

## PROJECT PERIODIC REPORT M1-M12



**JU Grant Agreement number:** 332830

**Project acronym:** CRYSTAL

**Project title:** Critical System Engineering Acceleration

**Date of latest version of Annex I against which the assessment will be made:** 28.02.2013

**Periodic report:** 1<sup>st</sup> ☒ 2<sup>nd</sup> ☐ 3<sup>rd</sup> ☐ 4<sup>th</sup> ☐

**Period covered:** from M1 to M12

**Name, title and organisation of the scientific representative of the project's coordinator:**

Dr. Christian El Salloum / AVL List GmbH

**Tel:** +43 316 787 3056

**E-mail:** Christian.ELSalloum@avl.com

**Project website address:** <http://www.crystal-artemis.eu>

**Declaration by the scientific representative of the project coordinator**

I, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the JU Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate):
  - ☒ has fully achieved its objectives and technical goals for the period;
  - ☐ has achieved most of its objectives and technical goals for the period with relatively minor deviations<sup>1</sup>;
  - ☐ has failed to achieve critical objectives and/or is not at all on schedule<sup>2</sup>.
- The public website is up to date, if applicable.
- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 5 (Project Management) in accordance with Article III.2.f and IV.1.f of the JU Grant Agreement.

Name of scientific representative of the Coordinator: Christian El Salloum

Date: 30/05/2014

Signature of scientific representative of the Coordinator: .....

<sup>1</sup> If either of these boxes is ticked, the report should reflect these and any remedial actions taken.

<sup>2</sup> If either of these boxes is ticked, the report should reflect these and any remedial actions taken.

## Table of Contents

<b>1</b>	<b>PUBLISHABLE SUMMARY.....</b>	<b>6</b>
1.1	PROJECT OVERVIEW.....	6
1.2	CRYSTAL'S MAJOR OBJECTIVES AND EXPECTED IMPACT.....	7
1.3	THE STEP BEYOND STATE-OF-THE-ART PROVIDED BY CRYSTAL.....	8
1.4	CRYSTAL AT A GLANCE.....	9
1.5	RESULTS ACHIEVED SO FAR.....	9
<b>2</b>	<b>PROJECT OBJECTIVES FOR THE PERIOD.....</b>	<b>11</b>
2.1	SUMMARY OF THE RECOMMENDATIONS OF PREVIOUS REVIEWS (M9).....	11
<b>3</b>	<b>WORK PROGRESS AND ACHIEVEMENTS DURING THE PERIOD M1 - M12.....</b>	<b>14</b>
3.1	SUB PROJECT 1 (LEAD: AVL).....	14
3.1.1	WP 102 Dissemination and Exploitation (Lead: AVL).....	14
3.1.2	WP 103 Assessment of Project Objectives.....	29
3.2	SUB PROJECT 2 – AEROSPACE DOMAIN (LEAD: A-F).....	30
3.2.1	WP 200 – SP Coordination AEROSPACE (Lead: EADS-CAS).....	38
3.2.2	WP 201 UC (2_01a) Environmental Control Systems Use Case (Lead: A-G).....	42
3.2.3	WP 202 Preliminary Design for a new Regional TurboProp (Lead: ALA).....	44
3.2.4	WP 203 Mission Support Equipment (Lead: EADS-CAS).....	46
3.2.5	WP 204 Electrical Flight Control System (Lead: SAGEM).....	51
3.2.6	WP 205 CRYSTAL Space Toolset applied to Avionics Control Unit Software generation, test, V&V, and Certification (Lead: TASE).....	56
3.2.7	WP 206 Multi-Mode Navigation System (Lead: HON).....	60
3.2.8	WP 207 Crystal Space Toolset applied to Avionics Control Unit Software generation, test, V&V and Certification (Lead: TASF).....	62
3.2.9	WP 208 Public Use Case AEROSPACE (Lead: EADS IW-G).....	65
3.2.10	WP 209 Specifying Ontology AEROSPACE (Lead: EADS IW-F).....	70
3.2.11	WP 210 (2_01b) Simulation for PRA (Particular Risk Analysis) (Lead: A-F).....	73
3.2.12	WP 211 (2_01c) Fuel Management Risk Analysis (Lead: A-UK).....	75
3.3	SUB PROJECT 3 – AUTOMOTIVE DOMAIN (LEAD: AVL-S).....	78
3.3.1	WP 301 (Lead: VOLVO).....	86
3.3.2	WP 302 Development of a safety related assistance system (Lead: Daimler).....	88
3.3.3	WP 303 Functional powertrainarchitecture & control development wrt. integrated system, safety and req. eng. (Lead: AVL).....	89
3.3.4	WP 304 Test case definition interlinked with model based requirement engineering / Variant management (Lead: AVL).....	94
3.3.5	WP 305 ISO 26262 safety assessment and functional assessment for type of fluid changing in a climate control (Lead: CRF).....	98
3.3.6	WP 306 OS MutiCore Compatible AUTOSAR & Safety Mechanisms for ISO26262 compliance (Lead: Valoe-F).....	100
3.3.7	WP 307 Public Use Case AUTOMOTIVE (VIF).....	101
3.3.8	WP 308 Specifying Ontology AUTOMOTIVE (TUB).....	104
3.4	SUB PROJECT 4 – HEALTH DOMAIN (LEAD: PHILIPS).....	105
3.4.1	WP 401 Medical procedures in an interventional X-ray system (Lead: Philips).....	113
3.4.2	WP 402 Safety layer of an interventional X-ray system including collision prevention (Lead: Philips).....	118
3.4.3	WP 403 Motion control of patient table and X-ray beam positioning (Lead: Philips).....	122

3.4.4	WP 404 Medical certification and Requirements management Framework (Lead: BARCO)	126
3.4.5	WP 405 SW centric scalable safety critical medical display platform (Lead: BARCO)	128
3.4.6	WP 406 An intelligent infusion controller for Blood Pressure regulation in Operating Room (Lead: RGB)	130
3.4.7	WP 407 Specifying Ontology HEALTHCARE (Lead: TNO)	140
3.5	SUB PROJECT 5 – RAIL DOMAIN (LEAD: ASTS)	141
3.5.1	WP 501 ERTMS/ETCS Interoperable testing. New way (Lead: ASTS)	146
3.5.2	WP 502 Integrated modelling of core algorithms in TAS Control Platform (Lead: Trail)	152
3.5.3	WP 503 Traction Systems (Lead: ALS)	154
3.5.4	WP 504 Specifying Ontology RAIL (Lead: ASTS)	156
3.6	SUB PROJECT 6 - R&T ACTIVITIES (LEAD: EADS IW-UK)	157
3.6.1	WP 601 IOS Evolution & Development, Standardisation (Lead: EADS IW-UK)	161
3.6.2	WP 602 Platform builder (Lead: ALA)	165
3.6.3	WP 603 System analysis and exploration (Lead: VIF)	170
3.6.4	WP 604 Tools for Safety Engineering (Lead: AIT)	179
3.6.5	WP 605 AUTOSAR Tools & Components (Lead: TTTECH)	182
3.6.6	WP 606 Heterogeneous Simulation (Lead: FhG)	187
3.6.7	WP 607 Requirements Based Engineering (RBE) (Lead: REUSE)	190
3.6.8	WP 608 Product Lifecycle Management (Lead: SISW)	195
3.6.9	WP 609 Multi-viewpoint Engineering (Lead: Obeo)	199
3.6.10	WP 610 Variability Management (Lead: Tecnalia)	204
3.6.11	WP 611 Software Development Lifecycle (SDLC) Management Brick Community (Lead: IBM UK)	211
3.6.12	WP 612 Validation Models (Lead: MATE)	213
3.6.13	WP 613 Simulation Models (Lead: AVL)	218
3.7	BENEFICIARY REPORT	220
<b>4</b>	<b>DELIVERABLES AND MILESTONES TABLES</b>	<b>221</b>
<b>5</b>	<b>PROJECT MANAGEMENT</b>	<b>244</b>
5.1	CONSORTIUM MANAGEMENT TASKS AND ACHIEVEMENTS	244
5.1.1	Definition of project roles and responsibilities	244
5.1.2	Project Start	247
5.1.3	Project Handbook	247
5.1.4	Communication and Collaboration Support	247
5.1.5	Contractual Issues	247
5.1.6	Quality Management	248
5.2	REVIEW PROCESS FOR DELIVERABLES	248
5.3	PROGRESS MONITORING & CONTROLLING	249
5.4	PROBLEMS WHICH HAVE OCCURRED AND HOW THEY WERE SOLVED OR ENVISAGED SOLUTIONS	250
5.5	RISK MANAGEMENT	250
5.6	CHANGES IN THE CONSORTIUM	250
5.7	LIST OF PROJECT MEETINGS, DATES AND VENUES	250
5.8	PROJECT PLANNING AND STATUS	252
5.9	IMPACT OF POSSIBLE DEVIATIONS FROM THE PLANNED MILESTONES AND DELIVERABLES, IF ANY	252

---

5.10	ANY CHANGES TO THE LEGAL STATUS OF ANY OF THE BENEFICIARIES, IN PARTICULAR NON-PROFIT PUBLIC BODIES, SECONDARY AND HIGHER EDUCATION ESTABLISHMENTS, RESEARCH ORGANIZATIONS AND SMES .....	253
5.11	DEVELOPMENT OF PROJECT WEBSITE .....	253
<b>6</b>	<b>EXPLANATION OF THE USE OF THE RESOURCES .....</b>	<b>254</b>
<b>7</b>	<b>FOR BENEFICIARIES WITHOUT A CORRESPONDING NATIONAL GRANT AGREEMENT, FINANCIAL STATEMENTS (FORM C).....</b>	<b>268</b>
<b>8</b>	<b>ANNEX.....</b>	<b>269</b>

# 1 Publishable summary

## 1.1 Project Overview

### Background and motivation

The processes of developing, deploying, governing, operating and maintaining modern safety-critical embedded systems is highly complex and requires specialized tools supporting different activities throughout the entire product life cycle. Therefore, OEMs and suppliers are typically operating a large set of tools from different vendors often complemented by custom in-house solutions. The overall process can be effective and efficient only, if it supports collaboration among all stakeholders and consequently interoperability between the tools they are using. Considering the ongoing outsourcing and globalization activities, interoperability and openness is getting even more crucial. In addition, the demand for supporting a large number of product variants further increases the complexity to be handled.

Today, tool integration is often done in an ad-hoc manner by creating proprietary bridges between each pair of tools. Such an approach does not scale, since the number of required bridges grows exponentially with the number of employed tools. Moreover, the resulting tool chain becomes extremely vulnerable to common changes like version upgrades from tool vendors, and the efforts for maintaining a large set of bridges is sooner or later no more acceptable. The main technical challenge in addressing this problem is the provision of open and common interoperability technologies supported by the different tools that generate and provide access to data covering the entire product lifecycle.

### CRYSTAL Strategy

The ARTEMIS Joint Undertaking project CRYSTAL (CRITICAL sYSTEM engineering ACceLeration) has identified this need and takes up the challenge to establish and push forward an Interoperability Specification (IOS) and a Reference Technology Platform (RTP) as an open European standard for safety-critical systems. This standard will allow loosely coupled tools to share and interlink their data based on standardized and open Web technologies that enable common interoperability among various life cycle domains. This reduces the complexity of the entire integration process significantly. CRYSTAL is strongly industry-oriented and will provide ready-to-use integrated tool chains having a mature technology-readiness-level (up to TRL 7). In order to reach this goal, CRYSTAL is driven by real-world industrial use cases from the automotive, aerospace, rail and health sector and builds on the results of successful predecessor projects like CEASAR, SAFE, iFEST, MBAT on European and national level.

Creating and establishing a new standard on a large scale in an already consolidated market cannot be achieved by small individual organizations. With a budget of more than 82 million Euro and 70 partners from 10 different European countries, CRYSTAL has the critical mass to accomplish this endeavour. The project consortium is made up of participants from all relevant stakeholders, including OEMs, suppliers, tool vendors and academia. Throughout the entire project, CRYSTAL will stay in close exchange with standardization organizations like ASAM, ProSTEP iViP, OASIS, OMG, CENELEC and others in order to build up on existing achievements and to join forces through collaboration in the standardization process.

## 1.2 CRYSTAL's major objectives and expected impact

The consortium has gathered leading technology providers, tool vendors, and research institutions in the fields of model-based systems engineering and software product lines to clearly identify and agree on what kind of advances to the state-of-the-art are required to meet the specified quantitative targets and business objectives (B1 to B5) as stated in the table below.

No.	Business needs	Business objectives	Priority
B1	<i>Enhance interoperability and provide seamless ready-to-use tool chains</i>	• Strengthen the seamless use of model-based systems engineering techniques	H
		• Provide implemented, validated, and ready-to-use integrated tool chains	H
		• Evolve interoperability specification towards a European standard and improve the RTP	H
B2	<i>Manage increasing embedded system complexity</i>	• Evolve interoperability specification and standard as well as improve RTP	H
		• Strengthen the seamless use of model-based systems engineering techniques	H
		• Improve the requirement management and development process, providing a standard – common – systematic approach featuring traceability	H
		• Manage complexity increase of 25% with 10% effort reduction	H
		• Improve the configuration management process in the preliminary design phases	H
B3	<i>Support cross-domain reusability, re-certification, re-qualification, and design variability</i>	• Improve and foster cross-domain reusability and variability management	H
		• Improve collaboration among engineering disciplines involved in embedded system development	H
		• Increase reusability of design and tools minimizing re-certification costs	H
		• Reduce effort and time required for re-validation and re-certification of systems after making changes by 10-15%	H
		• Transfer procedures and tools between different domains, e.g. between aeronautics and space business	H
B4	<i>Reduce development costs and time-to-market</i>	• Reduce development and development life cycle costs by 15-20% depending on application domain	H
		• 20% fewer design iterations	M
		• Reduce the cost of integration, configuration, deployment, and maintenance of appropriate tool chains for all major actors in the supply chain involved in the project by 50%.	H
B5	<i>Reduce validation and test effort</i>	• Opportunity to adapt a proprietary test suite to a real multi-provider interoperable environment without manually rewriting each test	H
		• Reduce time needed for system test definition by 80% (rail domain)	H
		• Reduce time needed to complete test analysis by at least 40%	M
		• Reduce time and effort needed for system validation by 15-20%	H

Most important identified business needs and related business objectives targeted in CRYSTAL (weighting: H=high interest/strong need, M=medium interest/need).

Table 1-1: CRYSTAL's major objectives and expected impact



The aims of CRYSTAL are ambitious and the expected results will have significant economical and societal impacts. OEMs will benefit from better supplier collaboration and reduced system design costs due to the improved and the smart integration of system analysis, safety analysis, and system exploration tools. In addition, the CRYSTAL IOS will increase the flexibility for all stakeholders and has the potential to deeply impact the market on a global level. OEMs can easily combine tools from different vendors, and tool vendors will be able to find new market opportunities in an open and extensible environment.

### 1.3 The step beyond state-of-the-art provided by CRYSTAL

CRYSTAL aims to mature innovative techniques, methods and tools developed in other research projects in order to bring them to a level of maturity that is compatible with a pre-deployment in industry. The technology readiness level (TRL) targeted is at least TRL5 at the end of the project (between TRL6 and TRL7 for at least 50% of the tool chains), so that an industrial deployment on operational environment can be envisaged in the three years after the end of CRYSTAL. All partners within CRYSTAL have agreed on 13 different technology brick groups which include all currently identified technology bricks from transportation and Healthcare which are strongly related to the AIPP1 technical objectives. However, the project will remain open for new bricks during the project duration. The following figure illustrates the brick group concept of CRYSTAL and the cross-domain technologies which will be driven forward and beyond the state-of-the-art.

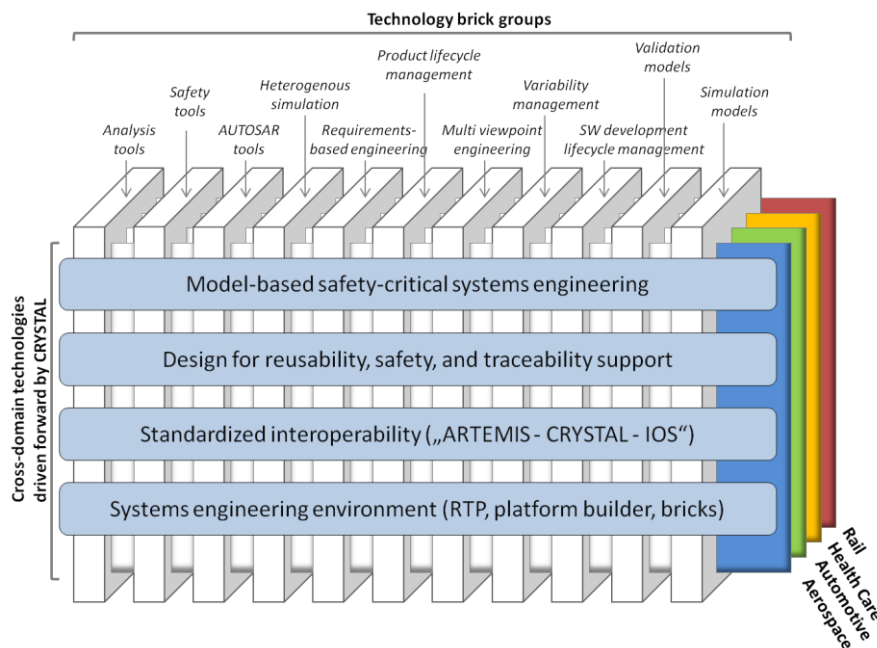


Figure 1-1: CRYSTAL Engineering Domains and Application Domains

Figure 1-2 The CRYSTAL implementation strategy (development process, user applications, engineering tool functions, IOS, and data management) shows the technical architecture of the CRYSTAL concept and highlights the different processes, user applications, and the embedding of the System Engineering Environment (SEE) with its interfaces to the engineering product and the engineering domains. CRYSTAL aims at linking development tools involved in current product development together to make them aware of each other's data and able to exchange it. This linking and exchange of data shall be done according to the Interoperability Specification (IOS) that



is to be defined in the project. The selection and adaptation of tools are based on use cases defined by industrial partners.

The cornerstones of the implementation strategy are:

- Apply IOS as the standard set of rules for future embedded systems.
- Reuse of existing standards if possible implemented from market leaders to efficiently integrate a maximum number of partners.
- Provide a set of tools sharing data via data service providers using IOS interfaces for easy, flexible and standardized data management.
- Separated data from tool functions (to keep data sovereignty). However, different functions can use the same data.

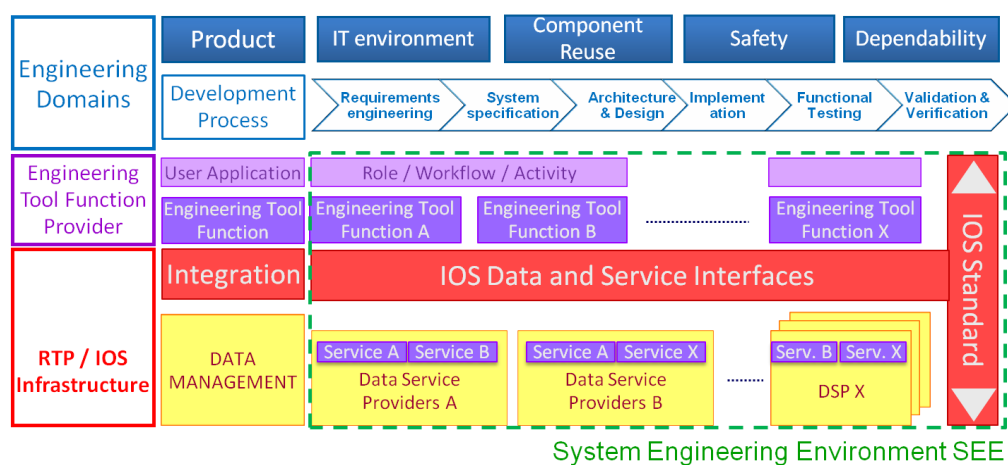


Figure 1-2: The CRYSTAL implementation strategy (development process, user applications, engineering tool functions, IOS, and data management)

## 1.4 CRYSTAL at a glance

### CRYSTAL

- will be an industry-driven application-/user-oriented project
- will **implement** – based on existing technologies (generic interoperable and federated technology bricks and services, COTS) – **ready-for-use integrated tool chains** that can be applied industrially in the partner's engineering environment
- will **drive forward cross-domain reusability, ontology technology, and interoperability** including an **interoperability specification (IOS)** and the cooperative reference technology platform (CRTP) towards a European *de facto* standard

## 1.5 Results achieved so far

The work in CRYSTAL is conducted in an iterative development process, generating refined results in each iteration step. One major focus for this period was to set up a technical management process for gathering, consolidating and refining the needs from the use cases of the different applications domains and for steering, validating and verifying the development of the IOS and the technology bricks in such a way that the use case needs are fulfilled. This technical management

process was jointly developed with all involved stakeholders and was implemented in a dedicated tool.

The other major objective for this period was the analysis of the state of the art, the first version of the use-case definitions and the first version of the documents describing the associated technology bricks and the meta-model of the platform builder.

The objectives for the first milestone at M9 “Use-Case Specification V1” have been fully achieved. Since then the work on identifying concrete interoperability services to implement the use cases has started, and the first version of the IOS specification was released.

In some selected use cases the first implementation results are already available, which serve as a means to refine our project-internal processes and can be shown to the public as first success stories.

## 2 Project objectives for the period

According to Annex I of the JU Grant Agreement, the objectives for the period from the start of the project to M12 are:

- Devise and implement the process for the administrative management process including (SP1):
  - deliverable review process
  - tracking of dissemination activities
  - tracking of exploitation activities
  - organization of meetings and workshops
  - reporting (costs, efforts and results)
- Provide a project handbook that serves as a manual for all partners with respect to administrative activities (SP1)
- Create the CRYSTAL Homepage (SP1)
- Devise and implement the technical management process (SP1 and SP6)
  - Define the roles and responsibilities of all stakeholders (use case owners and technology providers)
  - Define the collaboration and the communication structure between SP6 and the application SPs (SP2-SP5)
  - Establish full traceability among all involved artifacts in the development
- Establish the state-of-the-art (SP2-SP6)
- Provide a first version of the use case definitions (SP2-SP5)
- Provide a first version of the ontology documents (SP2-SP5)
- Start the design of the use-case demonstrators (SP2-SP5)
  - Define required IOS Services
  - Define involved technology bricks (e.g., tools) and required adaptations (e.g., IOS adaptors)
- Provide a first version of the documents describing the technology bricks (SP6)
- Provide a first version for the meta model for the platform builder (SP6)
- Provide the first version of the interoperability specification (SP6)

### 2.1 Summary of the recommendations of previous reviews (M9)

Recommendation 1:

*“For the next review, the project should establish and document clearly the scope and functionality of the IOS and the RTP and position CRYSTAL advances in relation to previous and on-going projects. This needs to go beyond tool – tool interaction for each specific domain and should include cross-domain applicability as well as an approach for establishing a system engineering environment (SEE) suited to the business needs.”*

Corrective Action:

The IOS V1 deliverable is now available in its final version and has been submitted to the ARTEMIS JU. It clearly describes the scope, functionality and architecture of the IOS and the IOS development process. Also the history of the IOS evolution and the relation to previous and on-going projects are elaborated. Both, the IOS and the RTP will be presented in detail in a dedicated slot at the M12 review.

---

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	11 of 269

#### Recommendation 2:

*“The role of ontology for the IOS has to be defined and should avoid being purely domain or use-case specific. Since extended interoperability requires semantic information the IOS has to address this aspect as well.”*

#### Corrective Action:

The ontology WPs in SP2-SP5 constitute a means to enrich the IOS with semantic specifications required for extended interoperability. This is done by (i) eliciting and defining generic and/or domain-specific Lifecycle Artefacts required for interoperability on a semantic level in the respective Use Case Engineering Methods and (ii) nominating candidates to be taken up into the CRYSTAL IOS. A consolidation to domain-agnostic Lifecycle Artefacts will be done whenever reasonable. The approach will be presented in detail at the M12 review.

---

#### Recommendation 3:

*“The RTP needs to support configuring a problem-oriented SEE with workflows to cope with e.g. change management, variability in product families, product lifecycle and post sales surveillance.”*

#### Corrective Action:

The CRYSTAL consortium includes tool providers who have already solution on the market with a high maturity to support various workflows. The IOS will include specifications specially dedicated to this topic, and in several use cases this is already explicitly addressed.

---

#### Recommendation 4:

*“The project should assure an adequate complexity of the use cases in relation to IOS and RTP and the use of models.”*

#### Corrective Action:

CRYSTAL follows an iterative process where also the Use-Case descriptions are updated in an iterative process (i.e. with each use-case development report). At the M9 review, some of the use cases descriptions were considered as inadequate with respect to the efforts spent. This was mainly a reporting issue (the use cases were actually much more complex than described in the early deliverables). The M12 deliverables describe these demonstrators in much more detail (use case development reports)

---

#### Recommendation 5:

*“The project management should implement a process to update the risk register on a regular basis and in due reaction to project execution (e.g. delayed deliverables)”*

#### Corrective Action:

The coordinator has set up a process based on the CRYSTAL SharePoint, which facilitates project-wide risk management in a transparent way with minimal overhead. The process allows each WP report any identified risk to the coordinator. The identified risks will be collected by the coordinator, and will be discussed in the technical board meetings where an overall assessment takes place and appropriate counter measures are developed.

---

#### Recommendation 6:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	12 of 269

---

*“The number of deliverables should be reduced to ensure effective achievement, avoiding repetition and relevant content.”*

Corrective Action:

According to the initial DoW, CRYSTAL would have to submit 305 deliverables in total. To reduce the number of deliverables we proposed a straightforward solution, which saves the overhead of 127 deliverables and results in an overall structure that is much more homogenous and thus easier to understand and to manage. This proposal is part of a request for amendment which is currently under review of our project officer.

---

Recommendation 7:

*“Dissemination requires establishing a detailed dissemination plan, identifying target audiences, means (e.g. fairs, roadshows, public use cases, publications) and metrics to assess dissemination efforts. The project’s web site should present achieved and planned dissemination activities.”*

Corrective Action:

The dissemination and exploitation plan is available now and has been submitted to the JU.

### 3 Work progress and achievements during the period M1 - M12

This section gives detailed information on the work performed and progress achieved for each Sub Project and Work Packages.

#### 3.1 Sub Project 1 (Lead: AVL)

##### 3.1.1 WP 102 Dissemination and Exploitation (Lead: AVL)

###### ***Project objectives for the period M1-M12***

During this period M1-M12, all the dissemination and exploitation objectives were followed.

###### ***Progress towards objectives***

###### Set-up of dissemination material for public use:

- CRYSTAL Leaflet
- CRYSTAL Homepage
- CRYSTAL Logo
- CRYSTAL Power Point Template
- CRYSTAL Poster Template
- CRYSTAL LinkedIn Group
- CRYSTAL Newsletter

###### Creation of deliverables:

All deliverables that were due in that period have been finalized and submitted to the JU.

See list of deliverables

Table 4-1

###### Planning of dissemination and exploitation activities:

All partners were asked via a survey to provide their dissemination and exploitation plans. The project partners have identified and defined dissemination and exploitation activities. All performed and planned dissemination activities and exploitation plans have been summarized in the deliverables "Report and Planning of Dissemination Activities V1 - D102.030" and "Exploitation Plan V1 - D102.040" that have been completed and submitted in time according to project schedule. Both, the Report and Planning of Dissemination Activities and the Exploitation Plan will be updated at M20.

###### Cooperation with other projects or standardization organizations

Cooperation is a central element for CRYSTAL. This is also the credo of the dissemination activities. To enable the collaboration in the most efficient way the steering board agreed on the following decision:

"CRYSTAL is committed to collaborate with other related research projects and with standardization organizations like the ARTEMIS Standardization Working Group, OASIS, ASAM or ProSTEP. The artefacts to be shared in such collaborations include the IOS Core Requirements and the IOS Refined Requirements as defined in the CRYSTAL Technical Management Process as well as the resulting IOS Specification. These three categories of artefacts are derived from the sum of the CRYSTAL use-cases, but are use-case agnostic in the way that they do not contain any IP-relevant or competition-relevant information of any specific use-case. Therefore, these artefacts

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	14 of 269

should be classified as public, which significantly simplifies the legal issues with respect to collaboration with third parties, in particular with standardization organizations. To implement this process, the dissemination level of the deliverables for the “Interoperability Specification” (D601.021, D601.022, D601.023) should be changed from “PP - Restricted to other programme participants” to “PU – Public”. Naturally all other public CRYSTAL deliverables (e.g., deliverables for the public use cases) can be shared with third parties for the purpose of collaboration.

## ***Work Package progress and achievements during period M0-M12***

### ***Tangible results***

#### **Coordinator-driven dissemination activities**

The coordinator-driven dissemination has the aim to present the entire project, its objectives and results. As such, it is not representing the one or the other domain. These dissemination activities are strategically planned around important milestones in the project. Examples for this are: the ARTEMIS-IA Co-summit representation or the conference on interoperability. Details on these two topics will follow in the later document.

#### **- ARTEMIS-IA Events**

The CRYSTAL dissemination leader is in direct contact to ARTEMIS-IA to discuss together with ARTEMIS-IA dissemination opportunities for CRYSTAL. The ARTEMIS-IA planning of dissemination activities is available to the CRYSTAL coordinator so as to plan what content may be introduced at a specific point of time. An example of such an activity has been the article on CRYSTAL in the ARTEMIS Magazine No. 14 [http://www.artemis-ia.eu/publication/download/publication/877/file/ARTEMISIA\\_Magazine\\_14.pdf](http://www.artemis-ia.eu/publication/download/publication/877/file/ARTEMISIA_Magazine_14.pdf) or the press interview at the ARTEMIS Spring Event (<http://vimeo.com/61879091>) to which CRYSTAL participated. Of course, CRYSTAL participates to all events initiated by ARTEMIS-IA. Already before project start, CRYSTAL participated to the ARTEMIS Spring Event by contribution with a poster, a presentation and a press interview. A real success has been the participation to the ARTEMIS & ITEA Co-Summit. Besides the booth with a perfect presentation of the aerospace public use case, there has been a presentation in the speakers corner. The event requested a significant amount of preparation by the project team and was crowned by the reception of the ARTEMIS Exhibition Award.

#### **- Conference on Interoperability**

Interoperability is the central topic in the CRYSTAL project. Therefore, it is of course a central topic for dissemination, too. This has been the reason that CRYSTAL stepped into an activity initiated by CESAR: the Interoperability conference.

In spring 2012, the CESAR project, together with iFEST, SAFECER and MBAT initiated the first conference on interoperability along with the ARTEMIS Spring Event. It was a great initial success with many project contributions. In summer 2013, a group of interested persons that contributed to the various projects gathered together in the common understanding to keep up this initiative. With strong CRYSTAL contribution (dissemination leader and IOS SP leader in the steering committee, technical project manager and technical experts in the conference committee and technical presentations during the event), the 2nd conference on interoperability took place on December 3rd 2013.

Now with the 2nd conference being a true success, activities to launch a further edition of the conference in 2014 have already started. Again, the CRYSTAL project is heavily involved in the preparation and shaping of this activity.

#### **- Meetings of the ARTEMIS Standardization Working Group**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	15 of 269



CRYSTAL participated in the organization of two meetings of the ARTEMIS Standardization Working Group on January 17<sup>th</sup>, 2014 in Brussels and on September 16<sup>th</sup>, 2013 in Vienna. One of the major topics of these meetings was the sustainability and standardization of the Interoperability Specification (IOS) where CRYSTAL is a major driver. In addition CRYSTAL used these meeting to strengthen the collaboration with standardization organizations like ASAM or ProSTEP.

#### - CRYSTAL Newsletter

Newsletters will be provided on a regular basis and contain information on the project and the activities performed. These newsletters are being sent to the project consortium and interested people outside the project who subscribed to the CRYSTAL newsletter via the CRYSTAL homepage. This gives persons outside the CRYSTAL consortium the possibility to receive the CRYSTAL newsletter. The first newsletter was released at the beginning of May, 2014.

#### Partner-driven dissemination activities

The

Title	Event / Dissemination Channel	Dissemination Type	Date	Partner
ARTEMIS Magazine	2 page presentation of CRYSTAL in the ARTEMIS Magazine	Article (not journal paper)	11.07.2013	AVL
Valeo internal Newsletter	Valeo companywide newsletter, Attracted interest from collaborators	Article (not journal paper)	30.09.2013	Valeo-F
Crystal - Durchgängige Entwicklung sicherheitskritischer Systeme	Virtual Vehicle Magazine: <a href="http://www.v2c2.at/news-media/vif-magazine/">http://www.v2c2.at/news-media/vif-magazine/</a>	Article (not journal paper)	10.1.2014	VIF
Poster presentation of CRYSTAL	Poster presentation of CRYSTAL at AVL Research Networking Day 2014. Researcher community, universities. 60 people	Article (not journal paper)	26.02.2014	AVL
AMAA Berlin	Flyer distribution at exhibition table AIT (in poster area) June 17-18, 2013	Others	17.06.2013	AIT
EUCAR Poster book	Contribution by CRYSTAL to the EUCAR Poster book. 1 page poster.	Others	03.09.2013	AVL
CRYSTAL announced as co-hosting Workshop Session in CfP and Introduction, Flyer Display and Distribution	Euromicro SEAA (Software Engineering and Advanced Applications) Conference 2013, Santander	Others	04.09.2013	AIT
CRYSTAL Flyer Display and Distribution	IDIMT 2013 (Interdisciplinary Information and Management Talks), Prague	Others	11.09.2013	AIT
CRYSTAL announced as co-hosting Workshop Session in CfP and Introduction Talk, Flyer Display	SAFECOMP 2013, Conference and DECS (Dependable Embedded Components and Systems) Workshop, organized by AIT	Others	24.09.2013	AIT

and Distribution in Exhibition/Poster Area				
Obeo Newsletter on Sirius	Emailing	Others	24.10.2013	Obeo
Sirius Website and logo	Social Media / Website	Others	27.10.2013	Obeo
CRYSTAL Flyers displayed/distributed in AIT Networking Session, addressed in face-to-face talks	ICT 2013, Vilnius	Others	06.11.2013	AIT
Eclipse Newsletter dedicated to Sirius	Emailing	Others	10.11.2013	Obeo
Airbus internal R&T exhibition: Innovation Forum	General Airbus employees with interest in R&T topics. Booth with tool-chain-demo. Demonstration of OSLC Interoperability	Others	14.11.2013	A-G
Public Private Partnership Gallery	Demo showing 3D animations being used to define correct system requirements	Others	20.11.2013	TNO
Co-operation between nSafeCer and other projects like CRYSTAL demonstrated by contributing nSafeCer Interoperability Poster	ARTEMIS Interoperability Conference 2013, Stockholm	Others	03.12.2013	AIT
Interoperability in Aerospace Public Use Case of Crystal Project	Artemis ICES (Innovative Centre for Embedded Systems) Poster presentation	Others	04.12.2013	POLITO, EADS IW, ALA
EADS SE-Forum	EADS Systems-Engineering Forum Poster Session Eurocopter / Marignane / F (EADS-Group-internal)	Others	12.12.2013	EADS-Cas
Poster, Logo and Flyer presentation	Embedded World in Nürnberg 24.-26. February	Others	24.02.2014	AVL
CRYSTAL Flyer Display and Distribution	ECSEL Austria General Assembly and Brokerage Event, Techgate Vienna, hosted by AIT	Others	28.02.2014	AIT
Web Orbital Aerospace	CRYSTAL Specific article uploaded to Orbital Aerospace corporate webpage, both in English and Spanish languages.	Others	14.03.2014	ORB

Working Group meetings, networking with other projects	ARTEMIS Spring Event, participation in Working Group meetings	Others	18.03.2014	AVL
Presentation of CRYSTAL in internal book	ITS R&T Annual Report 2013 Presentation of research projects within AVL. Management-level.	Others	25.03.2014	AVL
mails and linkedin	many mentions with IFX Munich and Villach in relation to the project. Also many ongoing external discussions on linkedin also relating to work being done under CRYSTAL Social Media / Website	Others	08.04.2014	IFX-UK
Example for modelling C2FT's in the Use Case 3.3	The example was set up to explain the use case owner how the C2FT approach can be used in the use case and to discuss the practicability of C2FT for the use case.	Others	09.04.2014	FHG
Presentation of RailModel Tool prototype.	TBD	Others	23.07.2014	TBD
Working group meetings, networking with other projects, e.g., ZIM project partners, etc.	Events on software engineering relevant to automotive industry	Others	01.03.2015	ALU-FR
Kitalpha Open Sourcing announcement to Polarsys IWG	Eclipse Polarsys meeting - Industry Working Group	Presentation	25.06.2013	TGS
Conference and Presentation	Philadelphia, USA <a href="http://incose.org/symp2013/index.php?q=taxonomy/term/10">http://incose.org/symp2013/index.php?q=taxonomy/term/10</a>	Presentation	30.06.2013	REUSE
Intelligent testing Conference	Presentation on Intelligent Requirements engineering - CRYSTAL mention on improving tool interaction	Presentation	16.10.2013	IFX-UK
Kitalpha presentation to Polarsys & Automotive Eclipse IWG	EclipseCon Europe 2013 - Industry Working Groups	Presentation	28.10.2013	TGS
Sirius By Example: Build Your Own Diagram, Table and Tree Editors in 20 Minutes	Eclipse Con Europe	Presentation	29.10.2013	Obeo
Turning Eclipse into an Arduino programming platform for kids	Eclipse Con Europe	Presentation	29.10.2013	Obeo
Sirius: Changing the Game of Systems Architecture	Eclipse Con Europe	Presentation	29.10.2013	Obeo

Enabling Technology program Models	Presentation of Crystal project and impact on TNO models for the team of the TNO Enabling Technology Models program.	Presentation	07.11.2013	TNO
Interoperability survey of needs at PDT Europe	Include references to Crystal in presentation. Did not include any Crystal material directly	Presentation	12.11.2013	EADS
Continuous Lifecycle 2013	Lifecycle Management in Engineering Environments, Promoting Interoperability standard to be used in CRYSTAL IOS, IHK Karlsruhe, Technical Experts	Presentation	12.11.2013	SIEMENS
Industrial Workshop	SDF & MDE event organized by All4TEC and CEA Combined design-safety process applied on a Rail use case	Presentation	18.11.2013	ALS
Public Private Partnership Gallery	Present Philips use cases and Crystal plans to operational management, engineers from both Philips and partners	Presentation	20.11.2013	PS-Tech, TNO
Public private partnership projects demonstrations	Operational R&D management from Philips & partners Different engineering functions The event show the progress and state of the art innovations in these projects: for Crystal we have shown the use cases, the goal and the approach that we take to come to a more effective system engineering flow.	Presentation	20.11.2013	TNO, PS-Tech
Workshop presentation at CRTS 2013	6th International Workshop on Compositional Theory and Technology for Real-Time Embedded Systems (co-located with the IEEE Real-time systems symposium) Theoretical compositional framework for alleviating pre-emption overheads of real-time components	Presentation	02.12.2013	TU/e
Interoperability in Aerospace Public Use Case of Crystal Project	2nd European Conference on Interoperability for Embedded Systems Development Environments	Presentation	03.12.2013	POLITO, EADS IW, ALA
Co-Simulation and the Functional Mockup Interface	2nd European Conference on Interoperability for Embedded Systems Development Environments	Presentation	03.12.2013	VIF
Public use case demonstrator	Artemis / ITEA conference. Presentation and demonstrator jointly	Presentation	04.12.2013	Alenia and EADS Airbus
CRYSTAL Presentation	ARTEMIS-IA Co-Summit 2013, Stockholm	Presentation	04.12.2013	AVL

CRYSTAL - Enabling Seamless Life-Cycle Collaboration for Safety-Critical Systems	ASAM International Conference	Presentation	04.12.2013	AVL
Managing detailed development data in a PLM framework	ARTEMIS-IA Co-Summit 2013 (Jan Söderberg)	Presentation	04.12.2013	SYS
Integration of CRYSTAL Poster in ECSEL Austria slide show at ECSEL Austria Booth	ARTEMIS/ITEA2 Co-Summit, Stockholm, ECSEL Austria Booth (supported by AIT)	Presentation	04.12.2013	AIT
R&D Tools meeting	R&D Tools Team, Dissemination of the CRYSTAL activities in the Barco Use Case	Presentation	20.12.2013	BARCO
Seamless Life – Cycle Collaboration for Mixed-Criticality Systems Engineering – The CRYSTAL Approach	HiPEAC 2014 2nd Workshop on Integration of Mixed-criticality Subsystems on Multi-core and Manycore Processors	Presentation	22.01.2014	AVL
SDMD / Model based engineering for medical display devices	International forum on medical device standards, compliance and software development, Dissemination of the CRYSTAL activities in the Barco Use Case. Target audience: Technical experts. Attracted domain: Medical device-dedicated software development & compliance professionals. 27-30 Jan 2014, Munich	Presentation	27.01.2014	BARCO
Virtual Reality Symposium 2014	International virtual reality symposium, Eindhoven, Netherlands. Demonstrating of technologies and projects to Industry and academia, mainly from the EU	Presentation	28.01.2014	PS-Tech
Agile Development in a Regulatory Context	Software Design for Medical Devices Europe, 27th - 30th January 2014, Munich, Germany	Presentation	28.01.2014	Barco
Sirius role-playing game: Build diagram, table and tree editors in 20 minutes!	Eclipse Con America	Presentation	17.03.2014	Obeo
EcoreTools 2.0: The Luna revival	Eclipse Con America	Presentation	17.03.2014	Obeo
Turning Eclipse into an Arduino programming platform for kids	Eclipse Con America	Presentation	17.03.2014	Obeo

Uses Cases of PolarSys technologies for Architects	Eclipse Con America	Presentation	17.03.2014	Obeo
ALM Forum	OSLC Connect, Promoting Interoperability standard to be used in CRYSTAL IOS, Technical Experts	Presentation	01.04.2014	SIEMENS
Integrerade utvecklingsmiljöer för elsystem	Elektronik i fordon. Swedish conference on automotive technology and strategies.	Presentation	08.04.2014	VOLVO
Workshop "Sharing our experiences creating models at TNO"	Presentation of Crystal at workshop for modelling experts. 12 attendees	Presentation	24.04.2014	TNO
Tool Vendor Challenge	Tool Vendor Challenge. INCOSE Symposium <a href="http://incose.org/symp2013/index.php?q=taxonomy/term/10">http://incose.org/symp2013/index.php?q=taxonomy/term/10</a> Philadelphia, USA	Workshop	30.06.2013	REUSE
Organization Standardization Working Group Workshop	ARTEMIS Standardization Working Group Workshop Vienna	Workshop	16.09.2013	AVL
Hosting joint Standardization WG Meeting ARTEMIS WG-CRYSTAL-MBAT-SafeCer	Artemis Standardization WG Meeting Vienna, TechGate (AIT)	Workshop	16.9.2013	AIT
Hosting joint Standardization WG Meeting ARTEMIS WG-CRYSTAL-MBAT-SafeCer	ARTEMIS Standardization WG meeting, Techgate, Vienna (AIT site), project participants from ARTEMIS-IA Standardization WG, CRYSTA, MBAT, SafeCer, R3-COP, standardization organizations OASIS, ASAM, ProSTEP, and the CoIE EICOSE.	Workshop	16.9.2013	AIT
Let's get Sirius	Eclipse Con Europe	Workshop	29.10.2013	Obeo
Interoperability in Crystal Project	2nd conference on interoperability	Workshop	03.12.2013	AVL
2nd European Conference on Interoperability for Embedded Systems Development Environments	Artemis Technology Conference, Promoting Interoperability standard to be used in CRYSTAL IOS, Technical Experts	Workshop	03.12.2013	SIEMENS
ARTEMIS-IA Co-Summit 2013	Booth presentation	Workshop	04.12.2013	AVL
Domain specific languages for industrial practices	A workshop about how to come up with good models that can be caputed in a DSL, with the goals of enabling the tracing of requirements and validation of models in the software engineering process.	Workshop	21.02.2014	TU/e - TNO - Philips - Siemens

Let's get Sirius	Eclipse Con America	Workshop	19.03.2014	Obeo
Sirius Roadshow - Paris	Workshop	Workshop	27.03.2014	Obeo
Sirius Roadshow - Nantes	Workshop (France)	Workshop	03.04.2014	Obeo
Sirius Roadshow - Toulouse	Workshop (France)	Workshop	10.04.2014	Obeo
Crystal Workshop at EADS	Crystal Workshop that I did with Andreas Keis and his team at EADS Airbus Space and Defence in Bremen on 25th April 2014.	Workshop	25.04.2014	CIC

Table 3-1 below shows the dissemination activities performed in the project.



