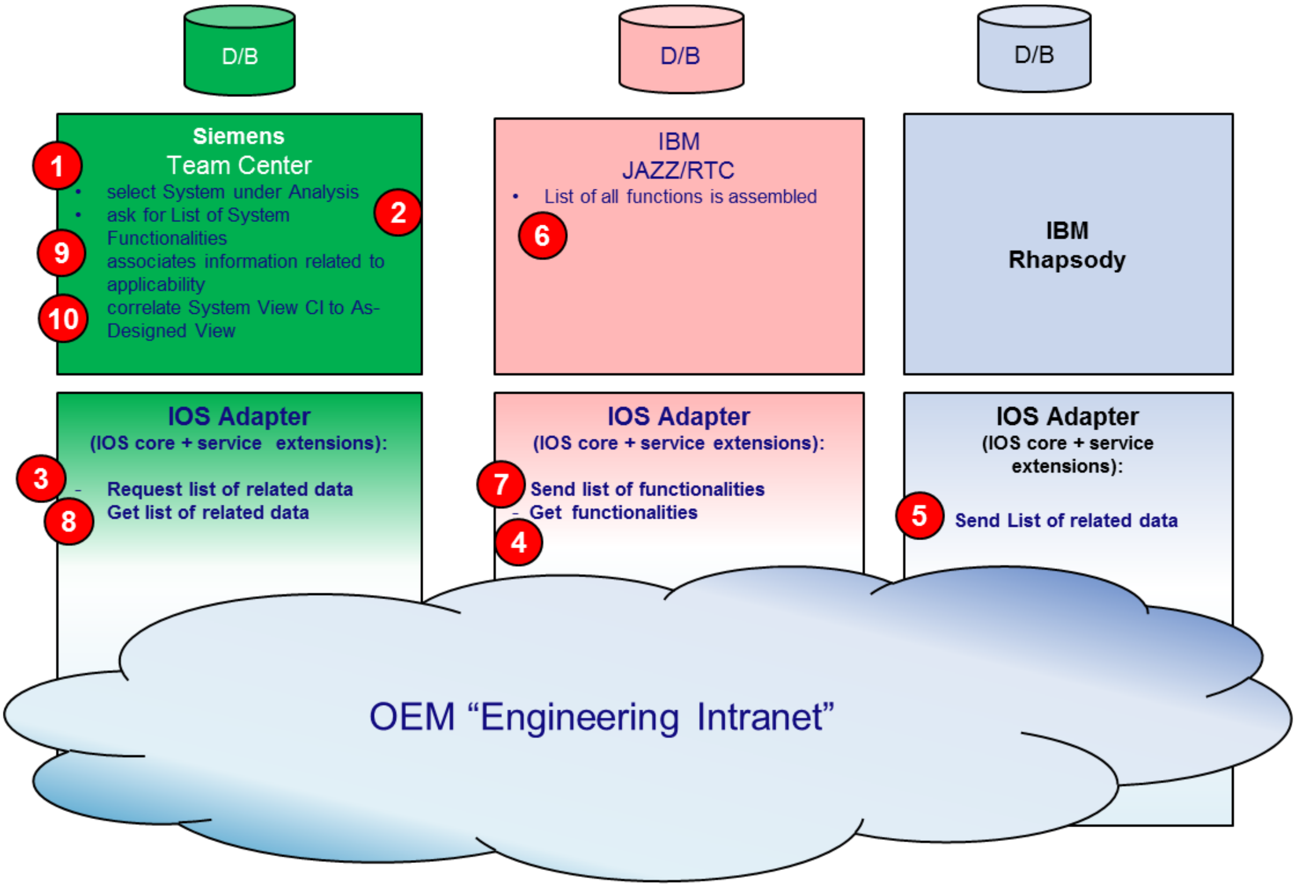
4.3 Change Impact Analysis & Maintain Consistency between Multi-viewpoints Models