Title	Event / Dissemination Channel	Dissemination Type	Date	Partner
ARTEMIS Magazine	2 page presentation of CRYSTAL in the ARTEMIS Magazine	Article (not journal paper)	11.07.2013	AVL
Valeo internal Newsletter	Valeo companywide newsletter, Attracted interest from collaborators	Article (not journal paper)	30.09.2013	Valeo-F
Crystal - Durchgängige Entwicklung sicherheitskritischer Systeme	Virtual Vehicle Magazine: <a href="http://www.v2c2.at/news-media/vif-magazine/">http://www.v2c2.at/news-media/vif-magazine/</a>	Article (not journal paper)	10.1.2014	VIF
Poster presentation of CRYSTAL	Poster presentation of CRYSTAL at AVL Research Networking Day 2014. Researcher community, universities. 60 people	Article (not journal paper)	26.02.2014	AVL
AMAA Berlin	Flyer distribution at exhibition table AIT (in poster area) June 17-18, 2013	Others	17.06.2013	AIT
EUCAR Poster book	Contribution by CRYSTAL to the EUCAR Poster book. 1 page poster.	Others	03.09.2013	AVL
CRYSTAL announced as co-hosting Workshop Session in CfP and Introduction, Flyer Display and Distribution	Euromicro SEAA (Software Engineering and Advanced Applications) Conference 2013, Santander	Others	04.09.2013	AIT
CRYSTAL Flyer Display and Distribution	IDIMT 2013 (Interdisciplinary Information and Management Talks), Prague	Others	11.09.2013	AIT
CRYSTAL announced as co-hosting Workshop Session in CfP and Introduction Talk, Flyer Display and Distribution in Exhibition/Poster Area	SAFECOMP 2013, Conference and DECS (Dependable Embedded Components and Systems) Workshop, organized by AIT	Others	24.09.2013	AIT
Obeo Newsletter on Sirius	Emailing	Others	24.10.2013	Obeo
Sirius Website and logo	Social Media / Website	Others	27.10.2013	Obeo
CRYSTAL Flyers displayed/distributed in AIT Networking Session, addressed in face-to-face talks	ICT 2013, Vilnius	Others	06.11.2013	AIT
Eclipse Newsletter dedicated to Sirius	Emailing	Others	10.11.2013	Obeo

Airbus internal R&T exhibition: Innovation Forum	General Airbus employees with interest in R&T topics. Booth with tool-chain-demo. Demonstration of OSLC Interoperability	Others	14.11.2013	A-G
Public Private Partnership Gallery	Demo showing 3D animations being used to define correct system requirements	Others	20.11.2013	TNO
Co-operation between nSafeCer and other projects like CRYSTAL demonstrated by contributing nSafeCer Interoperability Poster	ARTEMIS Interoperability Conference 2013, Stockholm	Others	03.12.2013	AIT
Interoperability in Aerospace Public Use Case of Crystal Project	Artemis ICES (Innovative Centre for Embedded Systems) Poster presentation	Others	04.12.2013	POLITO, EADS IW, ALA
EADS SE-Forum	EADS Systems-Engineering Forum Poster Session Eurocopter / Marignane / F (EADS-Group-internal)	Others	12.12.2013	EADS-Cas
Poster, Logo and Flyer presentation	Embedded World in Nürnberg 24.-26. February	Others	24.02.2014	AVL
CRYSTAL Flyer Display and Distribution	ECSEL Austria General Assembly and Brokerage Event, Techgate Vienna, hosted by AIT	Others	28.02.2014	AIT
Web Orbital Aerospace	CRYSTAL Specific article uploaded to Orbital Aerospace corporate webpage, both in English and Spanish languages.	Others	14.03.2014	ORB
Working Group meetings, networking with other projects	ARTEMIS Spring Event, participation in Working Group meetings	Others	18.03.2014	AVL
Presentation of CRYSTAL in internal book	ITS R&T Annual Report 2013 Presentation of research projects within AVL. Management-level.	Others	25.03.2014	AVL
mails and linkedin	many mentions with IFX Munich and Villach in relation to the project. Also many ongoing external discussions on linkedin also relating to work being done under CRYSTAL Social Media / Website	Others	08.04.2014	IFX-UK

Example for modelling C2FT's in the Use Case 3.3	The example was set up to explain the use case owner how the C2FT approach can be used in the use case and to discuss the practicability of C2FT for the use case.	Others	09.04.2014	FHG
Presentation of RailModel Tool prototype.	TBD	Others	23.07.2014	TBD
Working group meetings, networking with other projects, e.g., ZIM project partners, etc.	Events on software engineering relevant to automotive industry	Others	01.03.2015	ALU-FR
Kitalpha Open Sourcing announcement to Polarsys IWG	Eclipse Polarsys meeting - Industry Working Group	Presentation	25.06.2013	TGS
Conference and Presentation	Philadelphia, USA <a href="http://incose.org/symp2013/index.php?q=taxonomy/term/10">http://incose.org/symp2013/index.php?q=taxonomy/term/10</a>	Presentation	30.06.2013	REUSE
Intelligent testing Conference	Presentation on Intelligent Requirements engineering - CRYSTAL mention on improving tool interaction	Presentation	16.10.2013	IFX-UK
Kitalpha presentation to Polarsys & Automotive Eclipse IWG	EclipseCon Europe 2013 - Industry Working Groups	Presentation	28.10.2013	TGS
Sirius By Example: Build Your Own Diagram, Table and Tree Editors in 20 Minutes	Eclipse Con Europe	Presentation	29.10.2013	Obeo
Turning Eclipse into an Arduino programming platform for kids	Eclipse Con Europe	Presentation	29.10.2013	Obeo
Sirius: Changing the Game of Systems Architecture	Eclipse Con Europe	Presentation	29.10.2013	Obeo
Enabling Technology program Models	Presentation of Crystal project and impact on TNO models for the team of the TNO Enabling Technology Models program.	Presentation	07.11.2013	TNO
Interoperability survey of needs at PDT Europe	Include references to Crystal in presentation. Did not include any Crystal material directly	Presentation	12.11.2013	EADS
Continuous Lifecycle 2013	Lifecycle Management in Engineering Environments, Promoting Interoperability standard to be used in CRYSTAL IOS, IHK Karlsruhe, Technical Experts	Presentation	12.11.2013	SIEMENS

Industrial Workshop	SDF & MDE event organized by All4TEC and CEA Combined design-safety process applied on a Rail use case	Presentation	18.11.2013	ALS
Public Private Partnership Gallery	Present Philips use cases and Crystal plans to operational management, engineers from both Philips and partners	Presentation	20.11.2013	PS-Tech, TNO
Public private partnership projects demonstrations	Operational R&D management from Philips & partners Different engineering functions The event show the progress and state of the art innovations in these projects: for Crystal we have shown the use cases, the goal and the approach that we take to come to a more effective system engineering flow.	Presentation	20.11.2013	TNO, PS-Tech
Workshop presentation at CRTS 2013	6th International Workshop on Compositional Theory and Technology for Real-Time Embedded Systems (co-located with the IEEE Real-time systems symposium) Theoretical compositional framework for alleviating pre-emption overheads of real-time components	Presentation	02.12.2013	TU/e
Interoperability in Aerospace Public Use Case of Crystal Project	2nd European Conference on Interoperability for Embedded Systems Development Environments	Presentation	03.12.2013	POLITO, EADS IW, ALA
Co-Simulation and the Functional Mockup Interface	2nd European Conference on Interoperability for Embedded Systems Development Environments	Presentation	03.12.2013	VIF
Public use case demonstrator	Artemis / ITEA conference. Presentation and demonstrator jointly	Presentation	04.12.2013	Alenia and EADS Airbus
CRYSTAL Presentation	ARTEMIS-IA Co-Summit 2013, Stockholm	Presentation	04.12.2013	AVL
CRYSTAL - Enabling Seamless Life-Cycle Collaboration for Safety-Critical Systems	ASAM International Conference	Presentation	04.12.2013	AVL
Managing detailed development data in a PLM framework	ARTEMIS-IA Co-Summit 2013 (Jan Söderberg)	Presentation	04.12.2013	SYS
Integration of CRYSTAL Poster in ECSEL Austria slide show at ECSEL Austria Booth	ARTEMIS/ITEA2 Co-Summit, Stockholm, ECSEL Austria Booth (supported by AIT)	Presentation	04.12.2013	AIT

R&D Tools meeting	R&D Tools Team, Dissemination of the CRYSTAL activities in the Barco Use Case	Presentation	20.12.2013	BARCO
Seamless Life – Cycle Collaboration for Mixed-Criticality Systems Engineering – The CRYSTAL Approach	HiPEAC 2014 2nd Workshop on Integration of Mixed-criticality Subsystems on Multi-core and Manycore Processors	Presentation	22.01.2014	AVL
SDMD / Model based engineering for medical display devices	International forum on medical device standards, compliance and software development, Dissemination of the CRYSTAL activities in the Barco Use Case. Target audience: Technical experts. Attracted domain: Medical device-dedicated software development & compliance professionals. 27-30 Jan 2014, Munich	Presentation	27.01.2014	BARCO
Virtual Reality Symposium 2014	International virtual reality symposium, Eindhoven, Netherlands. Demonstrating of technologies and projects to Industry and academia, mainly from the EU	Presentation	28.01.2014	PS-Tech
Agile Development in a Regulatory Context	Software Design for Medical Devices Europe, 27th - 30th January 2014, Munich, Germany	Presentation	28.01.2014	Barco
Sirius role-playing game: Build diagram, table and tree editors in 20 minutes!	Eclipse Con America	Presentation	17.03.2014	Obeo
EcoreTools 2.0: The Luna revival	Eclipse Con America	Presentation	17.03.2014	Obeo
Turning Eclipse into an Arduino programming platform for kids	Eclipse Con America	Presentation	17.03.2014	Obeo
Uses Cases of PolarSys technologies for Architects	Eclipse Con America	Presentation	17.03.2014	Obeo
ALM Forum	OSLC Connect, Promoting Interoperability standard to be used in CRYSTAL IOS, Technical Experts	Presentation	01.04.2014	SIEMENS
Integrerade utvecklingsmiljöer för elsystem	Elektronik i fordon. Swedish conference on automotive technology and strategies.	Presentation	08.04.2014	VOLVO
Workshop "Sharing our experiences creating models at TNO"	Presentation of Crystal at workshop for modelling experts. 12 attendees	Presentation	24.04.2014	TNO

Tool Vendor Challenge	Tool Vendor Challenge. INCOSE Symposium <a href="http://incose.org/symp2013/index.php?q=taxonomy/term/10">http://incose.org/symp2013/index.php?q=taxonomy/term/10</a> Philadelphia, USA	Workshop	30.06.2013	REUSE
Organization Standardization Working Group Workshop	ARTEMIS Standardization Working Group Workshop Vienna	Workshop	16.09.2013	AVL
Hosting joint Standardization WG Meeting ARTEMIS WG-CRYSTAL-MBAT-SafeCer	Artemis Standardization WG Meeting Vienna, TechGate (AIT)	Workshop	16.9.2013	AIT
Hosting joint Standardization WG Meeting ARTEMIS WG-CRYSTAL-MBAT-SafeCer	ARTEMIS Standardization WG meeting, Techgate, Vienna (AIT site), project participants from ARTEMIS-IA Standardization WG, CRYSTA, MBAT, SafeCer, R3-COP, standardization organizations OASIS, ASAM, ProSTEP, and the CoIE EICOSE.	Workshop	16.9.2013	AIT
Let's get Sirius	Eclipse Con Europe	Workshop	29.10.2013	Obeo
Interoperability in Crystal Project	2nd conference on interoperability	Workshop	03.12.2013	AVL
2nd European Conference on Interoperability for Embedded Systems Development Environments	Artemis Technology Conference, Promoting Interoperability standard to be used in CRYSTAL IOS, Technical Experts	Workshop	03.12.2013	SIEMENS
ARTEMIS-IA Co-Summit 2013	Booth presentation	Workshop	04.12.2013	AVL
Domain specific languages for industrial practices	A workshop about how to come up with good models that can be captured in a DSL, with the goals of enabling the tracing of requirements and validation of models in the software engineering process.	Workshop	21.02.2014	TU/e - TNO - Philips - Siemens
Let's get Sirius	Eclipse Con America	Workshop	19.03.2014	Obeo
Sirius Roadshow - Paris	Workshop	Workshop	27.03.2014	Obeo
Sirius Roadshow - Nantes	Workshop (France)	Workshop	03.04.2014	Obeo
Sirius Roadshow - Toulouse	Workshop (France)	Workshop	10.04.2014	Obeo
Crystal Workshop at EADS	Crystal Workshop that I did with Andreas Keis and his team at EADS Airbus Space and Defence in Bremen on 25th April 2014.	Workshop	25.04.2014	CIC

Table 3-1: Dissemination activities performed

### 3.1.2 WP 103 Assessment of Project Objectives

#### ***Project objectives for the period M1- M12***

The aim of this work-package is to systematically breakdown the main project objectives in order to derive appropriate measures to validate the impact of CRYSTAL and to execute an assessment of the project objectives with respect to the derived measures and based on the derived results and technical assessments done in the sub projects.

Within the reporting period Task 1.3.1 (Breakdown of project objectives) has started with the objective to refine the CRYSTAL main objectives into a set of metrics (and respective evaluation methods), in order to enable the evaluation of the project outcomes in a simple and reproducible way.

#### ***Work Package progress and achievements during period M1-M12***

##### ***Progress towards objectives***

The activities of this work package have started as planned in November 2013. The first activity is Task 1.3.1 (Breakdown of project objectives) with the goal to derive a set of metrics in order to enable the evaluation of the project outcomes.

As a starting point a more detailed schedule for the work within the work package has been defined.

On a technical level the following activities have been done:

- The task has contributed to the overall project activity to define a method to break down the project objectives towards technical innovations and links to users' requirements as the results will be an important input for this work package.
- During the plenary meeting end of November, first ideas of metrics have been presented and discussed as well as feedback from the end users have been collected.
- The available documentation of the use cases, in particular the planned implementation of the users stories have been studied with respect to the goals of this work package.
- Specific evaluation methods have been investigated, which are foreseen in specific use cases. First specific key metrics have been defined.
- Investigation of the engineering methods of some use case and user story descriptions towards identification of issues relevant to derive appropriate measures.
- Initial ideas on key metrics for the Crystal assessment of objectives have been collected.

##### ***Tangible results***

N/A (First deliverable at Month 24)

##### ***Reasons for deviations***

N/A

##### ***Reasons for failing to achieve critical objectives***

N/A

##### ***Use of resources***

Use of the resources is in plan.



**Collaboration with other projects**

N/A

**Statement on the dissemination activities and exploitation perspectives**

N/A

**Corrective actions**

N/A

**3.2 Sub Project 2 – Aerospace Domain (Lead: A-F)****Project objectives for the period M1- M12****Overview / SP Structure**

The Sub Project SP2 – AEROSPACE Domain consists of in total 12 work packages:

- 1 SP Coordination (WP200)
- 1 Common Use Case (WP208)
- 9 Company-specific Use Cases (WP201 – WP207, WP210 & WP 211)
- 1 Ontology work package (WP209)

In more detail:

WP	Title	Lead
<b>200</b>	SP Coordination AEROSPACE	Lead: Airbus – F Co-Lead: Airbus Def. and Space – D
<b>201</b>	UC – Environmental Control System	Airbus – D
<b>202</b>	UC – Prel. Des. for a new Reg. TurboProp	Alenia – I
<b>203</b>	UC – Mission Support Equipment	Airbus Defence and Space – D
<b>204</b>	UC – Electrical Flight Control System	Sagem – F
<b>205</b>	UC – Space Toolset for Avionics Control Unit	Thales Alenia Space – ES
<b>206</b>	UC – Multi-Mode Navigation System	Honeywell – CZ
<b>207</b>	UC – Space Toolset for Avionics Control Unit	Thales Alenia Space – F
<b>208</b>	Public Use Case	Airbus Group Innovation – D
<b>209</b>	Ontology AEROSPACE	Airbus Group Innovation – F
<b>210</b>	UC – Simulation for Particular Risk Analysis	Airbus – F
<b>211</b>	UC – Fuel Management Risk Analysis	Airbus – UK

**Overall Objectives**

The main objectives for the Aerospace Domain are listed in the DoW, Part B – Technical Annex on page 34 f.

- To mature innovative techniques, methods and tools developed in other research projects in order to bring them to a level of maturity that are compatible with a pre-deployment in European aeronautics industry. The Technology Maturity Level (TRL) targeted is at least TRL5 at the end of the project, so that an industrial deployment on operational environment can be envisaged in the three years after the end of CRYSTAL.
- To create within the aeronautics supply chain a common aeronautics vocabulary based on ontology technology for improving data exchange and increasing competitiveness reducing rework and misunderstanding between aeronautics actors.
- To implement the interoperability concept based on the interoperability standard initiated in the frame of CESAR and enhanced in the current project.

### **(Common) Objectives for the period M1 – M12**

The first period M1 – M12 of the project is used to create a strong basis to fulfil the overall objectives listed above.

From the first overall objective the following (common sub-) objectives can be derived for the first period of the project.

- Definition/Description of the Company-specific Use Case in an appropriate level of abstraction.

The Company-specific Use Cases (System under development) provide the basis for the validation of the CRYSTAL results and the TRL assessment. The format of the definition/description depends normally on the Company-specific Development and –Documentation Standard, e.g. Specification, Requirements and Architecture.

If applicable additional material like models for the system under development or the simulation of the system environment has to be created.

On the other side the targeted Company-specific SEE that derives from the CRYSTAL RTP has to be specified. The

- Specification of the Company-specific SEE typically consists of
  - Requirements,
  - Architecture, including
  - Bricks (Tools), selected from the CRYSTAL Brick List.

In order to demonstrate the improvements based on the CRYSTAL bricks

- SEE demonstrators are set up. Typically these SEE demonstrators
  - Represent subsets of the specified Company-specific SEE's,
  - Are normally based on state-of-the art technology,
  - Can include bricks coming from
    - CESAR or
    - other R&T projects like MBAT but

- Can also include new technologies developed in the frame of CRYSTAL.

Looking at the second overall objective the main (common sub-) objectives in the first year of the CRYSTAL project concerning

- AEROSPACE Ontology are
  - State-of-the-Art and need analysis and
  - Aerospace Ontology definition.

The future improvements towards the second overall objective are based on this State-of-the-Art survey.

Beside the CRYSTAL RTP and the derived Company-specific SEE's based on the CRYSTAL RTP the Interoperability Standard IOS is the second main objective in the CRYSTAL project. This is clearly addressed the third overall objective (see above).

Every work package (except the management work packages) has to define their requirements for the IOS and has to hand over these requirements to SP6. For the first period of the project the

- Generation of (first) inputs for the IOS include
  - Contribution to the definition of an appropriate process,
  - Contribution to the assessment of this process
  - Hand-over of defined (first) artefacts to SP 6.

In the Sub Project SP2 the assessment of this so-called "Interoperability Needs Capturing Process" was mainly done in the "Public Aerospace Use Case (WP208)" and the first inputs/artefacts were based on engineering methods.

Currently the "Technical Management Process" is implemented in all the domains and the generation of inputs for the first issue of the IOS is in progress.

### ***Progress and achievements during period M1-M12***

#### ***Progress towards objectives***

In chapter "Sub Project SP2 – AEROSPACE Domain" the overall objectives for the Aerospace Domain as listed in the DoW, Part B – Technical Annex on page 34 f. are refined for the first project period M1 – M12. The derived (common sub-) objectives that represent the pillars for SP2 in the first period of the project are:

- Definition/Description of the Company-specific Use Case (UC-Def.)
- Specification of the Company-specific SEE (SEE-Spec.)
- Executable Demonstrator (SEE-Demo.)
- State-of-the-Art of AEROSPACE Ontology (Ontology)
- Generation of (first) inputs for the IOS (IOS Inputs)

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	32 of 269

Additional sub-objectives of these objectives can be found in the chapter mentioned above.

Looking at these five objectives the SP 2 work package leaders reported progress towards these objectives as indicated in the table below:

WP	UC-Def.	SEE-Spec.	SEE-Demo.	Ontology	IOS Inputs
201	X	X			X
202	X	X	X		X
203	X	X	X	X	X
204	X	X	X	X	X
205	X	X			X
206	X	X	X		X
207	X				X
208	X	X	X	X	X
209	N/A	N/A	N/A	X	X
210	Information missing				X
211	X	X			X

Please notice:

- The five objectives listed here are only the most common objectives of the domain.
- WP 209 is exclusively dedicated to Ontology.
- WP 200 is not listed here, because WP 200 is dedicated to the domain management.

More details concerning

- these common objectives
- Use Case- / WP-specific objectives

can be found in the WP 201 – WP 211 reports.

### **Tangible results**

Basically after the first period of the project there are three types of tangible results available:

- Deliverables
- Demonstrators
- Dissemination results

The table below provides an overview about these three types of tangible results that were provided by the different work packages.

WP	Deliverables	SEE-Demo.	Dissemination
201	D201.011 Requirements – V. 1		Airbus internal

	D201.021 Demonstrator – V. 1		
<b>202</b>	D202.010 Use Case Description D202.021 Requirements Specification (for SEE) D202.031 SEE Specification – V. 1	<b>X</b> (incl. DOORS, Rhapsody, Matlab)	
<b>203</b>	D203.011 MSE Report – V. 1 D203.020 First MSE SEE (Prototype)	<b>X</b> (incl. Jazz Env., DOORS, Rhapsody, IBM Rational Gateway, IBM Rational Testconductor, IBM Rational Publishing Engine, Requirements Quality Suite, Vedit, FeatureIDE and pure::variants)	Airbus Group internal
<b>204</b>	D204.010 E-FCS RBE process and tool chain evaluation – V.1	<b>X</b> (incl. DOORS, Rhapsody, IBM Rational Gateway, Requirements Quality Suite)	Sagem internal
<b>205</b>	D205.010 Space Use Case Req. D205.020 Space Toolset Spec.		Paper for DASIA 2014
<b>206</b>	D206.010 Multi-Mode Navigation System Analysis, Development Needs, and the Proposed Tool-Chain Functionality D206.021 Architecture of the Tool Chain for the Multi-Mode Navigation System	<b>X</b> (incl. NuSMV model checker, Requirement Quality Suite)	Journal publication
<b>207</b>	D207.010 Use-case description		TASF internal
<b>208</b>	D208.010 Use Case Description	<b>X</b> (incl. Jazz Env., DOORS, Rhapsody, OpenModelica, Fault Tree+)	Airbus Group internal ARTEMIS/ITEA CoSummit Video
<b>209</b>	D209.010 State of the art for aerospace ontology	<b>N/A</b>	
<b>210</b>	D210.010 Simulation for PRA use case description		
<b>211</b>	D211.010 Fuel Management Risk Analysis use case description		

Please notice:

- For dissemination activities refer also to Chapter "2.1.7 Statement on the dissemination activities and exploitation perspectives"

More details can be found in the WP 201 – WP 211 reports.

### **Reasons for deviations from Annex I**

The following table gives an overview about deviations from Annex I and their impact as reported by the SP 2 partners.

WP	Deviation	Impact
200	From 01.2014 the WP is led by EADS-Cas	None
201	No deviation	N/A
202	No deviation	N/A
203	D203.020 one month delayed	None
204	No significant deviation	N/A
205	D205.010 delayed due to Spanish National Funding Assignment	None
206	No deviation	N/A
207	No significant deviation	N/A
208	Ahead of schedule; some M20 results already available	N/A
209	Some delay due to French contractual issues and project internal discussions	Recoverable
210	No deviation reported	N/A
211	No deviation	N/A

There are no crucial deviations mentioned by the partners. The discussions about the focus of the Ontology work package (WP 209) are quite natural. It is expected to solve this without any impact on the overall project (refer to chapter "X.2.1.8 Corrective Actions").

### **Reasons for failing to achieve critical objectives**

No partner reported any failed critical objectives. Consequently there is no impact.

WP	Failed critical Objectives	Impact
200	None	N/A
201	None	N/A
202	None	N/A
203	None	N/A
204	None	N/A
205	None	N/A
206	None	N/A
207	None	N/A
208	None	N/A
209	None	N/A
210	None	N/A
211	None	N/A

**Use of resources)**

The following table gives an overview about the use of resources, deviations from the planning (if any) and the expected impact as reported by the SP 2 partners.

WP	Planned vs. Actual Effort	Main Reason(s)	Impact
200	<b>EADS-Cas: 110 %</b>	Taking over SP lead	None; will be compensated
201	<b>As planned</b>	N/A	N/A
202	<b>As planned</b>	N/A	N/A
203	<b>88 %</b>	Ramp Up US Safety postponed to M12 due to availability of partner	None
204	<b>92 %</b>	Some Effort from WP 204 spend in WP 607	None
205	<b>92 %</b>	Delay in Spanish National Funding Assignment	None
206	<b>100 %</b>	N/A	N/A
207	<b>No significant deviation</b>	N/A	N/A
208	<b>122 %</b>	Development ahead of Schedule as agreed with the Partners	This will have a positive impact for all partners
209	<b>82 %</b>	French contractual issues; no grant agreement from DGCIS	Deviation expected to be recoverable
210	<b>100 %</b>	Resources were used as planned	None
211	<b>As planned</b>	N/A	N/A

As a summary it can be said, that the use of resources is good. Slight problems due to contractual issues or availability resources in the ramp up phase are normal issues.

**Collaboration with other projects**

The following table gives an overview about the related projects that are mentioned by the SP 2 partners in their work package reports.

WP	CESAR	MBAT	SPES-XT (D)	iFest
201	<b>X</b>		<b>X</b>	
202		<b>X</b>		
203	<b>X</b>	<b>X</b>	<b>X</b>	
204	<b>X</b>			
205				
206				<b>X</b>
207		<b>X</b>		



208	X	X	X	
209				
210				
211				

**Statement on the dissemination activities and exploitation perspectives**

The following table gives an overview about the dissemination activities and exploitation perspectives explicitly listed in the work package reports of the partners.

WP	Dissemination	Exploitation
201	Airbus (internal) Innovation Forum;	
202		
203	Airbus Def. and Space internal CRYSTAL Workshop Airbus Group Systems Engineering Forum	Refer to Exploitation Plan
204	Internal	Internal Use of a "Enhanced Req. Process" on a Flight Control System Consideration of Results in Sagem's Software Governance
205	Paper for DASIA 2014: "Critical Systems Engineering Accelerator: Aerospace Demonstrator" Refer to Dissemination Plan	Refer to Exploitation Plan
206	Journal publication in review	
207	Internal	
208	Airbus Group Systems Engineering Forum ARTEMIS/ITEA2 CoSummit 2nd European Conference on Interoperability ARTEMIS ICES Poster Presentation Public Aerospace Use Case Video	
209		
210	Start of dissemination and communication activities after month 12. Dissemination of project outcomes will receive great attention and will be ensured on the basis of conferences and dedicated workshops towards the end of the CRYSTAL	Refer to Exploitation Plan
211		

Most of the partners stated, that they planned more dissemination activities and exploitation perspectives in the later phases of the project.

### **Corrective actions**

The following table gives an overview about necessary corrective actions that are expressed by the SP 2 partners.

There are only two points mentioned:

- Availability of a SP2 lead from A-F
- "Scoping" of the ontology work package

Both actions are already started. It is expected that this issues are solved until the next review.

WP	Corrective Actions
200	A-F: A-F is looking for a person to lead the sub-project EADS-Cas: N/A
201	N/A
202	N/A
203	N/A
204	N/A
205	N/A
206	N/A
207	N/A
208	N/A
209	Closer link with SP6 and with the public use case Active contribution to scoping discussions with other ontology WPs and SP6 Clarification of the role of the ontology in CRYSTAL, including its relationship with IOS
210	N/A
211	N/A

### **3.2.1 WP 200 – SP Coordination AEROSPACE (Lead: EADS-CAS)**

The CRYSTAL AEROSPACE (SP 2) domain consists of:

- 9 Company-specific industrial use cases
- 1 Common use case (WP 208)
- 1 Ontology work package (WP 609)

For the complete list of work packages refer to SP 2 – AEROSPACE Domain.

The work package WP 200 – SP Coordination AEROSPACE Domain is dedicated to the technical management of the sub-project.

The main objective of this work package is "to ensure an efficient technical management of the aerospace sub-project (SP2) all along the CRYSTAL project" (refer to DoW, Work package 200).

This means in more detail:

- Create an Environment for information exchange between the SP 2 partners,
  - Set up periodic Coordination Meetings
  - Provide minutes of meetings
  - Trace actions;
- Foster, co-ordinate and harmonize common SP 2 activities;
- Communicate Information from the CRYSTAL
  - Project Management
  - Steering Board
  - Technical Board
 to the SP 2 partners and vice versa;
- Foster communication and information exchange with
  - the other domains and
  - the R&T work packages (SP 6);
- Represent the SP 2 partners in the technical board;
- Harmonize presentations outside the domain (e.g. for reviews);
- Represent the SP 2 partners in reviews;

This section gives details for each work package the work performed and progress achieved.

### ***Progress towards objectives***

The SP 2 is well aligned and harmonized. The regular Coordination Meetings offer an environment for exchange on general and status information.

Especially the Public Use Case (WP 208) is a perfect scene for in-depth technical discussions. Several processes were defined and/or assessed in the Public Use Case, e.g. the Interoperability Needs Capturing Process.

### **A-F:**

- SP 2 Lead (05.2013 – 12.2013)
- SP 2 Lead (from 01.2014)
  - A-F is looking for a person to lead the project (some internal constraints on recruitment)
- Participation / Contribution to the technical subjects
  - Participation to the regular WebEx meetings
  - Contribution to the 1<sup>st</sup> interim review

### **EADS-CAS:**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	39 of 269

- SP 2 Co-lead (05.2013 – 12.2014)
- Support of SP 2 lead A-F
  - Participation to regular Coordination WebEx Meetings
  - Participation to SP2 Workshop in Toulouse, 19. & 20.09.2013
- SP 2 Lead (from 01.2014)
  - Organization of regular Coordination Meetings (see next chapter)
  - Provision of Minutes
- Participation in / Contribution to the regular Technical Board WebEx meetings;
- Participation in / Contribution to the Technical Board Workshops
  - In Vienna, 03.05.2013
  - In Munich, 25. & 26.11.2013
  - In Munich, 01. & 02.04.2014
- Preparation of the SP 2 presentation for the 1<sup>st</sup> Interim Review
- Participation in / Contribution to the 1<sup>st</sup> Interim Review

#### **EADS-IW-G:**

- Participation to regular WebEx meetings
- Participation to SP2 Workshop in Toulouse on Sep 19th and 20th, 2013
- Support of the SP2 Presentation for JU Interim Review in Brussels on Feb 11th, 2014
- Presentation of Demonstrator as part of SP2 Presentation at JU Interim Review and JU Interim Review Dry Run in Brussels (Feb 10th and 11th, 2014)

#### **Sagem:**

- Contribution to the management of the aeronautical domain.
- Participation to Toulouse September 19-20th, 2013 SP2 meeting.
- Participation to monthly coordination and reporting webex meeting.
- Reviews of some SP2 deliverable (especially from WP203 and WP206)

#### ***Tangible results***

During the first year of the CRYSTAL project execution the CRYSTAL SP 2 partners met regularly either in WebEx meetings or in face-to face meetings. In total the sub-project held:

- 10 WebEx meetings and
- 2 face-to-face meeting

In more detail:

Date	Kind of Meeting	Location
03.05.2013	Kick-Off Meeting (F-2-F)	Vienna / A
22.05.2013	Coordination Meeting	WEBEX

19.06.2013	Coordination Meeting	WEBEX
17.07.2013	Coordination Meeting	WEBEX
21.08.2013	Coordination Meeting	WEBEX
19. & 20.09.2013	Workshop (F-2-F)	Airbus, Toulouse / F
16.10.2013	Coordination Meeting	WEBEX
20.11.2013	Coordination Meeting	WEBEX
18.12.2013	Coordination Meeting	WEBEX
20.01.2014	Coordination Meeting	WEBEX
25.02.2014	Coordination Meeting	WEBEX
07.04.2014	Coordination Meeting	WEBEX

For all meetings minutes are available on the AVL SharePoint.

In November and December 2013 the SP 2 partners agreed on a first issue of Evaluation Criteria. These Criteria were worked out in a written format and provided to the CRYSTAL Project Management in December 2013.

#### ***Reasons for deviations from Annex I***

Currently there are no deviations. Consequently there is no impact on other tasks as well as on available resources and planning.

#### ***Reasons for failing to achieve critical objectives***

Currently all critical objectives are achieved. Consequently there is no impact on other tasks as well as on available resources and planning.

#### ***Use of resources***

##### **EADS-CAS:**

EADS-CAS has currently some additional effort due to the fact that EADS-CAS took over the domain lead. This will be compensated by using effort from the EADS-CAS contribution to WP101 to WP 200.

Details see Annex I Use of resources of each beneficiary

#### ***Collaboration with other projects***

This chapter is not applicable for WP200 – SP Coordination AEROSPACE. The work package deals only with management tasks.

#### ***Statement on the dissemination activities and exploitation***

This chapter is not applicable for WP200 – SP Coordination AEROSPACE. Dissemination and exploitation is in the responsibility of the Use Cases (WP201 – WP 208 and WP 210 – WP 211) and the Ontology WP (WP209).

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	41 of 269

**Corrective actions.**

Not applicable.

**3.2.2 WP 201 UC (2\_01a) Environmental Control Systems Use Case (Lead: A-G)*****Project objectives for the period M1- M12*****Abstract**

The Environmental Control Systems (ECS) Use Case shall support a collaborative model based initiative between system design and safety domain. An integrative model approach represents design aspects from different domains which shall be enabled by multi-view point modelling and associated analysis methods. Both functional and non-functional design properties shall be modelled, combined with nominal as well as erroneous behaviour of the controller application as well as equipment functions. The non-functional aspects formalizes performance and safety property for least two different 'descriptive' viewpoints in which the design shall be assessed with respect to dynamic and/or state-dependent executable models. An integrated framework shall be developed for defining overall design and assessment entities based onto an appropriate data model that also supports transformation and interoperability with standard analysis tools. The environmental control use case supports concurrent modelling and analysis for detailed design on system and equipment level that improve early maturity and reduce design costs.

**Objectives**

The key objectives of the ECS Use Case are the evaluation of the Reference Technology Platform (RTP) with respect to the industrial requirement provided within the aeronautics domain. Dedicated technology bricks related to the use case are integrated in the RTP to assess the developed methods on scalable and real data. Further objectives are CRYSTAL supported methods and implementations for seamless data interoperability and multi-viewpoints systems engineering. Generic design entities are defined in a super structured environment as the instantiation of domain RTP. Standard tools like Matlab / Simulink and e.g. safety analysis tools are connected the RTP ensuring data exchange by IOS. By exercising RTP – system domain models are transferred and integrated in safety models in order to consider inadvertent failures and emergent functional behaviour. In particular methods to determine qualitatively and quantitatively impact of multiple-failure occurrences are subject of the ECS use case as well as failure propagation and fault tree analysis including timed and state-dependent failure analysis.

Following objectives are targeted in particular for M1-M12:

Exercise re-use and seamless data link of functional models in different domains

- Modelling of design entities of different domains in an integrated (intersecting) model
- Modelling of functional requirements for design validation (stimuli and observer)
- Execute functional models for controller application as well as the environment for validation and verification purposes
- Derive requirements for interoperability, meta model and seamless data transfer/transform capabilities

Integrate safety attributes and methodological concepts into functional models to enable seamless safety analysis from functional models with dysfunctional models:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	42 of 269

- Identify safety attributes (non-functional statistic properties) attached to physical components
- Identify models for failure injection on
  - Timing, sequences
  - Events, values
- Elaborate on functional safety properties e.g. for
  - Omission failures
  - Commission failures
  - Partial and total loss of function
- Functional Hazard Analysis (qualitative)
- Fault Tree Analysis (quantitative) with SARAA (Airbus proprietary tool framework)

### ***Work Package progress and achievements during period M1-M9***

#### ***Progress towards objectives***

A detailed ECS use case description version 1 was created under responsibility of national project leader in order consider and capture the entire technical inputs. All impacted Airbus domains provides valuable contributions in converging iterations and in a constructive collaboration. Involved partners in the use case have reviewed the deliverables to ensure communication and understanding of the technical challenges. By referencing to models, artefacts and design data - needs and requirements are identified for the CRYSTAL partners to develop and support a.o. tool interoperability, data management as well as analysis and assessment methods for system design.

#### ***Tangible results***

- ECS use case description, 1. version
- Preliminary description of the ECS use case demonstrator, 1. version
- Detailed design modelling (Matlab/Simulink) with provision of models and relevant data
- Requirements captured, defined and provided to CRYSTAL partners

#### ***Reasons for deviations***

No deviation from Annex I

#### ***Reasons for failing to achieve critical objectives***

No failing of achievable objectives foreseen

#### ***Use of resources***

No deviation between planned and performed use of resource

#### ***Collaboration with other projects***

Participation in national research project SPES-XT on method development and exploitation on embedded systems. Information flow ensured by same project responsibility of Airbus department 'Systems, Methods and Tools'.

Since CRYSTAL targets methods on detailed system design, complementary activities are performed within SPES-XT project for architecture design and assessment for software deployment on distributed computers (a.o. controller applications, network data transfer and dedicated hardware implementations).

### ***Statement on the dissemination activities and exploitation perspectives***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	43 of 269



Experiments and results on new methods and interoperability standards will be demonstrated in a relevant tool-chain by Airbus in order to sustain dissemination and exploitation as planned in the Annex I.

Participation in Airbus internal innovation forum with preliminary live demonstrator from Airbus Group Innovations to disseminate first interoperability concepts and to capture stakeholders.

### **Corrective actions**

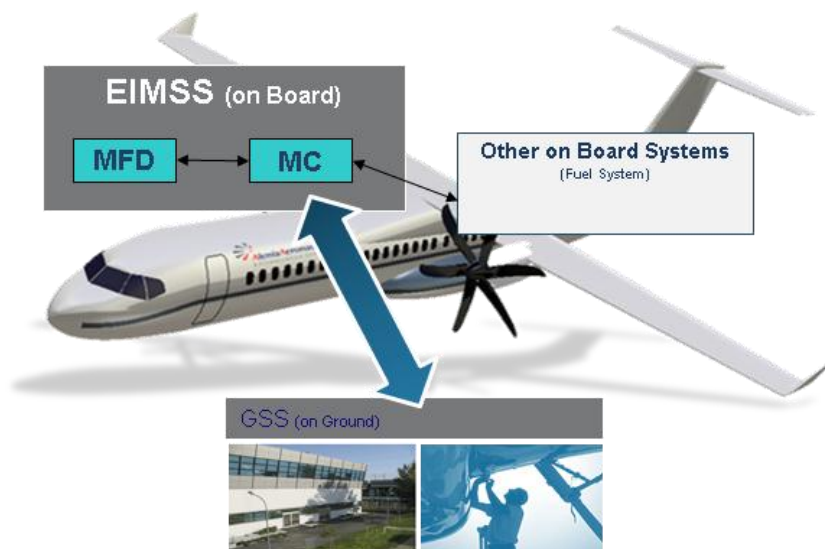
Not applicable

## **3.2.3 WP 202 Preliminary Design for a new Regional TurboProp (Lead: ALA)**

### **Project objectives for the period M1-M12**

On the basis of a concrete industrial use case related to the development of a new regional Aircraft the objective of this work package is to identify the needs in terms of methodologies, practices, data models and tools interoperability required to the technology bricks and IOS.

In this context the main goal of this WP is the definition and design of an innovative diagnostic and monitoring system to be installed on a New Regional Turboprop. Task for this team, being defined in the Description of Work (DoW), is that of developing the Enhanced and Integrated Monitoring and Support System (EIMSS) to be integrated in the fuel system architecture, interfacing with the required equipment. Modeling activity fits the project requirement of testing the interoperability among some different tools used to design this system.



### **Work Package progress and achievements during period M0-M12**

During the first twelve months the use case requirement and specification have been set up considering the WP goals. Engineering methods for the WP202 have been selected from the common source of those defined in WP 208 and then a tailoring activity have been performed in order to adapt them to the peculiarities of the private use case.

Both a Physical model and a Functional model have been preliminary built considering how to link both in the development process.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	44 of 269

### ***Progress towards objectives***

Considering physical modelling during the first six months a general assessment of the state-of-arts within the fuel system architecture was preliminarily performed. Design process was then started. To this purpose, a Matlab® (by TheMathworks) code was developed to simulate a simple traditional fuel system (M1-M6). Doors by IBM was used to state and manage the top level requirements, which define the system specifications, with a particular care for the functional requirements. The preliminary model developed within Matlab® was improved to meet this baseline characteristics and to allow the performance requirements updating.

On functional modelling Systems Engineering Methodologies were applied to perform several analyses. The top down recursive approach called Harmony® (based on SysML language) was applied for the preliminary requirement allocation and functional design. Subsequently functional analysis was carried out within Rhapsody® and Doors® tool. Design synthesis phase was finally proposed by resorting to a top level baseline. Trade off studies were even performed by defining some Figures of Merit, being chosen among some simple design drivers, and they were used as selection parameters.

The two partners shared the achievement of the task with Polito more focused on the Physical modelling and Alenia Aermacchi concentrated on the Functional modelling.

### ***Tangible results***

- selection of a consolidated and reviewed tool chain
- shared a common understanding of the use case with tool chain
- common and shared set of requirement for the use case
- definition together with ICT department of the architecture of the demonstrator environment
- preliminary development of the physical and functional models of use case systems
- assessment and tuning of applied methodology (e.g. Rhapsody)

These results have been formalized in due deliverables:

- D202.010 – “Use Case Description” that describes the underlying development processes and the set of involved process activities and engineering methods
- D202.021 – “Requirements Specification” that details the use case, defines the initial version of user requirements, shows the activity sequence to identify services and describes operational scenarios
- D202.031 - “SEE Specification - V1” that defines the concepts of the dedicated SEE and involved tools, defines tool functionalities and services needed or to be implemented and defines an integration plan and the evaluation criteria

### ***Reasons for deviations***

N/A

### ***Reasons for failing to achieve critical objectives***

N/A

### ***Use of resources***

The resources have been used as planned.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	45 of 269

### ***Collaboration with other projects***

Information flow established with ARTEMIS JU project MBAT due to Crystal people concurrently involved in MBAT

### ***Statement on the dissemination activities and exploitation perspectives***

Dissemination planning has been set up with a first activity on M13

### ***Corrective actions***

N/A

## **3.2.4 WP 203 Mission Support Equipment (Lead: EADS-CAS)**

### ***Overview***

Airbus Defence & Space develops avionic systems that support helicopter pilots in degraded visual environments which can be caused by e.g. rain, fog, sand, dust and snow. Many accidents can directly be attributed to such degraded visual environments where pilots often lose spatial and environmental orientation. In this case study we employ the landing symbology function which is part of the situational awareness suite Sferion™. The landing symbology function supports helicopter pilots during the landing approach. It enables the pilot to mark the intended landing position on ground using a head-tracked HMS/D (Helmet Mounted Sight and Display) and HOCAS (Hands on Collective and Stick). During the final landing approach the landing symbology function enhances the spatial awareness of flying crews by displaying 3D conformal visual cues on the HMS/D. Additionally, obstacles residing in the landing zone can be detected and classified using a real-time OWS (Obstacle Warning System). The situational awareness suite Sferion™ constitutes a product line. Different features can be selected for the landing symbology function depending on the customer and the helicopter platform to which the solution shall be deployed.

### ***Project objectives for the period M1- M12***

#### **Overall Objectives**

The work within this work package is centred on the Landing Symbology function. The function is used to identify the needs in terms of new methodologies and tools within the CRYSTAL scope and evaluate, disseminate and exploit the CRYSTAL results.

The main purpose of the use case is to

- demonstrate the application of a model-based multidisciplinary collaborative development paradigm including integrative model-based system design and model-based safety analysis,
- investigate the application of domain ontologies and their potential for improving quality of life cycle artefacts Ontology-based requirements formalization and validation,
- develop an effective methodology to support system families, variant management and re-use of artefacts, and Artefacts advanced traceability, and
- describe standardized processes providing guidance to ensure compliance with relevant industrial standards.

For the period M1 to M12, in particular the objectives of the tasks T231 (Use Case Definition) and T232 (Prototyping IOS Concepts) are relevant. These objectives are summarized below.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	46 of 269

### T231 Objectives – Use Case Definition

The current situation regarding systems engineering lifecycle environments is deeply analyzed. Areas of possible improvements are identified for the methodologies and tool chains with respect to the aspects defined by the user stories. Based on this analysis, requirements are derived to support the specification of services to be provided by the RTP/IOS and the providers of brick applications. This involves the following activities:

- Use case definition: the industrial use case, preliminary defined in the proposal, is refined with respect to the selected user stories.
- Requirements elicitation: requirements relevant for this use case are elicited from the analysis of applicable standards, state of practice in the domain, needs specified in the selected user stories and use case partner's constraints in order to provide requirements to the RTP/IOS sub-project.
- Requirements consolidation: refine captured requirements; agree and prioritize requirements with brick application providers and the RTP/IOS sub-project.

### T232 Objectives – Prototyping IOS Concepts

A prototype based on existing technology bricks and RTP/IOS services is developed early in the project. The brick providers provide documentation and training material for their tools. Sample data is used to implement parts of the use case. The aim of this prototype is to

- gather experience with the technology bricks, the IOS specifications and the RTP infrastructure,
- validate the technical specification of the demonstrator, and
- provide early feedback to solution providers.

### Deliverables

According to the JU Grant Agreement included in Annex I, the deliverables for the first 12 month are listed below:

- D203.011: MSE Report – V1: this document describes in detail the outcome of T231, i.e. the context in which the use case is applied, the process activities, the related engineering methods as well as the derived requirements that shall be fulfilled by RTP/IOS and technology bricks.
- D203.020: First MSE SEE (Prototype): this document describes in detail the outcome of T232, i.e. the tool chain and tool functions of the prototype, the usage scenarios exemplified by lifecycle data provided for the Landing Symbolology function, and an initial assessment of the current technical status.

### ***Work Package progress and achievements during period M1-M12*** ***Progress towards objectives***

#### T231 Progress – Use Case Definition

This task primarily dealt with the implementation of the IOS needs capturing process suggested by the technical project management with the aim to specify a set of engineering methods and related requirements. The following activities have been performed:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	47 of 269

- Participation in / contribution to 13 workshops for the elaboration of the MSE use case between June 2013 and April 2014: definition of relevant process activities, identification of engineering methods, technology baseline and required innovations, elicitation of requirements for the RTP, IOS and bricks.
- Setup of the SysML modelling and reporting environment for the MSE use case definition.
- Preparation of the Systems Engineering Management Plan for the MSE use case.
- Development of a traceability meta-model that provides a tool independent definition of the traceability link semantics of linked artefacts.
- Internal dissemination: presentation of WP203 results to other organizational entities in Airbus Defence & Space.

### **T232 Progress – Prototyping IOS Concepts**

- Prototyping using Requirements Quality Suite provided by WP607.
- Analysis and prototyping using different approaches for variability management: FeatureIDE, Vedit, and pure::variants with connectors to IBM Rational DOORS and IBM Rational Rhapsody.
- Workshop with use case partner FhG IESE in Friedrichshafen on April 22, 2014.
- Integration of MSE prototype based on existing technology.
- Setup of initial IBM Jazz environment.

### **EADS-IW-G Contribution**

EADS-IW-G mainly contributed in the review of deliverables D203.011 and D203.020. In addition, informal exchange with the use case owner has taken place. Due to the collaboration, some aspects of this work package have already been addressed in WP208 (Public Use Case Aerospace), which is led by EADS-IW-G, and the respective deliverable D208.010.

### **EADS-IW-UK Contribution**

EADS-IW-UK participated in informal exchange with the use case owner. A web meeting is scheduled on April 28, 2014. The aim is to analyze the applicability of the IOS safety tool chain developed in the CESAR project.

### **FhG Contribution**

FhG contributed in the review of deliverables D203.011 and D203.020. Informal exchange with the use case owner has taken place, mainly related with variability management issues in the MSE use case and identification of respective needs. FhG performed an in-depth analysis of different approaches for variability management using FeatureIDE and pure::variants. Support was provided to the use case owner in introduction of pure::variants. A physical meeting is scheduled in Friedrichshafen on April 22, 2014.

### **Deliverables**

All deliverables requested in the period M1 to M12 have been submitted to JU:

- D203.011: MSE Report – V1 Due date: M9
- D203.020: First MSE SEE (Prototype) Due date: M9

### **Progress Reports**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	48 of 269

- Activities Report M9
- Activities Report M12
- WP203 Annual periodic report M12

### ***Tangible results***

#### **T231 Results – Use Case Definition**

- SysML model that provides a detailed definition of the MSE use case comprising user stories, process activities, engineering methods, interaction of related bricks and related requirements.
- Traceability meta-model.
- Deliverable D203.011: MSE Report – V1.

#### **T232 Results – Prototyping IOS Concepts**

- MSE prototype based on existing technology including IBM Rational DOORS, IBM Rational Rhapsody, IBM Rational Gateway, IBM Rational Testconductor, IBM Rational Publishing Engine, Requirements Quality Suite, Vedit, FeatureIDE and pure::variants.
- IBM Jazz Environment.
- Deliverable D203.020: First MSE SEE (Prototype)

### ***Reasons for deviations***

Deliverable D203.020 was delivered in M10 with no impact on other tasks.

### ***Reasons for failing to achieve critical objectives***

All critical objectives have been accomplished on time.

### ***Use of resources***

The following table provides an overview of the planned and actual resources:

Partner No	Partner Short Name	Planned Efforts (PM)	Actual Efforts (PM)
19	EADS-CAS	23.4	20.6
20	EADS-IW-G	2.3	0.7
22	EADS-IW-UK	4.0	0.0
26	FhG	3.3	3.5

### **Use of Resources**

The efforts have been mainly used for:

- Production of data: creation of SysML model for the MSE use case definition, creation of lifecycle data for the MSE use case: requirements, functional analysis model, variability models.
- Integration and setup of SEE environments: prototype based on existing technology, setup of IBM Jazz environment



- Production of deliverables: D203.011 and D203.020
- Review of deliverables: review of D202.010 (ALA) on Oct 28, 2013; review of D202.021 (ALA) on Jan 23, 2014; review of D202.031 (ALA) on Jan 28, 2014; review of D205.010 (TASE) on Mar 3, 2014; review of D204.010 (Sagem) on Jan 20, 2014; review of D210.010 (A-F) on Jan 20, 2014.

### **EADS-CAS**

Less efforts due to delayed project start and team ramp-up with no impact on project objectives.

### **EADS-IW-G**

Some of the aspects of UC 203 have been addressed in WP208. The respective effort for those aspects has been allocated to WP208. No impact expected.

### **EADS-IW-UK**

EADS-IW-UK mainly contributes to user story "Safety Analyses" and supports the SEE based on IBM Jazz platform. Both topics have been started at the end of this report period in M12. No impact expected.

### **FhG**

No significant deviation.

#### ***Collaboration with other projects***

Excellent information flow has been established with ARTEMIS JU project MBAT since the use case responsible is also actively involved in MBAT. An example is the exchange on the requirements consistency analysis approach developed in MBAT.

In addition, we build on results achieved in the ARTEMIS JU project CESAR (e.g. related with requirements formalization, use of ontologies and variability management).

EADS-CAS participates in the national research project SPES-XT on method development and exploitation on embedded systems. Information flow has been established recently. SPES-XT participants have been invited to a CRYSTAL dissemination workshop.

### ***Statement on the dissemination activities and exploitation perspectives***

#### **Dissemination Activities**

Internal dissemination activities have been performed, e.g. a CRYSTAL workshop was held to communicate the results of this work package. Presentations have been delivered to Airbus Group level PLM harmonization projects. A poster session was organized at the EADS Systems Engineering Forum.

Detailed information on dissemination can be found in the deliverable D102.010: Dissemination Plan V1.

#### **Exploitation Perspectives**

A demonstrator environment based on IBM Jazz platform has been setup together with the company-internal IT department. The means to integrate different types of data (requirements, system models, safety-related data, etc.) based on interoperability standards will have a large impact on future Systems Engineering Environments that will be deployed in the company. Results from the CRYSTAL project will be considered by the company's software governance.

Detailed information on exploitation can be found in the deliverable D102.040: Exploitation Plan V1.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	50 of 269



### Corrective actions

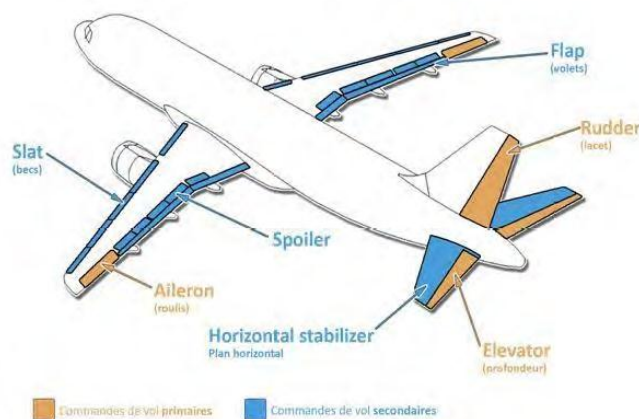
Not applicable.

## 3.2.5 WP 204 Electrical Flight Control System (Lead: SAGEM)

### Project objectives for the period M1- M12

#### Overview

The use case addressed in this work package WP204 is an electrical system allowing a safe control of flap surfaces. It represents a typical kind of critical application for flight control command of an aircraft.



This use case is representative of the kind of product SAGEM is able to design on the basis of its customer requirements. Therefore, ensuring that a consistent, complete and high quality set of requirements properly shared between customers and SAGEM is provided in input to design teams is a key condition to target a quality product fully meeting customer expectations.

### Overall Objectives

The lack of requirements quality often leads to additional efforts, cost overrun and schedule drifts in downstream development activities. One of the means to improve requirements quality is to formalize requirements using boilerplates, domain ontologies and patterns in order to allow automatic analysis and test generation.

Boilerplates provide requirements templates which consist of fixed syntax elements and attributes. The primary benefit of using boilerplates is that they allow requirements to be captured in a consistent fashion. Domain ontologies provide assistance in filling the attributes of boilerplates. Based on domain ontologies requirements quality analysis (including assessment of CCC (Completeness, Consistency, Correctness) and redundancy) can be automated.

According to each industrial process, an additional requirements formalization step should be optionally available based on pattern requirement capture (a smooth transition from natural language to boilerplates to pattern have been defined and validated during CESAR project). A pattern provides additional semantic restrictions to a boilerplate (syntax restrictions).

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	51 of 269

The requirement patterns allow deeper requirements analysis of the Completeness, Consistency and Correctness of a set of requirements, of system architecture consistency, and allow generating automatically test cases for requirements.

That is why, within WP204, the main objectives will be to define a process with integrated tools to enhance Requirements Engineering (including DOORS requirements, requirement ontology and SysML models...) in order to

- To share common vocabulary within the project/organization/supply chain
- To enhance the quality of the specification at each step of development process
- To help the reuse of requirements from previous project.

For the period M1 to M12, in particular the objectives of the tasks T241 (Use Case Definition), T242 (Integration of the tool chain) are relevant. These objectives are summarized below.

### **T241 Objectives for period M1-M12 – Use Case Definition**

The first year of the project aims at:

- refining the use case: the industrial use case, preliminary defined in the proposal, is refined with respect to the selected user stories.
- Creating a reference based on current engineering methods in order to be able to assess the improvement provided by CRYSTAL project.
- Defining a first version of needs for Requirements Based Engineering Process based on the analysis of applicable standards, the state of practice in the domain, the use case partner's constraints.
- Carrying out first feasibility studies about the RBE expected process
- Identifying needs for technical providers and interoperability standards
- Consolidating and refining captured requirements; agree and prioritize requirements with brick application providers and the interoperability sub-project.

### **T242 Objectives for period M1-M12 – Integration of the tool chain**

The objective of this task for the first year of the project is to integrate the “off-the-shelf” tools from The Reuse Company (Knowledge Manager, Requirement Quality Analyser, Requirement Authoring Tool) with IBM DOORS in order to prototype the RBE process and have a first feedback of the gap between the industrial needs and the status of the tools.

The brick providers provide documentation and training material for their tools. Sample data is used to implement parts of the use case. The aim of this prototype is to:

- Transfer know-how about technology bricks
- gather experience with the technology bricks
- validate the technical specification of the demonstrator,
- provide early feedback to solution providers.

### **T243 Objectives for period M1-M12 – Assessment / validation of the tool chain**

This task will more relevant for next years of the project. For the first period, the goals are to early verify:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	52 of 269

- The ability from Sagem system engineer to use the ontology concept,
- The ability of the process for the ontology construction and maintenance to be relevant for on the field applications enabling ontology control over time and avoiding ontology pollution
- The future potential of the tools to help providing warnings about respect of applicable CESAR Completeness/Correctness/consistency (CCC) criteria, in order to consolidate/update the requirements for the work package.

### **Deliverable**

According to the JU Grant Agreement included in Annex I, the deliverable for the first 12 month is

- D204.010: E-FCS RBE process and tool chain evaluation V1

### **Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

### **Progress towards objectives**

#### **T241 Progress – Use Case Definition**

Sagem, REUSE, UC3M, OFFIS have reached a shared and clearer understanding about the technical needs to be filled by the WP607 RBE tool chain for the satisfaction of WP204 needs.

We have identified the gaps between the industrial needs and the current status of the WP607 tools. That leads to the definition of a first roadmap for WP204 and WP607.

We have initiated the design of "Requirement process" including ontology technologies. This is a first version not yet finalized.

We have written a first specification for CRYSTAL WP2.4 tool chain needs: E-FCS RBE process and tool chain evaluation - V1.

We have initiated the alignment between WP204, WP203 and WP607 and the prioritisation of RBE needs through the definition of technical core requirements. For synchronization purpose, Sagem have organized 2 face-to-face workshops:

- Organization/ Participation / Contribution to workshop in Paris on June 11, 2013
- Organization/ Participation / Contribution to workshop in Paris on Jan 23-24, 2014

#### **T242 Progress – Integration of the tool chain**

Sagem have installed the "off-the-shelf" tools from The Reuse Company (Knowledge Manager, Requirement Quality Analyser, Requirement Authoring Tool) with IBM DOORS in order to prototype the RBE process.

The installation and integration of the tools were successful.

A training session to these tools was organized in Madrid on September 2013, the 16-17<sup>th</sup>. This allowed the transfer of know-how about ontology bricks and contributed to the alignment between WP203, WP204 and WP607.

#### **T243 Objectives – Assessment / validation of the tool chain**

Sagem have tested the current version of the WP607 tools for dealing with ontologies and confirmed the interest for ontology technology if improvements are realized within CRYSTAL project.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	53 of 269

Sagem have created a “requirements for electrical Flight Control System” reference based on current engineering methods. This will allow assessing the improvement provided by CRYSTAL project.

### **Sagem Contribution**

Sagem has:

- lead the work package,
- organized 2 face-to-face workshops
- defined the industrial needs for the work-package
- defined relevant “engineering methods” for the use case
- participated to “Requirement Quality Suite” training session
- contribute to the WP607 RBE requirements in collaboration with other partners
- installed and tested the “off-the-shelf” version of ontology based tools
- written down the deliverable D204.010: E-FCS RBE process and tool chain evaluation V1.

### **Reuse Contribution**

Activities have consisted of collaboration in several workshops for gathering, analysing, ranking and documenting the user needs.

### **UC3M Contribution**

UC3M has been analysing the use case and its refinements according to its needs. UC3M also contributes with the study of the integration with other tools and the IOS.

UC3M collaborated in the first list of user needs, analysis and ranking.

### **OFFIS Contribution**

OFFIS analysed and discussed the industrial requirements and the CCC to be developed within WP6.7 with SAGEM, TRC and UC3M.

### **Deliverables**

All deliverables requested in the period M1 to M12 have been submitted to JU:

- D204.010: E-FCS RBE process and tool chain evaluation V1 Due date: M9

### **Progress Reports**

- Activities Report M9
- Activities Report M12
- WP204 Annual periodic report M12

### ***Tangible results***

#### **T241 Results – Use Case Definition**

- Definition of industrial needs for RBE process and WP607 bricks.
- The first list of user needs has been collected, analysed and ranked. Furthermore, a list of refined requirements has been traced back to the user needs.
- An agreement on the first CCC analysis techniques to be implemented for the use case has been found.
- Definition of Core requirements for WP607.

- Traceability of WP607 core requirements to industrial needs.
- D204.010: E-FCS RBE process and tool chain evaluation V1

#### **T242 Results – Integration of the tool chain**

- Installation of IBM Rational DOORS, IBM Rational Rhapsody, IBM Rational Gateway, Requirements Quality Suite
- Training session to WP607 tools (Requirements Quality Suite) in Madrid on Sep 16-17, 2013.
- Detailed description in document: D204.010: E-FCS RBE process and tool chain evaluation V1

#### **T243 Results – Assessment / validation of the tool chain**

- System Specification for “electrical Flight Control System” written without CRYSTAL RBE process to be used as a reference
- First feedback from the first test of Requirements Quality Suite provided in D204.010: E-FCS RBE process and tool chain evaluation V1

#### **Reasons for deviations**

No significant deviation.

#### **Reasons for failing to achieve critical objectives**

All critical objectives have been accomplished on time.

#### **Use of resources**

The following table provides an overview of the planned and actual resources:

Partner No	Partner Short Name	Planned Efforts (PM)	Actual Efforts (PM)
14	REUSE	1	1
41	OFFIS	1.2	1.5
48	Sagem	6	5
65	UC3M	1	1

There is no significant deviation. Indeed WP204 and WP607 are highly connected and aligned. Some efforts initially planned for WP204 have been spent for WP607 with no impact for project objectives.

#### **Use of Resources**

The efforts have been mainly used for:

- Production of data:
  - System Specification for “electrical Flight Control System”
  - Definition and refinement of needs for “CRYSTAL RBE process” including alignment effort between WP203, WP204, WP607 and WP601.
- Integration, prototyping and first test of RBE tool chain

- Training to “off the shelf” Requirements Quality Suite
- Production of WP204 deliverables: D204.010
- Review of internal and external deliverables (WP203 and WP206 for instance).
- Participation to workshops:
  - Paris on June 11, 2013
  - Madrid on Sep 16-17, 2013.
  - Paris on Jan 23-24, 2014

### ***Collaboration with other projects***

ARTEMIS project CESAR is considered as a reference to many topics:

- Process specification
- Requirements specification including specification Completeness/Correctness/Consistency (CCC) criteria
- Ontology methods
- Formal languages

### ***Statement on the dissemination activities and exploitation perspectives***

#### **Dissemination Activities**

Internal dissemination activities have been performed based on regular WebEx meeting. Capitalization at Safran Group level is planned at the end of the project.

#### **Exploitation Perspectives**

First exploitation perspective for Sagem would be the use this "enhanced requirements process" developed within CRYSTAL project on its "Flight Control System" activities, then on avionics perimeters if significant improvement in quality of specification is measured (reduction of non-quality in development leading to reduction of cost and delays...).

In case of success, this process will be deployed to the Safran group. This will impact the aeronautical market. This process, whose one of the goal is to help the stakeholders of a project understanding each other, might be deployed among the external supply chain.

Second exploitation perspective would be to leverage on interoperability standards which would have a large impact on future Systems Engineering Environments that will be deployed in the company. Results from the CRYSTAL project will be considered by the company's software governance.

#### ***Corrective actions***

Not applicable.

### **3.2.6 WP 205 CRYSTAL Space Toolset applied to Avionics Control Unit Software generation, test, V&V, and Certification (Lead: TASE)**

#### ***Project objectives for the period M1- M12***

#### **WP205 Objectives**

The targets for this work package are:

- Extend the project results to the Space Domain
- Define a new standard set of tests and tools for space software

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	56 of 269

- Align ESA methodology with "commercial" one as defined in the CRYSTAL project
- Reduce cost of ISVV activities
- Reduce the risk of software customers
- Harmonize software supplier and ISVV supplier approaches to reduce iterations
- Provide clear and understandable assessments to software customers
- Align ESA Standards with solutions proposed in the project
- Define an "ESA Compatible" Toolset
- Define an "ESA Compatible" Test Campaign
- Demonstrate the proposed Toolset and Procedure through the certification of an actual flight software module

The application to be implemented for the Space domain is the low level software for an Avionics Control Unit whose application software could include autonomous navigation features based on GPS, inertial and/or image acquisition inputs as well as FPGA on flight reconfiguration control.

This unit will be based on a LEON architecture running in multicore configuration inside an FPGA exploiting the state of the art fault tolerant techniques. The low level software is composed of Boot, Drivers and Test software.

#### Project Deliverables expected for Period M1-M12:

Deliverable Number <sup>61</sup>	Deliverable Title	Lead beneficiary number	Estimated indicative person-months	Nature <sup>62</sup>	Dissemination level <sup>63</sup>	Delivery date <sup>64</sup>
D205.010	Space Use Case Requirements	60	1.00	R	CO	9
D205.020	CRYSTAL Space Toolset Specification	60	1.00	R	CO	12

#### Work Package progress and achievements during period M1-M12

This section gives details for each work package the work performed and progress achieved.

#### Progress towards objectives

**Deliverables** presented, according to DOW:

D205.010	WP2_5	Space Use Case Requirements	Month: 9
D205.020	WP2_5	CRYSTAL Space Toolset Specification	Month: 12

Deliverable D205.020 preliminary version has been delivered in February, it is under external review process. Final version will be delivered end April.

#### Progress Report Deliveries:

- Activities Report M9

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	57 of 269



- Activities Report M12
- WP205 Annual periodic report M12

### Meetings and Communications:

- Spanish and WP205 kick-off meeting 13-November
- Monthly Progress Teleconferences
- P2P communication with Tecnalia, GMV, ITI, Orbital
- Communication with project coordinator for change in DoW
- Communication with reviewers and SP2 leader to orient Deliverables content

### Tangible results

Deliverables:

D205.010	WP2_5	Space Use Case Requirements	Month: 9
D205.020	WP2_5	CRYSTAL Space Toolset Specification	Month: 12

D205.010. Space Use Case Requirements: This document contains a summary of the ECSS-E-40 Series requirements for the space systems applied to the CRYSTAL domain. More specifically, summarizes the specific needs to be covered by the CRYSTAL bricks in order to be able to be space qualified. As well it provides a first guideline of the design rules to be followed in the different bricks. This document also describes the use case for the Space domains in terms of the SW to be developed as well as the executing HW platform.

D205.020. CRYSTAL Space Toolset Specification: This document is the formal specification of the tools required to configure the CRYSTAL space Toolset as well as a first draft of the application procedure of the CRYSTAL tools to the Space Environment, including design rules, guidelines for the usage of tools and Best Practices. This document has been generated after a formal review of the previous requirements and the inclusion of cross domain recommendations and results.

This deliverable is under external review process. Final version will be delivered end April.

### Participants Contributions:

**TECNALIA** has contributed to the definition of the requirements that the different bricks must comply with in order to be applied to the space domain. The technical tasks performed have been described and reflected in the associated deliverable D.205.010, for which TECNALIA has worked specifically to define the requirements needed to integrate the "Autonomous Fault Tolerant System Design Methodology" in this Use Case.

**GMV** has:

- o Contributed to the definition of the Space Use Case High level requirements.
- o Described the applicable standards.
- o Identified and described the involved engineering methods.
- o Contributed to the elaboration of the D205.010 deliverable "Space Use Case Requirements"
- o Participated in several WP teleconferences to provide inputs and status of the WP tasks

**ITI** has contributed to the refinement of the WP205 use case in collaboration with TASE and the other partners involved in this use case in task T2.5.1. Moreover, ITI has also participated in the

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	58 of 269

detection of interoperability needs among the different tools utilised in the V-model of such use case. ITI has also contributed to the completion of the first version of the deliverable D205.010. Finally during this period, ITI has also derived the functional and IOS requirements to be included in the brick B2.55 Scheduling Requirement Analysis (to be developed in WP603). A refined use case WP205 definition has been obtained, detailing the Engineering Methods and highlighting the IOS needs between the tools used in the V

**Orbital Aerospace** has contributed to the WP2.05 Space Use Case definition by supporting leader TASE in the technical specification of the Demonstrator framework (both HW and SW) along with the rest of partners. Additionally, Orbital Aerospace has participated in the first version of deliverable D205.010 providing Use Case requirements to integrate the brick B.251 AUGER in the Engineering Methods defined according to space embedded SW development standards, specially focusing on Independent Software Validation and Verification (ISVV) stages. The first version of deliverable D205.010 was released, including the Use Case Demonstrator technical framework, Use Case requirements and related Engineering Methods and proposed Bricks integration.

### ***Reasons for deviations***

Deliverable 205.010 was delivered in M11 due to delay in Spanish national funding assignment with no impact on other tasks.

Deliverable 205.020 draft version has been delivered on time. Final version to be delivered by end of April.

### ***Reasons for failing to achieve critical objectives***

Critical objectives have been accomplished on time.

### ***Use of resources***

Resources have been used as per following table:

Company Short	WP	Efforts planned (PM)	Efforts actual (PM)
60_TASE	WP2_05	27	27
28_GMV	WP2_05	6,6	1,65
32_ITI	WP2_05	2,5	2,5
27_Tecnalia	WP2_05	12	12
42_ORB	WP2_05	12	12

As project start was shifted to November due to delay in Spanish national funding assignment a stronger effort has been done during 2014 up to April in order to recover the planning and the scheduled activities flow.

### ***Collaboration with other projects***

#### ***Statement on the dissemination activities and exploitation perspectives***

TASE has prepared in collaboration with GMV a paper for DASIA 2014: "Critical Systems Engineering Accelerator: Aerospace Demonstrator".

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	59 of 269

Detailed information about dissemination and exploitation perspectives can be found in the following TASE documents:

CRYSTAL Deliverable D102.040 Exploitation Plan V1.

CRYSTAL Deliverable D102.010 Dissemination Plan.

### **Corrective actions**

Not applicable.

## **3.2.7 WP 206 Multi-Mode Navigation System (Lead: HON)**

### **Project objectives for the period M1- M12**

The objective of this work package is to instantiate a tool chain for the Multi-Mode Navigation System use case, demonstrate functionality of the tool chain, and advance the tool chain to a close-to-production TRL.

The European Air Traffic Management (ATM) system is currently undergoing dramatic changes in order to address growth of air traffic and congestion of airspace as well as reduce noise and fuel consumption. In order to use the available airspace efficiently, high-performance navigation systems are required. At the same time, there is a big strive for reducing cost of the final product. Analyses show that if there is no fundamental change in the development approach, new avionics systems will become hardly affordable for the OEMs and new technologies will be extremely difficult to deploy as a result.

Navigation systems are a vital part of aircraft avionics. They provide information of the aircraft position, velocity, and attitude to other aircraft systems, such as flight management systems, flight control systems, surveillance systems, as well as to the pilots through the flight displays.

Dependent on the category, current aircraft are equipped with different grades and types of navigation systems like Attitude Heading Reference Systems (AHRS) and Inertial Reference Systems (IRS). To date, sensor grade predetermines performance and cost of the navigation system.

Navigation-grade sensors deployed in navigation systems add significantly to the final cost. Lower-grade sensors can substitute these sensors only after engaging an aiding source of position information compensating the sensors imprecision.

The current innovation trend is to use a Global Navigation Satellite Systems (GNSS) as an aiding source, giving primarily position, velocity, and time information. The system fuses aiding signal with the navigation sensor information by typically advanced statistical mechanism to achieve the best performance. Fusing algorithms are the major source of SW complexity of a navigation system.

Due to complexity and high computation demands, developers tailor the navigation system implementation to specific aircraft requirements and optimize them for a specific hardware platform. Even minor system changes results in significant adaptations and re-certification effort, and the resulting re-application cost.

From the abovementioned description, there are several challenges pertinent to the current de-sign approach of the navigation systems.

#### **• Cost reduction by lower-grade sensors**

We propose different architectures to reach the expected effect – lower-grade sensor with no performance loss resulting in a lower cost. However, it is not immediately obvious which solution satisfies all criteria in an optimal way. Therefore, early architecture space exploration is crucial to achieve the expected business effect. The main analysis criteria in this case are cost and number of the deployed sensors, complexity of the developed SW, required performance of the deployed HW navigation system safety, reliability, and maintainability. Obviously, system engineers need multiple views of the system architecture integrated in the same environment should they be able to efficiently explore different architecture options and take the right decisions.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	60 of 269

### • **Preservation of performance by advanced safety analysis**

Using lower-grade sensors and using aiding signal has significant consequences with respect to achieving the required safety and performance. Safety analysis becomes more complex due to consideration of more failure modes and more systems that are external. Moreover, navigation systems assist other avionics systems at higher-criticality level than before, and hence, must be designed to the according DAL.

The current safety analysis methods represent only static deduction and induction process related to safety reasoning. Complex dynamic systems require more dynamic and better-integrated safety analysis methods providing engineers with immediate assistance rather than forcing them to conceive reasoning and mitigations manually.

### • **Platform portability by system modularity**

Trading off sensor cost for higher system complexity caused by information aiding becomes reasonable when focusing economies of scale. In this case, we expect that portability among different platforms and platform types (Type 23, Type 25, etc.) will yield the expected business impact. The problem in doing so is partially different requirements on functions and performance of different aircraft.

Therefore, it is important to design the solution in a modular way to be able to re-design and revalidated the system for different platforms in an efficient manner, short time, and respecting all OEMs and regulatory requirements.

## ***Work Package progress and achievements during period M1-M12***

This section gives details for each work package the work performed and progress achieved.

### ***Progress towards objectives***

#### **T2.6.1 Use Case Definition**

Honeywell documented Multi-Mode Navigation System use case in the D206.010 deliverable. Moreover, envisioned tool chain was described and needed technology bricks were identified. Masaryk University integrated tools that integrate tasks of consistency checking and vacuity checking for a set of LTL (Linear Temporal Logic) formulae. The integrated tool (MUSAT) made available to Honeywell partner.

#### **T2.6.2 Prototyping IOS concepts**

Honeywell created the architecture of the tool chain and the tool integration including the needs for the technology bricks integrations.

Honeywell closely cooperated with Masaryk University on advanced safety analysis based on formal methods and fully integrated with our tool chain. The architecture is described in D206.021.

#### **Deliverables**

D206.010: Multi-Mode Navigation System Analysis, Development Needs, and the Proposed Tool-Chain Functionality – delivered in M9

D206.021: Architecture of the Tool Chain for the Multi-Mode Navigation System – external review, due date: M12

### ***Tangible results***

We have described the tool chain and its architecture in the deliverables. We have integrated NuSMV model checker from FBK with our tool chain. We are closely collaborating with Masaryk University on safety analysis and improved sanity checking. Moreover, we are cooperating with REUSE Company on integrating their tools and we have made progress on both sides to make our tooling more compatible.

### ***Reasons for deviations***

Not applicable.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	61 of 269

### **Reasons for failing to achieve critical objectives**

Not applicable.

### **Use of resources**

There is no deviation. Resources used as planned.

The following table provides an overview of the planned and actual resources:

Partner No	Partner Short Name	Planned Efforts (PM)	Actual Efforts (PM)
29	HON	40	40
36	MU	6	6

### **Collaboration with other projects**

Integration technology extending Open Services for Lifecycle Collaboration was based on work from ARTEMIS project iFEST.

### **Statement on the dissemination activities and exploitation perspectives**

#### **Dissemination Activities**

Journal publication on the integration of consistency checking and vacuity checking for a set of LTL (Linear Temporal Logic) formulae is under review process.

More dissemination activities are planned.

#### **Exploitation Perspectives**

All businesses which uses model based development can speed-up the development by using the formalized requirements and formal verification even before the system design is created. By using open integration technologies like OSLC we will enable tool interchange-ability. Tool chain will be exploited by employing on multiple industrial projects.

Using unified and restricted terminology when creating requirements will lead to less defects introduced in requirement level and enable the easier requirement formalization. Domain ontology will be exploited by requirement elicitation and by creating requirement patterns.

### **Corrective actions**

Not applicable.

## **3.2.8 WP 207 Crystal Space Toolset applied to Avionics Control Unit Software generation, test, V&V and Certification (Lead: TASF)**

### **Project objectives for the period M1- M12**

#### **Overview**

The objective of this work package is to improve the avionics engineering process by providing a model based approach for system design offering multi-view point capabilities and multi-criteria evaluation of system solutions.

Avionics engineering process is complex due to the complexity of the final product and its criticality (equivalent to the DO-178 DAL B for the embedded software for example). Many actors (system engineers, hardware engineers, control engineers, safety engineers, software engineers, ...) are collaborating to deliver the product but the current interoperability of tools is quite poor (i.e. based on ad-hoc formats and solutions) and the sharing of models between the disciplines has to be improved (each domain having its own model "as an island". Thales Alenia Space objective in this

use-case is to improve its avionics engineering process through the use of latest technology in the domain of multi-view point engineering and multi-criteria evaluation that are provided by the WP609.

The business objective being to have a better time to market of the product lines (very important in this fast moving sector with a lot of competition), to reduce costs (due also to competitive environment) and finally to reduce also non quality costs all along the process (by reducing human errors, communications problems, ...)

For the period M1 to M12, in particular the objectives are to define the user needs for the Crystal toolset in order to meet Thales Alenia Space objectives.

### **Deliverable**

According to the JU Grant Agreement included in Annex I, the deliverable for the first 12 month is

- D207.010: Use-case description (delivered)

### ***Work Package progress and achievements during period M1-M12***

This section gives details for each work package the work performed and progress achieved.

### ***Progress towards objectives***

The work on this first period has been focussed on defining the requirements for the realisation of the use-case.

The process was to make several interviews with avionics architects for several on-going at Thales Alenia Space. Then a technical note has gathered all the activities performed by the avionics engineers during the avionics development process. In particular this technical note lists all the analysis that are performed during the system definition (safety, power consumption, bandwidth ...), for each analysis it lists the input and the output of the analysis. This document will be used to define the needs in terms of model contents to be handled by the architecture sketcher and the fine definition of the use case.

Participation to aerospace domain requirement meeting and also training sessions from technology providers.

The work is synthesised in the D207.010 deliverable that describes the considered use-case for the project

### **TAS-F Contribution**

TAS-F has:

- lead the work package,
- organized 1 face-to-face workshops
- defined the industrial needs for the work-package
- defined relevant "engineering methods" for the use case
- participated to "Requirement Quality Suite" training session
- perform internal interview and synthesis of Thales Alenia Space needs for crystal

---

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	63 of 269



- written down the deliverable D207.010: Use-case description.

### **TRT Contribution**

Activities have consisted of collaboration in several workshops for gathering, analysing, ranking and documenting the user needs concerning both the multi-view point engineering and the multi-criteria analysis.

### **Deliverables**

All deliverables requested in the period M1 to M12 have been submitted to JU:

- D207.010: Use-case description Due date: M12

### **Progress Reports**

- Activities Report M9
- Activities Report M12
- WP207 Annual periodic report M12

### **Tangible results**

- Definition of industrial needs for TAS process and WP609 bricks.
- The first list of user needs has been collected, analysed and ranked.
- D207.010: Use-case description

### **Reasons for deviations**

No significant deviation.

### **Reasons for failing to achieve critical objectives**

All critical objectives have been accomplished on time.

### **Use of resources**

There is no significant deviation.

### **Collaboration with other projects**

ARTEMIS project MBAT results and interactions with MBAT participants are useful for the definition of the IOS and the interoperability standard understanding

### **Statement on the dissemination activities and exploitation perspectives**

#### **Dissemination Activities**

Internal dissemination is done through regular meetings with engineering departments where the progress of the CRYSTAL project is demonstrated.

#### **Exploitation Perspectives**

##### Multi-view point modelling environment

- Description: The technical solutions and the associated process enable the design of the spacecraft avionics following several viewpoints (power, mass, electrical budget, ...)
- Business Case and Market: All the avionics engineers in Thales Alenia Space



- Roadmap for Exploitation: Following successful CRYSTAL use case, a adoption plan will be setup will associated internal funding to prepare operational deployment (industrialisation, user support, training, ...)
- Expected availability for use: Some solutions are already available and operationally used (Eclipse based graphical modeller, ...), full CRYSTAL solution will be deployed around 2017.

#### Multi-criteria trade-off environment

- Description: The technical solutions and the associated process enable evaluate architecture candidate according to a evaluation model merging several criteria (cost, complexity, performance, maintainability, reliability, ...)
- Business Case and Market: All the avionics engineers in Thales Alenia Space
- Roadmap for Exploitation: Following successful CRYSTAL use case, an adoption plan will be setup will associated internal funding to prepare operational deployment (industrialisation, user support, training, ...)
- Expected availability for use: CRYSTAL solution will be deployed around 2017.

#### Expected Exploitable Result

- Description: Adoption of IOS principles by the European space community and CRYSTAL open source solutions based on Eclipse
- Business Case and Market: All the European space industrials and the different space agencies (ESA, French CNES, German DLR, ...)
- Roadmap for Exploitation: Several presentation of CRYSTAL results are foreseen during space conferences or workshops in order to present the interoperability approach, the open source Crystal tooling and the interest of it. The objective being to foster the European space actor efforts related to tooling towards a better cooperation on tools in order to reach together a stronger position.
- Expected availability for use: Dissemination already started, real adoption expected soon (2015).

#### **Corrective actions**

Not applicable.

### **3.2.9 WP 208 Public Use Case AEROSPACE (Lead: EADS IW-G)**

#### ***Project objectives for the period M1- M12***

The objective of this work-package is to specify and develop an aerospace use case whose data can be shared between all the CRYSTAL partners without Intellectual Property Rights (IPR) constraints. This includes definition of the use case itself, development of use case data, building of a System Engineering Environment (SEE) to support the use case, and assessment of SEE and bricks.

The focus of the reporting period M1 to M12 has been on the definition of the use case and on the development of the use case data. The objective was to define the public aerospace use case in such a way that it describes typical aerospace engineering challenges with respect to (tool) interoperability, and that it helps SP2 Use Cases refinement.

In addition, the WP objective of building of a System Engineering Environment has been partially addressed. The refined objective for this reporting period has been to perform a prototyping of IOS Concepts to refine and validate the feasibility and value of the CRYSTAL interoperability approach,

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	65 of 269

and to demonstrating parts of the CRYSTAL interoperability approach using a mix of partially integrated models.

### **Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

#### **Progress towards objectives**

The overall progress of WP208 towards the objectives is according to plan.

With regard to the objective of setting up the public aerospace use case, a first deliverable that describes this use case (D208.010) has been defined and sent to the JU. The deliverable contains a description of the use case perimeter (development of a de-icing system for a regional aircraft) as well as a specification of 12 Engineering Methods.

With regard to the objective of developing use case data, the following data has been defined so far:

- Requirement Artefacts: 208 Artefacts related to Requirements Management have been defined
- Architecture Management Artefacts: 1040 Artefacts for Architecture Management have been defined. These are mainly SysML model artefacts representing the functional architecture and behaviour of the System under Development
- Test case related artefacts: 25 Artefacts related to the test case definition have been defined.
- Physical Behaviour Models: One Simulink model and one Modelica Model have been defined to describe the creation of Ice on Aircraft components for a worst-case flight scenario.

With regard to the objective of building a System Engineering Environment, in collaboration with WP6.11, a first demonstrator based on the IBM SSE and RELM solutions has been developed and deployed at EADS Innovation Works in Hamburg. This demonstrator environment has been used to realize the Engineering Method "Change Impact Analysis". Also, the specification of a brick for connecting Open Modelica into the environment using CRYSTAL IOS concepts has been initiated. In collaboration with WP66, a first Open Modelica connector has recently been developed and included into the demonstrator environment.

With regard to the objective of supporting dissemination activities, WP208 results (especially the current demonstrator) have been presented at the following conferences:

- 2nd European Conference on Interoperability for Embedded Systems Development Environments, Stockholm, December 3<sup>rd</sup>, 2013
- Artemis / ITEA conference, Stockholm, December 4<sup>th</sup>, 2013
- EADS Systems-Engineering Forum; Marignane, December 12th, 2013

In addition, a video presenting the CRYSTAL approach by showing the current public aerospace use case demonstrator has been developed. The video is currently under review.

The statements of the individual partners of WP208 with regard to progress towards objectives are provided hereafter:

- EADS IW-G:
  - Leading of the Work Package, including organisation of progress meetings, writing of MoM, progress reports, etc.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	66 of 269

- Contribution to the writing of Deliverable D208.010
- Development of a first SEE Demonstrator
- Contribution to the definition of use case data (e.g. models).
- ALA:
  - Contribution to the definition of typical aerospace engineering methods with focus on process management, the interactions among ALM and PLM domains, SA/RMT Analysis and Configuration Management.
  - Provision, together with PoliTO, of a subject for Use case scenario, that is based on an Aircraft's De-Icing solution. Different possibilities are considered and modeled. During the period we started the functional modeling of these solutions, starting from a set of requirements we defined. These requirements and other data related to Aircraft's systems have been defined to be realistic.
  - We supported the realization of the first demonstrator for the Aerospace Public UC that has been presented at the Artemis IA Co-Summit in Stockholm in December 2013.
- EADS CAS:
  - Review of WP208 use case presentation.
  - Review of WP208 engineering methods.
  - Feedback on public use case aerospace demonstrator.
- EADS IW UK:
  - Iterative development of the connector for Open Modelica – simulation tool - to the current system engineering platform.
  - Development/deployment of a software solution to allow Semantic searches against the actual platform based on the principles of linked data
- Polito:
  - This WP is focused on the definition of an Anti-icing or De-icing System to be installed on a New Generation Regional Turboprop. To this purpose, during the first months of the project, a study of the state-of-art of the technology has been carried out. A lot of architectures have been proposed and evaluated. Among those solutions some looked to be applicable to the project goals as the pneumatic, thermoelectric, chemical and aero-thermic systems. All those systems were analyzed and for each proposed solution the possibility to install on several parts of the aircraft was explored. In particular, together with the other partners, it was decided to propose the anti-icing system to protect wing leading edge, tail surfaces, engines fairing and propellers. The following months were devoted to define the environmental model, to forecast the ice accretion during the different mission profiles. To this purpose, a Matlab ® model was built up. The pneumatic system has been selected as a first case study and a physical model has been drawn by using the Simulink® environment. In this model, the inflation and the deflation sequence for each boot has been simulated for the specific scenario foreseen by the inputs of the program. Accordingly to interoperability, being one of the main goals of the CRYSTAL project, the Simulink® model was built by taking into account its position in the tool chain that has been defined preliminarily.