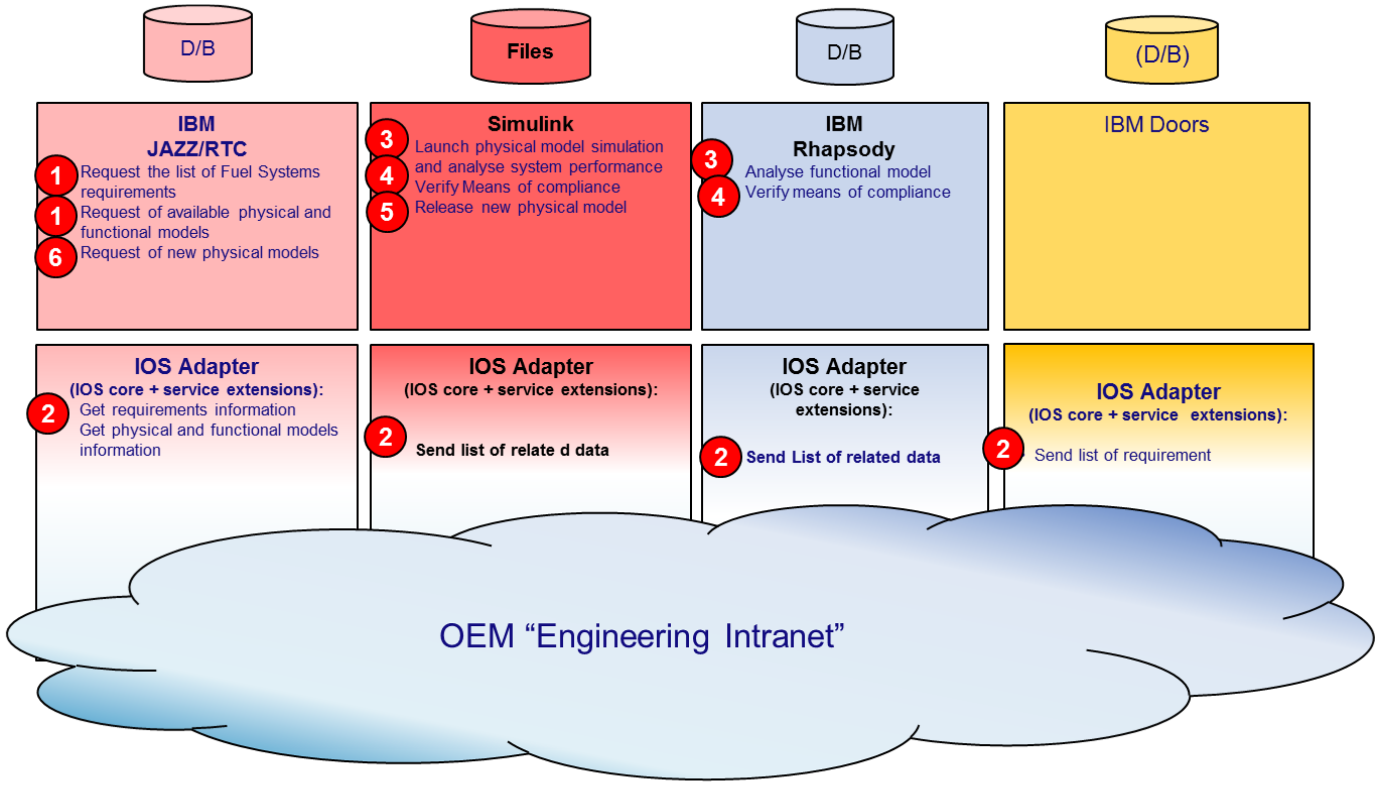
4.4 Provide Process Management



4.5 Provide Configuration Control



4.6 Heterogeneous Simulation



5 Overview of the data used in the Use Case

The preliminary definition and development of an Enhanced Integrated Monitoring and Support System (EIMSS) for a New-Generation Turboprop will be considered for the development of the Alenia Aermacchi use case.

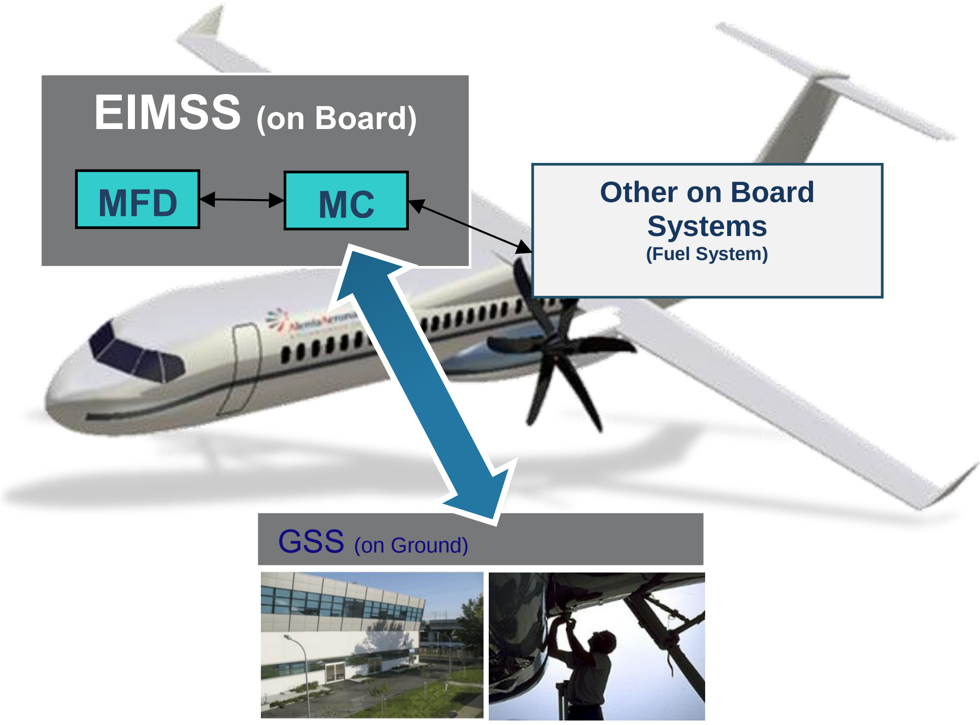


Figure 3: Overall schema of EIMSS System

5.1 Data defined for the EIMSS System

For the EIMSS and Fuel System (one of the system whose data will be gathered and monitored by EIMSS) will be defined the following data:

- EIMSS and Fuel System Requirements
- Systems Functional analysis model
- Reliability analysis starting from Fuel System functional model

5.1.1 EIMSS and Fuel System Requirements

After organizing the requirement structure (considering for instance ATA100) starting from Top Level the System Aircraft Requirements will be decomposed through the different levels till EIMSS system and Fuel System: in the requirement manager (DOORS) will be created the due modules containing the requirements for systems and sub-systems:

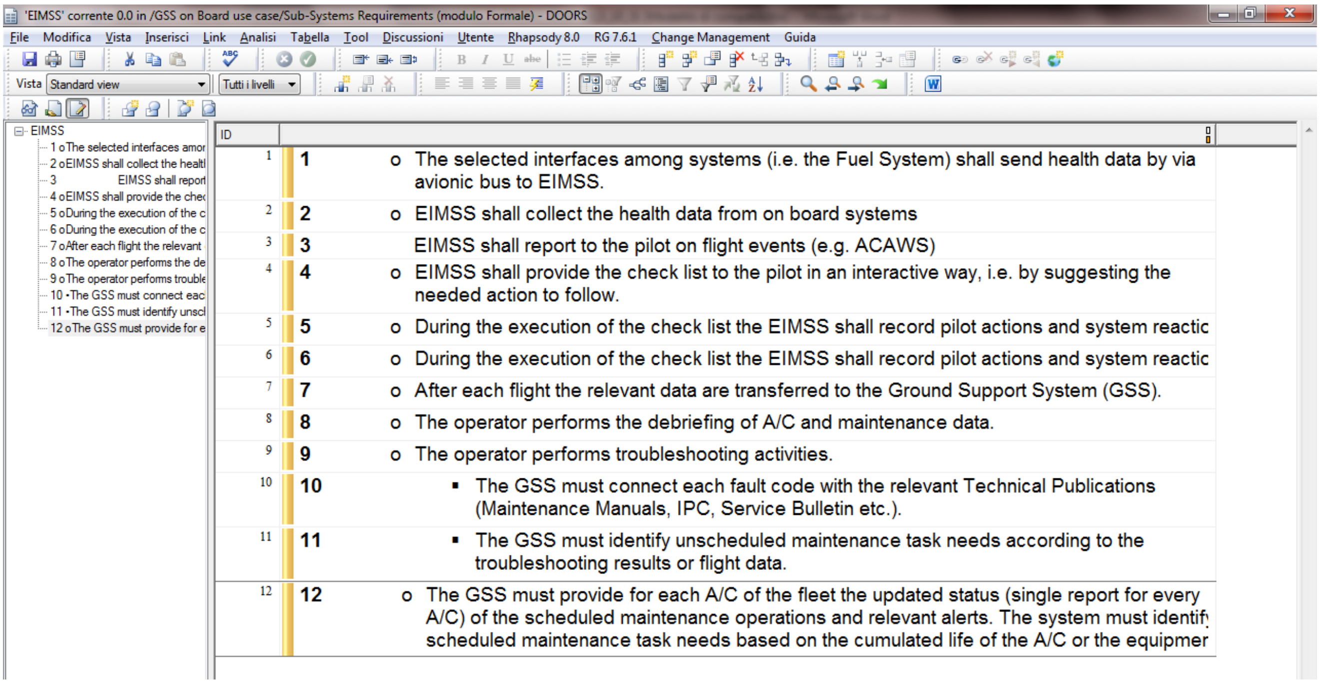


Figure 4: EIMSS Requirement in DOORS

5.1.2 Systems Functional Analysis Model

From requirements next step is modelling in Rhapsody the functional model and logical behaviour of the involved systems

1. use cases will be linked to system requirement,
2. use case will be refined in activity diagrams representing which activities should be performed in order to accomplish the use case
3. Sequence diagram will be produced in order to show the sequence of messages between systems parts during each activity
4. Block definition diagram and internal block diagram will be defined in order to describe relationship between parts and interfaces among them respectively.
5. A state machine diagram will show which will be the different status of the system and the triggers that allow the system to move from one status to another one.