### ***Tangible results***

The statements of the individual partners of WP208 with regard to Tangible results are stated hereafter:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	67 of 269

- EADS IW-G:
  - Support in the completion of Deliverable D208.010
  - Successful set-up a Demonstrator
  - Definition of significant amounts of Use Case Data (refer to chapter 2.1.1).
- ALA:
  - The first Demonstrator set-up that has been completed ahead of original schedule has been reviewed and supported.
  - The requirements relevant to the system being designed have been defined and provided.
  - The modelling activity at functional level has been performed.
  - The foreseen deliverable has been produced in order to describe the Use Case.
  - D208.010 has been delivered at M9.
  - Contacts with WP209 related to domain ontology and WP608 related to PLM Bricks has been established.
- EADS CAS:
  - Comment sheets for review of WP208 engineering methods.
- Polito:
  - A description of all the selected Anti or De-Icing Systems have been provided and a more detailed analysis was written in case of the Pneumatic System. The physical model built up by resorting to the Simulink®, allowed to size it properly, within an iterative process. Dimensions of the different boots are updated in a sensitivity analysis and results of simulation allow the user selecting the optimized solution and a suitable architecture. The Matlab® code, used to forecast the ice accretion upon several surfaces, provides an ice accretion profile, being an input for the physical model.
  - For the first Milestone, an interoperability simulator was implemented by EADS IW Germany, in Hamburg. Both the Matlab® code and the physical model were inserted for a further testing activity.
  - Results of this WP show that it is already at an advanced stage of its development, if it is compared to some other scheduled activity.

### ***Reasons for deviations***

One of the objectives of the Public Aerospace Use Case is to serve as a piloting use case on which CRYSTAL approaches should be applied, implemented and tested first. At the CRYSTAL Kick-off Meeting in Vienna on May 2<sup>nd</sup> and 3<sup>rd</sup>, CRYSTAL SP2 partners expressed the need to advance the prototyping activities in order to have a demonstrator illustrating the expected SP2 System Engineering Environments ready as soon as possible, if possible by the end of year 2013 (around M9).

Since the definition of a first WP208 SEE environment was initially foreseen for M20, a significant amount of additional effort had to be spent by WP208 leader (EADS IW G) in order to advance this prototyping activity.

### ***Reasons for failing to achieve critical objectives***

N/A

### ***Use of resources***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	68 of 269

The following table provides a comparison of planned effort per partner for the period M1 to M12 vs Actual consumption of effort as reported by partner:

Partner ID	Partner	M1 to M12 planned according to partner	M1 to M12 actual consumption as reported	Deviation
2	A-F	0,57	0,57	0
5	ALA	13,3	13,8	0,5
19	EADS-CAS	0,9	0,5	-0,4
20	EADS IW-G	4	12,5	8,5
22	EADS IW-UK	1,7	1	-0,7
46	POLITO	14,8	14,8	0
<b>WP208</b>	<b>TOTAL</b>	<b>35,27</b>	<b>43,17</b>	<b>7,9</b>

The effort has been spent to progress towards the objectives and to obtain the results as described in Chapter 2.1.1 and 2.1.2.

In total, more effort has been spent on WP208 than initially planned. This deviation is mainly due to the partner EADS IW G, who is leading this Work Package. The main reason for this deviation is the advancement of the SEE development activities as described in Chapter 2.1.3.

Only minor deviations have been reported by ALA, EADS-CAS and EADS-IW-UK with no impact on project objectives.

### ***Collaboration with other projects***

There has been an exchange of information of CRYSTAL WP208 members with members of the Artemis JU Projects CESAR and MBAT, as well as with members of the German national funded project SPES XT.

Various results of the CESAR project have been used as basis for CRYSTAL WP208. For example, the CRYSTAL WP208 Engineering Method "Analyse Requirements" has been defined taking into account the respective Requirements analysis scenario in the CESAR public aerospace use case. Also, the CRYSTAL WP208 Engineering Method "Trade-off Analysis" is inspired from the CESAR SP3 multi-viewpoint approach and architecture trade-off analysis method. Furthermore, the interoperability approach as defined in the CESAR Interoperability Specification has been used as a basis for the realisation of the connectors in the current WP208 demonstrator.

With regard to MBAT, an information exchange is ongoing between CRYSTAL WP208 and MBAT WP1.5 (Aerospace Use Case) and SP3 (MBAT Reference Technology Platform) to coordinate the definition of the public aerospace demonstrators in both projects.

The aim is to ensure that both Demonstrators rely on the same interoperability and platform approach; so that MBAT defined connectors could be deployed on the CRYSTAL Public Aerospace Demonstrator and vice versa.

With regard to SPES XT, some interaction has been established between CRYSTAL WP208 Leader and SPES XT EC2 (Optimal Deployment) and QT3 (Method and Tools) members. As for MBAT, the objective here is to ensure that both Demonstrators rely on the same interoperability

and platform approach; so that SPES XT defined bricks could be deployed on the CRYSTAL Public Aerospace Demonstrator and vice versa.

### ***Statement on the dissemination activities and exploitation perspectives***

WP208 partners have supported the presentation of CRYSTAL results at the Artemis / ITEA co-summit in Stockholm on Dec. 4<sup>th</sup> 2013 by presenting the WP208 demonstrator at the CRYSTAL booth. The CRYSTAL booth has been visited by several representatives of other Artemis JU projects, of ITEA projects, and also of some national funded projects.

WP208 partners have supported the following dissemination activities:

- EADS SE-Forum
  - EADS Systems-Engineering Forum
  - Poster Session
  - Eurocopter / Marignane / F
  - (EADS-Group-internal)
  - 12/12/2013
  - Uwe Kuehne
  - EADS-CAS
- Public use case demonstrator
  - Artemis / ITEA conference. Presentation and demonstrator jointly
  - 12/4/2013
  - Gray Bachelor
  - Alenia and EADS Airbus
- Interoperability in Aerospace Public Use Case of Crystal Project
  - 2nd European Conference on Interoperability for Embedded Systems Development Environments
  - 12/3/2013
  - Giovanni Antonio DI MEO
  - POLITO, EADS IW, ALA
- Artemis ICES (Innovative Centre for Embedded Systems) Poster presentation
  - 12/4/2013
  - Giovanni Antonio DI MEO
  - POLITO, EADS IW, ALA

In addition, a video presenting the CRYSTAL approach by showing the current public aerospace use case demonstrator has been developed. The video is currently under review.

### ***Corrective actions***

N/A

## **3.2.10 WP 209 Specifying Ontology AEROSPACE (Lead: EADS IW-F)**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	70 of 269



## ***Project objectives for the period M1- M12***

### **Objectives**

The objective of WP209 is to specify, illustrate and demonstrate the usages and potential benefit of a domain ontology in the IOS. The ontology aims to provide common, unambiguous semantics and vocabulary to facilitate interoperability between engineering tools in the aerospace domain, scoped by SP2 use cases. According to the JU Grant Agreement, the aerospace ontology WP is structured in four tasks; the two first ones being mainly concerned for the current M1-M12 reporting period.

- Task 2.9.1: State of the art and need analysis
- Task 2.9.2: Aerospace ontology definition
- Task 2.9.3: Aerospace ontology exploitation
- Task 2.9.4: Aerospace ontology evaluation

### **Deliverables**

According to the JU Grant Agreement, the deliverable for the first 12 month is the following:

- D209.010: State of the art. This document describes the best practices and the advanced methods and tools to treat the product data description in the aerospace domain, with particular focus on the relevant standards.

## ***Work Package progress and achievements during period M1-M12***

### ***Progress towards objectives***

Progress on the work of the work package is not as advanced as it had been planned. We are experiencing difficulties in reaching a common and agreed view on what should be done, especially in establishing clear work streams between application ontology (e.g. RBE ontology) and contribution to IOS (e.g. ICT interoperability). French consortium is also experiencing contractual issues that impact the effort level. Yet, to date, we consider this doesn't imply unrecoverable threats on project objectives.

To date, the State of the Art in domain ontology analysis has been completed and the first deliverable submitted on due date.

Since the aerospace domain ontology shall be scoped by SP2 use cases; part of the activity has been the follow-up of the use cases and especially the public use case, in order to help us think through the different types of dependencies that may exist between different model elements.

The Work Package has performed an expectation analysis, established links with the SP2 public use case, collected relevant documentation and standards based on the use cases in SP2, and started identifying sub-part of those standards relevant for the use cases.

The statements of the individual partners of WP209 with regard to progress towards objectives are provided hereafter:

- EADS-IW-F:
  - Leading of the Work Package, including organization of progress meetings, writing of MoM, progress reports, etc.
  - D209.010 contribution
  - Analysis of expectations regarding usage of a domain ontology within SP2 use cases - Questionnaire "Expectations for the aerospace domain ontology"

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	71 of 269

- Description of relevant existing standards and resources in aerospace domain and previous projects
- Start identifying subparts of standards relevant for SP2 and Public use cases
- Follow up of SP2 use cases
- Coordination with other SPs ontology WP to agree on a common position of domain ontology in IOS
- ALA:
  - Participation / contribution to WP209 WebEx meetings
  - Participation in the discussion about expectations for the aerospace domain ontology.
  - D209.010 Editor and contribution.
  - Contacts with WP208 in order to clarify different aspects including: data models for managing system functional views and traceability aspects
- EADS-CAS:
  - Participation / contribution to WP209 WebEx meetings
  - Contribution to discussion of link between Aerospace Ontology (WP209) and RBE Ontology (WP607)
- SAGEM:
  - Participation / contribution to WP209 WebEx meetings
  - Contribution to discussion of link between Aerospace Ontology (WP209) and RBE Ontology (WP607)
- POLITO:
  - Participation / contribution to WP209 WebEx meetings
  - Contribution to the state of the art for Semantic web technologies description (RDF, OWL an SPARQL).

### ***Tangible results***

The deliverable requested in the period M1 to M12 was submitted to JU:

- D209.010: State of the art Due date: M9
- Activities Report M9
- Activities Report M12
- WP209 Annual periodic report M12

### ***Reasons for deviations***

- There is sensible underspending in effort from EADS-IW-Fr partner with respect to the plans due to French contractual issues: no grant agreement from DGCIS to date (T0+12).



- ALA effort has been a bit higher with respect to the plans due to editing and contributing effort in D209.010; this will be balanced in the next period
- There is slight underspending in effort from partners involved in RBE topics compared to effort planned. This has only marginal impact considering the due contribution.
- A-F: no major deviations

### ***Reasons for failing to achieve critical objectives***

To date, we think that the observed deviations don't imply unrecoverable threats on project objectives.

### ***Use of resources***

The following table provides an overview of the planned and actual resources:

Partner No	Partner Short Name	Planned Efforts (PM)	Actual Efforts (PM)	Deviation
21	EADS-IW-Fr	6	3	-3
5	ALA	2.3	3.3	1
19	EADS-CAS	0.7	0.2	-0.5
48	SAGEM	0.4	0.2	-0.2
46	POLITO	5.5	5.5	0
2	A-F	6.3	6.3	0
	<b>Total</b>	21.3	18.5	-2.7

### ***Collaboration with other projects***

(none)

### ***Statement on the dissemination activities and exploitation perspectives***

(none)

### ***Corrective actions***

A closer link with SP6 and with the public use case is likely to foster quicker development of the domain ontology specification and development. There is currently an active contribution to scoping discussions with other ontology WPs and SP6 in order to clarify the role of the ontology in CRYSTAL, including its relationship with IOS.

## **3.2.11 WP 210 (2\_01b) Simulation for PRA (Particular Risk Analysis) (Lead: A-F)**

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

The objective of this use case is to put in place a modelling and simulation methodology that can support the particular risk analysis (e.g. engine and tyre burst, bird strike) that are led at Airbus in order to ensure the aircraft safety and to fulfil the aviation regulations requirements.

The purpose of the performed activity until month 12 was to establish as complete as possible a description of the use case intentions, application areas, questions, goals, and user community expectations.

This past activity has required careful coordination with evaluation and testing carried out by business users. This has necessitated an efficient and pragmatic organization. PRA use case key driver for innovation is to remove all existing showstoppers in safety aircraft design analysis as shown below.

Specific tasks at this stage has included a review of the internal documentation to identify application areas, specific question sets, and expected outputs. Discussions with Airbus program leaders and safety designer as the primary end user, researchers and model developers to prioritize question sets and goals.

Due to this complexity of the task and the targeted effort, an optimum has been reached for the WP 210 program based on a twofold approach.

- A top-down approach based on Aircraft program knowledge of the businesses and research maturity allowing the reduction of complexity by the federation and factorization of similar design process and modelling concepts.
- Followed by a bottom-up approach based on today safety designer allowing to elicit key modelling capabilities and related interoperability to be developed in order to maximize with regards to the effort, safety End to End simulation chain performance.

WP 210 performed activities breakdown is as follow:

#### Preparation of the Safety Business Requirement Dossier

The Safety Business Requirements Dossier documents the overall requirements for Safety design capabilities to be developed and evaluated within the CRYSTAL project. These requirements are based on an analysis of today aircraft process dedicated to PRA “Uncontained Engine Rotor Failure (UERF)” selected to represent a broad cross-section of safety lifecycle design needs in order to determine the outline of safety developments functionality requirements. This dossier under progress has been established through end users face-to-face interviews and common technical workshop. The Business Requirement Dossier contribution can be broadly classified into four items:

- Item 1 UERF process analysis: Carried out to evaluate the “As is” of UERF design context and detail key industrial expectation for innovative “To be” process based on CRYSTAL technology.
- Item 2 Aircraft program Modelling & Simulation (M&S) process breakdown: Carried out to analyze in detail the Aircraft program needs in terms of safety functionalities. E.g. dedicated safety “End to End chain” during systems architecture design phases.
- Item 3 Safety platform architecture: To break down business and functional requirements into modular functions, define information flows, and identify the most appropriate architecture solution that are consistent with business needs and the safety platform infrastructure constraints.
- Item 4 Use case & story board strategy: To specify document and model the WP 210 use case & related story board strategy from information obtained from interviews with the stakeholders. This activity aimed to show and quantify the ability of CRYSTAL capabilities to support the aircraft safety designer in building safety models.

### Preparation of the Safety Specification Dossier

The Safety Specification Dossier is the technical documentations for:

- Safety capabilities: All safety stakeholders have contributed to elaborate this Specification Dossier in order to set targeted capabilities.
- Use case platform integration: This task has been jointly performed and decided by IT leader (who elaborates and deploy that platform) and safety-leader (supporting with their knowledge/insight). Contributors have mapped requirements w.r.t. internal and CRYSTAL capability bricks. And set the roadmap for integration / validation of safety capabilities.
- Use case specification: The global objective is to assess the use case w.r.t. the CRYSTAL model-based multidisciplinary collaborative approach. The Use case specification Dossier intends to describe the testing strategy put in place and the way demonstration of criteria has been addressed on the basis of storyboards. To monitor progress towards its objectives within CRYSTAL it has been identified KPIs in order to check its true impact on business processes. It is expected to mainly analyse the overall efficiency of the new safety process compared to standard process.

### ***Tangible results***

This period focused on the UERF PRA process itself, and asks the team to consider the goals of their modelling activity w.r.t CRYSTAL project. This activity has provided outputs; and documenting detailed context of the final use case formulation. Next step is the consolidation of the use case data model, its related Conops (concept of operations) and the platform deployment.

### ***Reasons for deviations***

No deviations

### ***Reasons for failing to achieve critical objectives***

No failing of achievable objectives foreseen

### ***Use of resources***

No deviation between planned and performed use of resource

### ***Collaboration with other projects***

N/A

### ***Statement on the dissemination activities and exploitation perspectives***

Dissemination and exploitation activities are described in the "Reporting and Planning of dissemination activities" and the "Exploitation Plan".

### ***Corrective actions***

No actions

## **3.2.12 WP 211 (2\_01c) Fuel Management Risk Analysis (Lead: A-UK)**

### ***Project objectives for the period M1- M12***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	75 of 269

The Fuel System stores the fuel in a series of tanks allocated in the wings, horizontal stabilizer and/or fuselage. The fuel is redistributed between the tanks to ensure engine feed and other functions as lateral and longitudinal CG position modification.

In-tank equipment as sensor and fuel probes are provided for fuel quantity management and monitoring. The data is acquired and sent to the control computer, which provides control commands to in-tank valves and pumps to perform engine feed, fuel transfer, jettison or any other required function.

### Overall Objectives

1. Evaluation of multi-physic simulation of Fuel Management System within the Safety Analysis context.
  - a. Fuel management system function simulation - Required fuel feed supply to the engines, fuel quantity measurement and fuel distribution.
  - b. Build assertive models of programmatic and multi-physical components
  - c. Model-base safety analysis. Applying Particular Risk Analysis with respect to Uncontained Engine Rotor Failure (UERF) associated Failure Conditions, to generate fault trees and minimum cut sets with the impacted components including systems, sub-systems and system interfaces.
  - d. Control and indication interface integration in the flight deck
2. Assess technology bricks related to Fuel Management Risk Analysis use case.
  - a. Produce computational components
  - b. Compose candidate architectures
  - c. Predict behaviour and performance of candidate solutions based on simulation and formal proof activities.
3. Express architectures as a set of interconnected and interacting components
  - a. Produce IOS architecture: using IBM JAZZ platform to have the impact analysis on traceability features for the following Tool chain: DOORS, Rhapsody, Simulink, Dymola/Open Modelica.
  - b. The simulations and co-simulations will be targeted to use FMI platform.
4. Consolidate the interface and data exchange between vendor modelling tools.

### M1-M12 objective

According to the JU Grant Agreement included in Annex I , the deliverable for the first 12 month is list below;

D2.1.3.1: Fuel Management Risk Analysis use case description: this document will describe the generic use case: the system itself, the engineering activities considered and the tools chain envisaged to support this activity.

### *Work Package progress and achievements during period M1-M12*

#### **Progress towards objectives**

Fuel Management Risk Analysis use case description is submitted to JU on 31<sup>st</sup> March 2014.

In this document, we describe the Fuel system and associated architecture; focus on Fuel Quantity Management System. The Safety analysis for the impact of Uncontained Engine Rotor Failure (UERF), one of most critical Particular Risk Analysis is illustrated. Then we describe fuel function modelling and simulation process and safety model-based analysis process, the associated tools

chain to be developed in the frame of CRYSTAL. The engineering methodology is described as well. The more detailed information will be written in the next version of report.

First version of the use-case definitions is describing the associated technology bricks and the meta-model of the platform builder.

### ***Tangible results***

Fuel Management Risk Analysis use case description is submitted to JU on 31<sup>st</sup> March 2014.

- Detailed Description of the Use Case Process
- Define the model based safety methodology
- Identified primary Tools and Methods
- Modelling and Simulation for dysfunctional, functional, multi-physics architecture
- Initialize Interoperability platform between the Safety, Performance and Physical Models

### ***Reasons for deviations***

No deviation from Annex I

### ***Reasons for failing to achieve critical objectives***

No failing of achievable objectives foreseen

### ***Use of resources***

No deviation between planned and performed use of resource

### ***Collaboration with other projects***

The Fuel Management risk analysis use case is supporting the PRA use case led by Airbus France WP2.01b, the more detailed information about the PRA use case is available in document D210.010. It also provides input to WP601 (IOS Development) required to derive specific IOS-related requirements as well as input to WP602 (Platform Builder) required to derive adequate meta models.

### ***Statement on the dissemination activities and exploitation perspectives***

A demonstrator environment based on IBM Jazz platform with Airbus Group Innovations (EADS-IW) is identified. A number of types of operability have been considered.

- Integration of different types of data (Requirements, Design Model, Safety related data, etc.) managed by several tools to enable traceability related capabilities, such as search and query for data and data relationships, and change request impact analysis.
- Enabling co-simulation and heterogeneous simulation to improve system architecture trade-off analysis.
- Providing model management capabilities, such as configuration management and collaborative working on fine-granular levels for design, safety, and simulation models.

In addition, this project aims at realizing interoperability needs by defining an open and standardized Interoperability specification, which will be based among others on the emerging OSLC standard.

### ***Corrective actions***

Not applicable

### 3.3 Sub Project 3 – Automotive Domain (Lead: AVL-S)

#### *Project objectives for the period M1- M12*

##### Overview / SP Structure

The Sub Project SP3 – Automotive Domain consists of in total 9 work packages:

- 1 SP Coordination (WP300)
- 1 Public Use Case (WP307)
- 6 Company-specific Use Cases (WP301 – WP306)
- 1 Ontology work package (WP308)

In more detail:

WP	Title	Lead
300	SP3 Coordination - Automotive	AVL-S
301	UC – Function development for heavy vehicles	VOLVO
302	UC – Development of a safety related assistance system	DAIMLER
303	UC – Functional powertrain architecture & control development wrt. integrated system, safety and req. eng.	AVL
304	UC – Test case definition interlinked with model based requirement engineering. / Variant management	AVL
305	UC – ISO 26262 safety assessment and functional assessment for type of fluid changing in a climate controller	CRF
306	UC – OS MultiCore Compatible AUTOSAR & Safety Mechanism for ISO26262 compliance	VALEO-F
307	Public Use Case	ViF
308	Ontology Automotive	TU Berlin

#### Overall Objectives

The main objectives for the Automotive Domain are listed in the DoW, Part B – Technical Annex on page 85 f.

- To mature innovative techniques, methods and tools developed in other research projects in order to bring them to a level of maturity that are compatible with a pre-deployment in the European Automotive industry. The Technology Maturity Level (TRL) targeted is at least TRL5 at the end of the project, so that an industrial deployment on operational environment can be envisaged in the three years after the end of CRYSTAL.
- To create within the automotive industry a vocabulary based on ontology technology for improving data exchange and increasing competitiveness reducing rework and misunderstanding between aeronautics actors.
- To implement the interoperability concept based on the interoperability standard initiated in the frame of CESAR and enhanced in the current project.

### **(Common) Objectives for the period M1 – M12**

The first period M1 – M12 of the project is used to create a strong basis to fulfil the overall objectives listed above.

From the first overall objective the following (common sub-) objectives can be derived for the first period of the project.

- Definition/Description of the Company-specific Use Case in an appropriate level of abstraction.

The Company-specific Use Cases (System under development) provide the basis for the validation of the CRYSTAL results and the TRL assessment. The format of the definition/description depends normally on the Company-specific Development and –Documentation Standard, e.g. Specification, Requirements and Architecture.

If applicable additional material like models for the system under development or the simulation of the system environment has to be created.

On the other side the targeted Company-specific SEE that derives from the CRYSTAL RTP has to be specified. The

- Specification of the Company-specific SEE typically consists of
  - Requirements,
  - Architecture, including
  - Bricks (Tools), selected from the CRYSTAL Brick List.

In order to demonstrate the improvements based on the CRYSTAL bricks

- SEE demonstrators are set up. Typically these SEE demonstrators
  - Represent subsets of the specified Company-specific SEE's,
  - Are normally based on state-of-the art technology,
  - Can include bricks coming from
    - CESAR or
    - other R&T projects like MBAT but
  - Can also include new technologies developed in the frame of CRYSTAL.

Looking at the second overall objective the main (common sub-) objectives in the first year of the CRYSTAL project concerning

- Automotive Ontology are
  - State-of-the-Art and need analysis and
  - Strongly leaning on a domain independent Ontology definition.



The future improvements towards the second overall objective are based on this State-of-the-Art survey.

The Interoperability Standard IOS is for the automotive domain the most significant objective in the CRYSTAL project. This is clearly addressed in the third overall objective (see above).

Every work package (except the management work packages) has defined an initial set of their requirements (Engineering Methods) for the IOS and has handed over these requirements to SP6. For the first period of the project the

- Generation of (first) inputs for the IOS include
  - Significant push from the Automotive domain to establish a process that ensures all aspect from the Engineering Methods are considered within the IOS
  - Contribution to the definition and assessment of this process
  - Hand-over of defined (first) artefacts to SP 6.

In the Sub Project SP3 the assessment of the so-called "Interoperability Needs Capturing Process" was mainly done in the "Public Automotive Use Case (WP307)" and the first inputs/artefacts were based on engineering methods. The Public Use case within SP3 represents a central role within domain to which all Use Cases contribute in a way that various aspects of the V-Cycle are represented. Furthermore, the Public Use Cases acts as a forum to discuss and review the Domain specific needs for interoperability, verify that the CRYSTAL process is able to capture these needs and acts a link to other domains, including SP6, to assure an alignment of the IOS requirements is supports across the domains.

Currently the "Technical Management Process" is implemented in all the domains and the generation of inputs for the first issue of the IOS is in progress.

### ***Progress towards objectives***

In chapter "Sub Project SP3 – AUTOMOTIVE Domain" the overall objectives for the Automotive Domain as listed in the DoW, Part B – Technical Annex are refined for the first project period M1 – M12. The derived (common sub-) objectives that represent the pillars for SP3 in the first period of the project are:

- Definition/Description of the Company-specific Use Cases (UC-Def.)
- First version of the company-specific SEE specification (SEE-Spec.)
- First prototypical demonstrator (SEE-Demo.)
- State-of-the-Art of AUTOMOTIVE Ontology (Ontology)
- Generation of (first) inputs for the IOS (IOS Inputs)
- Definition of requirements for SP6 bricks (REQ)

The SP 3 work package leaders reported progress towards these objectives as indicated in the table below:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	80 of 269

WP	UC-Def.	SEE-Spec.	SEE-Demo.	Ontology	IOS Inputs	REQ
301	X	X	X	X	X	X
302	X	X	X	X	X	X
303	X	X	X	X	X	X
304	X	X	X	X	X	X
305	X			X	X	X
306	X			X		X
307	X	X	X		X	
308	N/A	N/A	N/A	X	N/A	

Please notice:

- The six objectives listed here are only the most common objectives of the domain.
- WP 308 is exclusively dedicated to Ontology – all partners have provided input to the state-of-the-art investigation for the AUTOMOTIVE ontology.
- WP 300 is not listed here, because WP 300 is dedicated to the domain management. Nevertheless, WP 300 has established the required processes in order to ensure the collaboration and harmonization within the AUTOMOTIVE domain and to improve the communication with other WPs. With this respect, WP 300 has been successful in the task of SP Quality Management.

More details concerning

- these common objectives
- Use Case- / WP-specific objectives

can be found in the WP 301 – WP 308 reports.

### **Tangible results**

Basically after the first period of the project there are three types of tangible results available:

- Deliverables
- Demonstrators
- Dissemination results

The table below provides an overview about the Deliverables and Demonstrators that were provided by the different work packages. The dissemination activities are described in Section 3.1.1

WP	Deliverables	SEE-Demo.
301	D301.010 Use Case Definition D301.021 Milestone Report - V1	<ul style="list-style-type: none"> <li>• Working OSLC connection between Simulink and SystemWeaver</li> <li>• Support for generation of AUTOSAR information from SystemWeaver.</li> <li>• ASL timing models available in DTFSim and Orca</li> </ul>

<b>302</b>	D302.011 Milestone Report - V1	<ul style="list-style-type: none"> <li>• Process model - no implementation so far</li> </ul>
<b>303</b>	D303.011 Milestone Report - V1	<ul style="list-style-type: none"> <li>• Initial AVL RQ-Management tool adaptations developed</li> <li>• Requirements mapping implemented in AsureSign tool</li> </ul>
<b>304</b>	D304.011 Milestone Report - V1	<ul style="list-style-type: none"> <li>• Prototypical OSLC connections are implemented for the tools AVL Creta, AVL Santorin, and HP QualityCenter</li> <li>• Prototypical implementation of requirement formalization for the WLTP emission legislation</li> </ul>
<b>305</b>	D305.011 Milestone Report - V1	<ul style="list-style-type: none"> <li>• Simulink and SysML models for the demonstrator have been developed</li> </ul>
<b>306</b>	D306.011 Milestone Report – V1	
<b>307</b>	D307.011 Milestone Report - V1	<ul style="list-style-type: none"> <li>• First demonstrator including PTC Integrity, Artisan Studio, and Simulink</li> </ul>
<b>308</b>	D308.010 State of the art for automotive ontology	

More details on the specific automotive use cases can be found in the WP 301 – WP 308 reports.

### ***Reasons for deviations***

The following table gives an overview about deviations from Annex I and their impact as reported by the SP 2 partners.

<b>WP</b>	<b>Deviation</b>	<b>Impact</b>
<b>300</b>	From 01.2014 the WP is led by EADS-Cas	None
<b>301</b>	No deviation	N/A
<b>302</b>	No deviation	N/A
<b>303</b>	No deviation	N/A
<b>304</b>	No deviation	N/A
<b>305</b>	No deviation	None
<b>306</b>	IOS Contribution not clear	No 1 <sup>st</sup> EM contribution for SP6
<b>307</b>	No deviation	N/A
<b>308</b>	Awaiting alignment with other Ontology WPs	N/A

There is one notable deviation from Valeo, this is due to some internal alignment issues on how to contribute to the CRYSTAL Project. The impact of this deviation is currently still considered as small as support from Infineon / Vif and AVL-S for Valeo is ongoing and because of the small WP consisting of Valeo and Elektrobit and quick and agile recovery is expected. The discussions about the focus of the Ontology work package (WP 308) are quite natural. It is expected to solve this without any impact on the overall project (refer to chapter "X.2.1.8 Corrective Actions").

### ***Reasons for failing to achieve critical objectives***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	82 of 269

No partner reported any failed critical objectives. Consequently there is no impact.

WP	Failed critical Objectives	Impact
300	None	N/A
301	None	N/A
302	None	N/A
303	None	N/A
304	None	N/A
305	None	N/A
306	None	N/A
307	None	N/A
308	None	N/A

### **Use of resources**

The following table gives an overview about the use of resources, deviations from the planning (if any) and the expected impact as reported by the SP 3 partners.

WP	Planned vs. Actual Effort	Main Reason(s)	Impact
300	90%	N/A	N/A
301	103%	N/A	N/A
302	102%	N/A	N/A
303	93%	N/A	N/A
304	97%	N/A	N/A
305	110%	N/A	N/A
306	78%	N/A	N/A
307	79%	N/A	N/A
308	80%	N/A	N/A

As a summary it can be said, that the use of resources is good and in line with the progress and deviation reported above.

### **Collaboration with other projects**

The following table gives an overview about the related projects that are mentioned by the SP 3 partners in their work package reports.

WP	CESAR	MBAT	EMC2	ATESST	VARIES	NETAP	VETESS
301	X	X	X	X		X	X
302	X	X					
303	X	X	X		X	X	X

304	X	X	X	X	X
305	X				X
306					
307	X		X		X
308	X		X		

### **Statement on the dissemination activities and exploitation perspectives**

The following table gives an overview about the dissemination activities and exploitation perspectives explicitly listed in the work package reports of the partners.

WP	Dissemination	Exploitation
301	CRYSTAL interoperability challenges and solutions were presented at "Elektronik I Fordon" in Gothenburg, Sweden, April 8-9 2014	In terms of the use case we are working close to the product development organization at Volvo Trucks and have very good channels to introduce CRYSTAL results in the actual development process provided that the results are mature enough. In fact, some of the desired tool connections that are described in the use case are already being implemented although currently using proprietary interoperability solutions (e.g. Simulink-SystemWeaver).
302	Planned after M12	-
303	<p>Synergien in der Modellbasierten Antriebstrang- und Testsystementwicklung: <a href="http://www.vdi-wissensforum.de/de/nc/angebot/detailseite/event/01TA502014/">http://www.vdi-wissensforum.de/de/nc/angebot/detailseite/event/01TA502014/</a></p> <p>Synergien in der Modell-basierten Antriebsstrang- &amp; Testsystem-Entwicklung - Virtual Vehicle Magazine: <a href="http://www.v2c2.at/news-media/vif-magazine/">http://www.v2c2.at/news-media/vif-magazine/</a></p> <p>Requirements Engineering meets System Design: Tag des Systems Engineering: <a href="http://www.tdse.org/">http://www.tdse.org/</a></p>	-
304	Publication with UC partner CTH about the requirement formalization of the WLTP emission legislation standard with a proposed tool chain set-up to automate requirement validation.	-

305	CRF internal Trainings of Electronic Engineering Master students at University of Genoa,	Training for teachers, trainers, workers, and MSC students
306	Valeo internal	new design standards and multicore development training for Valeo
307	<p>“Crystal - Durchgängige Entwicklung sicherheitskritischer Systeme“ In Virtual Vehicle Magazine: <a href="http://www.v2c2.at/news-media/vif-magazine/">http://www.v2c2.at/news-media/vif-magazine/</a></p> <p>“Co-Simulation and the Functional Mockup Interface”, Presentation at 2nd European Conference on Interoperability for Embedded Systems Development Environments</p>	-
308	Not yet planned	Not yet planned

Most of the partners stated, that they planned more dissemination activities and exploitation perspectives in the later phases of the project.

### **Corrective actions**

The following table gives an overview about necessary corrective actions that are expressed by the SP3 partners.

All actions are considered minor corrective actions.

WP	Corrective Actions
300	N/A
301	N/A
302	N/A
303	N/A
304	PTC: Intensify discussion on needs of engineering methods with IOS applicability
305	DITEN: Increase in MM expenditure, without increasing the budget.
306	VALEO: A meeting with SP 3 Domain Lead is planned to agree on report content
307	N/A
308	TUB: Supporting the discussions about the role of the domain ontologies.

### 3.3.1 WP 301 (Lead: VOLVO)

#### ***Project objectives for the period M1- M12***

The objective of this work package is to realise and implement a use case from Volvo, which focuses on function development in heavy vehicles. The use case is based on the tools currently in use within Volvo, or on tools that fill certain near-future needs in Volvo's current development environment. The implemented and integrated systems engineering environment will then be applied and validated on data from the development of an adjustable speed limiter function for trucks.

The objectives for the reporting period have been the following:

- To detail the development process in terms of current and desired work flow, involved tools and work products.
- To establish constructive collaboration among the partners involved in the use case.
- To identify the different interoperability challenges included in the use case e.g. traceability and data exchange needs.
- To get hands-on experience on the OSLC standard and how it can be applied in the context of the use case.

#### ***Work Package progress and achievements during period M1-M12***

##### ***Progress towards objectives***

##### Detailing of the use case

The use case description has been detailed by Volvo in discussion with the partners in order to ensure that the work flow is complete and that the role and place for each tool in the flow is clear. The description particularly emphasizes the data entities that are expected to be linked or exchanged among the tools. This is further described in the engineering methods which have been provided as input for SP6. It is expected that the use case description will be updated during the next reporting period as we will continue to refine and implement the desired interoperability functionality.

##### Constructive collaboration

To make the collaboration concrete, we are applying the work flow and tool interoperability described in the use case on an example system called "adjustable speed limiter" (ASL). This means that a separate repository has been set up where real product data (e.g. models, code, documents) related to the example system can be accessed and used by all use case partners. An important part of the repository is a SystemWeaver server containing the majority of the design information associated with the ASL function. In addition we have received tool installations from several partners to elaborate on (i.e. Systemite, AIT, ArcCore).

##### Interoperability challenges

Based on the use case description we have started to look closer at the interoperability challenges involved in order to identify the different types of interoperability that needs to be addressed. The basic types identified so far are traceability (linked data) and data exchange (model generation). The partners have then investigated these types of interoperability for different parts of the use case. For example, Systemite has investigated model generation from SystemWeaver to Simulink and (together with ArcCore) from SystemWeaver to ArcticStudio. AIT and OFFIS have investigated how to model the timing related information that is available in SystemWeaver in DTFSim and Orca. Arcticus has investigated how to map EAST-ADL models to their internal Rubus format.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	86 of 269



Chalmers and AIT have investigated how the functional requirements and test information in SystemWeaver can be used for formal verification and test case generation respectively.

### Hands-on OSLC

OSLC may be an enabler for improved interoperability but since the standard is new and evolving we have little experience of it. We have therefore made prototyping activities based on existing examples in order to progressively expand our knowledge. So far this has resulted in that we have been able to implement an OSLC connection between Simulink and SystemWeaver such that requirements in SystemWeaver can be linked to blocks in Simulink. We will continue to implement OSLC connections for the other tools involved in the use case. The knowledge and software produced is shared among the use case partners in order to facilitate OSLC implementations in the different tools.

### ***Tangible results***

- SystemWeaver database with engineering information for ASL.
- Engineering methods provided for SP6.
- Detailed description of the use case in deliverables D301.010 Use-Case Definition and D301.021 Milestone Report – V1.
- OSLC connection between Simulink and SystemWeaver allowing linking of requirements in SystemWeaver to Simulink blocks.
- Support for generation of AUTOSAR information from SystemWeaver.
- ASL timing models available in DTFSim and Orca.

### ***Reasons for deviations***

N/A

### ***Reasons for failing to achieve critical objectives***

N/A

### ***Use of resources***

No significant negative deviations. However, one tool partner in our use case (Verum) was unfortunately declared bankrupt in December 2013. We are currently working on a solution where IBM NL through sub-contracting of IBM Haifa is able to take over Verum's contribution to our use case. Since the tool support offered by Verum is included as an extension (or complement) of the existing work flow, the impact of the bankruptcy is small.

### ***Collaboration with other projects***

Synergies with ARTEMIS project MBAT (Model Based Analysis and Test) exist since both Volvo and AIT are part of MBAT. Due to that MBAT also addresses OSLC and interoperability, and has been running for more than two years, we have been able to use results and experiences from MBAT as input for our work.

### ***Statement on the dissemination activities and exploitation perspectives***

#### Dissemination

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	87 of 269

CRYSTAL interoperability challenges and solutions were presented at “Elektronik I Fordon” in Gothenburg, Sweden, April 8-9 2014.

### Exploitation

There are several projects that are looking into interoperability based on OSLC (e.g. iFEST, MBAT, CRYSTAL) which implies that the critical mass needed to achieve de-facto standardization may soon be reached. There are however important aspects of interoperability such as versioning and data storage that may be too weakly supported by OSLC to allow full replacement of existing tailored solutions.

In terms of the use case we are working close to the product development organization at Volvo Trucks and have very good channels to introduce CRYSTAL results in the actual development process provided that the results are mature enough. In fact, some of the desired tool connections that are described in the use case are already being implemented although currently using proprietary interoperability solutions (e.g. Simulink-SystemWeaver).

### **Corrective actions**

N/A

## **3.3.2 WP 302 Development of a safety related assistance system (Lead: Daimler)**

### ***Project objectives for the period M1- M12***

The objectives of this SP3 use case are to define SP6 requirements on a user level derived of a “Daimler development project” and the evaluation of the SP6 results implemented in a prototype application in the project context.

For this reporting period the focus of the work package was deduct and specifying the engineering methods for the Daimler development project. For that the target process with methods and tools has to be defined.

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

WP3.2 completes the model for the development process, which describes all tasks including input/output. The work products are mapped to responsible tools. The interoperable tasks are identified and the main engineering methods are deduct about the tasks. The engineering methods are specified and documented in the given template.

DAIMLER	<ul style="list-style-type: none"> <li>- WP leader, coordinates activities in the WP</li> <li>- Provide the use case(development project)</li> <li>- Provide target process</li> <li>- Review for D304.011, D308.010 and D610.031</li> </ul>	D302.011 D307.011 D308.010 D610.031 - Contents contribution
TUB	<ul style="list-style-type: none"> <li>- Contribution and review D302.011</li> <li>- Conceptual work, engineering methods</li> </ul>	D302.011 - Contents contribution
ALU-FR	<ul style="list-style-type: none"> <li>- Contribution D302.011</li> <li>- Conceptual work, data model</li> </ul>	D302.011 - Contents contribution

ITKE	<ul style="list-style-type: none"> <li>- Contribution D302.011</li> <li>- Tool expert for Enterprise Architect and Simulink</li> </ul>	D302.011 - Contents contribution
PTC	<ul style="list-style-type: none"> <li>- Contribution D302.011</li> <li>- Tool expert for Integrity</li> </ul>	D302.011 - Contents contribution

**Tangible results**

Model of process. Mapping of work products to responsible tools in the model. Identification of interoperable tasks and engineering methods. Specified engineering methods.

**Reasons for deviations**

No deviation from Annex I.

**Reasons for failing to achieve critical objectives**

No failing of achievable objectives foreseen.

**Use of resources**

There is slight underspending in effort (22MM) compared to effort planned (24MM).

**Collaboration with other projects**

Not applicable

**Statement on the dissemination activities and exploitation perspectives**

Not applicable

**Corrective actions**

Not applicable

### 3.3.3 WP 303 Functional powertrainarchitecture & control development wrt. integrated system, safety and req. eng. (Lead: AVL)

**Project objectives for the period M1- M12**

The overall objective of this work package is to realise and implement the use cases from AVL, which focuses on integrated system, safety & requirements engineering within automotive powertrain and control development. The use case is based on the tools currently applied within AVL, as well as on tools that are considered for current and future oriented development environments.

The objective concerning the use case content is to increase quality and efficiency of powertrain systems & safety activities by applying model based systems engineering (MBSE) based on the defined Use Case of AVL. These activities cover the development process in respect to requirements engineering and systems design/analysis, the support of discipline specific development activities, as well as the integration and validation of the system under development. In order to reach this objective, existing (and emerging) methods and tools to support MBSE must be brought to a maturity level that can be applied/rolled-out in an industrial environment and integrated to tool chains to support users in terms of engineering and support activities.

Within the period M1-M12 the main objective of the work package was to detail the use case. This is done by a clear and detailed definition of the use case framework as applied within AVL, as well

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	89 of 269

as taking aspects concerning relevant engineering methods and bricks from the use case partners into consideration.

In order to provide required information to WP6, the following objectives were defined:

- Description of Use Case and System Development Process incl. process activities and deliverables
- Identification of engineering methods and detailed description of selected engineering methods
- Definition of initial interoperability requirements incl. development and description of demonstrators
- 

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

AVL:

Use Case Framework and Process defined. Use Case details defined in terms of:

Task 1 - Collect RQ's:

- Description of system development & according context for UC
- System development activities of UC
- Deliverables resulting out of system development

Task 2 - Prototyping IOS Concepts:

- Development / engineering methods applied
- Detailed description of selected engineering methods incl. handover to WP6
- Initial interoperability needs/requirements for IOS/RTP defined

Task 3 - Building SSE:

- Definition of initial concept for Interoperability Demonstrator for SysML/RQ-Management tool (Artisan Studio & Integrity) - ongoing
- Definition of required RQ-Management tool adaptations (Specification Domain) - ongoing

Task 4 - SEE and Brick assessment:

- Initial review of first draft of Interoperability Demonstrator to assess usage potential and benefits to be gained in industrial environment
- Initial review of AVL RQ-Management tool adaptations

AIT:

Elaboration how AIT's tool, WEFACT could be best applied in AVL use case.

AVL-S:

Within this work-package, AVL Schrick has been supporting 01\_AVL. Within this reporting period a start has been made to pilot the Model Based System Engineering Methodology real customer project. Starting with the definition of the Engineering Methods (Requirement engineering, SYSML Modelling), the MBSE Methodology has been refined considering the overall CRYSTAL goal of an interoperable tool-chain. The engineering methods are described such that the tool vendors within the consortium understand how interoperability could support our Use Case.

Training at AVL-S has taken place in order to align the MBSE methodology, PTC Integrity environment and the SYSML environment with the pilot projects objectives.

The PTC Integrity environment has been setup and is currently in use within the pilot project. The modelling work with SYSML has been started

**FhG:**

Tailoring of the C2FT approach with respect to use case 3.3: C<sup>2</sup>FTs are safety analysis models that are tightly integrated into system models. The general C<sup>2</sup>FT approach is applicable to different kinds of system models. It can be applied to the functional architecture model, the technical architecture model and other models. However, the concrete application of the C<sup>2</sup>FTs approach depends on the system model. This means that the approach for constructing C<sup>2</sup>FTs has to be tailored to the considered kind of system models.