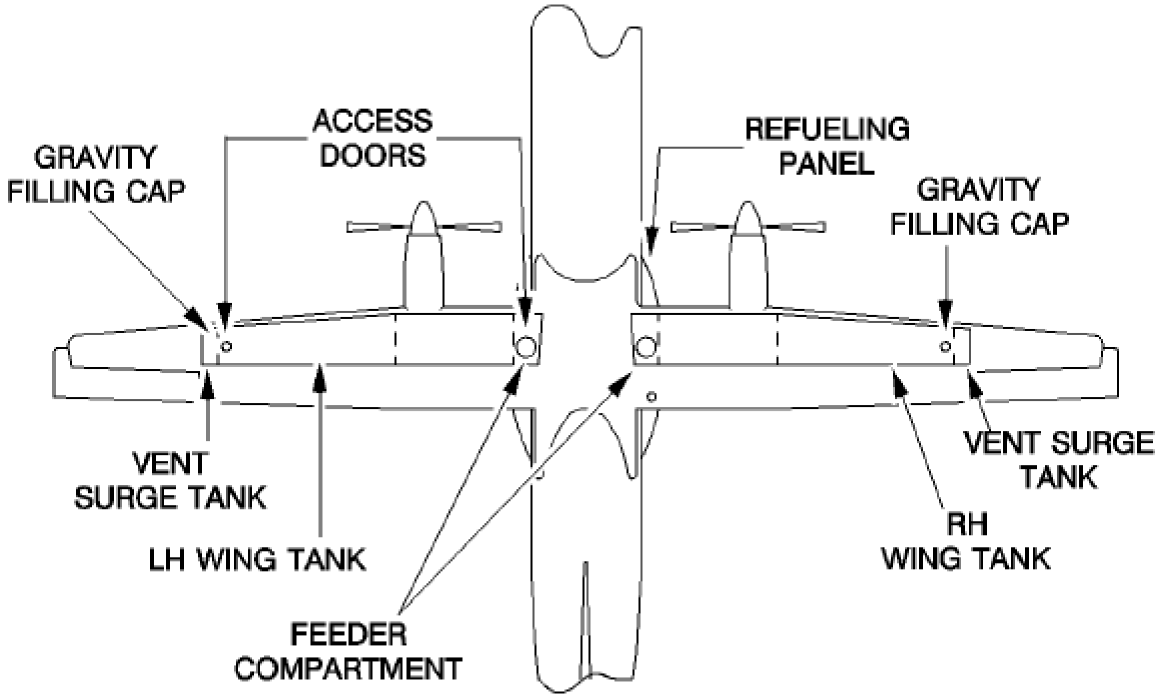


Figure 5: Typical schema of a turboprop fuel system

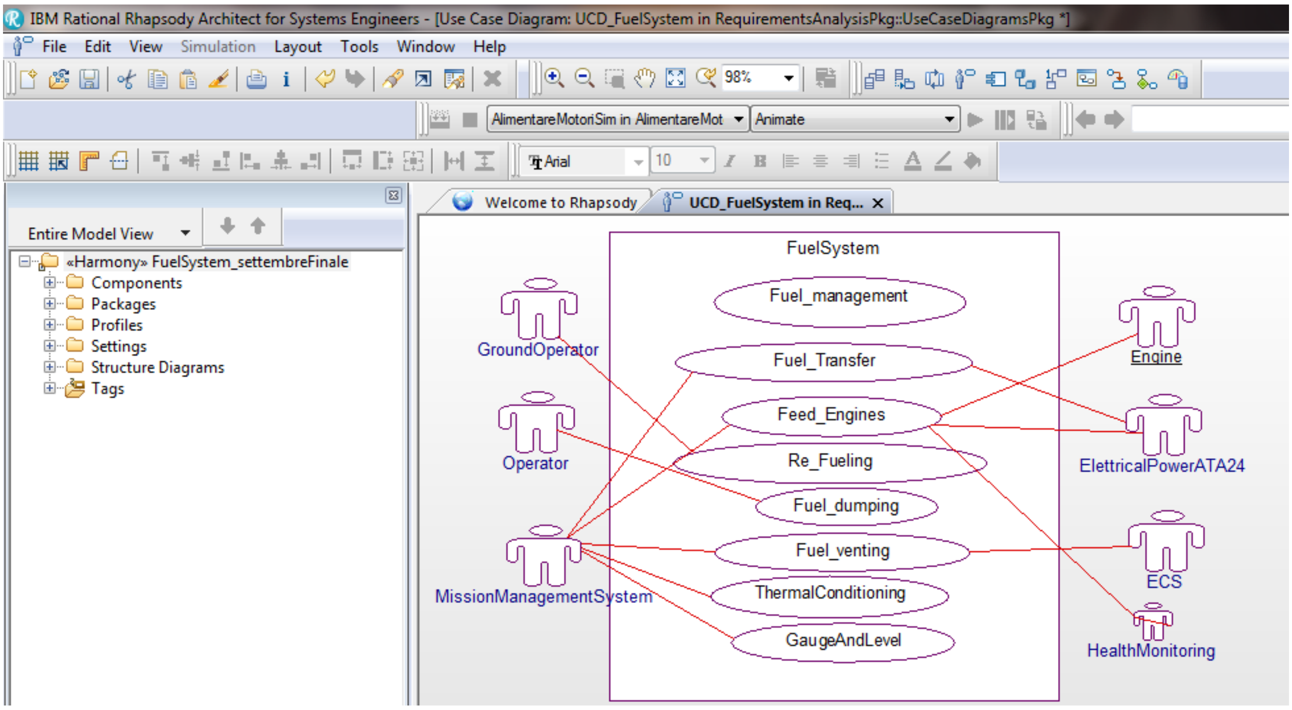


Figure 6: Use case diagram from Fuel System functional model in Rhapsody

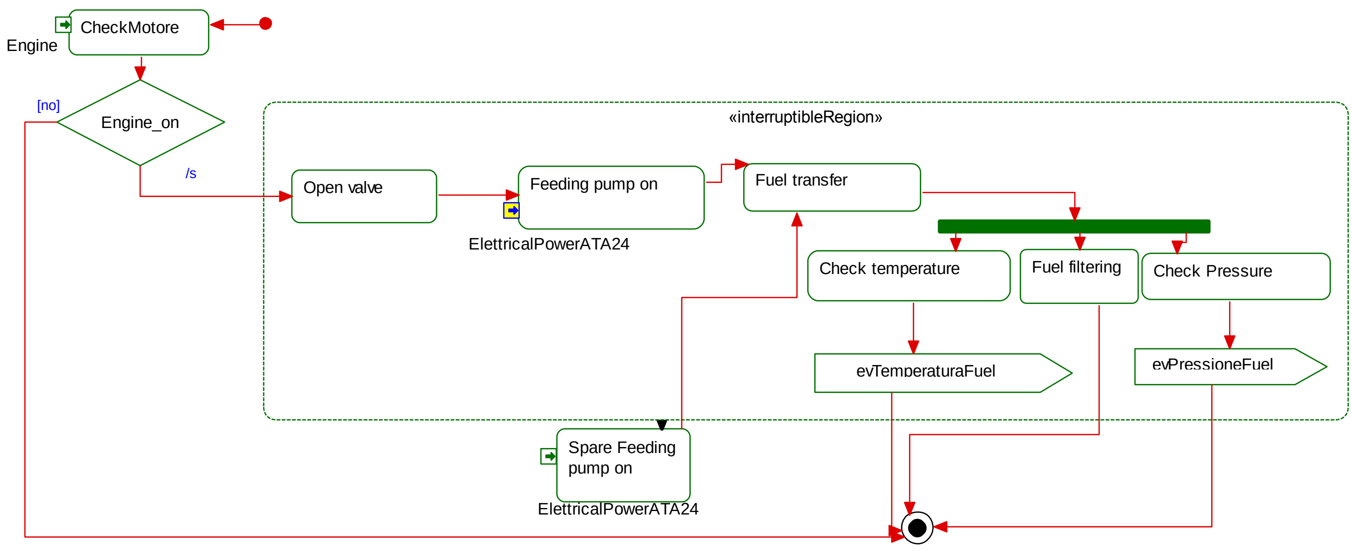


Figure 7: Activity diagram from Fuel System functional model in Rhapsody

5.1.3 Preliminary Sizing Physical Model

The physical model of the monitored system will be provided, although a preliminary sizing should be envisioned as reported as follow. This sizing will allow to reach the required performance while complying with the set of requirements, and the macro-functions envisioned in the Rhapsody model.

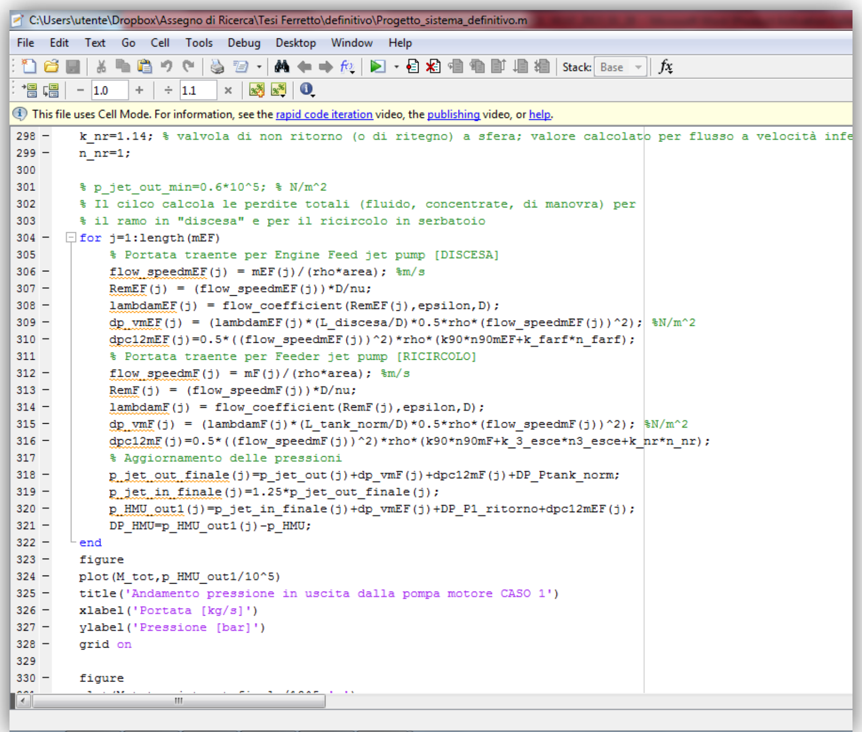


Figure 8: Preliminary Sizing Script for the FUEL system.