**IFX-UK:**

We are working on the Variation management within the 3.3 automotive use-case. Currently we are analysing the state of the art solutions being used. We have also been in discussion with the avionics group to see their proposed solutions also. For our solution we started by implementing a central database solution but alternate tooling and an issue with moving the data from one database to another is leading us to drive an API direct access solution for the data instead on asureSign for the Data Analyser Dashboard  
Collaboration with TVS on the asureSign tool to detect over and under engineering across different domains - pre-silicon IP, Pre-silicon SOC, post silicon validation (IP and SOC), PTE and SW

**VIF:**

The focus in the first period of the project has been the elicitation of requirements for this use-case. This resulted in two clearly defined tasks. The first one will cover the definition of a concept for the mapping between different structural representations. This means that there is a semantical and syntactical gap between functional and product-centric representations. The second task is concerned with the semi-formalization of requirements, which can then be used to generate a first basic part of the system architecture in SysML. The main development will be done in Brick B3\_7 and B3\_1.

**PTC:**

USE case framework, process, initial interoperability needs for use case identified

***Tangible results*****AVL:****Task 1 - Collect RQ's:**

- Process for system development & according context for UC described
- System development activities of UC defined and described
- Deliverables resulting out of system development identified and documented

**Task 2 - Prototyping IOS Concepts:**

- Development / engineering methods applied in system development identified and described
- Detailed description of selected engineering methods developed and aligned with UC partners
- Initial interoperability needs/requirements for IOS/RTP defined and aligned with UC partners
- Required Adaption of AVL RQ tool configuration defined and aligned for RQ Management tool (Integrity)

**Task 3 - Building SSE:**

- Initial concept for Interoperability Demonstrator for SysML/RQ-Management tool (Artisan Studio & Integrity) developed and discussed

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	91 of 269

- Initial AVL RQ-Management tool adaptations developed

#### Task 4 - SEE and Brick assessment:

- First draft of Interoperability Demonstrator analyzed
- First AVL Integrity configuration adaptations reviewed and changes documented

#### AIT:

T1: Contribution to reports and deliverables for the AVL use case

#### AVL-S:

Defined engineering methods describing the workflow and data exchange within the Use Case.

The MBSE method is ready for deployment at AVL-S.

By applying the MBSE method to a pilot project a clearer picture of the workflow and dataflow is visible within the pilot project which will lead at a later stage to a refinement of the engineering methods based on real-life project data and work flow experience.

The created models in SYSML and datasets in PTC Integrity are ready to be used as an example for testing IOS-enable tools

#### FhG:

- Description of the (use case 3.3 tailored) C2FT's approach (M9 deliverable)
- Example" Functional model of a power train with related C2FT's" : This document describes an example for modelling component-integrated component fault trees (C2FT's). The example was set up to
  - get a common understanding concerning elements in the functional architecture,
  - discuss the practicability of the C2FT modeling approach for use case 3.3,
  - discuss in how far the information that is required for modelling C2FT's is provided by models that are created in use case 3.3,
  - discuss which of the information that is given by the C2FT models is used in the use case 3.3.

#### IFX-UK:

Presentations and analysis of the issues is on-going. The basic database solution is under development within Infineon currently .

The asureSign tool now implements all the requirements mapping as requested and is currently being rolled out within Infineon, on-going improvements are being supervised, Training given and documentation produced. Also some webinars are also being advertised within the consortium and also within VeTess and other external groups.

#### VIF:

There is currently a first prototype of the requirements semi-formalization tool.

#### PTC:

first Demonstrator for System - and SW design and its management, requirements for interoperability identified

### **Reasons for deviations**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	92 of 269

**IFX-UK:**

Originally a model based RE flow was suggested within this use-case. This was analysed and rejected as a result of the VeTess project. The work is being replaced with analysing and producing a boilerplate to support a Natural Language semi-formal notation solution as highly recommended by the ISO26262 standard for ASIL-C and D safety requirements.

***Reasons for failing to achieve critical objectives******Use of resources*****AVL:**

AVL resources for this WP used in order to define UC content, create organizational awareness of topics, define & detail methods, tools and processes covering UC content. Use of AVL resources in PM's to be consolidated provided by AVL project management (outside scope/responsibility of WP leader @ AVL)

**AIT:**

Efforts Planned: 1 PM; Efforts Actual: 0,5 PM; Resources were needed to become common with the AVL use case and prepare AIT's contribution to WP deliverables.

**AVL-S:**

Effort Planned: 10,89 PM; Effort Actual: 11,51 PM

**FhG:**

Efforts Planned: 2 PM

**IFX-UK:**

Efforts Planned: 5,2 PM; Efforts Actual: 5,2 PM; Time spent on analysing current solutions trialling the KID and DAD design solution into the current flow and extrapolating all the required data that is required for storage. Review and re-planning to move onto API work with asureSign as a more optimum solution.

**VIF:**

Efforts Planned: 5,64 PM; Efforts Actual: 4 PM; The actual use is lower than planned, because of the linear project planning. The implementation will need more ressources than the definition of requirements. This means that more efforts will be used in the last phase of the project.

**PTC:**

Efforts Planned: 1,4 PM; Efforts Actual: 0,6 PM;

***Collaboration with other projects******Statement on the dissemination activities and exploitation perspectives***

ID	Title	Event / Dissemination Channel	Dissemination Type	Date	Partner



21	Co-Simulation and the Functional Mockup Interface	2nd European Conference on Interoperability for Embedded Systems Development Environments	Presentation	03.12.2013	VIF
49	Synergien in der Modellbasierten Antriebstrang- und Testsystementwicklung	<a href="http://www.vdi-wissensforum.de/de/nc/angebot/de/tailseite/event/01TA502014/">http://www.vdi-wissensforum.de/de/nc/angebot/de/tailseite/event/01TA502014/</a>	Article (not journal paper)	18.11.2014	VIF, AVL
50	Synergien in der Modell-basierten Antriebsstrang- & Testsystem-Entwicklung	Virtual Vehicle Magazine: <a href="http://www.v2c2.at/news-media/vif-magazine/">http://www.v2c2.at/news-media/vif-magazine/</a>	Article (not journal paper)	15.05.2014	VIF, AVL
51	Requirements Engineering meets System Design	Tag des Systems Engineering: <a href="http://www.tdse.org/">http://www.tdse.org/</a>	Presentation	12.11.2014	AVL
52	Intelligent testing Conference	Presentation on Intelligent Requirements engineering - CRYSTAL mention on improving tool interaction	Presentation	16.10.2013	IFX-UK
53	mails and linkedin	many mentions with IFX Munich and Villach in relation to the project. Also many ongoing external discussions on linkedin also relating to work being done under CRYSTAL	Social Media / Website	08.04.2014	IFX-UK
54	Example for modelling C2FT's in the Use Case 3.3	The example was set up to explain the use case owner how the C2FT approach can be used in the use case and to discuss the practicability of C2FT for the use case.	Others	09.04.2014	FHG

**Corrective actions**

Not applicable

### 3.3.4 WP 304 Test case definition interlinked with model based requirement engineering / Variant management (Lead: AVL)

**Project objectives for the period M1- M12**

WP3.4 is divided by two sub use cases UC3.4a and UC3.4b. Both sub use cases have some overlapping fields and will be combined to an overall use case. The objective of these sub uses cases according the DOW was to increase quality and efficiency of powertrain system engineering activities

- by applying model-based requirement engineering (AVL, UC3.4a)

- by applying requirements engineering as defined by AVL-R (UC3.4b) with increased automation of test case generation and simulation model variant management.
  - This use case is extended by the areas of integration of a System-of-Systems (SoS) platform, and the creation of an integrated tool environment
- Both UCs have in common to enable straightforward simulation model exchange on basis of the IOS specification

Currently many steps in these activities are done manually, e.g. creating simulation models separate for different purposes, adapting them for several variants, compiling and composing them for a certain test case scenario. In addition, requirements are either defined implicitly within the models or are only loosely coupled with a requirement management tool. These implicit or loosely coupled requirements do not enable automated verification of these requirements within a certain V-model.

Thus, the major objective of this work package is to provide an integrated requirement management and verification approach as well as integrated variant management and test case generation. This is done by coupling the appropriate tool chains with the IOS Specification developed within the CRYSTAL project and apply corresponding methods to ensure these major objectives.

Due to an improved interoperability of modelling/simulation tools, however, the current situation is considered to be improved significantly. Modelling/simulation environments could exchange or link data by applying well defined interfaces and services.

Consequences of are:

- An improved degree of automation
- A reduced set of development overhead
- Project collaboration becomes more straightforward

In addition to interoperability aspects, a centralized model management environment (e.g. a model backbone) enables further advantages such as versioning and variant management, single point of source, etc. and will also integrate the two sub use cases to an overall use case (e.g. by sharing simulation models)

### ***Work Package progress and achievements during period M1-M12***

This section gives details for each work package the work performed and progress achieved.

#### ***Progress towards objectives***

- Overall UC objectives
  - Separation of sub-use-cases done as well as definition the commonalities and interaction points of both use cases. Internal workshops of the UC leaders AVL and AVL-R are done regularly to involve people in the UC definition phase and increase the impact of the planned use case (AVL and AVL-R).
  - First concepts of the overall objective of simulation model exchange on the basis of OSLC are developed (AVL and AVL-R).
  - The activities in WP3.4 regarding model-based requirement engineering were monitored and aligned to activities in SP6 appropriately (support by OFFIS, CTH, VIF, TUG, TTTech, FhG).
- UC3.4a (lead: AVL)

- Definition of UCs for the first project period is finished. Regular meetings (internally of the UC leader AVL and externally with the project partners) were coordinated (AVL, AVL+R, support by all remaining WP partners).
- Definition of engineering methods and embedding them into the public use case (so-called harmonized interoperability challenges) (AVL, FhG, IST)
- The partners currently work most on the topic of requirements engineering and IOS Concepts. For that reason, AVL has invited twice for a requirement engineering workshop with the additional focus on OSLC (AVL in collaboration mainly with FhG, CTH, VIF, TUG, OFFIS, PTC).
- The discussion has led to a deliverable, with an extensive use case description and the development of corresponding engineering methods, whose implementation is started in order to progress towards the use case objectives of model-based requirement engineering (AVL, AVL-R).
- For model-based requirement engineering requirement formalization has been considered as a major challenge. In the use case, requirements formalization will be addressed by integration of emission legislation using the example WLTP. The creation of first prototypes of requirement formalization for the WLTP emission legislation is coordinated by AVL and aligned with the activities of UC partners (AVL, FhG, CTH, VIF, TUG, OFFIS).
- Coordination of IOS Tool integration to connect the various aspects of the requirement formalization will be the next step here (direct result of the requirement workshops (AVL, FhG, CTH, VIF, TUG, OFFIS).
- Furthermore, AVL is currently coordinating prototyping IOS concepts according to the use case definition for the tools AVL Creta, AVL Santorin and HP Quality Center. First concepts for integrating AVL Cruise/Boost, AVL VeVaT/Magic and PTC Integrity (regarding AVL-R activities), Atego ArtisanStudio are developed as well (collaboration with VIF, FhG, CTH, TUG).
- Planned use case extension by AVL in collaboration with TUG and VIF: Definition and refinement of an internal requirements formalization language for synchronous systems. The language is used within the recently developed tool MoMuT::REQs, to formalize requirements and enable an automated analysis and test case generation procedure. The tight coupling of requirements and test cases also enables a very high grained traceability between the work products.
- UC3.4b (lead AVL-R)
  - Model Exchange and Integration of a System-of-systems (SoS) platform.  
To improve the quality of these control system models, proper simulation models of the plant and the physical vehicle behavior enables development frontloading. For vehicle simulation, AVL-R is using the simulation environment AVL BOOST RT. In addition the imported AVL BOOST RT have to be integrated and configured in the versatile System-of-systems (SoS) platform where different hardware or software systems to create a new execution environment. The current activity is focus on the synchronization of the Part one from AVL to exchange the data from there test and Data backbone. In Addition, AVL-R is synchronizing with TTTech to use the exchanged model in the SoS-Platform
  - Integrated Tool environment.  
The interconnection between several tools and their interoperability capabilities and the integrated tool environment (AVLab) is currently realized in a not standardized way and has to be improved. For an improvement it has to be analyzed about an

IOS implementation. Currently we are in the definition phase of the usage of IOS for our integrated Tool environment (collaboration with PTC, VIF).

- Variant management:

The main part of this use case is to improvement with variability/variant management concepts. Regarding this, there has also been a first phase to understand the challenges of the use case. In the second phase we started to specify the requirements. This process is currently on-going. (collaboration with PTC, VIF)

- 

### **Tangible results**

- Overall UC

- Use case definitions are well documented in form of corresponding deliverables. Workshop and meeting results are documented by corresponding meeting protocols. Use Case Definitions are well communicated and supported inside AVL/AVL-R and are well coordinated and aligned with the WP partners activities.

- UC3.4a

- Definition of engineering methods and harmonized interoperability challenges (AVL, FhG)
- Analysis of the WLTP standard and development of architectural modeling structure based in this analysis (FhG).
- First prototypes of requirement formalization for the WLTP emission legislation are implemented by the project partners VIF, CTH, FhG and were supported by AVL, OFFIS and TUG by several coordination, consulting and review activities. This includes a concept for model transformation about generating SysML elements based on formalized textual requirements and an initial setup for a controlled experiment comparing three different formalization techniques (MSD, FSP, Boilerplate via DSL)
- In order to provide an integrated tool chain for model-based requirement engineering, the provided solutions need to be integrated. Currently, the partners are coming up with first tool integration prototypes and concepts (AVL, VIF, CTH, FhG, TUG)
- According to the use case definitions, IOS prototypes are implemented for the tools AVL Creta, AVL Santorin and HP QualityCenter in form of OSLC adapters. These adapters are already applied in first experimental integrated tool chains based on the use case definitions (AVL, VIF, IST).
- Concepts for such OSLC adapters are already available for AVL Cruise/Boost, AVL VeVaT/Magic, PTC Integrity and Atego ArtisanStudio. These concepts are partly developed in collaboration with the WP partners (AVL, PTC, FhG, CTH, IST).

- UC3.4b

- Definition of engineering methods has been completed (AVL-R, PTC, TTTech).
- Model Exchange and Integration of a System-of-systems (SoS) platform  
First investigation results of the applied simulation model and the needed HW. Concepts for adaptations in the proposed hardware and in the content of the model have been created (AVL-R, TTTech).
- Identification of use case driven requirements for the IOS and collection & communication of these requirements to the IOS related work packages (AVL-R)

- Integrated Tool environment  
First concepts about the usage of IOS especially for model exchange (AVL, AVL-R, VIF, PTC).
- Variant management  
Enhancing the current implementation of AVL with additional requirements to accelerate the development process. (AVL-R, PTC, VIF)

■

### ***Reasons for deviations from Annex I***

- UC3.4b:
  - Focus change from requirement engineering to variant management without any change in other tasks or in the basic project planning (the next milestone M20 will be kept, see also Section 0)

### ***Reasons for failing to achieve critical objectives***

- UC3.4b:
  - Delayed prototype development will be compensated via an AVL-R internal resource shift. Results will be delivered in M20.

### ***Use of resources***

- UC3.4b related issues:
  - Due to a longer use case definition phase compared to the original plan, especially efforts for implementation are shift to a later period in the project. In this later period, a higher amount of efforts is now planned and is expected to compensate the current deviation.

### ***Collaboration with other projects***

- UC3.4a:
  - MBAT project: Information flow has happen especially in the area of requirements validation and verification as well as on tool interoperability in the realm of requirement engineering (collaboration with TUG).
  -

### ***Statement on the dissemination activities and exploitation perspectives***

- UC3.4a:
  - Publication with UC partner CTH about the requirement formalization of the WLTP emission legislation standard with a proposed tool chain set-up to automate requirement validation.

### ***Corrective actions***

N/A

## **3.3.5 WP 305 ISO 26262 safety assessment and functional assessment for type of fluid changing in a climate control (Lead: CRF)**

### ***Project objectives for the period M1- M12***

The project objectives were focused on the use case definition and engineering environment description for the application of a new climate system with a safety relevant modification due to the use of a toxic and flammable refrigerant fluid.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	98 of 269

---

**Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

**Progress towards objectives**

The activity was focused on the description and modelling of the use case and its engineering environment, aiming to identify the main interoperability challenges for the IOS specification, both in relation to the actual use case and to the more general aspects involved in the definition of the common automotive use case linked to WP307.

The main interoperability challenges were identified and the modelling has been completed within the Simulink and Enterprise Architect frameworks. To provide means for traceability of work items and transformation/translation between models for interactions are identified as general IOS specifications for the use case, where the main challenges are to identify which links are necessary and which artefacts need to be linked and at which level of detail.

The work has been done considering the application of ISO 26262 standard requirements.

The deliverable related to the activity performed, D305.011 Milestone Report - V1, has been completed and submitted in time according to project schedule.

**Tangible results**

The activity about the modelling has produced the Simulink model of the climate system, as the actual use case, and the UML/SysML model in the Enterprise Architect environment reflecting the safety requirements elaborated after the hazard analysis and risk assessment on the item.

**Reasons for deviations**

No deviations.

**Reasons for failing to achieve critical objectives**

N.A.

**Use of resources**

The resources involved were used for the above described activities.

They were as planned 13.5 PM month for CRF and 9 PM for DITEN.

No deviations occurred.

**Collaboration with other projects**

N.A.

**Statement on the dissemination activities and exploitation perspectives**

Currently the CRF dissemination activities related to the application of the use case are only internal, by meeting among potential interested actors, looking to the application for the assessment results according to ISO 26262 standard.

The exploitation perspective is related to the enhancement of good practices by spreading results internally, and by the customers, and to the possible improvement of the engineering environment extended also to other more general applications.

The dissemination activities of DITEN are related to trainings of Electronic Engineering Master students at University of Genoa, during Academic Year 2013-2014, based on the presentation of



the workflow and modelling sample in SysML, for automotive domain and general system engineering in CRYSTAL environment.

The exploitation perspective - the activity is no profit in schools - is related to the MSc student training on Model-Based System Engineering and to the training for teachers, trainers and workers. A first set of lectures (for MSc students) is being released in March 2014 (SysML basic). The next releases (periodical) will involve more examples and models, typically coming from the automotive domain. This will allow also extending the audience reach, in particular in the direction of industrial training. First results will be available by March 2014, then periodical updates will come.

### ***Corrective actions***

N.A.

## **3.3.6 WP 306 OS MultiCore Compatible AUTOSAR & Safety Mechanisms for ISO26262 compliance (Lead: Valoe-F)**

### ***Project objectives for the period M1- M12***

The project objectives were focused on the identification of a user story to support the use case definition and engineering environment description.

### ***Work Package progress and achievements during period M1-M12***

This section gives details for each work package the work performed and progress achieved.

### ***Progress towards objectives***

The activity was focus on the identification of a candidate which we know will dictate the use of a multicore controller. The engine controller has been identified and Valeo will provide Matlab/Simulink models and requirements. But because of its complexity it has been decided to cut it down to only part of the functionalities which is representative and manageable by a small project team.

In term of hardware, criteria for selecting a microcontroller have been used to select the right one.

The SW architecture for the user story is currently under construction and must be AUTOSAR 4.0 compliant. Safety recommendation from ISO 26262 standard are also been built.

In term of interoperability, the dissemination of requirements coming from different sources from OEM to the SW configuration has been identified had the challenge to be address by Crystal. This implies change into tools like Elektrobit Tresos Studio. Adaptation of the OS is also needed to support multicore and safety requirements.

The deliverable related to the activity performed, D306.011 Milestone Report - V1, has been completed and submitted.

### ***Tangible results***

Microcontroller selected.

User Story is identified

### ***Reasons for deviations from Annex I***

No deviations.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	100 of 269



**Reasons for failing to achieve critical objectives**

N.A.

**Use of resources**

The resources involved were used for the above described activities.  
They were as planned 12 PM month for Valeo and 36 PM for ElektroBit.

**Collaboration with other projects**

N.A.

**Statement on the dissemination activities and exploitation perspectives**

Currently the VALEO dissemination activities related to the application of the use case are only internal, by meeting among potential interested actors and by internal newspaper article describing the activities.

The exploitation perspective is related to the enhancement of good practices by spreading results internally, creating new design standards and add rules for multicore development training, and to the possible improvement of the engineering methods extended also to other more general applications.

**Corrective actions**

N.A.

**3.3.7 WP 307 Public Use Case AUTOMOTIVE (VIF)****Project objectives for the period M1- M12**

The objective of this first reporting period was the description of the public use case.  
This task investigates the detailed use case descriptions of the non-public use cases in order to identify a subset of interacting bricks that could serve as a point of demonstration. However, due to the large heterogeneity between the use cases it was not intended to build a common use case but instead to highlight the commonalities and differences between the automotive partners. It is therefore not necessary to define and create sample data for a concrete example system.

**Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

**Progress towards objectives**

All automotive use case leaders have contributed to the description of the public use case with a description of relevant aspects in their respective use cases. Moreover, since WP3.7 has been functioning as a forum for automotive coordination, the automotive partners have participated in regular telephone meetings discussing common interoperability challenges and topics within the automotive domain.

As a result of these discussions and a face-to-face workshop, the automotive domain has defined a set of general preliminary automotive IOS challenges. These interoperability challenges have been harmonized and synchronized within the domain and with the IOS working group and serve as an input for the IOS definition. All partners have contributed to the completion and revision of deliverable D307.011 Milestone Report - V1.

A first version of the demonstrator has already been set up and presented in the interim review meeting. All partners have already provided ideas how results from their industrial use cases could be included in the demonstrator.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	101 of 269

### Meetings and Communications:

We organize a *weekly WebEx-Meeting* in order to discuss relevant topics – this includes the definition of the demonstrator for the automotive domain, the execution of the technical management process, and the harmonization of identified interoperability challenges.

In order to intensify these activities there has also been a *face-to-face workshop* in February, which has been used for a detailed investigation of the automotive challenges and their harmonization.

The PUC Automotive has established itself as a *forum for discussions* and exchange of know-how within the automotive domain. We also invite other domains to participate for special topics in order to foster cross-domain communication.

*Communication with SP6*, especially WP601, is ensured by the close collaboration with the IOS representative for the automotive domain.

### Partner contributions:

**VIF** is responsible for the lead and coordination of the public use case automotive. In this first phase of the project, we decided to use this public use case as a discussion forum for the whole automotive domain. The core group involves the use case leaders and the widened group includes all partners working in the automotive domain. VIF organizes weekly meetings with specific topics in order to keep the partners informed and the discussions ongoing. VIF also organized a F2F workshop in order to specify the core interoperability challenges of the automotive domain. One main purpose of this work package is the demonstration of the results of the automotive domain. We have already implemented a first version of a demonstrator and planned some extensions. So far, the demonstrator is based on existing proprietary interfaces and used to identify the interoperability challenges in more detail. During the design of the demonstrator it has been kept in mind that proprietary interfaces will be substituted by IOS compliant interfaces in the next phases of the project. VIF provides the Systems Engineering Environment and supports the implementation of this demonstrator.

**CRF** regularly participates in the WebEx meetings for the improvement of the general automotive IOS challenges understanding/definition.

The contribution to the deliverable of the period (D307.011 Milestone Report - V1) has been completed, revised, and delivered in time.

**Volvo** has presented the interoperability challenges regarding Simulink - SystemWeaver connection and has contributed to deliverable D307.011 Milestone Report V1 - Public Use Case Automotive.

**AVL** provides, based on content of WP303, specific input for WP307 concerning the following topics:

- Definition of classification system / top-down approach to structure system development into different levels - from vehicle to software levels
- Definition and documentation of systems engineering process on vehicle and powertrain system level
- Description of powertrain system requirements engineering and management process
- Definition of interoperability challenge for the mapping of functional structures to product structure element represented in bill of material (BoM) as a main requirement in order to close the gap between traditional hardware- oriented product development and systems engineering.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	102 of 269

Regarding WP304 there has also been considerable input to the Public Use Case. First of all, there has been quite a lot of contribution to the deliverable. Second, WP304 served as an important example for several discussions in the automotive domain, e.g. the derivation of harmonized interoperability challenges and the incorporation of other standards and technologies except of OSLC (e.g. ASAM ODS, FMI, etc.).

**AVL-R** has defined three different user scenarios in UC3.4b. These user scenarios describe different interoperability challenges which are conceptually defined and transferred. AVL-R has contributed to the provision of automotive-wide harmonized input to specific IOS needs and the automotive demonstrator.

**AVL-S** has, together with VIF, organized regular meetings in order to foster the communication in the automotive domain. Domain lead and Public use case lead have been a joint activity of both partners.

**Daimler** has elaborated use case-driven input from WP3.2 about engineering methods concerning system level development steps towards the public use case in WP3.7. Additionally, use case-specific interoperability challenges have been specified and transferred. For providing automotive-wide harmonized input to specific IOS needs, WP3.2 contributed their viewpoint towards WP3.7 and SP6.

**Valeo-F** has contributed to the description of the public use case with a description of our use case. Moreover, since WP3.7 has been functioning as a forum for automotive coordination, we have participated in regular telephone meetings discussing common interoperability challenges in the automotive domain.

### ***Tangible results***

*D307.011 Milestone Report - V1:* In this first deliverable the single partner use cases and their potential contribution to the public use case have been described. This deliverable also includes a first description of the automotive demonstrator. The deliverable has been provided as a joint effort of all partners in time.

*Automotive demonstrator:* The automotive demonstrator has been built together with PTC, because they are a major tool provider in the automotive domain. A first version of the demonstrator has already been presented at the interim review meeting in Brussels in February. We are constantly working on the extension of this demonstrator. Until now, still using proprietary or existing interfaces – the demonstrator will be used to get a clear understanding of interoperability challenges in the automotive domain. In the second phase of the project, these interfaces will be step-by-step substituted by standardized (IOS compliant) interfaces. This means that the demonstrator will then be used to evaluate the project results.

### ***Reasons for deviations***

There are no deviations.

### ***Reasons for failing to achieve critical objectives***

Critical objectives have been accomplished on time.

### ***Use of resources***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	103 of 269

Details see Annex I Beneficiary Report

The actual use is lower than planned for some partners, because of the linear project planning. The implementation will need more resources than the definition of requirements. This means that more efforts will be used in the last phase of the project.

### ***Collaboration with other projects***

The automotive domain has been in contact with different use case and tool providers in the MBAT project in order to gain insights in their work and experiences with respect to tool interoperability.

### ***Statement on the dissemination activities and exploitation perspectives***

“Crystal - Durchgängige Entwicklung sicherheitskritischer Systeme“ In Virtual Vehicle Magazine: <http://www.v2c2.at/news-media/vif-magazine/>

“Co-Simulation and the Functional Mockup Interface”, Presentation at 2nd European Conference on Interoperability for Embedded Systems Development Environments

### ***Corrective actions***

No corrective actions required.

## **3.3.8 WP 308 Specifying Ontology AUTOMOTIVE (TUB)**

### ***Project objectives for the period M1- M12***

In this work package the main objective is the creation of an ontology for the automotive domain that can be utilized in the IOS. The scope of the ontology should cover the different use cases of the automotive subproject SP3.

The main task for this reporting period was the collection of the state of the art for automotive ontologies with the goal to collect all relevant input for an own ontology that works best for the IOS.

### ***Work Package progress and achievements during period M1-M12***

This section gives details for each work package the work performed and progress achieved.

### ***Progress towards objectives***

The main task in this reporting period is the collection of the state of the art for automotive ontologies. To come up with all relevant information, we looked into previous projects, as well as into the core standards and technologies that are relevant for the automotive sector. The results can be found in D308.010 and focus mostly on 3 sources: ISO 26262, Autosar and EAST-ADL.

Partner	Activities	Deliverables
TUB	As WP leader, TUB contributes to all tasks and coordinates all activities in the WP. Specific activities include: - Task leader T3.8.1 - Editor D308.010	D308.010 - Editor - Contents contribution
AVL	- Contribution and review D308.010 - Topics OSLC, DODT, Cesar, ontology based requirements engineering	D308.010 - Contents contribution - Review
AVL-R	- Contribution D308.010 - Topic Autosar	D308.010 - Contents contribution

CRF	- Contribution D308.010 - Topic ISO 26262	D308.010 - Contents contribution
DAIMLER	- Contribution D308.010 - Topic Ontology Tools	D308.010 - Contents contribution
VALEO	- Contribution D308.010 - Topic EAST-ADL	D308.010 - Contents contribution
VOLVO	- Contribution and review D308.010 - Topics OSLC, DODT, Cesar	D308.010 - Contents contribution - Review

**Tangible results**

D308.010, State of the art for automotive ontology

**Reasons for deviations**

No deviation from Annex I

**Reasons for failing to achieve critical objectives**

No failing of achievable objectives foreseen.

**Use of resources**

There is slight underspending in effort (4.25MM) compared to effort planned (5.33MM).  
Details see in Annex I Use of resources of each beneficiary

**Collaboration with other projects**

Not applicable

**Statement on the dissemination activities and exploitation perspectives**

Not applicable

**Corrective actions**

There is active contribution to scoping discussions with other ontology WPs and SP6 in order to clarify the role of the ontology in CRYSTAL, including its relationship with IOS. Once the scoping discussions on the role of ontology in Crystal have finished, the work can continue with increased effort.

### 3.4 Sub Project 4 – Health Domain (Lead: Philips)

**Project objectives for the period M1- M12**

The SP4 objectives are in close alignment with the Crystal objectives:

- Enhance interoperability and provide seamless ready-to-use tool chains
- Manage increasing embedded system complexity
- Support cross-domain reusability, re-certification, re-qualification and design variability
- Reduce development & design costs and time-to-market

The objectives have been specified per period by means of the deliverables. In M1-M12, the focus was on describing the use cases and the requirements to IOS and SEE.

In the period until M12, we have laid down a solid base for achieving the goals:

- Defined the use cases
- Used new tools and new models to gain insight in the desired Engineering workflow
- Defined the tool chain (current and desired)
- Defined engineering methods, technical core requirements, technical refined requirements and technical items
- First steps in defining the IOS

### ***Progress and achievements during period M1-M12***

#### ***Progress towards objectives***

Since the Healthcare use case owners do not have very diverse experience with model-driven development we took the following approach as described in Figure 1. The figure will be explained below.

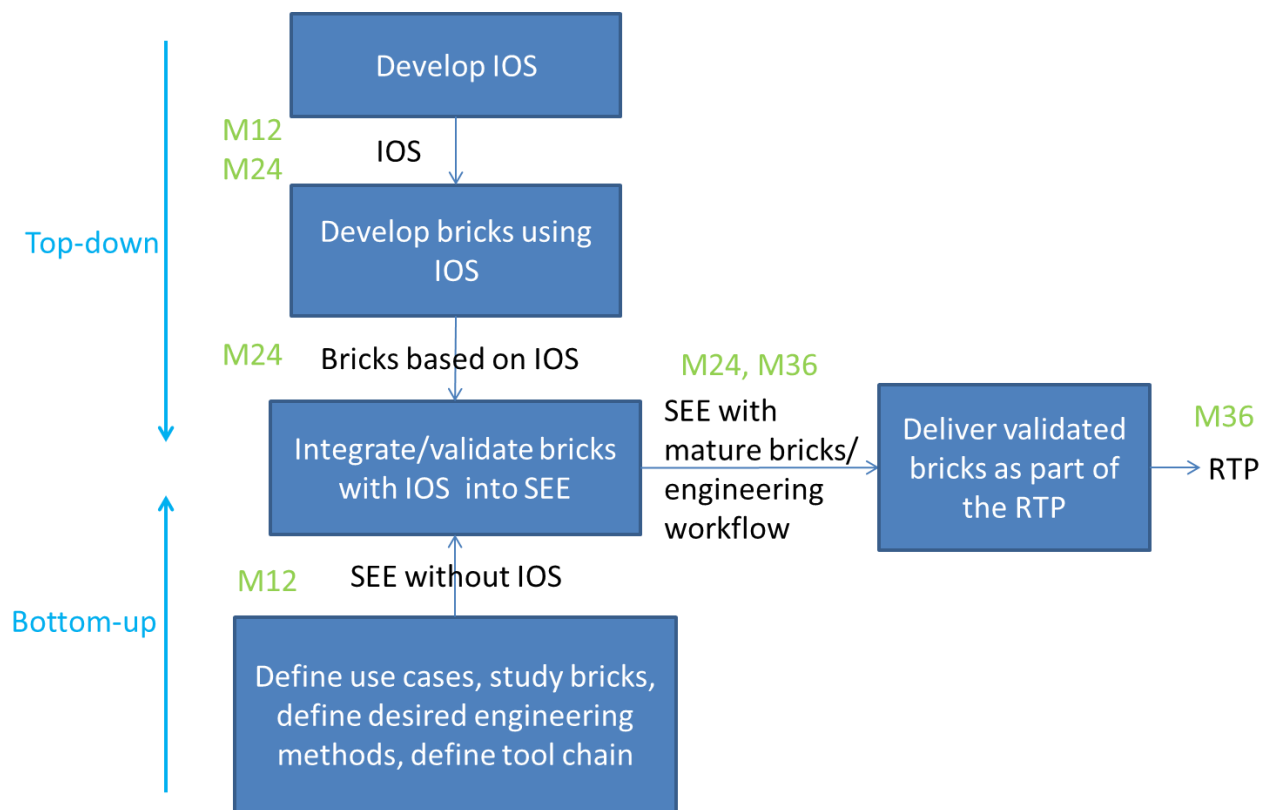


Figure 3-1: Crystal approach

Until M12:

- Define the use cases and the challenges
- Study and experiment with the bricks we intend to use within the desired engineering workflow; this is necessary to understand if these bricks can help the use cases to improve / accelerate the system engineering workflow:

- TNO: Modelica, FMI, GraphViz, SVN/Git, XPoser, Eclipse
  - Philips: Matlab/Simulink, DOORS NG, RQM, HP QC, Rhapsody, RTC, safety risk management, QlikView, XPoser
  - TU/e: Gazebo, Orocos, DSL's,
  - PS-Tech: NobiVR, OGRE
  - IBM: DOORS NG, RQM, Design manager, Jazz platform
  - Barco: PTC Integrity, JIRA
  - ITI: IBM Doors NG, IBM Quality Manager
  - RGB: IBM Doors NG, Matlab/Simulink, IBM Quality Manager
- Construct the desired Engineering workflow by defining the 26 Engineering Methods for this Engineering workflow with the intended use of the bricks; this includes improvements in the interoperability, functionality and the use of the bricks. 15 Technical core requirements were added to the core requirements in the Crystal sharepoint site.
  - Define the tool chain/SEE that is needed to optimize the system engineering workflow, expressed in technical core requirements, technical refined requirements and technical items.
  - For the Engineering Method VerifyRequirements, derive the IOS requirements/services for the bricks used within this Engineering Method

Progress expected for M24 & M36:

- Complete IOS requirements / services for other Engineering Methods as defined in the use cases
- Develop IOS for bricks; develop functionality for bricks
- Improve functionality of bricks to further improve suitability for the desired SEE
- Integrate these bricks into the SEE and use the SEE by creating simulation models to validate the SEE
- Deliver validated bricks to the Reference Tool Platform

For M12 the activities as mentioned above are described in the documents in Table 1.

Note: D401\_901, D402\_901 & D403\_901 are documents as identified in the Amendment (draft\_DOW CRYSTAL (332830) PartB\_Amendment, Jan-April 2014). These documents are defined to show the progress in developing the Philips use cases and to provide an answer on the reviewers request to justify the effort spent by Philips until M12.

Deliverable	Title	Partner	Delivery	Comment
D400_011	SP4 management report	Philips	M9	
D401_010	Use Case Definition	Philips	M9	
D401_020	Prototyping IOS concepts	Philips	M9	
D402_010	Use Case Definition	Philips	M9	



D403_010	Use Case Definition	Philips	M9	
D400_020	System engineering performance analysis report	TU/e	M12	
D401_001	Use Case Development Report	Philips	M12	This document includes: - an update of D402_010, Use Case Definition
D402_001	Use Case Development Report	Philips	M12	This document includes: - D402_021, prototyping IOS concepts - an update of D402_010, Use Case Definition
D403_001	Use Case Development Report	Philips	M12	This document includes: - D403_021, prototyping IOS concepts - an update of D403_010, Use Case Definition
D404_010	Requirements tooling report	Barco	M12	
D405_010	Tool and methodology report	Barco	M12	
D406_010	Tool and methodology report	RGB	M12	
D407_010	State of the art for Healthcare ontology	TNO	M12	
	SP4_00_REPORT_PERIOD_M12	Philips	M12	
	WP4_01_ REPORT_PERIOD_M12	Philips	M12	
	WP4_02_ REPORT_PERIOD_M12	Philips	M12	
	WP4_03_ REPORT_PERIOD_M12	Philips	M12	
	WP4_04_ REPORT_PERIOD_M12	Barco	M12	
	WP4_05_ REPORT_PERIOD_M12	Barco	M12	
	WP4_06_ REPORT_PERIOD_M12	RGB	M12	

Table 3-2: overview deliverables SP4

Regarding WP4.0, the following progress has been made:

#### TU/e

The content of this WP was changed; this WP addresses tooling for measuring the effectiveness of changes in the workflow as proposed by the other WPs. TU/e has conducted a study of process improvement metrics and in cooperation with Philips has selected appropriate KPIs for the null-measurement. These KPIs focus on defect resolution and characterize the gap between the phase the defect has been detected and the defect has been caused, as well as the process followed during the defect resolution. The KPIs have been implemented and calculated for the chosen system development project. The study has been described in D400\_020.

#### Philips

Domain leadership

Setup system performance measurement using QlikView and FRASR tooling.

M12 deliverable D400\_021 has been created which provides the first 2 KPI's and zero-measurements.

#### ***Tangible results***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	108 of 269

---

#### WP4.0: Philips, TU/e

##### TU/e

The KPIs have been implemented and calculated for the chosen system development project.

##### Philips

M12 deliverable D400\_020 has been created which provides the first 2 KPI's and 0-measurements.

#### WP4.1, 4.2 & 4.3: Philips, TNO, TU/e, IBM, PS-Tech

Philips and their partners have worked on a number of activities to start-up using model-driven development. The goal is to understand the needs/requirements for tooling and to understand the optimized workflow, described in Engineering Methods.

We have used different tools & models for different phases in the system engineering workflow.

The results:

- Defined Engineering Methods for the use cases
- Defined the tool chain
- Defined the technical core requirements, technical refined requirements and technical items
- Define the 1<sup>st</sup> IOS specifications / services for Engineering Method Verify Requirements
- Created demonstrations and simulations for virtual requirements validation, clinical incident search tool and virtual software testbed
- Optimized safety risk management workflow
- 1<sup>st</sup> definition of KPI's for system engineering performance and zero-measurements
- Explored over 20 software tools that were new for the organisation involved
- Created simulations for visual requirements validation and virtual testing; for an example see Figure 3-2.

Detailed results can be found in the WP progress reports and in D401\_901, D402\_901 & D403\_901.

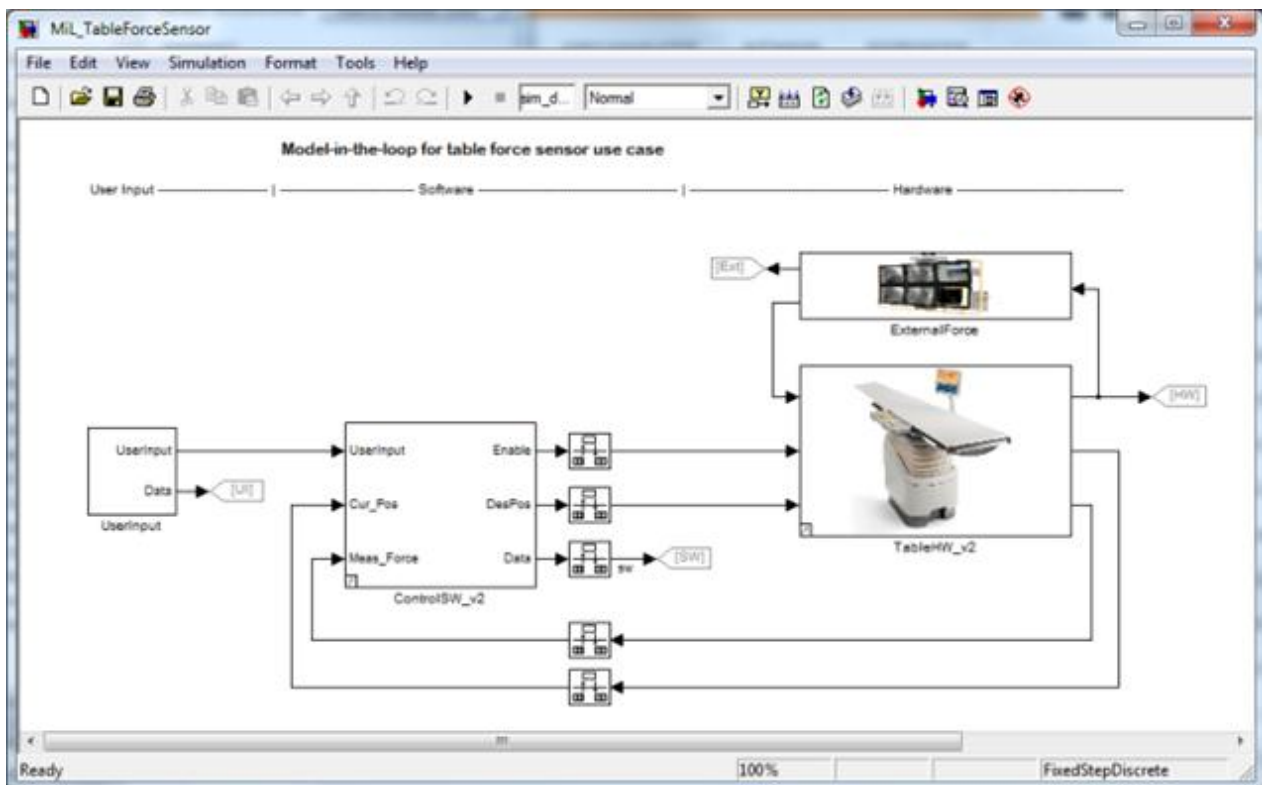


Figure 3-2 Matlab Modelling of table force sensor

#### WP4.4 & 4.5: Barco, TNO, TU/e, IBM

- A combined use case 404-405 description was created by Barco with the support of IBM, TNO and TUe.
- Requirements were defined for the new requirement framework with a IEC62304 compliant workflow.
- Study was conducted to compare and evaluate all possible tool candidates for this new workflow.
- A pilot project was launched in the Barco Healthcare division with PTC Integrity.
- This pilot project will cover the compliance with IEC62304 on system level.
- The Pilot project SEE has been installed at Barco and 3 Engineering Methods with key contribution to the key artefacts as requested by IEC62304 have been supported with new tooling.
- Three implementation tracks were installed at Barco taking care of the first implementation activities; these include the IEC62304 compliance on development level.
- In Track 1, Barco started on a fully agile and modular software design tool chain for the new Barco Quality Assurance platform, 5 new engineering methods were installed: Requirements Gathering, Requirements Traceability, Iterative Development, Process Automation, Key Quality Metrics.
- Track 2 is focusing on the new design process for our first Hybrid software FUN100 platform, for this track we have worked out a new Test Framework, we started with the implementation of 2 new engineering methods: Component Integration Testing and Unit

Testing. Next to this we worked new methodologies for the architectural design and software engineering for this FUN100 platform.

In Track 3 IBM, TNO and TUE are assisting Barco to introduce new modeling and simulation techniques supporting the Barco modular design process. A joint demonstrator has been defined. An IBM hosted SEE has been installed to implement the Barco RM process in that environment using DOORS Next Generation and Rational Quality Manager. TNO then created a first generation image pipeline performance model with special emphasis on latency. The objective of TUE is to predict execution performance of a processing pipeline (Gstreamer) more accurately, as part of the intended workflow.