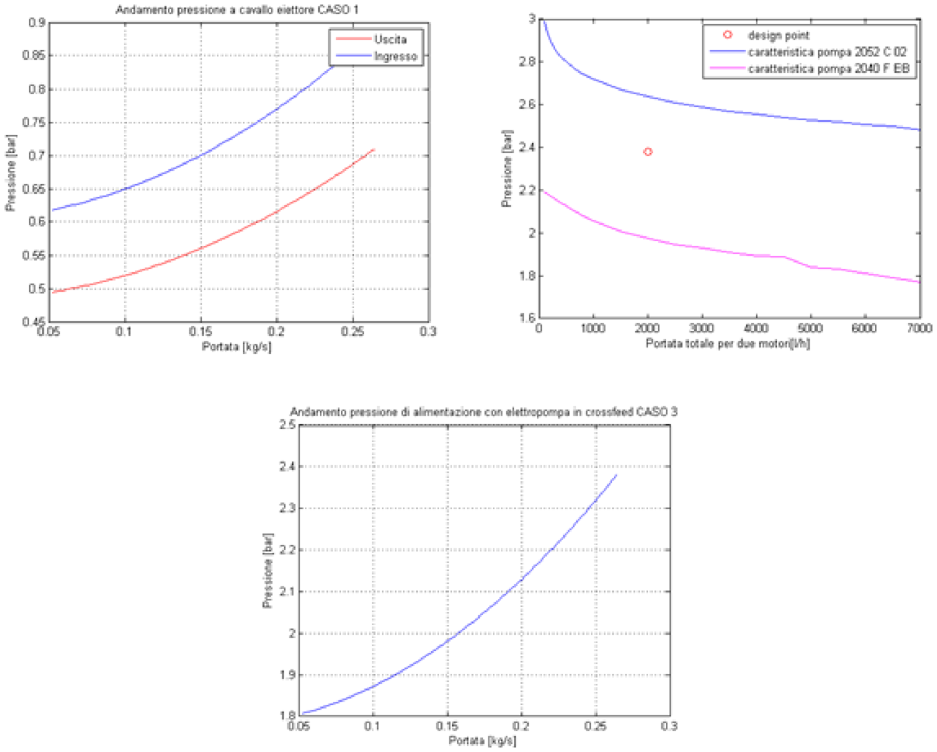


Figure 9: Some Preliminary sizing results for the FUEL System components.

5.1.4 Reliability Analysis in Windchill QS

Once defined the functional model the data shall be imported in Windchill QS to perform needed analysis