More details can be found in the WP 404 405 progress reports and in D404\_010, D405\_010.

#### WP4.6: RGB, ITI, TNO

- At present works on bricks development are under way. In this period ITI has contributed to the refinement and specification of the RGB use case, detailing the engineering methods of this V-model that will also make use of IOS. This V-model and use case refinement is being detailed in D406.010. ITI and TNO are collaborating in these tasks.
- TNO created a hardware in the loop simulation including a black box model of human response to blood pressure medication using human response behaviour from literature. This HiL simulation is intended to enable certification of the RGB controller.

#### WP4.7: TNO, ITI, TU/e, RGB, Philips

- The objective of WP4\_07 is definition of an ontology for healthcare systems engineering, scoped by SP4 use cases. Based on the use cases in SP4, we have extracted relevant standards for the ontology. Desk research has provided additional standards that apply to the scope of healthcare systems engineering. The SoTA of D407.010 (revised) lists all relevant standards that provide a foundation for construction of such an ontology. We have set up a workflow for creating the ontology, including validation in practice and taken the first step in assembling and filtering relevant domain terminology.

#### ***Reasons for deviations from Annex I***

Not applicable

#### ***Reasons for failing to achieve critical objectives***

Not applicable

#### ***Use of resources***

Overall, the use of resources is on track. For details, see the WP progress reports and Annex I use of resources of each beneficiary.

The use of resources for WP400:

<b>Activities WP400 2013 - 2014</b>	<b>Partner</b>	<b>Manmonths spent</b>
Activity: system engineering performance analysis D400_020	Philips	2
Activity: system engineering performance analysis D400_020	TU/e	6
SP Lead	Philips	7

The use of resources for the other SP400 work packages is shown in the related WP reports.

#### The use of resources for SP400

Planned effort in manmonths:

Work package	Barco	IBM NL	ITI	Philips	PS-Tech	RGB	TNO	TU/e	Grand Total
4.0	1			9		1		6	17
4.1		0		75	7		16		98
4.2		2		70			8	7	87
4.3		2		70			4	22	98
4.4	34	2							36
4.5	90	2					7	6	105
4.6		0	9,5			59	4		72,5
4.7		0	4	4		1,33	8,7	2	20,03
<b>Planned Total</b>	<b>125</b>	<b>8</b>	<b>13,5</b>	<b>228</b>	<b>7</b>	<b>61,33</b>	<b>47,7</b>	<b>43</b>	<b>533,53</b>

Actual effort in manmonths

Work package	Barco	IBM NL	ITI	Philips	PS-Tech	RGB	TNO	TU/e	Total
4.0	1			9		1		6	17
4.1		3,5		88	5,5		13,5		110,5
4.2		0,7		70			9,6	5,5	85,8
4.3		0,2		68			3,9	13,5	85,6
4.4	36	0,7							36,7
4.5	93	2,5					0	5	100,5
4.6		0,2	9,98			59	3,4		72,58
4.7		0,2	2,45	0,5		1,33	7,6	2	14,08
<b>Actual Total</b>	<b>130</b>	<b>8</b>	<b>12,43</b>	<b>235,5</b>	<b>5,5</b>	<b>61,33</b>	<b>38</b>	<b>32</b>	<b>522,76</b>

#### ***Collaboration with other projects;***

The information flow between the Crystal project and other related projects is managed on WP level. Therefore these statements will be made when applicable in the WP progress reports.

The CESAR and MBAT project findings and results are transferred through participation of key partners in both projects. CESAR and MBAT are well represented in the Crystal technical board.

#### ***Statement on the dissemination activities and exploitation perspectives***

The R&D management of the partners show a lot of interest in the results of Crystal. On June 18 2014, the demonstrators and the plans for the next year will be presented to the management of the different partners.

#### ***Corrective actions***

Not applicable

### 3.4.1 WP 401 Medical procedures in an interventional X-ray system (Lead: Philips)

#### ***Project objectives for the period M1- M12***

WP 401 objectives:

The WP4.1 objectives have been extended as described in the Amendment.

The progress of WP4.1 is based on the objectives and description of work as stated in the Amendment.

In the draft\_DOW CRYSTAL (332830) PartB\_Amendment, Jan-April 2014, 2 objectives from WP4.2 have been moved to WP4.1:

- Component-based reference architecture
- Architecture validation by simulation & visualization

The aim of use case 4.1 is to investigate the use of interoperable tooling for the following aspects:

- requirements management, including traceability
- 3D visualization and simulation (instead of real prototyping) to validate requirements with users providing multi user and multi-location collaboration
- high-level simulation of a component-based reference architecture
- Domain Specific Languages (DSLs) to deal with modelling related to medical procedures and user input

Tooling to support these aspects will be evaluated on a use case which concerns the development of a software layer which defines part of the workflow of medical procedures and the modelling related to user input which also depends on the current medical procedure. Important in this layer is the possibility to deal with new medical procedures in fast but safe way.

#### Objectives M12:

- Study in detail the engineering workflow concerns / challenges
- Study possible solutions and interoperability aspects → extract optimized workflow out of the solutions (EngineeringMethods).
- Demonstrate a possible solution

#### ***Work Package progress and achievements during period M1-M12***

This section gives details for each work package the work performed and progress achieved.

#### ***Progress towards objectives***

The deliverable D401\_901 gives an overview of the progress towards the objectives. It provides details for each task / activity performed.

#### Philips:

As an answer to an increased design complexity due to higher demands on flexibility in the clinical room layout together with an increased variability triggered by efforts to adapt the same product platform for a broader audience, we have investigated the use of modelling in WP4.1.

At the same time, early verification of system concepts and reuse of modelling effort in the engineering flow is needed for creating acceptable time-to-market for safety critical system engineering products.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	113 of 269

In the first twelve months of the CRYSTAL project, activities A1, A2, A3, A5, A7, A8, A9, A10, A11, A12 and A13 cover individual models in the ecosystem architecture.

Models are recognized as a means to counter complexity by raising the level of abstraction as requirements aid by defining the desired product behaviour (e.g. behaviour models).

- Activity A1 and A7 revealed that 3D visualization a good way to discuss and gain early feedback from clinical users on new concepts and requirements and as design aid by defining the actual product behaviour (e.g. architectural / structural models)
- Activity A3 with DSLs and model checkers revealed several inconsistencies in the current user interaction requirements specification that otherwise would be found late in the project at a high cost
- Activity A10 and A9 revealed that modeling is a requisite for manage the complexity of 3D multi-axis patient-oriented movement concepts as verification aid by predicting product behaviour (e.g. emulation or simulation models)
- In Activity A11, A8 and A13, demonstrators are created on a physical target system. Although the feedback is of high value as validation aid by providing early clinical feedback on the product behaviour, the cost of creating such demonstrators is high, and puts an additional load on critical resources in the project.

The goal is to understand the needs/requirements for tooling and to understand the optimized workflow, described in EngineeringMethods.

The following activities have been done in cooperation with partners:

- Activity A1: Early concept validation of mechatronics using 3D virtual reality viewer
- Activity A2: Early visual verification of system requirements using 2D viewer
- Activity A3: Functional Requirements Analyzing and Formalization using DSL
- Activity A4: Infrastructure to early visual verification visualize using 3D virtual reality viewer
- Activity A5: Early visual verification of formal requirements in DSL using 3D viewer
- Activity A3: Functional Requirements Analyzing and Formalization using DSL
- Activity A5: Early visual verification of formal requirements in DSL using 3D viewer
- Activity A12: Early verification of software design concepts using POOSL
- Activity A6: Couple DSL to requirements management tooling using OSLC
- Activity A7: Early verification of system design concepts using 3D viewer
- Activity A8: Early verification of system design concepts using demonstrator
- Activity A9: Early verification of mechatronics design concepts using Matlab
- Activity A10: Early verification of mechatronics design concepts using Matlab and 3D viewer
- Activity A11: Early verification of mechatronics design concepts using demonstrator
- Activity A12: Early verification of software design concepts using POOSL
- Activity A13: Early verification of software design concepts using demonstrator
- Activity A14: Coupling requirements to verification test cases using HPQC
- Activity A15: M9 demonstrator Caliber – HPQC – IBM RQM
- Activity A16: M12 Demonstrator: Integrated demo WP4.1 + WP4.3
- use case definition & use case development report



- WPLoad

#### PS-Tech:

In collaboration with Philips, the Philips XPoser tool has been integrated with the virtual reality (VR) capabilities offered by PS-Tech's NobiVR tool. The XPoser tool is a physics based simulation of the CT hardware, which could be used for visual requirements engineering, design evaluation, and hardware simulation. What has been realized so-far is the first integration of the VR visualization parts of NobiVR with a third party 3D visualization tool (XPoser). From this basis, features are still to be added, such as VR tracking input for head-tracking / interaction.

#### TNO:

In close collaboration with Philips Healthcare, modeling techniques have been applied to parts of the interventional X-ray systems of Philips. This concerns the modeling of requirements, using domain specific languages and visualization, and the validation of software architectures using executable models. The requirements models revealed a number of conflicts and ambiguities; more experiments are needed to evaluate the usefulness of the approach and to investigate whether the modeling can be made suitable for domain experts. The architectural models can be seen as a first evaluation of the technology; more details have to be added to make design choices explicit.

#### IBM NL:

Within WP4.1, we worked on a number of activities to start-up using model-driven development. The goal is to understand the needs/requirements for tooling and to understand the optimized workflow, described in EngineeringMethods. IBM NL supported Philips to define a development process that is supported by OSLC-integrated toolchain using Rational Team Concert, Doors Next Generation and Rational Quality Manager. We build an IBM hosted demo environment and provided access to Philips, TNO and TU/e. We provided OSLC knowledge to enable other partners to integrate tools from other vendors. The following activities have been done: - Use Case definition support - Support specifying Philips development process - Building the IBM hosted SEE environment - Building demonstrator for Requirements Verification based on Philips content. - M9 Demonstrator Caliber - HP QC - IBM RQM - OSLC enablement. - Support TNO to add OSLC terminology into ontology. - Investigate possibilities to enable DSL for OSLC integration via Design Manager.

### ***Tangible results***

#### Philips:

Use Case Development Report D401\_901 has been created. This report described the detailed results for every activity.

The overall outcome in cooperation with TNO, IBM NL & PS-Tech:

- Engineering Methods defined: optimized workflow
  - o First IOS specification defined based on EngineeringMethod VerifyRequirements
- Models for different phases in Engineering workflow
- Envisioned tool chain
- Tool requirements: interoperability and functional
- Integrated demonstrator

#### PS-Tech:

The main result is:

- NobiVR integration with XPoser
  - a. NobiVR integration with Qt-based software
  - b. NobiVR integration with Ogre3D engine-based software
  - c. Configurable stereo visualization and physical screen configuration.

#### TNO:

The three main results are

1. a visualization of the possible choices concerning image display and the development of a Domain Specific Language (DSL) which allows experiments with these choices
2. a DSL to capture and analyze the requirements concerning the priority of movements
3. an executable model of a hybrid architecture for movement control using the POOSL language and the latest version the tool support for POOSL developed in WP 6.03.

#### IBM NL:

We supported in the creation of the Use Case Development Report D401\_901. This report described the approach to come to a SEE with an optimized workflow and interoperable tooling. We built the IBM hosted SEE. We reported on the possibilities of OSLC integration of the DSL.

#### ***Reasons for deviations***

Not applicable

#### ***Reasons for failing to achieve critical objectives***

Not applicable

#### ***Use of resources***

The table below provides a detailed overview of the efforts per activity:

Philips activities until M12	Partner	Manmonths spent
Activity A1: Early concept validation of mechatronics using 3D virtual reality viewer	Philips	4
Activity A2: Early visual verification of system requirements using 2D viewer	Philips	4
Activity A3: Functional Requirements Analyzing and Formalization using DSL	Philips	1
Activity A4: Infrastructure to early visual verification visualize using 3D virtual reality viewer	PS-Tech	6
Activity A5: Early visual verification of formal requirements in DSL using 3D viewer	Philips	1
Activity A3: Functional Requirements Analyzing and Formalization using DSL	TNO	13,5
Activity A5: Early visual verification of formal requirements in DSL using 3D viewer		
Activity A12: Early verification of software design concepts using POOSL		
Activity A6: Couple DSL to requirements management tooling using OSLC	IBM NL	3,5
Activity A7: Early verification of system design concepts using 3D viewer	Philips	3
Activity A8: Early verification of system design concepts using demonstrator	Philips	12
Activity A9: Early verification of mechatronics design concepts using Matlab	Philips	4
Activity A10: Early verification of mechatronics design concepts using Matlab and 3D viewer	Philips	6
Activity A11: Early verification of mechatronics design concepts using demonstrator	Philips	10

Activity A12: Early verification of software design concepts using POOSL	Philips	1
Activity A13: Early verification of software design concepts using demonstrator	Philips	18
Activity A14: Coupling requirements to verification test cases using HPQC	Philips	11
Activity A15: M9 demonstrator Caliber – HPQC – IBM RQM	Philips	4
Activity A16: M12 Demonstrator: Integrated demo WP4.1 + WP4.3	Philips	*
use case definition & use case development report	Philips	6
WPLead		2

\*: effort spent in WP4.3, Activity A8

#### Philips:

Detailed description of the activities can be found in D401\_901.

Planned effort: 75 man-months. Actual effort: 88 man-months.

Relatively high amount of effort is spend in the studies that were needed to understand the different early verification engineering methods, especially on Component based reference architecture and Architecture validation by simulation & visualization which were originally planned in WP4.2.

#### TNO:

In the last year, two times a key research member left the team. Currently, new candidates are interviewed.

#### IBM NL:

We did not plan to work on this Work Package, but together with the WP Lead (Philips) we decided to move effort from WP4.2 and WP4.3 to WP4.1, due to the scope change of WP4.2 and WP4.3.

#### PS-Tech:

Key project member left in M10, new candidates are interviewed.

#### ***Collaboration with other projects***

The Allegio project under the Dutch COMMIT program will reuse the knowledge in the area of Domain Specific Languages (Xtext/Eclipse) and rapid prototyping (POOSL) to apply on the use cases in Crystal.

DSL's for creating a model for collision prevention has been prototyped in Allegio on current architecture. This was the reason for the change request on WP4.2 as described in the Amendment.

Hybrid architecture and DSL's for movement sequences including anti-collision will now be prototyped in Crystal.

#### ***Statement on the dissemination activities and exploitation perspectives***

Dissemination activities:

- Philips: presented the use cases and Crystal plans to operational management, engineers from Philips and partners
- TNO gave a demonstration of the POOSL tooling to operational management, engineers from Philips and partners

- PS-Tech gave a demonstrator of the NobiVR tooling to operational management, engineers from Philips and partners

### **Corrective actions**

Not applicable.

## **3.4.2 WP 402 Safety layer of an interventional X-ray system including collision prevention (Lead: Philips)**

### **Project objectives for the period M1- M12**

#### WP 402 Objectives:

The WP402 objectives have been extended as described in the Amendment (draft\_DOW CRYSTAL (332830) PartB\_Amendment, Jan-April 2014).

This use case concerns the evaluation of interoperable tooling to be used within the overall (safety) risk management process which deals with safety aspects such as collision detection and prevention during the development and maintenance of an interventional X-ray system. We investigate the use of tools and techniques to support the execution of the risk management process, with an emphasis on:

- safety requirements, certification
- FTA, FMEA, FMEDA, fault injection, stress testing
- Propagation of a safety field call
- Monitoring of safety performance of the system in the field
- Design change propagation into safety management
- Consistency between tools and techniques

#### Objectives M12:

- Study safety risk management workflow challenges
- Study possible solutions for safety risk management
- Identify the optimized workflow and corresponding EngineeringMethods.
- Develop tools to support this optimized workflow
- Use and evaluate and improve this optimized workflow
- Build demonstrator for showing part of this new workflow
- Define tool requirements for Engineering Methods

#### Objectives M24 & M36:

- Develop further improvements for the safety risk management workflow
- Develop tooling that supports the safety risk management workflow
- Implement & demonstrate solutions for this optimized workflow and interoperability
- Implement and evaluate IOS and tooling
- Optimise tooling to form new SEE

### **Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	118 of 269

### Progress towards objectives

The deliverable D402\_901 gives an extensive overview of the progress towards the objectives. It provides details for each task / activity performed.

#### Philips:

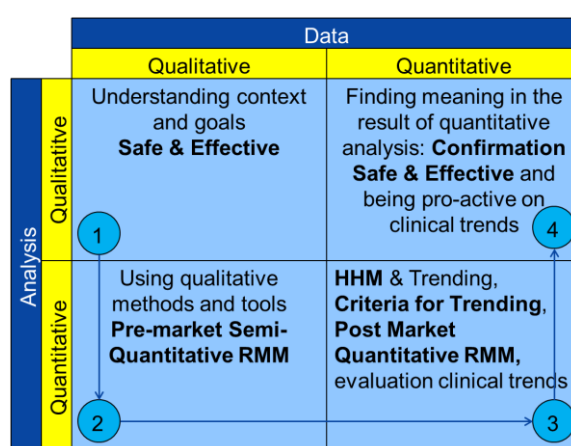
WP402 focusses on improving the *safety risk management process*. In general, the *safety risk management process* is running in parallel to the *development process*.

The requirements for the safety risk management process are defined in ISO 14971: “*Medical devices – Application of risk management to medical devices*”, with the following extensions:

- Usability → IEC 62366 “*accesses and mitigates risks caused by usability problems*”
- IT-networking → IEC 80001-1 extends the definition of harm with: “*Reduction in effectiveness or breath of data and system security*”

The challenges here are:

1. To manage the overwhelming complexity of safety management and it's reporting to FDA and Philips management, at an aggregated level to enable building an all-over opinion on the system safety level. With the very elaborate safety management and safety analysis information at individual part and cause level, this is no longer comprehensible for a normal human.
2. To embed comparison between estimated ‘residual risk’ (during pre-market design time) and ‘actual risk’ (actual observed risk based on post-market surveillance data) as a routine process into safety risk management. Such a comparison acts as learning cycle and would support realistic pre-market safety risk management likelihood estimations.
3. To be able to focus risk assessments separately on clinical and on technical safety, since the clinical view on safety hazards is quite different from the technical view on these hazards. One large safety FMEA, including both foci, is inefficient, since the participants have different background knowledge and skills.
4. To be able to anticipate pro-actively on clinical trends (quadrant 4 in the figure below). At M0 both the Risk Analysis and the available Risk Data are pure qualitative (quadrant 1 in the figure below).



Within WP402, Philips has worked on a number of activities for safety risk management.

We have improved the safety risk management workflow in compliance with the safety regulations and used different models and tools to support this optimized workflow.

The following activities have been done:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	119 of 269

- Use case definition & Use Case Development Report
- WP Lead (coordination, focus definition, monitoring progress, reporting)
- Activity A1: Product Risk Management Improvements
- Activity A4: Product Risk Management (QlikView) Application: setup architecture, data warehouse and application for product risk management application.
- Support the following activities with TNO, ITKE & IBM:
  - o Activity A2: Analysis of safety risk management process
  - o Activity A3: Safety incident search tool for safety risk management

### TNO:

TNO has extensively analysed the Philips Healthcare safety management process and laid this down in the Use case 402.010 deliverable. In particular, TNO concentrated on feedback from system use in the market to the development team ('experience feedback'). TNO created a UML sequence diagram to make the interactions clear between the various teams involved in safety risk management. Also, research questions per case study were defined and additional improvements were generated. See activity A2 - Analysis of safety risk management process in D402\_901.

The engineering methods selected were then translated by TNO into detailed requirements to brick 3.6 (WP604) and a long list of technical items for improvement. A selection was made to provide core requirements (step 5) and priority setting for technical items is underway (March 2014).

### Prototyping

- To reduce the amount of hand work in tracking safety risk progress and reduce the number of Excel data exchanges, a conceptual data structure was set up based on the current Philips process. This was laid down in an Access database
- An OSLC medical incident search tool was created to search medical incident databases like the FDA Maude database. This allows for frequent and easy to use queries on medical incident database, thus providing the needed 'experience feedback' from the users to the safety management team. In this way, corrective actions can be quickly defined - if needed. See Activity A3 - Safety incident search tool for safety risk management in D402\_901.
- TNO proposed a novel visualization of the development process (H model instead of V model) to make the role of validation and certification more explicit, to include the system lifecycle and to emphasize the agile current character of current development processes.

### TU/e:

The TU/e is currently investigating the support of modularity in the various language workbenches to develop DSLs. This research will eventually contribute to the effort by TNO to develop a domain specific language to describe the behaviour of moving parts in a surgery room.

### IBM:

Within WP402, Philips worked on a number of activities for safety risk management. We supported Philips in investigating tool usage for Safety Risk Management. The following activities have been done: - Use Case definition support - OSLC enablement

## ***Tangible results***

### Philips:

We created a Use Case Development Report D402\_901. This report described in detail the approach to optimize the safety risk management with models of safety concepts and tooling. The

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	120 of 269

new safety risk management workflow has been evaluated. Bottlenecks in information flow, stakeholder needs and tooling were identified.

It also gives a detailed description of the study to setup QlikView for safety

- Optimized safety risk management workflow described
- EngineeringMethods described:
  - ComplaintRiskEvaluation
  - CollectAndAnalyseAdverseSafetyEvents
  - AssessImpactDesignChanges
  - FieldSurveillance

#### TNO:

Use case WP402 deliverable D402.010, in particular research questions, possible improvement and detailed description of the use case process (chapter 3)

Conceptual data model for safety risk management (MS Access)

OSLC demonstrator for safety incident search. Including database server, RESTful services and OSLC adapter. Web interface for querying public safety incident databases, starting with FDA Maude database.

#### TU/e:

Preliminary ideas on the topic of DSL application, together with TNO.

#### IBM:

We supported in writing the Use Case definition report. We built the SEE.

#### **Reasons for deviations**

Not applicable

#### **Reasons for failing to achieve critical objectives**

Not applicable

#### **Use of resources**

Activities 2013 - 2014	Partner	Manmonths spend
Activity A1: Product Risk Management Improvements	Philips	42
Activity A2: Analysis of safety risk management process	IBM NL	0,7
Activity A2: Analysis of safety risk management process	TU/e	5,5
Activity A2: Analysis of safety risk management process	TNO	6,7
Activity A3: OSLC Market surveillance tool for safety risk management		
Activity A4: Product Risk Management (QlikView) Application	Philips	21
Activity Use Case definition & Use Case Development Report	Philips	5
Activity WPLed	Philips	2

#### Philips:

Detailed description of the activities can be found in D402\_901.



TNO:

So far, mostly safety analysis experts were involved. Gradually, more software effort is included.

***Collaboration with other projects***

Not at this time.

***Statement on the dissemination activities and exploitation perspectives***

Cooperation with TNO, IBM, ITKE (WP604) on tooling requirements and support for safety risk management engineering flow.

For M12&M24, Philips will actively seek within the Crystal project for further knowledge and experience in safety risk management in order to optimize the workflow.

***Corrective actions***

Not applicable

### 3.4.3 WP 403 Motion control of patient table and X-ray beam positioning (Lead: Philips)

***Project objectives for the period M1- M12***WP 403 Objectives:

This use case focuses on mixed physics/data-based modelling and simulation. The aim is to examine sensorial and mechanical uncertainties in robotic positioning systems and on how these uncertainties translate to the performance of the systems in their environment and therefore on the safety of the complete system. This will result in important input for WP4.1, by providing models and identifying uncertainties for the purpose of collision prevention of the system with its environment (human and objects) and with other (possibly moving) systems. . An additional goal is to reduce the need for testing on a real system through a time and resource accurate simulation of the hardware subsystem.

The work package was redefined early 2014 as described in the Amendment 1 of Jan-April 2014.

The development of the motion control layers of an interventional X-ray system is used to investigate interoperable tooling for:

- component-based development
- multi-disciplinary modeling and simulation, supporting continuous integration and the model/software/processor/hardware in the loop sequence
- code generation from models
- real-time behaviour and performance analysis
- a framework for continuous test and integration

Objectives M12:

- Study challenges for testing components (hardware & software) within the X-Ray system
- Study possible solutions for component testing
  - Model to code transformation for Motion Control Interface

- Implementation of the communication abstraction layer
- Matlab modelling for table force sensor
- Simulation architecture and levels of integration
- Continuous build, integration and test environment
- Identify optimized workflow for component testing and corresponding EngineeringMethods
- Build demonstrator that connects a simulator for hardware and a simulator for functional behaviour.

### **Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

#### **Progress towards objectives**

The deliverable D403\_901 gives an extensive overview of the progress towards the objectives. It provides details for each task / activity performed.

#### Philips:

As an answer to an increased design complexity due to higher demands on flexibility in the clinical room layout together with an increased variability triggered by efforts to adapt the same product platform for a broader audience, we have investigated the use of modelling in WP4.3.

At the same time, early verification of system concepts and reuse of modelling effort in the engineering flow is needed for creating acceptable time-to-market for safety critical system engineering products.

In the first twelve months of the CRYSTAL project, we started with using IBM Rational Rhapsody (A1) and MatLab Simulink (A5) as modelling tools for both raising the abstraction level and automatic code generation. Although both tools and mythologies are considered to have added value, we concluded that Rhapsody bring less abstraction compared to MatLab for mechatronics challenges.

Amongst others we investigated the added value of new tools on software configuration management (A2) and visualization of simulation models. As the first approach on modelling with MatLab was not connected to the mechatronics software platform, initiatives were started to define a simulation architecture and integration plan (A6). This has led to a first implementation of a Communication Abstraction Layer to be able to integrate the simulation model from MatLab into the mechatronics software platform (A7).

With Activity A8, we integrated a first simple motion control and environment emulator of WP4.3 in the complex use case study of WP4.1. This integrated demonstrator gains the insight that real-time related requirements needs to be added to the interoperability tool specification (IOS).

The outcome of this activity paves the way for using and reusing models during several engineering methods of the development process.

Within WP4.3, we worked on a number of activities to start the use of model-driven development.

The following activities have been done:

- Use Case definition & Use Case Development Report
- WP Lead (coordination, focus definition, monitoring progress, reporting)
- Activity A1: Model-to-code transformation for the Motion Control Interface

- Activity A2: IBM Rational Team Concert (RTC) pilot
- Activity A3: Evaluating the organizational needs and potential benefits of using GAZEBO and OROCOS
- Activity A4: Evaluation and considerations related to the levels of integration
- Activity A5: The Matlab Modelling for the table force sensor
- Activity A6: The definition of a simulation architecture and integration plan
- Activity A7: The actual implementation of Communication Abstraction Layer
- Activity A8: M12 Demonstrator: Integrated demo WP4.1 + WP4.3

#### TNO:

TNO has substantially contributed to the definition of the use case WP403. In several discussion with people from Philips, a possible development process (workflow) is defined for model-based control software development.

In order to demonstrate this process, TNO developed simulation models for the case study 'Table force sensor'. First TNO developed a Matlab/Simulink model representing the iXR table. The model is derived from the specification documentation and validated using some measurements. In order to demonstrate model-in-the-loop testing, also a model of the control software is made. Using these models, a standard verification test can now be simulated. Furthermore, an option could be to load the real software can be loaded into the Matlab/Simulink environment to perform software-in-the-loop testing. Alternatively, the hardware model could be compiled to run real-time in a software test environment of Philips. This will demonstrate testing of control software against virtual hardware / a model of the real system as developed by TU/e.

#### TU/e:

The work has focused on the 'Hardware in the loop' simulation which is part the proposed workflow of this same use case. TU/e built the tool to generate an interface for mixed simulations, based on a description of that interface. Matlab models developed by TNO are integrated in this mixed simulation such demonstrating testing of control software against a real-time simulation model, and also the re-use of models from earlier stages of the design. In addition, traces along this generated interface can be collected for developing models automatically, for tracing errors and for diagnostics. In addition TU/e has studied other tools for such simulation.

#### IBM:

Within WP4.3, we worked on a number of activities to support Philips in applying model-driven development. The goal is to understand the needs/requirements for tooling and to understand the optimized workflow, described in EngineeringMethods. The following activities have been done: Use Case definition support, Building SSE , OSLC enabling

#### ***Tangible results***

##### Philips:

For the Tangible results we refer to the Use Case Development Report D403\_901. This report described the approach to come to a SEE with an optimized workflow and interoperable tooling. It also gives a detailed description of each activity / study.

#### TNO:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	124 of 269

Use case description. Matlab/Simulink simulation environment with several models of the control software and the iXR table.

TU/e:

Use case description. Development of method and prototype for an automatic generation of a HiL interface.

IBM:

We supported in writing the Use Case definition report. We built the SEE.

**Reasons for deviations**

Not applicable

**Reasons for failing to achieve critical objectives**

Not applicable

**Use of resources**

Activities 2013 - 2014	Partner	Manmonths spend
Activity A1: Model-to-code transformation for the Motion Control Interface	Philips	33
Activity A2: Continuous, build, integration & test	Philips	23
Activity A3: Evaluating organizational needs & potentials GAZEBO / OROCOS	TU/e	13,5
Activity A5: The Matlab Modelling for the table force sensor		
Activity A4: Evaluation and considerations related to the levels of integration	TNO	4,3
Activity A5: The Matlab Modelling for the table force sensor		
Activity A6: The definition of a simulation architecture and integration plan		
Activity A7: Actual implementation of the Communication Abstraction Layer		
Activity A8: The Demonstrator Hardware in the loop (HiL) simulation	Philips	5
Activity Use Case definition & Use Case Development Report	Philips	5
Activity Use Case definition & Use Case Development Report	IBM NL	0,2
Activity WPLoad	Philips	2

Philips:

Detailed description of the activities can be found in D403\_901. Part of the effort for A8 has been used for discussing and supporting the activities A3 – A7 leading to the demonstrator.

Planned effort: 70 manmonths. Actual: 68 manmonths.

TU/e:

Some underspending of mm is due to a late start caused by having to wait for candidates. Currently, two more technical staff are added to the project and have made up for most of the pending work.

IBM NL:

So far we did not spend much effort on this WP yet since our involvement will only be needed later in the project. We plan to scale up our involvement in this WP during Y2 and Y3 of the Crystal project. During the first year we moved effort from this WP to WP4.1.

#### ***Collaboration with other projects***

Not applicable.

#### ***Statement on the dissemination activities and exploitation perspectives***

Dissemination activities:

- Philips: presented the use cases and Crystal plans to operational management, engineers from Philips and partners

#### ***Corrective actions***

No corrective actions

### **3.4.4 WP 404 Medical certification and Requirements management Framework (Lead: BARCO)**

#### ***Project objectives for the period M1- M12***

The objectives of this work package for the reporting period were:

- Setting up a toolchain that allows compliance with IEC62304 regulation for medical devices in regulation by FDA and other regulatory institutes.
- Requirements management tools able to track, record and visualize requirements.
- Working in an interoperable way with the tools used in the design, validation, testing and documentation phases.
- Tools for automatic generation of product documentation and product specification and compliance results for a specific product variant.

#### ***Work Package progress and achievements during period M1-M12***

##### ***Progress towards objectives***

Since the activities in both Barco Use Cases 404 and 405 are closely linked to each other, in the period M1-M9, the partners worked on both Barco use cases 404 and 405 as one linked use case. A combined use case description was created by Barco with the support from IBM, TNO and TUE.

At Barco the activities started to set up a requirement framework compliant with IEC52304.

Requirements were defined for the new requirement framework with a IEC62304 compliant workflow.

Study was conducted to compare and evaluate all possible tool candidates for this new workflow.

A pilot project was launched in the Barco Healthcare division with PTC Integrity.

This pilot project will cover the compliance with IEC62304 on system level.

The Pilot project SEE has been installed at Barco and 3 Engineering Methods with contribution to the key artefacts as requested by IEC62304 have been supported with new tooling.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	126 of 269

The IEC62304 compliance on component level are closely linked with the component-oriented and modular design activities and are as such described in the work of use case 405.

In the context of this pilot project an SEE has been installed at Barco and the following Engineering Methods have been implemented in this first reporting year:

- Requirements Management.
- Software Risk Management.
- Test Management.

All these Engineering Methods have a direct contribution to the key artefacts as requested by IEC62304.

#### ***Tangible results***

- CRYSTAL\_D\_D404 010 - Requirements tooling report (M12)

#### ***Reasons for deviations***

No deviation from Annex I.

#### ***Reasons for failing to achieve critical objectives***

No failing of achievable objectives foreseen.

#### ***Use of resources***

- Barco: Since the activities in both Barco Use Cases 404 and 405 are closely linked to each other, in the period M1-M9, the partners worked on both Barco use cases 404 and 405 as one linked use case. Following this approach the total effort was equally divided over the 2 use cases, this also reflects in the effort reporting for M1-M9.
- IBM: We moved some effort from this WP to WP4.5 due to activities that can be combined, like building SEE. Also, the Engineering Method Verify Requirements took less effort than expected, where the WP4.5 Engineering Method Functional Modeling took a little more.
- TNO: Resources have been used as planned.
- TUE: Resources have been used as planned.

#### ***Collaboration with other projects***

Not applicable.

#### ***Statement on the dissemination activities and exploitation perspectives***

Dissemination activities:

Partner	Dissemination	Date
Barco	Launch of the PTC Integrity Pilot Project (Presentation to operational BARCO R&D key stakeholders).	01 Nov 2013

Exploitation perspectives:

Following results are foreseen at the end of the project:

- Tool chain to make it possible to track requirements from definition phase up to testing as part of a continuous integration/development process.

- Tool chain to automatically generate certification documentation based on a product requirement and functionality description.

The CRYSTAL project will allow Barco to transform from hardware centric medical display platforms to more modular and software centric display platforms compliant with 62304. This will allow Barco to increase our development and certification efficiency, resulting in an increasing quality and compliance of our products.

This will allow Barco to keep our existing market share (50%) in the diagnostic display market, and allow us to significantly grow and gain market share in the clinical review display segment.

### ***Corrective actions***

Focus and track discussions of the IOS requirements.

## **3.4.5 WP 405 SW centric scalable safety critical medical display platform (Lead: BARCO)**

### ***Project objectives for the period M1- M12***

The objectives of this work package for the reporting period were:

- Tools and methodologies to support component-oriented & modular design, allowing product variance based on configuration without the need to recompile code.

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

Since the activities in both Barco Use Cases 404 and 405 are closely linked to each other, in the period M1-M9, the partners worked on both Barco use cases 404 and 405 as one linked use case. A combined use case description was created by Barco with the support from IBM, TNO and TUE.

IBM contributed specific to the requirement process, this is also linked with the Requirement Framework activities of WP404. TNO contributed especially the introduction of performance modeling to the Barco process and the interaction with functional modeling (as defined by IBM) was added. The partners jointly created the corresponding UML activity diagrams.

Three implementation tracks were installed at Barco taking care of the first implementation activities; these include the IEC62304 compliance on development level.

In Track 1, Barco started on a fully agile and modular software design toolchain for the new Barco Quality Assurance platform, 5 new engineering methods were installed:

- Requirements Gathering.
- Requirements Traceability.
- Iterative Development.
- Process Automation.
- Key Quality Metrics.

Track 2 is focusing on the new design process for our first Hybrid software FUN100 platform. The FUN100 platform is using one Hybrid software source base which includes both embedded

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	128 of 269



software and VHDL. The same source based is built into multiple deliverables / install packages which typical depend on the interface board and/or the medical displays it is intended for.

For this track we have worked out a new IEC62304 compliant Test Framework, we started with the implementation of 4 new engineering methods:

- Component Integration Testing
- Unit Testing.
- Architectural design.
- Software engineering.

In Track 3 IBM, TNO and TUE are assisting Barco to introduce new modeling and simulation techniques supporting the Barco modular design process, we started implementing the following 3 engineering methods:

- Functional Modeling.
- Performance Simulation.
- Combining Functional Modeling & Performance Simulation.

Based on the use case, Barco, IBM and TNO defined a joint demonstrator. Here the interaction of functional modeling and performance modeling for simulation of an imaging pipeline is selected.

IBM the IBM hosted SEE and supported Barco to implement their RM process in that environment using DOORS Next Generation and Rational Quality Manager. This RM process will connect the RM/QM process of WP4.4 to the engineering of components. TNO and IBM installed and debugged a Rhapsody/ Simulink bridge. TNO then created a first generation image pipeline performance model with special emphasis on latency.

The objective of TUE is to predict execution performance of a processing pipeline (Gstreamer) more accurately, as part of the intended workflow. TU/e has worked on the problem definition, and is now working on analysis and modeling of actual run-time system. Tools under consideration are Gstreamer and correspondent languages. Interface concern these tools, but also the components to be run by the Gstreamer framework.

### ***Tangible results***

- CRYSTAL\_D\_D405 010 – Tool and Methodology Report (M12)

### ***Reasons for deviations***

No deviation from Annex I.

### ***Reasons for failing to achieve critical objectives***

No failing of achievable objectives foreseen.

### ***Use of resources***

- Barco: Since the activities in both Barco Use Cases 404 and 405 are closely linked to each other, in the period M1-M9, the partners worked on both Barco use cases 404 and 405 as one linked use case. Following this approach the total effort was equally divided over the 2 use cases, this also reflects in the effort reporting for M1-M9.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	129 of 269

- IBM: We spent a little more effort for this WP than planned because of the more complex Engineering Method. That was compensated with a lesser effort on WP4.4.
- TNO: Due to discussions on scope (Hardware in the loop vs. performance modeling) and input needed from the use case owner, the start of the performance modeling was delayed. Currently, the work is on track
- TUE: According to plan; slow start due to hiring.

#### ***Collaboration with other projects***

Not applicable.

#### ***Statement on the dissemination activities and exploitation perspectives***

Dissemination activities:

Partner	Dissemination	Date
Barco	Presentation: Agile Development in a Regulatory Context @ Software Design for Medical Devices Europe, 27th - 30th January 2014, Munich, Germany	28 Jan 2014

Exploitation perspectives:

Following results are foreseen at the end of the project:

- Change the design methodology from hardware centric to software centric, making it possible to easily create product variants by simply changing configuration rather than having to write new code or recompile code.
- Replace the proprietary FPGA based hardware platform by a COTS platform while keeping the same level of safety and performance.

The CRYSTAL project will allow Barco to transform from hardware centric medical display platforms to more modular and software centric display platforms compliant with 62304.

This will result into a serious reduction in R&D effort spent (30%) on development and maintenance compared to our current HW centric platform.

This will allow Barco to keep our existing market share (50%) in the diagnostic display market, and allow us to significantly grow and gain market share in the clinical review display segment.

#### ***Corrective actions***

Focus and track discussions of the IOS requirements.

### **3.4.6 WP 406 An intelligent infusion controller for Blood Pressure regulation in Operating Room (Lead: RGB)**

#### ***Work Package progress and achievements during period M1-M12***

This work package incorporates tools to support certain phases of the development of an Intelligent Infusion Controller. The system operates delivering vasoactive drugs with the goal to

reduce patient's hypertension in a patient undergoing surgical intervention in OR or in postcardiac surgery in ICU. Works in this first years have been focused on Task 4.6.1. "Use Case definition" in which it has been investigated the use of interoperable tooling as a support means for the UC, and Task 4.6.2, "Prototyping IOS Concepts".

Use Case 4.06 presents the development of a medical device. The main challenge in the development process consists on obtaining a product that provides the functionality and meets the certifications and norms required for its use in real medical environment. The fact of fulfilling these norms forces the development process to accomplish some required steps and tasks for providing evidences about the correct behavior of the system and that the development process has been performed as expected.

The inclusion of some new steps and tools to support new engineering methods is required. This change is due to the fact that some regulations have changed and because the new product must be designed to a high safety level compared with previous products developed by the company.

The system under development is a drug infusion device that operates delivering vasoactive drugs to maintain the patient blood pressure under some limits in Operating Rooms (OR) or Intensive Care Unit (ICU). The system operates as a closed control loop reading the blood pressure and applying the required drug quantity to reduce it, if required. A special algorithm based on fuzzy logic is used for performing such monitoring and controlling.

Figure 3-3below shows the components of the system. The device to be developed is labelled as Control Algorithm. The perfusor (element that injects the drug) and the blood pressure measurer are COTS devices.

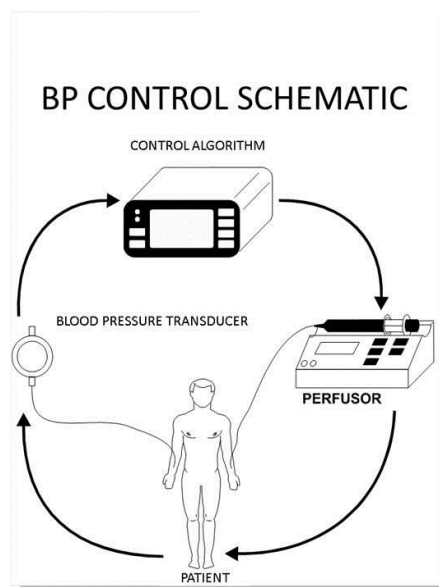


Figure 3-3: System components diagram

Next figure shows real COTS components used in this product.

In general the device consists of the following components:

- A multi-parameters vital sign monitor. The device that displays information and allows the interaction with the device.
- An infusion pump. Injects the drug to the patient.
- Communication bus between components.
- Control algorithm
- Communication with external devices.



Figure 3-4: Device

The development of the system covers both hardware and software.

The main benefits of this product, among others, are:

- Diagnosis and therapeutic capabilities
- Enhancing patient care
- Releasing the nursing work

The system operates delivering vasoactive drugs with the ultimate goal of reducing patient's hypertension, and precisely controlling blood pressure measurements in a patient undergoing surgical intervention or in post cardiac surgery in Intensive Care Unit (ICU).

Hypertension occurs frequently in the immediately postoperative period after cardiac surgery, in spite of adequate analgesia and sedation. The usual management of this hypertension is by infusion of quick acting and ultra-short response vasodilators.

At present there are no or little technological alternatives practiced. The only noticeable alternative is the employment of medical assistants concentrated on the delivery of drug, while doing a lot of other things simultaneously. The probability of human error is quite high and the project would contribute to improve working quality of the clinical staff and the patients' safety.

The device performance combines:

- Diagnosis and therapeutic capabilities,
- Means for enhancing patient care,
- Means for releasing the nursing work, so that the clinical staff can have more time to focus on other equally demanding areas.

In a typical scenario, the physician in charge will define, at the beginning of the process, the target MAP (Mean Arterial Pressure) where he/she considers the patient is adequately controlled. Vasodilator drug will be infused continually; every 20 seconds, the system will decide the new infusion value applying a control algorithm. This will take into consideration past behavior of patient's MAP to drug infusion.

For this purpose, the system needs to integrate several features at the component level:

- Means to measure MAP values, from an either invasive or no-invasive Vital Signs Monitor (VSM)
- Means to infuse vasodilator drug from one or more Infusion Pumps. This accessory must be fully integrated and interoperable with VSM.
- Safe communication between above components.
- A control algorithm
- Connectivity means to an Information System

Then thanks to the integration of these features the product will be able to control the delivery of vasoactive drugs through infusion and monitor the effects on the patient in order to guarantee his/her wealth.

RGB is developing a set of tools for development under the V model, that will eventually (out of Crystal scope) support the product certification of a Blood Pressure controller in Hospital OR (Operating Room) or ICU (Intensive Care Unit).

### ***Progress towards objectives***

In order to perform the various technical core requirements, RGB is evaluating in WP4.06 a number of IBM Rational Systems and Software Engineering (SSE) solutions. The ultimate goal is to help to specify, design, implement and validate the controller as well as the software within. We are very interested to enable traceability across the lifecycle of the product.

Different tools are being tested. Some of them have already been selected:

- IBM Rational DOORS and DOORS Next Generation for requirements management
- IBM Rational Quality Manager for automating testing and defect management

Others are under selection, and others are being developed specifically.

The development process is based on a V cycle as shown in figure below. This use case is mainly centered on the tasks at the top of the V, namely, the Requirement Specification (1), Rapid Prototyping of the Architectural Design (2) and the System Validation (7). This is due to the fact that those tasks provide most of the information required as evidences for certification process and, therefore, the automation and the interconnection of such a data will produce a high benefit in the development cycle.

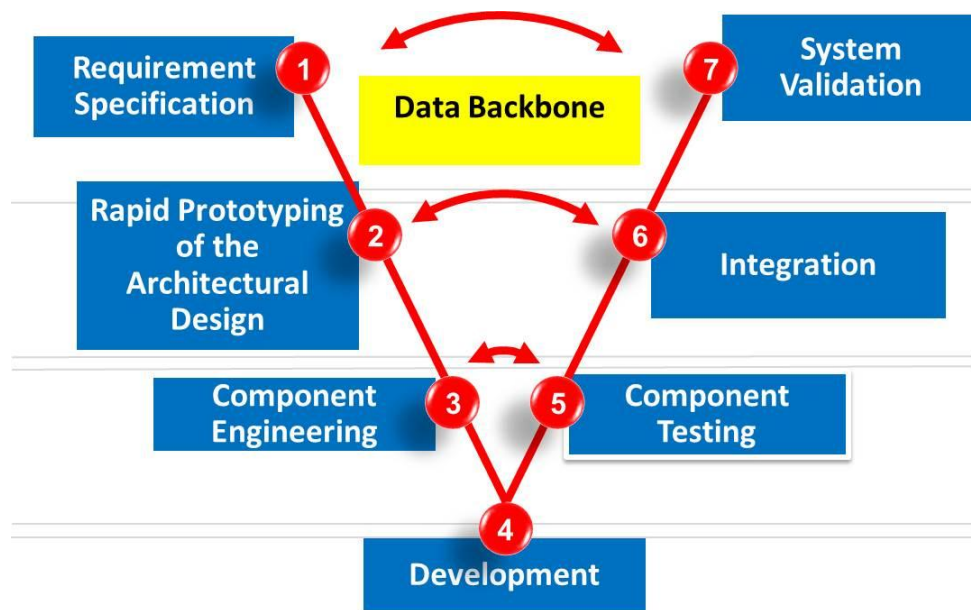
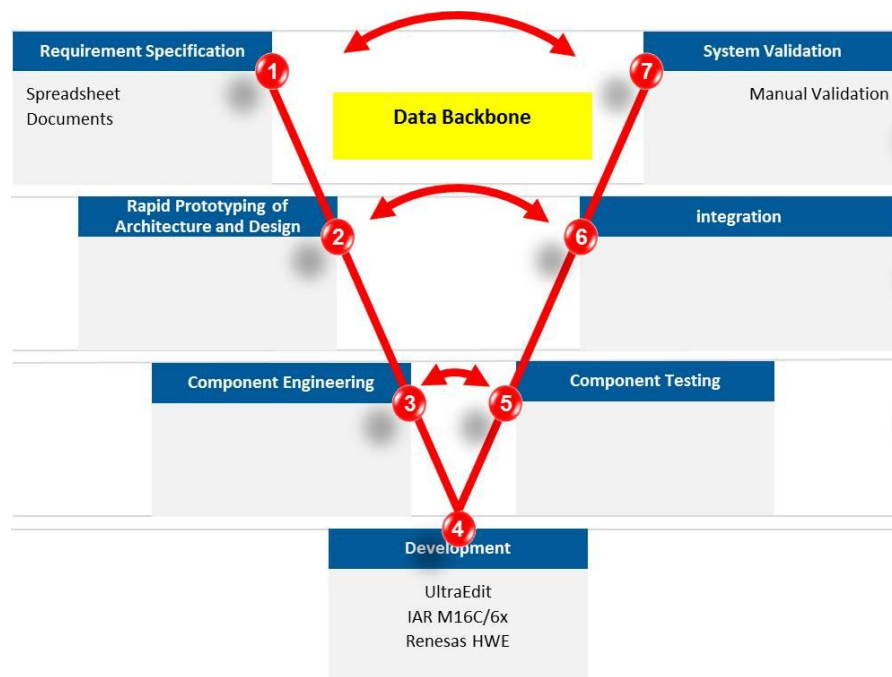


Figure 3-5: Development Cycle

The objective is to have a connection between Requirements Specification and the Architecture Design, to allow a more efficient design cycle and a connection between Requirement Specification and System Validation. The main issue is to trace requirements to design elements and to validation test cases. This is a very important task and a must for the certification process.

The company is moving from a very basic development cycle, that is shown in figure below, to this new model and with the incorporation of some tools to speed up the process.



Current development cycle

The new development process starts specifying the requirements and the use of a Requirement Management tool. The requirements are stored in a database. In interoperability for medical standards there are some standards that must be taken into consideration, therefore a set of interoperability requirements must be added to the product requirements. Those requirements come from the B4.16.

The design of the system is based on the requirements. In the design process there are some tools to perform performance and interoperability analysis to help in the task of choosing the best architectural design that meets all the requirements. Those tools are the ones developed in B4.14 and B4.15 for performance and interoperability analysis.

The validation test cases can be created once the requirements are available. The test cases must be linked with the requirements. A Test Management tool is required for storing the test case information and for the traceability needs.

In the Validation process it is often needed some simulators to be used instead of a real device or environment because availability problems or impossibility of using a real device or environment. The validation process includes the use of Hardware in the Loop (HiL) device developed in B4.06.

It is clear that there are some connections between the tools used in different phases of the development. There is a clear link between stage 1 and 7, and 1 and 2. These connections provide the interoperability requirements for this use case.

The figure below shows the new development cycle including the tools that are going to be integrated to help in different phases and that require interoperability among them.



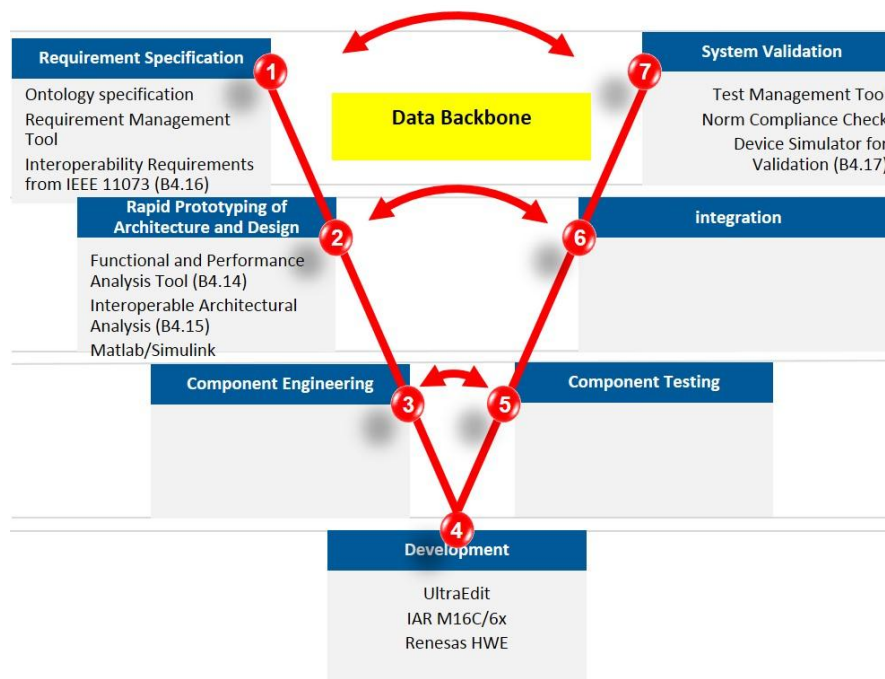


Figure 3-6: Detailed IOS challenges

### Tangible results

Use Case **WP4.6** is making use of bricks developed by TNO, ITI.

**RGB** has been collaborating with ITI and TNO in the specifications of brick B4.06 “Simulation with HW in the loop (HiL) of Real-Time Critical Features”, (integration of B4.06 and B4.17). As a result of this, the definition of the technical core requirements for WP606 has been defined. RGB has also contributed to D606.011.

RGB makes use of Hardware in the Loop (HiL) devices to simulate components of a system, in order to provide a means to evaluate the system before all devices or elements are available in hardware. In medical devices it also provides a means to evaluate patient safety requirements by simulating the patient without risks. This tool allows to evaluate system behaviour (RGB, ITI, TNO). The HiL will substitute a patient to safely evaluate the product.

The simulator includes as a core a model of the human behaviour that must be developed and integrated in the Hardware in the Loop structure. This model behaviour relates only to the changes in blood pressure related to every update of the drug infusion value. In practice, it is based on a transfer function, under a complex framework, in which a number of parameters can be modified. An additional added value still under discussion would incorporate a non-real time solution under restricted HW conditions, for quick analysis of the controller algorithms.

To test the developed software before implementation on a real system, additional tools are used to evaluate HW/SW performance for a specific HW configuration. This work is part of **WP6.3** “Guaranteeing real-time execution of critical features”, and in particular through **B4.14**. “Functional and Performance Analysis”. This brick deals with Functional & Performance analysis tool provide means to evaluate performance and functional requirements analysis at early stages. Timing and Resource allocation is dependent to the final application. The tool will be focused to early evaluate system behaviour.

In this same **WP6.3**, RGB is participating in **B4.15**, Interoperable architectural analysis tool to provide means to evaluate interoperable architectural requirements analysis at early stages. It is required to define the ICT perspective requirements to guarantee the integration of the new elements by modelling the architectural environment by defining a safety and secure model.

In **WP6.8**, RGB is collaborating with ITI in the establishment of the specifications for the B4.16. In this **WP6.8**, also, it will be addressed the need of using norms for Medical Devices interoperability in **B4.16**: Modelling for EN ISO/IEEE 11073 standards

WP6.11 Lifecycle management of simulation models is oriented toward a working method rather than a tool. The goal in Use Case 4.6 could help to improve the certification process as we envision the need to evaluate in the long term a complete line of projects, starting with BP control functionality under varying conditions e.g. different type of drugs, use of several complementary drugs simultaneously, use of varying monitoring methods of the BP , etc,

Finally, a number of engineering Methods have been identified as interesting for the Use Case. Among them the ones selected for further work have been:

### Model Based Analysis

In the process of architecture design, the Model Based Analysis allows to check the suitability of architecture to meet the requirements based on the creation of a model. The model allows to perform different kind of analysis such of timing, throughput, interoperability, etc.

Models are much easier to build than the final device, so several different architectures can be modeled as a solution for a problem. A trade-off analysis can be carried out by comparison between model can be done and the architecture that best meets the requirement can be selected.

<b>Input</b>	Detailed Requirements
<b>Output</b>	Architecture Design validated
<b>Tools</b>	Model Based Analysis Tools
<b>Interoperability</b>	Connection with Requirement Management tool

### Validation Plan Definition

Based on the requirements the engineering method consists on the preparation of the process required to check that the requirements are meet. That includes the definition of the test cases, test environment, test equipment and so on. Test cases must be linked with the requirements. Traceability is very important.

<b>Input</b>	Detailed Requirements
<b>Output</b>	Validation plan (set of use cases)
<b>Tools</b>	: Test Management tool
<b>Interoperability</b>	Connection with the Requirement Management Tool

### Validation Plan Execution

This is the most innovative one. Implies iteration between rtHIL and QM. When a test has been defined that incorporates parameters, the rtHIL can access the parameters and this opens thus the door to test automation. HiL is connected to the controller via the infusion pump and the arm simulator. It contains the patient's model and the connectivity means to the patient's model.

The demonstration of the Engineering Method is decomposed in several scenarios. Each scenario performs a specific action that is needed to perform the EM.

Figure 3-7: Tools involved in the EM shows the tools used in the Engineering Method and its relations.

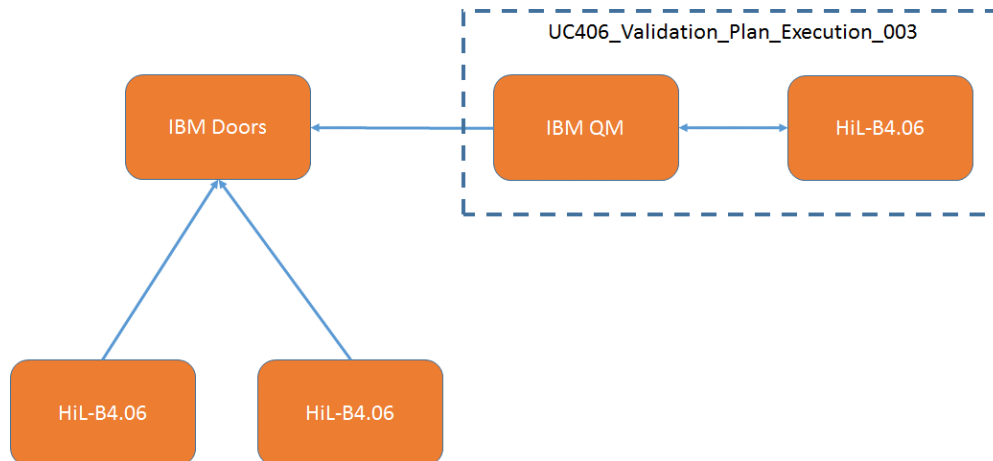


Figure 3-7: Tools involved in the EM

The Engineering Method consists in the execution of the validation process as defined in the validation plan. The plan includes the tests and all the details required to the correct execution of the tests. In some cases

<b>Input</b>	Validation Plan
<b>Output</b>	Test cases results
<b>Tools</b>	Test Case Management tool, Test Case Execution tool, HiL device
<b>Interoperability</b>	Connection between Test Case Management tool and HiL device.

### Requirement Traceability

The requirements must be traceable with the architecture components and until the test cases. The Engineering Method consists in the creation of the traceability matrix linking requirements with architecture elements and test cases.

<b>Input</b>	Requirements, Architecture Components, Test Cases
<b>Output</b>	Traceability Matrix
<b>Tools</b>	Requirement Management Tool
<b>Interoperability</b>	Connection between Requirement Management tool and Test Case Management tool.

### Impact Analysis

The Engineering Method covers the process of determining the parts of the project affected by a change. It is based on the traceability matrix.

<b>Input</b>	Change Proposal, Traceability matrix
<b>Output</b>	Identification of the elements affected by the change
<b>Tools</b>	Requirement Management tool, Test Case Management tool
<b>Interoperability</b>	Connection between Requirement Management tool and Test Case Management tool

#### ***Reasons for deviations***

N/A

#### ***Reasons for failing to achieve critical objectives***

N/A

#### ***Use of resources***

As previously mentioned, the company is moving from a very basic development cycle, to the new and more complex approach and with the incorporation of some tools to speed up the process.

This first year RGB has used slightly more resources than initially expected (not really significant), because our role in Crystal as Use Case owner has demanded quick responses to the consortium demands. For these answers, RGB has undergone an internal adaptation process that has demanded many resources.

#### ***Collaboration with other projects***

N/A

#### ***Statement on the dissemination activities and exploitation perspectives***

Besides the developed Web page, RGB's dissemination / exploitation activities have been related to the presentation of CRYSTAL concepts in the MEDICA Exhibition BOOTH that took place in Düsseldorf in November 2013. A photo of such event is included.



Figure 3-8: MEDIC Exhibition booth

**Corrective actions**

N/A

**3.4.7 WP 407 Specifying Ontology HEALTHCARE (Lead: TNO)****Project objectives for the period M1- M12**

The objective of WP4\_07 is definition of an ontology for healthcare systems engineering, scoped by SP4 use cases. The ontology aims to provide common, unambiguous semantics and a vocabulary for the use cases and deliverables in the healthcare domain. It facilitates interoperability between (ICT) systems and tooling environments in the healthcare domain and extends the generic set of engineering concepts of IOS developed in SP6 by adding healthcare domain specific concepts.

**Work Package progress and achievements during period M1-M12****Progress towards objectives**

Based on the use cases in SP4, we have extracted relevant standards and guidelines for the ontology. Desk research has provided additional standards that apply to the scope of healthcare systems engineering. The SoTA of D407.010 lists all relevant standards that provide a foundation for construction of the ontology.

We have set up a workflow for creating the ontology, including validation in practice by means of process and repository mining (TU/e). We have taken the first step in assembling and filtering relevant domain concepts and terminology.

The table below highlights the contributions of various partners involved in the WP.

Partner	Activities	Deliverables
---------	------------	--------------

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	140 of 269

TNO	As WP leader, TNO contributes to all tasks and coordinates all activities in the WP. Specific activities include: - Task leader T4.7.1 - Editor D407.010 - Workflow T4.7.2	D407.010 - Editor - Contents contribution
TU/e	- Contribution and review D407.010 - Research DSL/Ontology - Workflow T4.7.2 - Use of FRASR tooling	D407.010 - Contents contribution
ITI	- Contribution and review D407.010 - Workflow T4.7.2 review	D407.010 - Review
Philips	- SP4 use cases knowledge/input	D407.010 - Review

**Tangible results**

- D407.010, State of the art for healthcare ontology
- Workflow for creating the ontology (presentation)

**Reasons for deviations**

No deviation from Annex I

**Reasons for failing to achieve critical objectives**

No failing of achievable objectives foreseen.

**Use of resources**

There is slight underspending in effort (7.6MM) compared to effort planned (8.7MM).

**Collaboration with other projects**

Not applicable.

**Statement on the dissemination activities and exploitation perspectives**

Not applicable

**Corrective actions**

There is active contribution to scoping discussions with other ontology WPs and SP6 in order to clarify the role of the ontology in CRYSTAL, including its relationship with IOS. Once the scoping discussions on the role of ontology in Crystal have finished, the work can continue with increased effort.

### 3.5 Sub Project 5 – Rail Domain (Lead: ASTS)

**Project objectives for the period M1- M12****Overview/SP Structure**

The Sub Project SP5 – Rail Domain consists of in total 5 work packages:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	141 of 269



- 1 SP Coordination (WP 500)
- 3 Company-specific use cases (WP 501, WP 502, WP 503)
- 1 Ontology work package (WP 504)

In more detail:

WP	Title	Lead
500	SP Coordination RAIL	Ansaldo STS S.p.A. – I
501	UC – ERTMS/ETCS Interoperable testing. New way.	Ansaldo STS S.p.A. – I
502	UC – Integrated modelling of core algorithms in TAS Control Platform	Thales AT – AT
503	UC – Traction Systems	Alstom Transport – FR
504	Specifying Ontology RAIL	Ansaldo STS S.p.A. – I

### Overall Objectives

The main objectives for the Rail Domain, listed in the DoW, Part B – Technical Annex (on page 36), are to define innovative processes, methods and tools for the design of complex and hybrid railway systems, and, in particular:

- To mature innovative techniques, methods and tools developed in other research projects in order to bring them to a level of maturity that are compatible with a pre-deployment in European railway industry. The Technology Maturity Level (TRL) targeted is at least TRL5 at the end of the project, so that an industrial deployment on operational environment can be envisaged in the three years after the end of CRYSTAL.
- To create within the railway supply chain a common railway vocabulary based on ontology technology for improving data exchange and increasing competitiveness reducing rework and misunderstanding between railway actors.
- To implement the interoperability concept based on the interoperability standard initiated in the frame of CESAR and enhanced in the current project.
- To set up customized industrial framework relying on the CRTP and the platform builder capabilities.

### (Common) Objectives for the period M1 – M12

The first period M1 – M12 of the project has been used to create a strong basis to fulfil the overall objectives listed above. In particular, the SP objectives for the reporting period in question were:

- Definition/description of the company-specific use cases which can provide the basis for the validation of the CRYSTAL results and the TRL assessment.
  - Definition of use cases
  - Specification of methodological requirements
  - Choice of modelling methodologies
  - Collection of requirements specifications for bricks to integrate



- Identification and evaluation of relevant tools
- Definition of requirements for IOS
- Analysis and formalization of bricks (implementation activities)
- Implementation of a first demo in order to demonstrate the improvements in consequence of the application of the CRYSTAL bricks
- Investigation of existing standards and ontology catalogues in order to create a solid basis for a widely accepted vocabulary.
- Application of ontology activities for the definition of interoperability standard.

### ***Sub project progress and achievements during period M1-M12***

#### ***Progress towards objectives***

Looking at the above mentioned common objectives for the period M1 – M12, the SP 5 work package leaders have reported progress towards these objectives as indicated in the table below:

	WP 501	WP 502	WP 503	WP 504
Definition of use case	X	X	X	
Specification of methodological requirements	X	X	X	
Choice of modelling methodology	X	Ongoing	X	
Collection of requirements specifications for bricks	X	X	X	
Identification and evaluation of relevant tools	X	Ongoing	X	
Definition of requirements for IOS	X	X	X	
Analysis and formalization of bricks (implementation activities)	X	X	X	
Demo implementation		X	X	
Investigation of existing standards and ontology catalogues				X
Application of ontology activities for the definition of interoperability standard.				Ongoing

Please notice:

- WP 504 is exclusively dedicated to ontology.
- WP 500 is not listed here, because it is dedicated to the domain management.

More details concerning the use case-/WP-specific objectives can be found in WP 500 – WP 504 reports.

#### ***Tangible results***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	143 of 269

- Submission to JU of the following deliverables:
  - CRYSTAL\_D\_D501 010 - Data and Methodologies report
  - CRYSTAL\_D\_D501.020 - Use Case Requirements Specifications
  - CRYSTAL\_D\_D502 010 - Use case definition
  - CRYSTAL\_D\_D502.020 - Bricks interface requirements
  - CRYSTAL\_D\_D503 010 - Use Case Requirements Specifications
  - CRYSTAL\_D\_D503.020 - IOS Needs For RTP Specifications
  - CRYSTAL\_D\_D503.030 - IOS Design Requirements
  - CRYSTAL\_D\_D504.010 - State of the art for RAIL ontology
- Presentation of demonstrator results during the 1<sup>st</sup> JU Interim Review Meeting in Bruxelles.

#### ***Reasons for deviations from Annex I***

There are no crucial deviations mentioned by partners.

The only exception is represented by Thales AT, which decided not to use SCADE in the context of model driven automated test-case generation. Hence, as reported in its WP report, <<The safety analysis tool MB RAMS (AIT) will not be used in this use case, we will switch to Safety Architect (All4tech) This results in a shift of efforts to T3 (building SEE)>>.

#### ***Reasons for failing to achieve critical***

N/A

#### ***Use of resources***

In general, resources have been used as planned, with the following exceptions:

- Thales AT: <<Due to reasons given in 2.1.3 we are undercommitted for the M1-M12 period. The efforts can be shifted to T3 (building SEE)>>.
- Austrian Institute of Technology: <<Efforts spent are lower than planned because decisions regarding Thales AT use case were taken later than expected and the work was shifted slightly back, thereby falling into the next reporting period. The delay can be easily compensated within the coming few months>>.
- Alstom Transport: <<Due to the fact that the deliverables work started later than expected due to a staffing issue, Alstom Transport spent less effort than anticipated>>.

N. B.: The MU spent by Ansaldo STS S.p.A. in the first year represent much less than 1/3 of total MU. This does not mean that Ansaldo plans to spend less than what initially expected: Ansaldo will stick to the plan, spending all the expected MU within the end of the project. Indeed, the Ansaldo activities have to intensify in the second and in the third year of the project.

#### ***Collaboration with other projects***

The following table gives an overview about the related projects that are mentioned by the SP 5 partners in their work package reports.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	144 of 269

WP	CESAR	MBAT	TRUFAL	MOGENTES	VERDE	IMOFIS	ADN4SE	FSF	InteGRail
501	X	X							
502			X	X					
503		X			X	X	X	X	
504	X								X

### **Statement on the dissemination activities and exploitation perspectives**

The following table gives an overview about the dissemination activities and exploitation perspectives explicitly listed in the work package reports of the partners.

WP	Dissemination	Exploitation
501	Journal paper entitled: "Towards Model-Driven V&V assessment of railway control systems" on International Journal of Software Tools and Technology Transfer (STTT)	Refer to Exploitation Plan
502	<ul style="list-style-type: none"> <li>Internal seminar about Thales Austria tool chain used in Crystal, Crystal RTP and IOS</li> <li>Paper about WP 5.2 tool chain used in Crystal and connection to Crystal RTP and IOS</li> </ul>	Refer to Exploitation Plan
503	SDF & MDE event organized by All4TEC and CEA (Combined design-safety process applied on a Rail use case)	See below
504	N/A	See below

### **Exploitation perspectives:**

WP 503: It is expected that the CRYSTAL project defines the mechanisms and delivers an implementation of a design framework in its Reference Technology Platform (RTP). This framework should help to structure tools interactions through a widely adopted standard as a support of the Engineering process in use within Alstom. The prime focus of the use case concerns the integration of the safety analysis process in the design process. It is expected that the concurrency of the activities as well as the fact that system and software actors in the one hand and the safety engineers in the other hand will share project knowledge through extra design views such as dysfunctional and non-functional ones.

It must be mentioned that next to the focus set in Crystal project, Alstom Transport is engaged in other national or European programs that together should complement the definition and the validation of the next generation of Alstom Design Platform. This resulting platform has to provide efficiency gains throughout the design cycle allowing a more efficient share of knowledge among

large design teams and providing means to perform continuous validation of functional and non-functional requirements, thus shortening significantly rework phases.

**WP 504:** The domain ontologies have to extend and refine the common IOS ontology, aiding the currently developed CRYSTAL Interoperability Specification platform to fulfil the different types of needs expressed by the use case drivers, and paving the way to the creation and the consolidation of an IOS environment.

### **Corrective actions**

The following table gives an overview about necessary corrective actions that are expressed by the SP 2 partners:

WP	Corrective Actions
501	Focusing on discussion of IOS requirements
502	N/A
503	Clarifying OSLC specification and implementation roadmap
504	Focusing on discussion of IOS requirements

## **3.5.1 WP 501 ERTMS/ETCS Interoperable testing. New way (Lead: ASTS)**

### **Project objectives for the period M1- M12**

The objectives of this work package for the reporting period in question were:

- Defining the details of ASTS use case, specifying its main methodological requirements.
- Collecting all the requirements specifications for bricks to integrate to be adopted in ASTS use case.
- Conducting the first implementation activities for the bricks.

### **Work Package progress and achievements during period M1-M12**

#### **Progress towards objectives**

##### **Task 5.1.1 - Use Case Definition (Collect RQ)**

Involved partners: ASTS, AIT, MATE, SUN, UNIFED-II

Progress: Completing the first steps aimed to the implementation of the bricks.

- ASTS: choice of modelling methodology to be adopted in ASTS use case; collection of requirements specifications for bricks; coordination of implementation activities.
- AIT: preparation of own contribution to ASTS use case.
- MATE: analysis and formalization of bricks B5.1, B5.3, B5.4.
- SUN: definition of a model-driven methodology for the automatic generation of test sequences.
- UniFED II: definition of requirements for brick B5.1; collection of state-of-art of modelling methodologies and enabling techniques.

##### **Task 5.1.2 - Prototyping IOS concepts (Definition)**

Involved partners: ASTS, MATE, SUN, UNIFED-II

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	146 of 269

Progress: Focussing on IOS and RTP definitions and prerogatives. Requirements harmonization for IOS integration.

### ***Tangible results***

Submission to JU of the following deliverables:

- CRYSTAL\_D\_D501 010 - Data and Methodologies report
- CRYSTAL\_D\_D501.020 - Use Case Requirements Specifications

### ***Reasons for deviations***

N/A

### ***Reasons for failing to achieve critical objectives***

N/A

### ***Use of resources***

- ASTS: Resources have been used as planned.  
N. B.: The MU spent in the first year represent much less than 1/3 of total MU. This does not mean that ASTS plans to spend less than what initially expected: ASTS will stick to the plan, spending all the expected MU within the end of the project. Indeed, the ASTS activities have to intensify in the second and in the third year of the project.
- AIT: Resources were needed to become common with the use case and prepare AIT's contribution to WP deliverables.
- MATE: The resources have been used as planned.
- SUN: The resources have been used as planned.
- UniFED II: Resources have been used as planned. In particular for the state-of-the art analysis of modelling and enabling technologies, definition and harmonization of requirements.

### ***Collaboration with other projects***

The participation of ASTS in Crystal project aims to complete the renewing of its tools and methodologies on the whole workflow, improving the tool chain already developed in similar European research projects such as CESAR and MBAT.

### ***Statement on the dissemination activities and exploitation perspectives***

Dissemination activities:

Partner	Dissemination	Date
ASTS SUN UNIFED-II	Journal paper entitled: "Towards Model-Driven V&V assessment of railway control systems" on International Journal of Software Tools and Technology Transfer (STTT).	Accepted for publication (estimated date: Middle 2014).

Exploitation perspectives:

- ASTS

Expected Exploitable Result	Business Case and Market	Roadmap for Exploitation	When results become available for use
Exploiting CRYSTAL Technical Innovations (Tools and Methodologies) in <u>Test Definition activities</u>	<u>Improvement in ASTS Testing Process</u> which should easily reduce time and costs needed for the V&V activities.	Having the opportunity to use a new methodology thanks to which the model becomes a sort of “natural step” in test definition process (so that, once the model is defined, the test cases can be semi-automatically generated from it), would imply a significant reduction of time and costs during the validation phase.	End of the project
Exploiting CRYSTAL Technical Innovations (Tools and Methodologies) in <u>Test Definition activities</u>	<u>Improvement in ASTS Testing Process</u> which should easily reduce time and costs needed for the V&V activities.	The traceability of the model, both on system requirements and on generated tests, could support the engineers in the analysis of the impact of modifications in system requirements during the whole life cycle of the system, reducing time needed to identify the impacted tests and to modify them after changes in requirements.	End of the project
Exploiting CRYSTAL Technical Innovations (Tools and Methodologies) in <u>Test Executions activities</u>	<u>Improvement in ASTS Testing Process</u> which should easily reduce time and costs needed for the V&V activities.	Through the conversion into a data standard format it will be possible to solve the interoperability problems due to different proprietary data formats (coming from heterogeneous providers) that hinder the test execution.	End of the project

Exploiting CRYSTAL Technical Innovations (Tools and Methodologies) in <u>Test Report Analysis activities</u>	<u>Improvement in ASTS Testing Process</u> which should easily reduce time and costs needed for the V&V activities.	The automatic traceability between requirements and tests would simplify the maintenance of entire test suite and the analysis of the results, speeding up the identification of requirements or parts of the system not rightly implemented.	End of the project
Exploiting CRYSTAL Technical Innovations (Tools and Methodologies) in <u>Test Report document Drawing up activities</u>	<u>Improvement in ASTS Testing Process</u> which should easily reduce time and costs needed for the V&V activities.	Through the automatic generation of the report of the testing campaign it will be possible to reduce significantly the effort currently spent in manually analyzing that report.	End of the project

- MATE

<b>Expected Exploitable Result</b>	<b>Business Case and Market</b>	<b>Roadmap for Exploitation</b>	<b>When results become available for use</b>
Rail Model	The tool provides a software solution initially focused for the rail domain, which allows the modelling of the behaviour of complex and synchronous systems. The adoption of the tool in the rail domain industries, allows to save time and reduce the costs of these activities. The support offered to the technical team in the generation of test cases, helps the industries to be more competitive.	Consultancy services on customizations of the modelling environment and on tools for the automatic test case generation.	End of the project



IOP test writer Tool	The tool allows the creation of scripts defined in IOP language. The IOP language is specific of rail domain, a tool that supports the generation of test script in IOP language offers great benefits to the railway industry accelerating the test activities to be carried out on a real environment or through a simulator.	Creation of a new product and customisation support.	First prototype end 2015. Ready for exploitation first half 2017
Log Analyzer Tool	The tool allows to analyze the test execution log and support the engineering team in the identification of failed tests and requirements not correctly implemented. The features introduced by the tool reduces the time required to implement changes to get a working system.	Creation of a new product and customisation support.	First prototype end 2015. Ready for exploitation first half 2017
IOS/OSLC expertise	One of main topic in Crystal is the IOS (tool interoperability specification). The interoperability specification defined in Crystal can be extended to companies interested to use OSLC/IOS in their development process.	Consultancy services.	End of the project

- UNIFED-II

Expected Exploitable Result	Business Case and Market	Roadmap for Exploitation	When results become available for use
-----------------------------	--------------------------	--------------------------	---------------------------------------

Enhanced know how on verification processes in the railway domain, Model Based System Testing and Tools Interoperability.	CRYSTAL activities will results in a positive influence on the research and learning activities of the Electrical and Information Technology Department (DIETI) at the University of Naples Federico II	Public results from the research activities will be integrated in academic courses as well as in learning projects for graduated students	End of the project.
---	---	---	---------------------

### **Corrective actions**

Focusing on discussion of IOS requirements.

## **3.5.2 WP 502 Integrated modelling of core algorithms in TAS Control Platform (Lead: Trail)**

### **Project objectives for the period M1- M12**

The objective of this work package during the period M1-M12 was:

#### **T1 Use Case Definition (Collect RQ)**

- Use case definition and prototyping for collection of requirements for modelling needs
- Collect relevant modelling methodologies and technologies for the use case
- Relevant tools identification: Find tools relevant to the use case
- Definition of characteristics, interfaces, tools used in this work package
- First demonstrator on applicability of our approach
- Definition of AIT tool interfaces for effective use in our tool chain

#### **T2 Prototyping IOS concepts (Definition)**

- Definition of the interfaces for the use case models and tools within CRYSTAL platform
- Definition of required adaptations/combinations of tools and interfaces in terms of IOS/RTP compliance
- 

### **Sub project progress and achievements during period M1-M12**

#### **Progress towards objectives**

##### **TRAIL:**

1. First iteration of Use Case Definition has been completed successfully leading to deliverable D502.010 (use case definition)
2. For the specification of the IOS requirements an early demonstrator has been developed showing the feasibility of the model based automated test case generation approach
3. Selection of modelling techniques and tool evaluation is still ongoing. Different safety analysis tools are tested

##### **AIT:**

T1: Elaboration of RAMS concept in TRAIL Use Case, Contributions to D502.010, and Preparation of environment for TRAIL use case. Preparation of D502.020

T2: Elaboration of Brick interfaces.

T1, T2: preparation and presentation of these works at interim review.

### **Tangible results**

In-time submissions of deliverables D502.010 and D502.020.

Presentation of demonstrator results during the JU Interim Review Meeting in Bruxelles.

### **Reasons for deviations**

##### **TRAIL:**

After an internal analysis it was decided to not use SCADE in the context of model driven automated test case generation. The safety analysis tool MB RAMS (AIT) will not be used in this

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	152 of 269

use case, we will switch to Safety Architect (All4tech) This results in a shift of efforts to T3 (building SEE)

### ***Reasons for failing to achieve critical objectives***

N/A

### ***Use of resources***

#### **TRAIL:**

Due to reasons given in “reasons for deviations” we are under committed for the M1-M12 period. The efforts can be shifted to T3 (building SEE).

#### **AIT:**

Resources were needed to become common with the Thales use case and prepare AIT's contribution to WP deliverables. Efforts spent are lower than planned because decisions regarding the use case were taken later than expected and work was shifted slightly back, thereby falling into the next reporting period. The delay can be easily compensated within the coming few months.

### ***Collaboration with other projects***

Part of this use case (testing automation) builds on the work done in the FP7 projects TRUFAL and MOGENTES together with AIT.

### ***Statement on the dissemination activities and exploitation perspectives***

These dissemination/exploitation activities are submitted in WP1.2 as well.

#### **Dissemination activities:**

<b>Date of event / publication</b>	<b>Short description of media / event</b>	<b>What is the possible CRYSTAL contribution?</b>
2015 & 2016	Internal seminar about Thales Austria tool chain used in Crystal, Crystal RTP and IOS	Activity performed by Thales Austria in WP 5.2 and also more generic goals
TBD	Paper about WP 5.2 tool chain used in Crystal, connection to Crystal RTP and IOS	Activity performed by Thales Austria in WP 5.2

#### **Exploitation activities:**

<b>Expected Exploitable Result</b>	<b>Business Case and Market</b>	<b>Roadmap for Exploitation</b>	<b>When do you expect the results become available for use?</b>
Tool support for capturing safety driven design features derived from safety requirements and safety analysis	Validation time reduction through facilitation of the validation of design measures stemming from safety requirements.	Use of methodology in future safety analyses on products based on model driven engineering	3-5 years

Tool support for model based automated test generation	Shorter time-to-market and cost reduction through ease of the V&V process	Implementation of automated test case generation as part of the standard testing methodologies within the working group	3-5 years
--	---	---	-----------

### **Corrective actions**

N/A

## **3.5.3 WP 503 Traction Systems (Lead: ALS)**

### **Project objectives for the period M1- M12**

The objectives of this work package for the reporting period in question were:

- Defining the details of ALS use case, specifying its main methodological requirements.
- Projecting workflow, process, data and tooling needs onto IOS functional requirements
- Producing first models of the use case to allow preliminary tests with the main technology provider.
- Evaluating the current maturity of OSLC specification and implementation in concerned tools.

### **Work Package progress and achievements during period M1-M12**

#### **Progress towards objectives**

##### **Task 5.3.1 - Use Case Definition (Collect RQ)**

Involved partners: ALS, ALL4TEC

Progress: done

- ALS: specifying the Rail Use case, producing first models and meta-models supporting the safety process consistently with the Alstom methodology.
- ALL4TEC: analysing Alstom process and use-case requirements

##### **Task 5.3.2 - Prototyping IOS concepts (Definition)**

Involved partners: ALS, ALL4TEC

Progress: The IOS needs for RTP specifications are defined after an overall analysis of the targeted combined Design-Safety process.

A first design view is now elaborated to specify the required IOS services to comply with the expressed needs.

### **Tangible results**

Submission to JU of the following deliverable:

- CRYSTAL\_D\_D503.010 - Use Case Requirements Specifications
- CRYSTAL\_D\_D503.020 – IOS Needs For RTP Specifications
- CRYSTAL\_D\_D503.030 – IOS Design Requirements
- Contribution to:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	154 of 269

- CRYSTAL\_D\_D604.011 - Specification, Development and Assessment for Safety Engineering

### **Reasons for deviations**

There is no deviation in the deliverables although the work started later than expected due to a staffing issue. Thanks to efforts made by the project's actors it was possible to keep the expected deliverable pace.

### **Reasons for failing to achieve critical objectives**

N/A

### **Use of resources**

Due to the reason explained in 2.1.3, ALS spent less effort than anticipated  
Status at T0+9 was 6.5MM spent versus 8 planned

### **Collaboration with other projects**

The participation of ALS in Crystal project aims at constructing the next version of the system development framework. It is expected that several project's results will allow to get a rather complete solution introducing significant breakthroughs. Results of projects like VERDE and IMOFIS (National) are already integrated and contribution from MBAT, ADN4SE (National) as well as FSF ( IRT SystemX project) should complete the platform.

### **Statement on the dissemination activities and exploitation perspectives**

#### Dissemination activities

Industrial Workshop	SDF & MDE event organized by All4TEC and CEA Combined design-safety process applied on a Rail use case	presentation	18.11.2013	Elie Soubiran	ALS
---------------------	---	--------------	------------	---------------	-----

#### Exploitation perspectives

It is expected that the CRYSTAL project defines the mechanisms and delivers an implementation of a design framework in its Reference Technology Platform (RTP). This framework should help to structure tools interactions through a widely adopted standard as a support of the Engineering process in use within Alstom. The prime focus of the use case concerns the integration of the safety analysis process in the design process. It is expected that the concurrency of the activities as well as the fact that system and software actors in the one hand and the safety engineers in the other hand will share project knowledge through extra design views such as dysfunctional and non-functional ones.

It must be mentioned that next to the focus set in Crystal project, Alstom Transport is engaged in other national or European programs that together should complement the definition and the validation of the next generation of Alstom Design Platform. This resulting platform has to provide efficiency gains throughout the design cycle allowing a more efficient share of knowledge among large design teams and providing means to perform continuous validation of functional and non-functional requirements, thus shortening significantly rework phases.

### **Corrective actions**

ALS needs toward the project: Clarify OSLC specification and implementation roadmap because it is currently difficult to plan the convergence of the demonstrator based on available bricks or declared availability.

## **3.5.4 WP 504 Specifying Ontology RAIL (Lead: ASTS)**

### **Project objectives for the period M1- M12**

The objectives of this work package for the reporting period in question were:

- Exploring existing standards and ontology catalogues to create a solid basis for a widely accepted vocabulary.
- Applying ontology activities on the definition of the interoperability standard (IOS).

### **Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

#### **Progress towards objectives**

Task 5.4.1 - Evaluating state-of-the-art ontology

Involved partners: ASTS

Progress: study of the state of the art of railway ontology and assessment of all the required needs towards the creation of a domain ontology well located within a unique IOS ontology context.

#### **Tangible results**

Submission to JU of the following deliverable:

CRYSTAL\_D\_D504.010 - State of the art for RAIL ontology

#### **Reasons for deviations**

N/A

#### **Reasons for failing to achieve critical objectives**

N/A

#### **Use of resources**

ASTS: resources have been used as planned.

N. B.: The MU spent in the first year represent less than 1/3 of total MU. This does not mean that ASTS plans to spend less than what initially expected: ASTS will stick to the plan, spending all the expected MU within the end of the project. Indeed, the ASTS activities have to intensify in the second and in the third year of the project.

#### **Collaboration with other projects**

In order to collect the existing standards and the ontology catalogues related to the rail domain, the outcomes of several previous projects such as InteGRail and CESAR have been taken into consideration.



### **Statement on the dissemination activities and exploitation perspectives**

N/A

Exploitation perspectives - The domain ontologies have to extend and refine the common IOS ontology, aiding the currently developed CRYSTAL Interoperability Specification platform to fulfil the different types of needs expressed by the use case drivers, and paving the way to the creation and the consolidation of an IOS environment.

### **Corrective actions**

Focusing on discussions concerning the role of domain ontology and its connection with the other ontologies within the project.

## **3.6 Sub Project 6 - R&T ACTIVITIES (Lead: EADS IW-UK)**

### **Project objectives for the period M1- M12**

The objective of the sub project 6 “R&T ACTIVITIES” is to develop the CRYSTAL RTP; this includes all technology bricks (WP603-WP613), the RTP Platform Builder (WP602) and the RTP Interoperability Specification (WP601). The Interoperability Specification (IOS) is a cornerstone of the CRYSTAL RTP strategy. The baseline for the IOS was already defined by the ARTEMIS CESAR project. CRYSTAL will enhance the IOS and together with relevant stakeholders (major tool-vendors and industrial end-users) increase the maturity and industrial acceptance in order to prepare a standardization of the IOS.

However, the largest part of SP6 in terms of effort and involved partners belongs to the development of the so called CRYSTAL technology Bricks. Bricks are processes, methods and tools (more detailed definition below) which do enable the IOS. Therefore the Bricks can be seen as “standardized” building blocks (thanks to the IOS), which can be used to construct a user specific RTP instance.

The process of “building” an RTP instance based on available Bricks will be supported by the RTP Platform Builder (cf. WP602).

Work Package Nr.	Work Package Name
WP601	IOS Evolution & Development, Standardisation
WP602	Platform builder
WP603	System analysis and exploration
WP604	Tools for Safety Engineering
WP605	AUTOSAR Tools & Components
WP606	Heterogeneous Simulation
WP607	Requirements Based Engineering
WP608	Product Lifecycle Management
WP609	Multi-viewpoint Engineering
WP610	Variability Management
WP611	Software Development Lifecycle (SDLC) Management Brick Community
WP612	Validation Models
WP613	Simulation Models

### **Sub project progress and achievements during period M1-M12**

This section gives details for each sub project the work performed and progress achieved.

### **Summary of progress towards objectives**

Within SP6 all bricks are developed which will form the CRYSTAL RTP. Also the Interoperability Specification and the RTP Platform Builder are part of SP6.