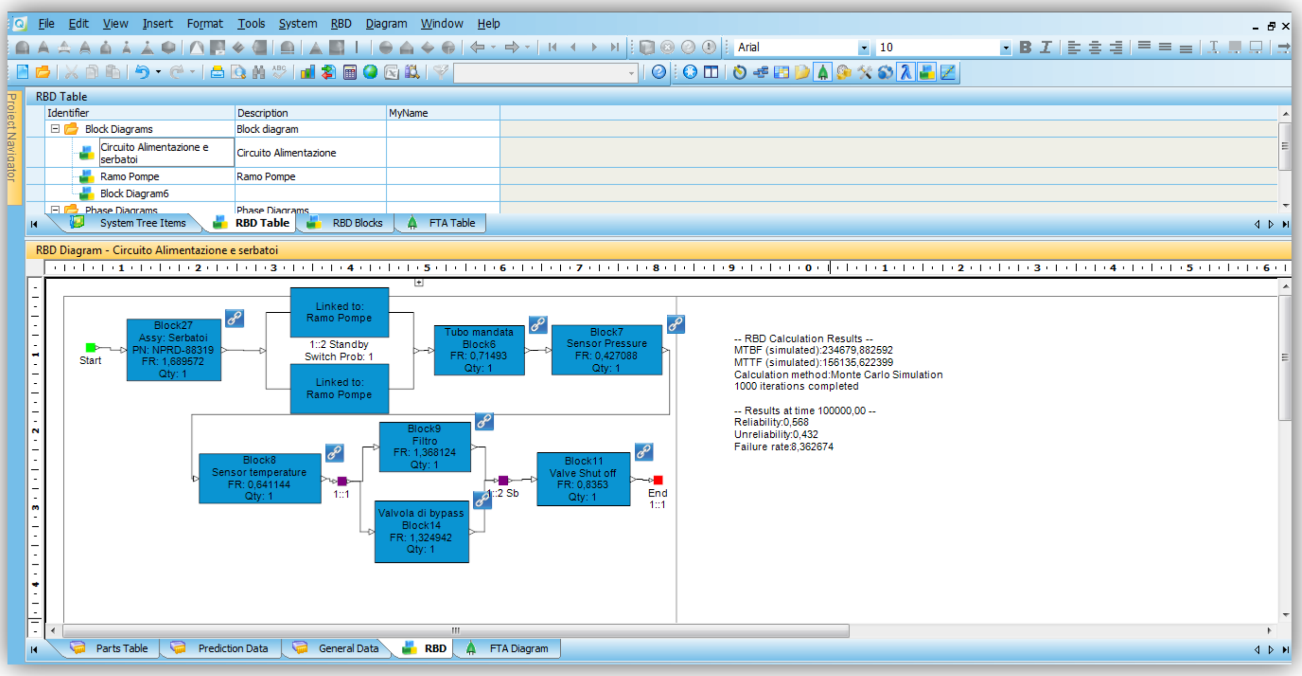


Figure 8: Fuel System reliability analysis in WindChill QS

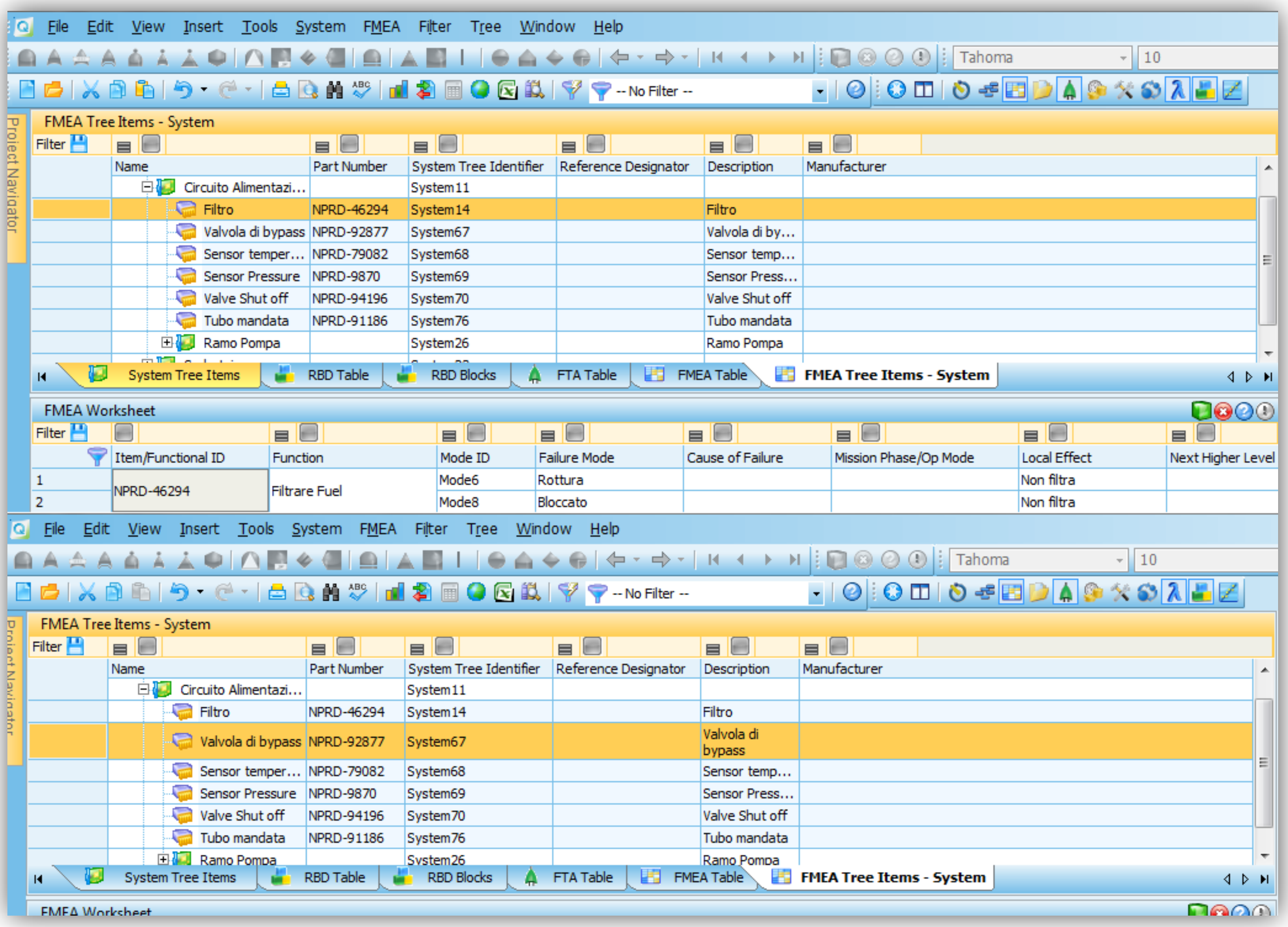


Figure 9: Fuel System FMEA in Windchill QS

6 Envisaged Architecture

Figure 10 illustrates the System Engineering Environment for the Private Aerospace Use Case as it is currently envisaged. The figure depicts either the tools involved and the envisaged architecture of HW with two main server: one for IBM suite and the other for Siemens Teamcenter PLM.

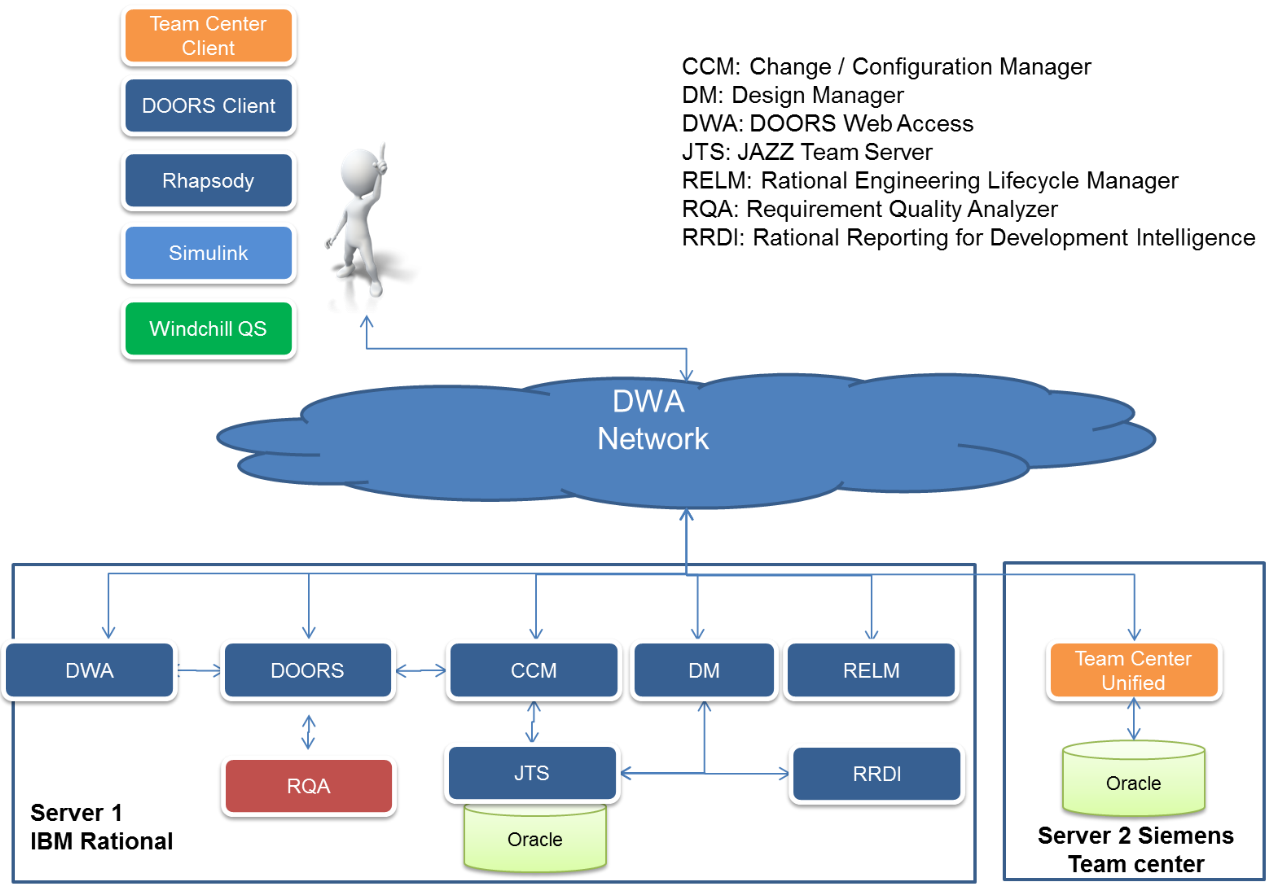


Figure 10: Envisaged Systems Engineering Environment for Private Use Case

Once the architecture will be deployed the integration plan will follow the implementation of the scenarios starting from “Functional Model Development” and “Functional Model Analysis” that are the most interesting from WP202 partners. The evaluation criteria for the success of the integration of the SEE will be the percentage of OSLC connections built over the overall envisaged links in the tool-chain.

7 Abbreviations and Definitions

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

ALM	Application Life-Cycle Manager
BPMN	Business Process Model and Notation
CI	Configuration Item
EIMSS	Enhanced Integrated Monitoring and Support System
GSS	Ground Support System
MBSE	Model Based Systems Engineering
MC	Maintenance Computer
MoE	Means of Evidence
OSLC	Open Services for Lifecycle Collaboration
PLM	Product Life Cycle Manager
RBD	Reliability Block Diagram
RM&T	Reliability, Maintainability & Testability
SE	Systems Engineering
SEE	System Engineering Environment
SPEM	Software & Systems Process Engineering Meta-model
SysML	Systems Modelling Language
V&V	Verification & Validation

Table 15: Terms, Abbreviations and Definitions

8 References

CRYSTAL consortium; 2013	Annex I - "Description of Work"
CRYSTAL consortium; 2013	D202.010 “Use Case Decription”