From a SP management point of view, two key activities were carried out within the reporting period (both described in D600.010):

- Definition of a technical management process in order to define, describe and develop the bricks; but also to link the bricks development to the overall CRYSTAL development process / objectives
- Definition of an IOS needs capture process; a key activity of the first year was to educate use case owners regarding IOS and to collect their needs. It was lessons learnt from CESAR project that this is essential, but not an easy task, as usually engineers are well trained to explain their system function needs but not the interfacing needs between the different disciplines/tools which are involved when developing their functions. The IOS needs capture process was introduced via a couple of training sessions so that in the end all use case owners are able to express and define their so called engineering methods and therefore also their IOS needs.

WP602 – Platform Builder – has delivered a first meta model, which will be discussed in order to identify the basis for the platform builder process/tool.

All bricks related work packages (i.e. WP603-WP613) have delivered their first bricks which can be used by the respective use cases.

### **Tangible results**

The table below shows all the deliverables done inside SP6 in order to document the achieved results.

Deliverable Number	Short Title
D600.010	Bricks Engineering Process Template
D601.010	State of the art – Interoperability
D601.021	Interoperability Specification - V1
D601.031	Report on Standardisation Work - V1
D602.011	Meta-model specification - V1
D603.011	Specification, Development and Assessment for System Analysis and Exploration - V1
D604.011	Specification, Development and Assessment for Safety Engineering - V1
D605.011	Specification, Development and Assessment for AUTOSAR Tools & Components - V1
D606.011	Specification, Development and Assessment for Heterogeneous Simulation - V1
D606.021	Heterogeneous Simulation Approach - V1
D607.011	Specification, Development and Assessment for Requirements based Engineering - V1
D607.021	Requirements Quality Analyzer - V1
D607.031	Requirements Authoring Tool - V1
D607.041	knowledgeMANAGER - V1
D608.011	Specification, Development and Assessment for Product Lifecycle Management - V1
D609.901	Specification, Development and Assessment Report V1
D610.011	Crystal Variability Management - V1
D610.031	Brick System Family Engineering Framework - V1

D611.011	Specification Development and Assessment for Software Development Lifecycle Management - V1
D611.051	A summary of the feedback from assessment of IBM Systems and Software Engineering Solution - V1
D612.011	Specification, Development and Assessment for Validation Models - V1
D613.011	Specification, Development and Assessment for Simulation Models - V1

### Use of resources

The table below shows the planned effort vs. used effort for each WP within SP6. The general trend is that SP6 in total is underspending. Several partners justify the underspending with ramp up activities, late start of the project (due to hiring processes, national grant agreements, etc.). However, all deliverables of SP6 could be delivered until M12, even if there were some small (less than 2 months) delays for several. The overall impact of the underspending of SP6 is not critical at the moment.

However there are some WPs with some remarkable differences regarding planned and used effort:

- WP601: Beside the reason given by some partner justifying the deviation, it is important to mention, that several partners from WP601 have been working with Use Case providers directly and have booked effort in the respective use case WP rather than in WP601. The focus of the interoperability specification activities in the first year was clearly on the relationship building with use case owners in order to get higher quality IOS needs from them. This was a lessons learnt from former projects like CESAR, where the IOS related requirements from use case owners did not meet the expected quality.
- WP611: several partners reduced their effort in this WP in order to allocate it directly to some use cases in order to understand better the Lifecycle Management aspect. For example the Aerospace Public Use Case demonstrator definitely benefited from this shift of efforts and as this use case is public, the whole consortium (including dissemination) will benefit as well.

Work Package	Planned Effort	Used Effort	Justification for Deviation (only regarding partners who had a relevant deviation)
WP601	70.5	52.6	EADS IW-UK: lack of resources (due to internal transfer of people between UK and France + people leaving the company) IBM-UK: Slower ramp up of the Crystal project
WP602	45.55	48.79	ALA: The effort has been a bit higher than planned due to the need to clearly define and share the Platform Builder concept among industrial partners and tool providers. ITI: A high level of involvement has been needed in order to collaborate in the definition of the meta-model and the specification.
WP603	101.6	83.46	TNO: Deliveries for this work package have to date been good but recruiting staff with the correct skills remains a problem since two times a key researcher left the team. Efforts are ongoing to bring the staffing up to full strength. ARCT: Our specification time frame has been shifted to be

			completed Q3 2014.
WP604	91.82	88.82	<p>AIT: A number of bricks extensions and improvements identified as relevant for the use cases have been started early due to higher availability of human resources. For instance, extending the bounded language inclusion problem in MoMuT from deterministic timed automata to non-deterministic timed automata with silent transitions for better real-time support.</p> <p>EADS IW-G: Late clarification of needs with Airbus and Cassidian. In any case, the use of effort is not linear for this Work Package. The main effort consumption is expected at later phases of the WP.</p>
WP605	79.13	74.83	Volvo: We have focused on developing our use case in WP3.1 in order to understand how the EAST-ADL/AUTOSAR interface is to be used.
WP606	35.01	31.57	TNO: The demonstration work is dependent on progress in WP406 (RGB case). This has delayed work somewhat.
WP607	58.57	50.35	UC3M: Funding arrived late from the National Funding Authorities, personal could not be contracted on time.
WP608	75.56	69.23	<p>EADS IW-G: Due to the decision with other partners to use the WP208 use case as piloting use case and concentrate on the quick development of a first WP208 SEE demonstrator, we had to spend more effort on WP208 and take this effort from elsewhere.</p> <p>The SEE demonstrator development roadmap required a focus on ALM related tasks in the first place. The integration with PLM is still an important topic but will occur after a first successful development of an ALM brick has been achieved.</p> <p>Consequently, the effort for the ALM related Work Package WP611 is higher in this first phase of the project, while the effort for the PLM related Work Package 608 is lower than initially planned.</p> <p>EADS IW-UK: this activities are link to Airbus Group Use Cases WP2.1 and WP2.3 and are not scheduled yet</p> <p>SISW: In the discussion with ALA we decided to regroup the deliveries in order to have a better and more streamlined structure</p>
WP609	187.3	150.2	TGS: Some experts left TGS to takeover MDE activities in Thales Units who were not replaced. Lack of French contract for the Crystal project.
WP610	74.86	64.3	<p>EADS IW-G: Due to the decision with other partners to use the WP208 use case as piloting use case and concentrate on the quick development of a first WP208 SEE demonstrator, we had to spend more effort on WP208 and take this effort from elsewhere.</p> <p>Among others, we decided to take the effort from WP6_10, since Product Line Engineering aspects were not in the focus of the development of the first WP208 SEE Demonstrator.</p>

WP611	55.66	28.03	<p>EADS IW-G: Due to the decision with other partners to use the WP208 use case as piloting use case and concentrate on the quick development of a first WP208 SEE demonstrator, we had to spend more effort on WP208 and take this effort from elsewhere.</p> <p>The SEE demonstrator development roadmap required a focus on ALM related tasks in the first place. Consequently, the effort for the ALM related Work Package WP611 is higher in this first phase of the project.</p> <p>IBM-UK: Partners realign or reduce effort. Fewer provider partners active in the WP. delays in Crystal ramp up</p> <p>IBM-NL: We originally planned to spend much more effort on this WP than we actually did. The reason is that we started this effort only end of last year due to a delay in the signing of the APCA. Coming year we will recover from this deviation by assigning additional staff to this WP.</p>
WP612	116.63	112.02	n/a
WP613	74.2	74.09	n/a

### **Collaboration with other projects**

An information flow / exchange was established to / with the following ARTEMIS / national funded projects. For more details, please check the dedicated WP report.

ARTEMIS Projects:

- MBAT
- CESAR
- EMC2

German national funded projects :

- SPES\_XT
- ARAMIS
- 

### **Statement on the dissemination activities and exploitation perspectives**

The CRYSTAL RTP & IOS were disseminated in several events – see dissemination report for more details. In December 2013 the 2nd European Conference on Interoperability for Embedded Systems Development Environments was organized in Stockholm by CRYSTAL in the context of the ARTEMIS Technology Conference series.

## **3.6.1 WP 601 IOS Evolution & Development, Standardisation (Lead: EADS IW-UK)**

### **Project objectives for the period M1- M12**

The main objective of this work package is to define the interoperability specification of the CRYSTAL RTP by re-using existing work and results from other ARTEMIS projects like CESAR, MBAT, iFEST, and others. Furthermore this work package shall start the discussion with relevant bodies in order to prepare the standardisation of the RTP interoperability specification.

The work package is divided into three tasks:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	161 of 269

- the first task will investigate and analyse existing interoperability specifications like the ones coming from the ARTEMIS CESAR, MBAT and iFEST projects and others (also non-ARTEMIS);
- the second task will consolidate the existing results and enhance them according to CRYSTAL additional objectives towards the CRYSTAL interoperability specification to meet the common needs of the industrial domains;
- the third task will establish links and run workshops with existing bodies for technical interoperability in the scope of safety critical systems engineering, in order to prepare the interoperability specification standardization.

### **Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

#### **Progress towards objectives**

The focus of M1-M12 regarding IOS was on dissemination of existing results from former projects like CESAR, MBAT, iFEST and education of industrial end users regarding the identification of IOS related needs, as this was identified as a weak point in some former projects. For that purpose a process was set up to collect the needs and templates were created to ease the data collection from use case providers. A series of web meetings / workshops were organized to educate end users. The result of this exercise is the basis for the interoperability specification. Several so called engineering methods were identified – these methods can be used across use cases and some even across domains. The methods are tool / technology independent and therefore a good base line for the interoperability specification.

Partner contributions to 6.1 for the reporting period:

Partner	Contribution to WP within the reporting period
ALA	Participation to the definition of template information for gathering IOS requirements. Participation to F2F meetings having IOS concerns among their primary objectives. Continuous analysis of the links and commonalities that exist among IOS concepts and SEE configuration properties.
AIT	AIT contributed to this work package by carrying out a number of standardization activities: <ul style="list-style-type: none"> <li>▪ May-Dec. 2013: IEC 61508-3 Amendmend resp. TS for “SW proven in use” ongoing</li> <li>▪ Dec. 2, 2013: IEC 61511 meeting Helsinki contribution to Part 1.</li> <li>▪ Jan. 28, 2014, London: New Work Item TC65 WG 17 Human Factors – Functional Safety</li> <li>▪ Feb. 4, 2014, Brussels: ARTEMIS standardization WG – Interoperability etc., Coop. with CRYSTAL, MBAT, nSafeCer</li> <li>▪ National mirror groups meetings of MR65 (all TC65, SC 65A, B, C, E Standards, CEN/CENELEC), TSK 44 (IEC TC 44 Machinery safety) and EG 56 (TC56 Dependability), ÖNORM/ASI FA 038 (ISO TC 22 SC 3 for ISO 26262) and FA 028 (ISO TC 184 SC 2, Robotics, TC4 and others on Machinery Safety)</li> </ul>
AVL	AVL participated actively in the IOS development. The activities where AVL participated include:



	<ul style="list-style-type: none"> <li>▪ Definition of IOS scope and architecture</li> <li>▪ Definition of the IOS development process</li> <li>▪ Integration of the IOS development process in the overall technical management process</li> <li>▪ Organization of meetings with the IOS core group and other required experts from the consortium</li> </ul> <p>Participation to events related to standardization:</p> <p>To foster the collaboration with standardization bodies and related projects, AVL participated to several events in order to meet the relevant stakeholders.</p> <ul style="list-style-type: none"> <li>▪ ARTEMIS and Standardization Working Group Workshop</li> <li>▪ ASAM International Conference</li> <li>▪ ARTEMIS and Standardization Working Group Workshop</li> <li>▪ ARTEMIS Spring Event</li> <li>▪ ProSTEP iViP Symposium</li> </ul> <p>D601.031: As the deliverable lead, AVL organized the work on the document and consolidated the input from the other partners</p>
EADS IW-UK	<p>Definition of a top-down approach to collect the IOS Needs from End Users.</p> <p>Organisation of several workshops (virtual and physical) to educate end users and technology providers about IOS concepts. Contribution to Deliverables D6.1.1 (State of the art – Interoperability) and D6.1.2 (Interoperability Specification)</p>
FBK	<p>Analysis of the results of the ARTEMIS projects pSafeCer and nSafeCer , for a possible re-use in Crystal, in particular as regards the RTP interoperability. FBK has contributed to task 6.1.2 and in particular to the extension of the IOS. FBK has contributed to the concept of the IOS, and its development by taking into account the validation and verification tools provided by FBK.</p>
FhG	<p>Contribution to IOS Specification in particular integration of harmonized interoperability challenges from automotive domain. Analysis of automotive engineering methods and definition of IOS core requirements.</p>
IBM UK	<p>Contributions to technical management process. Draft IOS contributions. Advisory role to multiple use-case owners and provider partners. Model the technical management process and align to IBM methods.</p>
ITI	<p>ITI has been working on the analysis of the state of the art that can be of interested for the Interoperability specification. ITI has also gained knowledge of OSLC as one of the elements for IOS. ITI has also collaborated in the revision of the Engineering methods prepared by the healthcare domain use cases, in order to ensure a good enough definition and for extracting commonalities among them. ITI has also participated in the workshops that have been organised for working on IOS.</p>
OFFIS	<p>OFFIS has provided presentations for dissemination purpose and for building up a consensus on the issues related to the IOS at project level, template documents and guidelines to be used for collecting Engineering Methods from the CRYSTAL use cases, has contributed to the definitions of collaboration models and processes to be implemented and deployed across the CRYSTAL domain SPs and Technical WPs towards the specification of the enhanced CRYSTAL IOS.</p>



SAGEM	Contribution to the definition of the WP601 objectives through the definition of Engineering Methods in the WP204 work package. Participation to the Munich IOS Meeting June 20-21, 2013.
SIEMENS	<ul style="list-style-type: none"> <li>work with the OASIS-OSLC standardisation organization to develop and enhance the OSLC stand which was chosen as basis for the CRYSTAL IOS</li> <li>represent CRYSTAL project in the Steering Committee of the OASIS-OSLC standardisation member section</li> <li>work with other standardisation organisation to promote the CRYSTAL IOS standard (a.o. ProSTEP, iViP, Incose)</li> <li>represent CRYSTAL IOS concerns in the ARTEMIS Standardisation Workgroup</li> <li>support of CRYSTAL dissemination activities in organizing conference about interoperability and speak at other relevant conferences (see dissemination plan).</li> <li>represent WP6.1 in the CRYSTAL technical board</li> <li>contribute as author to WP6.1 deliverable interoperability specification - V1</li> <li>support domain use case owner to define their UC engineering methods and map their engineering method activities to the IOS concerns.</li> </ul>
SYS	Participation in workshops and meetings. Focus on automotive related IOS such as Autosar
IST	Contribution to IOS specification. Definition of IOS requirements based on engineering methods (automotive domain)
TASE	TASE has contributed to the revision process of the Engineering Methods of the aerospace domain, identifying Engineering Methods and the way they interact each other and performing an alignment of these methods and interoperability scheme and requirements with respect to those selected for the aerospace public use case. TASE has participated in the different telcos/webinars held to that end by Project Coordinator and has held others by its own initiative with SP2 leader and Product Lifecycle Expert.
UNIFED-II	Preliminary investigation of existing interoperability specifications coming from the CESAR, MBAT projects.
VOLVO	We participated in SP6 telcos. We have reviewed deliverables D613.011 and D613.021 on simulation models.

### ***Tangible results***

The focus in the first 12 months of the project regarding to IOS was set to disseminate and educate partners regarding the IOS achievements from former projects like CESAR, MBAT, iFEST, etc. A couple of workshops and web meetings were organized.

Furthermore the focus regarding IOS was set on Process Lifecycle Interoperability where OSLC was discussed and selected as an existing solution to be used for the CRYSTAL IOS. A couple of OSLC related education sessions were organized in order to educate project partners.

The following deliverables were issued during the reporting period:

- D601.010 State of the art – Interoperability
- D601.021 Interoperability Specification

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	164 of 269

- D601.031 Report on Standardization Work

### ***Use of resources***

See Annex 1 Beneficiary Reports M1 - M12

### ***Collaboration with other projects***

A collaboration (IOS Task Force) was set-up between the ARTEMIS MBAT and CRYSTAL project in the context of IOS development. Several partners from this WP are also involved in the IOS WP of MBAT.

### ***Statement on the dissemination activities and exploitation***

The CRYSTAL IOS was disseminated in several events – see dissemination report for more details. In December 2013 the 2nd European Conference on Interoperability for Embedded Systems Development Environments was organized in Stockholm by CRYSTAL in the context of the ARTEMIS Technology Conference series.

## **3.6.2 WP 602 Platform builder (Lead: ALA)**

### ***Project objectives for the period M1-M12***

This WP has the objective to define solutions and methods to improve the instantiation of product development environments for embedded systems based on the configuration of a dedicated development process. The meta-model/specification representing the business development process will be defined and enriched in order to exhaustively support the specification and deployment of a fully integrated tool-chain instantiated for the desired project/product.

### ***Work Package progress and achievements during period M0-M12***

Using process development information (described in a model) together with deployment and IT infrastructure information, and using a specification to describe tools' properties, a Development Platform Architect, applying the Platform Builder, will be able to plan a development environment and it will be able to configure and validate the infrastructure to deploy.

### ***Progress towards objectives***

During this period M0-M12, all Milestone1's objectives and some objectives towards Milestone2 were followed. In detail WP 602 partners have identified and defined concepts relevant to Platform Builder. First of all, it was identified a Platform Builder workflow that specifies phases to be performed and objects to be produced to accomplish the main goal of Platform Builder WP; in the scope of Platform Builder, identified phases are: tailoring the Process, Configuring and Validating the System Engineering Environment.

On the basis of Platform Builder workflow phases, we have identified needed elements and specified the architecture for Platform Builder prototype.

In detail, main objectives for Milestone1 period were: meta-model definition and Platform Builder specification that deal with:

- Collect requirements from End Users to specify the Platform Builder
- Define meta-model in order to describe the System Engineering Environment (SEE) Platform and its relevant topics.

- Survey/Identify technologies to implement the Platform Builder (SoA) and select technologies.

The goal of Milestone 2 in our WP is to have the first version of Platform Builder ready to use and this deal with:

- Identify major features, selecting them from specification of Platform Builder, needed for a first version: tailoring the process and configure the SEE are the mains features to be implemented in M2.
- Identify a Use Case to apply the first version of Platform Builder

During this period, participants worked together to achieve these identified objectives. In order to assign activities and responsibilities of WP 602 to participants, identified tasks and objectives were assigned considering roles of partners in the project, as declared and described by each partner in the CRYSTAL DOW, and considering also roles defined in the context of WP 602. Table 3-3 shows results of this process.

This table shows the objectives for each task in order to achieve WP 602's goal:

Task	objectives
Task 6.2.1	Define concepts relevant to the system engineering environment, in details for Tool-Chain definition and needed IT infrastructure, and formalize them with a meta-model.
Task 6.2.2	Specify functionalities that a Platform Builder should have, in details a Platform Builder shall be able to generate a SEE configuration starting from a Tailored Process.

Table 3-3: tasks objectives in WP602

Within our WP, we have identified different roles in order to assign tasks to each partner:

**Technological Provider** role refers to who has technological knowledge and competence to define/specify meta-models, to support Platform Builder implementation/prototyping. It mainly participates in tasks 6.2.1 and 6.2.3 to extend meta-model in order to represent Development Environment Descriptor, Tool Descriptor, and IT Infrastructure Descriptor and to support Platform Builder prototyping.

**Use Case Provider** role refers to who is able to identify needs and requirements, as Industrial End User point of view, to specify the Platform Builder. It mainly participates to task 6.2.2.

**Tool Provider** role is the vendor view in order to define Tool's IOS aspect within SEE; it defines/specifies extension of meta-model to represent Tool descriptor to populate the Domain Tools catalogue.

Following these roles definitions and considering the efforts and roles described in the CRYSTAL DOW for each partners, each partner should be involved in different tasks as showed in Table 3-4

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	166 of 269

Partner	Role	Task 6.2.1	Task 6.2.2	Task 6.2.3	Contact person
ALA	Use Case Provider (WP Leader)	yes	yes	yes	Anna Todino
OFFIS	Technological Provider (Task leader)	yes			Guilherme Baumgarten/Stefan Henkler
ITI	Technological Provider (Task leader)		yes	yes	Ruben de Juan
FBK	Tool provider	yes	yes	yes	Pietro Braghieri
SYSTEMITE	Technological provider	yes	yes		Joachim Fritzson
AIRBUS- IW-UK	Technological provider		yes	yes	Jean-Luc Johnson
FhG	Technological provider		yes	yes	Christian Hein
IST	Tool provider		yes	yes	Stephan Pietsch
SAGEM	Use case provider		yes		Marc Malot
UNIFED-II	Technological provider		yes	yes	Stefano Russo
OBE0	Technological provider			yes	Stéphane LACRAMPE
A-F	Use case provider		yes		Odile Laurent/Gilles Gabarre (to be confirmed)
ALS	Use case provider		yes		Pascal Poisson

Table 3-4: roles of participants and tasks

During this period, WP 602 participants collaborate in order to:

- identify and define System Engineering Environment and Platform Builder requirements;

- analyze requirements and define a meta-model to address Platform Builder needed elements;
- perform a gap analysis between CRYSTAL Platform Builder meta-model and SPEM as baseline to define Tailored Process;
- analyze Platform Builder workflow and identify a preliminary Platform Builder Architecture;
- survey possible technologies to implement the Platform Builder prototype;
- on the basis of preliminary PB architecture, identify modules to implement and define user interfaces
- refine identified meta-models to address SEE configuration

Table 3-5 shows measurable contributions in terms of activities performed by Partners and relevant contribution on deliverables:

Partner	activities	Deliverables
ALA	As WP leader, ALA contributes to all tasks and coordinates all activities. Mainly support was capturing requirements to define Platform Builder architecture and to define meta-models needed to configure the SEE.	<ul style="list-style-type: none"> <li>- D602.011 Meta-model specification V1</li> <li>- D602.021 Platform Builder Specification V1</li> </ul>
AIRBUS-IW-UK	It has contributed identifying requirements and to support Use Case identification.	
FBK	FBK follows all tasks and it has contributed to the analysis and extension of the meta-model developed in Task 6.2.1. In Task 6.2.2 FBK has worked on the specification of the platform builder, contributing to the structure definition of the platform and providing hints to the technology selection due to its experience on EMF framework.	<ul style="list-style-type: none"> <li>- D602.011 Meta-model specification V1</li> <li>- D602.021 Platform Builder Specification V1</li> </ul>
FhG	No contribution.	-
ITI	As leader of T6.2.3, ITI coordinates the prototyping works and has also analyzed the more appropriate set of technologies for prototyping the Platform Builder. It has participated in the analysis of the Platform Builder Meta-Model and identifying which are the main elements to be considered when tailoring a process and defining a SEE and also to the preliminary draft of the Platform Builder Specification.	<ul style="list-style-type: none"> <li>- D602.011 Meta-model specification V1</li> <li>- D602.021 Platform Builder Specification V1</li> </ul>
IST	No contribution.	
OFFIS	As leader of T6.2.1, OFFIS coordinates activities for the meta-model definition. It has mainly collaborated to define Platform Builder meta-model and to define relevant concepts.	<ul style="list-style-type: none"> <li>- D602.011 Meta-model specification V1</li> </ul>

OBEO	As Technological Provider, they offer expertise on Eclipse framework and suggestions on relevant technologies.	
SYSTEMITE	No contribution.	
UNIFED-II	It has contributed to refine the Platform Builder workflow.	

Table 3-5: partners contributions

Use Case providers such as SAGEM, ALS, A-F are not deeply involved in tasks due to the fact that tasks' objectives need greater contribution from Technological Provider role, anyway they should to support application of identified Use Case for the assessment of Platform Builder approach in the next months.

### ***Tangible results***

- Definition of PB workflow
- Definition of requirements for PB specification
- Definition of PB specification, PB architecture
- Definition of PB meta model to represent Tailored Process and for SEE configuration
- Definition of System Engineering Environment meta-model such as: Tool descriptor (SW Component Descriptor) and Tool-Chain Descriptor and IT Infrastructure meta-model.
- User interfaces and User Story for SEE Configurator were described.

### ***Reasons for deviations***

Not applicable

### ***Reasons for failing to achieve critical objectives***

### ***Use of resources***

Refer to Amendment of Italian Cluster. FBK has in charge more months that planned.

### ***Collaboration with other projects***

Not applicable

### ***Statement on the dissemination activities and exploitation perspectives***

N/A

### ***Corrective actions***

A shared reference ontology for the concepts adopted in the context of Platform Builder development is proposed. It would help CRYSTAL partners in better understanding the objectives and the benefits of the Platform Builder solution. A better understanding would enhance the efficiency and cooperation level.

Use Case providers should agree on a common ontology for cross-domain concepts. Tool Providers should consider the idea to use a common ontology in order to classify Tools' functionality and relevant Artefacts.

In the next period, WP 602 needs contribution from Use Case providers in order to assess the Platform Builder approach; hopefully Use Case Provider should be more involved.

### 3.6.3 WP 603 System analysis and exploration (Lead: VIF)

#### ***Project objectives for the period M1- M12***

Architecture analysis provides support for predicting and evaluating the satisfaction of functional and non-functional requirements for concrete architecture variants, and thereby means for characterizing and comparing different solutions. According to the domain independence of the analysis of functional and non-functional requirements, this work package can be described in a generic way for all domains. Various bricks classified as structural system analysis and exploration tool or target platform dependent analysis tools make up this work package and individually describe the respective activities. A readiness level for the bricks described in this work package is defined at level 6 to 7 at the end of the project.

#### **Objectives of the single tasks:**

##### **Task 6.3.1 Model-based system analysis**

- Specialized point-solutions for system analysis and exploration are available in domain-specific languages. The needs of different domains concerned with safety-critical embedded systems are similar, providing the possibility to benefit from experiences and knowledge in other domains. One main contribution of this task is to evaluate the transferability of tools/methods available for one domain to other domains.
- Identify synergies between the implemented bricks to come up with a more holistic solution for system analysis and exploration.

##### **Task 6.3.2 System design and analysis with Sparx Enterprise Architect**

The aim of this task is to adapt and extend a standard interface to Enterprise Architect.

##### **Task 6.3.3 Model-based requirements engineering**

This task focuses on model-based requirements engineering to address current deficiencies in requirements engineering with respect to ambiguity and expressiveness. These deficiencies arise due to the use of informal text in collaborative requirement management software suites particularly in the automotive software domain. In this task, two different modeling languages, MechatronicUML and SysML/UML, for modeling of different types of requirements are used and improved.

*Note: Task 6.3.4 has changed because Verum left the project. IBM NL takes over the efforts and the new task description has been proposed in the amendment.*

##### **T6.3.4 Architecture analysis and validation with IBM Model Verifier**

- Interoperability of MoV with other tools
- Improvements and/or extensions to MoV to support analysis of discrete behavioural models, in particular adapting to the needs of the automotive domain.

##### **Task 6.3.4 Architecture analysis and validation with the ASD:Suite**

- Interoperability of the ASD:Suite with other tools.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	170 of 269



- Improvements and/or extensions to the ASD:Suite supporting architecture analysis in terms of a/o structure, complexity, and functional correctness.
- Improvements and/or extensions to the ASD:Suite supporting validation of components next to the existing automatic verification of components

#### **Task 6.3.5 System design and analysis with AVL Cruise**

CRUISE is the industry's most powerful, robust and adaptable tool for vehicle system and driveline analysis. The main objective of this task is the provision of IOS complaint interfaces.

#### **Task 6.3.6 Rapid design analysis (POOSL & NobiVR):**

- Support rapid design analysis and architectural exploration by a coupling of a simulation tool for functional behavior (POOSL) with a visualization engine (NobiVR) to show model behavior in the application domain
- Allow other tools to utilize the virtual reality layers of NobiVR.
- Support collaboration by multiple users at different locations on a shared instance of the VR layer.

#### **Task 6.3.7 Design, analysis, and exploration using Mathworks Polyspace**

The aim of this task is to adapt and extend a standard interface to Polyspace.

#### **Task 6.3.8 System analysis using AbsInt**

The aim of this task is to adapt and extend a standard interface to AbsInt.

#### **Task 6.3.9 System design, analysis, and synthesis using Rubus ICE**

Rubus Integrated Component Development Environment (Rubus ICE) is an IDE consisting of a set of tools for design, analysis, and synthesis of component-based real-time systems based on the Rubus CM model (model-based development).

The objectives for this task are:

- IOS integration and interoperability of the Rubus ICE tools with CRYSTAL standard.
- Improvements and extensions of the Rubus Analysis Model supporting integration with other models.

#### **Task 6.3.10 System and performance analysis with DTFSim**

The tool shall be integrated with other timing analysis tools, thereby achieving a holistic timing analysis for a system. Additionally, usability shall be improved by providing a graphical user interface, matching the requirements of the use case partner Volvo. The main goal is to reach a maturity level of the integrated tool fit for day to day application in industrial use.

Integration activities: The ongoing integration into MBAT RTP will be updated to the CRYSTAL RTP and extended by integration timing analysis tools defined by the use case. The requirements engineering and architecture model integration already worked at in MBAT will be improved based on user feedback. Additionally, direct use of Simulink blocks shall be supported.

#### **Task 6.3.11 Guaranteeing real-time execution of critical features**

A methodology will be developed to guarantee real-time execution of critical processing on platforms where a mix of processing functions of different priority levels are running in parallel.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	171 of 269

The methodology will consist of appropriate ways of specifying component behavior (memory usage, processing requirements, I/O requirements, etc.), methods for simulating performance levels in case of multiple parallel instances of components, and finally specifying design requirements and recommendations in order to guarantee real-time behavior.

#### **Task 6.3.12 Interoperable architectural analysis**

The main objectives of this task are:

- IOS integration
- Interoperable Architectural analysis tool provide means to evaluate interoperable architectural requirements analysis at early stages.
- It's required to define the ICT perspective requirements to guarantee the integration of the new elements by Modeling

#### **Task 6.3.13 Functional and performance analysis**

This task will be in charge of providing and adapting a simulation tool adapted to guarantee timing and resource allocation for critical applications. This tool aims to provide means to evaluate performance and functional requirements analysis at early stages.

#### **Task 6.3.14 Scheduling requirement analysis**

This task will be in charge of providing system models rich and expressive enough to properly capture all the requirements of complex developments, but concrete and realistic to be able to manipulate and analyze the system.

It will be designed/adapted existing tools to analyze the model. The tool chain shall support the full product life cycle: Capture system model (assisting the end user in this task); analyze the system and provide alternatives; implement the "what if" principle; generate configuration files (for example ARINC-653 XML); be able to perform incremental modifications of the system while ensuring the properties of the already verified parts of the model.

#### **Task 6.3.15 System analysis using ARTISAN Studio**

This task has two main objectives:

- IOS Integration
- Model-based requirement engineering profile for SysML

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

The detailed specification of bricks required a clear understanding of the use case requirements. Therefore, the persons responsible for the single bricks have been in close contact with the use case leaders since the beginning of the project. By getting a clear understanding of the use case, the respective requirements for system analysis and exploration have also become clearer. According to the technical management process, this led to the definition of Technical Core Requirements, Technical Refined Requirements, and Technical Items for the single bricks.

All partners have contributed to Deliverable D603.011.

#### **Partner contributions:**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	172 of 269

**AVL** has basically contributed to two tasks. In Task 6.3.5 “System design and analysis with AVL Cruise” the following steps have been done:

- Preparing AVL Cruise for a first prototype integration into the AVL Data Backbone T6.13.1
- First design concepts how to integrate AVL Cruise in the tool chain described by WP3.4 in form of OSLC integrations.

For Task 6.3.15 “System analysis using ARTISAN Studio” the following steps have been performed:

- Development of requirements models in SysML (lead Fraunhofer IESE)
- First design concepts for OSLC integration of ARTISAN Studio in the context of requirement engineering (lead: Fraunhofer IESE)

**ARCT** is currently defining their contribution to the project and working on a specification for implementation. They participated in project meetings and presented their project state and planned implementation.

**AIT** has contributed to the CRYSTAL technical management process for Task 6.3.10:

- Defining technical core requirements (according to usage of the DTFSim)
- Defining technical items and technical refined requirements (according to usage of the DTFSim)

**BARCO** has provided first input to the WP603 brick for guaranteeing real-time execution of critical features.

**CTH** has laid foundations, identified requirements, and developed first extensions in Task 6.3.3. Basically, requirements for MBRE from industrial demonstrators / use cases have been identified in close collaboration with UC 3.1 and UC 3.4.

CTH further conducted a state of research survey on model-based requirements engineering for embedded systems and contributed to a state of practice survey focusing on modelling approaches, notations, and usage.

**FBK** has contributed to the analysis of the transferability of tools/methods to other domains in Task 6.3.1. In particular, FBK has worked on the setup of a survey (questionnaire) targeted at collecting information from different actors operating in other domains. Moreover, FBK has carried out work to improve the extended version of the NuSMV model checker, in particular as concerns capabilities for model-based safety analysis, and to analyze the decomposition of the system architecture. This work is also linked with Task 6.4.4 in WP6\_04.

**FhG** has made progress regarding the following tasks:

- OSLC-training
- First structure for legal constraints (e.g. WLTP) as Input for SysML profile for Artisan
- Basic concepts for the formalization of requirements

This work has been done in close collaboration with WP304. For further details see the respective report for WP3\_04.

**IBM-NL** has taken over the tasks of Verum. System Analysis using Formal Methods is one of the objectives of this WP. Since Verum, leading this effort, has left Crystal, IBM NL has made an effort to fill this gap. A demo of IBM MoV was provided to the WP lead and the affected UC and was accepted to be a replacement of Verum ASD.

**ITI** has performed an analysis of the functional features and IOS requirements to be satisfied by the bricks B2.55, B4.14, and B4.15. This analysis has also considered the best way of providing IOS support. Furthermore, ITI has defined the brick specification and performed an architecture design for those bricks. ITI has also collaborated in the definition of the TCR (Technical core requirements) to be covered by WP603 bricks.

**ITKE** has contributed to this work package in various ways:

- Identification of different analysis and exploration types
- Comparative study of vertical and horizontal and deep knowledge integration technologies from perspective of users
- Investigation of key shortcomings in that field by the means of a survey

**VIF** is responsible for the lead of this work package and the respective deliverables. With this respect, we have been able to deliver the requested input and deliverables in time. There are regular meetings to ensure that the partners have all the information they need and that the work can be done according the Crystal processes.

Within the specific tasks, we have first set-up a questionnaire together with other partners in order to identify the current state-of-practice for model-based development in the domain of safety-critical embedded systems. This questionnaire resulted in a Technical Report and has been submitted as a conference publication. There has also been a lot of implementation work which has already been described for WP3\_3 and WP3\_4. Basically, the requirements are coming from these use cases and the actual implementation is done in WP6\_3.

**MATE** has identified the technical core requirements, technical refined requirements, and technical items of Use Case 5.1. Regarding the technical refined requirement TECH\_REF\_REQ\_0042, MATE has made the following contributions: To support model-based system analysis of railway control system MATE has analysed the more appropriate set of technologies for the implementation of a graphical editor based on a custom language (under progress) defined by UNIFED and SUN.

**TNO** has identified some technical core requirements, technical refined requirements, and technical items based on the healthcare engineering methods. Regarding the technical refined requirements, TNO has made the following contributions:

TNO has developed a textual POOSL editor for editing industrial size POOSL models based on Xtext and visualization for the architectural parts of POOSL models based on GraphViz. TNO further provides support for the modularization of POOSL files, for early validation of POOSL models based on a large collection of validation rules that are checked statically while editing, transformations between the textual POOSL format and the XML-based format that is supported by already existing POOSL tools (i.e. Rotalumis -a high-performance POOSL simulator and SHESim-

---

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	174 of 269

an existing POOSL editor), and debugging support based on the full Eclipse launching and debugging frameworks. Furthermore, the POOSL simulator (Rotalumis) has been extended with an implementation of sockets to support run-time interoperability with other tools (e.g., interactive visualizations).

**TRAIL** will mainly contribute to tasks specification and assessment from the viewpoint of the use case provided by Thales Austria. Special emphasis will be laid on the compliance of the approach with the safety standards applicable to the railway domain. So far no efforts have been placed since the contribution focuses on applicability of the model-based system analysis in the railway domain

**PS-TECH** needed to make preparations to develop NobiVR from an internal tool into a brick suitable for use by external parties in order to be able to use NobiVR within the CRYSTAL project. Additionally, PS-TECH has prepared to make their internal volumetric data visualization software components suitable for use by external parties, in anticipation of use in the Philips XPoser tool to use a phantom patient from which live simulated CT images can be shown.

**PHILIPS** has detailed out together with TNO and PS-Tech the tool requirements for POOSL & NobiVR and supported and validated the tool development.

**RGB** has collaborated with ITI in the definition of the functional features and IOS requirements to be satisfied by the bricks B4.14 and B4.15. For this purpose, RGB has provided all necessary information on the Use Case for ITI to define the brick specification and performance of an architecture design for such bricks.

**SUN** contributed in two main ways within Task 6.3.1 Model-based system analysis: (1) SUN has been an active partner in the definition of the survey published on-line that has been submitted to several industries aiding to identify the industrial usage and needs in the field of model-based engineering; (2) SUN has contributed also to the definition of a (domain-independent) methodology for testing by means of model-driven techniques. Moreover SUN is defining a pattern-oriented approach for facilitating the building of both system and test specification high level models.

**UNIFEDII** has contributed to Task 6.3.1 working at: 1) a survey about the needs and the state of practice in industry of model-based engineering and model-based system analysis methods (questionnaire), and 2) the definition of a methodology for test case generation and the background related to the main themes addressed by this research activity.

As for the point 2) the methodology being developed in collaboration with SUN envisages: a) the definition of a proper formal state-based language to be used for modeling the system behavior and formalize the requirements (from which the test specifications are obtained); b) the definition of Test Specification Patterns which provide general reusable models for recurrent classes of requirements; c) the development of a domain specific modeling language (Intermediate DSML) both as the target language of model transformation engines from the state-based models and as the source language to different model checkers. The activities related to the definition of the state-based language are conducted within WP6.12. A first set of test specification patterns has been defined within WP6.3.

### ***Tangible results***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	175 of 269

Deliverable D603.011 - *Specification, Development and Assessment for System Analysis and Exploration* - V1 has been submitted in time.

**Task 6.3.1:**

- *State of practice survey* focus on modelling approaches, notations, and usage  
Results are summarized in a technical report and a publication
- *Extension of the NuSMV* model checker regarding use case needs

**Task 6.3.2:**

Technical Core Requirements have been defined for this task

**Task 6.3.3:**

- *State of research survey* on model-based requirements modelling for embedded systems
- Extension of MSDs with Real-Time Constraints for modelling requirements with real-time annotations (GT-VMT 2014 publication)
- Requirements for MBRE from industrial demonstrators / use cases identified (relation to UC 3.1 and 3.4)
- First structure for legal constraints (e.g. WLTP) as Input for SysML profile for Artisan
- Boiler-plate-based approach for semi-formalizing WLTP-Requirements (prototype implementation)

**Task 6.3.4:**

A first demonstrator of MoV has been built in order to proof the applicability in this project.

**Task 6.3.5:**

- The requirements for this task have been identified in close collaboration with WP304.
- Non-OSLC-based integration of AVL Cruise and AVL Databackbone (Brick 3.83) is accomplished.

**Task 6.3.6:**

- Prototype implementation of an Eclipse plugin (TI\_0040 and TI\_0041) and a Rotalumis extension (TI\_0042) with the implemented functionality, together with the corresponding user documentation. These implementations are already used actively by WP4\_01.
- Based on Xtext, a textual POOSL editor for editing industrial size POOSL models has been developed. The basis is formed by the grammar, the meta-model, and scoping rules. The grammar and meta-model have been improved for ease of use, based on feedback from experienced POOSL users. In particular, content assistance to help new users using templates and quick fixes for typical mistakes has been added (TECH\_REF\_REQ\_0021).
- Based on GraphViz, a visualization for the architectural parts of POOSL models has been implemented; the graphical layout is determined automatically (TECH\_REF\_REQ\_0022).
- For modularization of POOSL files, an import mechanism to split large POOSL files into smaller ones has been developed. This mechanism differs from the standard Xtext mechanisms in the following ways: it is based on URIs and it works recursively. In particular

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	176 of 269



it supports multiple imports of the same file, and cyclic imports between files, which are very convenient in practice. (TECH\_REF\_REQ\_0024)

- For early validation of POOSL models, TNO has developed a large collection of validation rules that are checked statically while editing. The validation rules include acyclic relations, unique identifiers, and correct usage of language concepts. Moreover, warnings are generated for unused model elements. In particular, TNO has developed an innovative static type checker for POOSL that has already proved to be very useful for early fault detection (TECH\_REF\_REQ\_0025).
- Transformations between the textual POOSL format and the XML-based format have been developed which are supported by already existing POOSL tools, in particular Rotalumis - a high-performance POOSL simulator - and SHESim - an existing POOSL editor (TECH\_REF\_REQ\_0026).
- Based on the full Eclipse launching and debugging frameworks, Eclipse's launch and debug controls have been connected to the POOSL simulation engine. This includes the usual buttons for start/pause/resume/stop and various special buttons for performing single steps (TECH\_REF\_REQ\_0027).
- Based on the Eclipse launching and debugging frameworks, an Eclipse user interface that inspects the state of a running POOSL models has been developed. This includes inspection of the internal variables, the control pointers, and the full control state (based on the POOSL concept of a PET) (TECH\_REF\_REQ\_0028).
- The POOSL simulator (Rotalumis) has been extended with an implementation of sockets to support run-time interoperability with other tools (e.g., interactive visualizations) (TECH\_REF\_REQ\_0030).

#### **Task 6.3.7:**

Technical Core Requirements have been defined for this task

#### **Task 6.3.8:**

Technical Core Requirements have been defined for this task

#### **Task 6.3.9:**

Participated in project meetings and presented project state and planned implementation

#### **Task 6.3.10:**

For the DTFSim brick, two technical core requirements (TCR) have been identified according to the Technical Management Process:

- TECH\_CORE\_REQ\_0027: Model Transformation from Meta-models to timing-analysis tool models;
- TECH\_CORE\_REQ\_0028: Simulation based timing analysis of the system design

Based on the two TCRs, two technical refined requirements (TRR) have been defined:

- TECH\_REF\_REQ\_0037: Transformation of SystemWeaver models to DTFSim models
- TECH\_REF\_REQ\_0038: Analysis of timing chains and network load

Finally, five technical items (TI) have been identified on the base of the TCRs.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	177 of 269



- TI\_0051: Identification of/Mapping between model components
- TI\_0052: Implementation of the Transformation Process
- TI\_0053: GUI implementation for simulation result analysis
- TI\_0054: Implementation of the Ethernet protocol
- TI\_0055: GUI implementation for simulation model configuration

**Task 6.3.11:**

First input to the WP603 brick has been provided.

**Task 6.3.12:**

First specifications and IOS requirements for the respective brick have been defined. First list of technical core requirements for the respective brick are available.

**Task 6.3.13:**

First specifications and IOS requirements for the respective brick have been defined. First list of technical core requirements for the respective brick are available.

**Task 6.3.14:**

First specifications and IOS requirements for the respective brick have been defined. First list of technical core requirements for the respective brick are available.

**Task 6.3.15:**

Basic requirements for IOS implementation have been identified and a first structure for legal constraints (e.g. WLTP) as Input for a SysML profile for Artisan has been defined.

***Reasons for deviations***

The only main deviation is the substitution of Task 6.3.4. Verum left the project. Instead IBM-NL tool over this task. This has been discussed and agreed with the respective UC. There is no impact on other tasks.

***Reasons for failing to achieve critical objectives***

Critical objectives have been achieved.

***Use of resources***

For ARCT there is a deviation because the specification time frame has been shifted to be completed Q3.

ITKE reported the volatility of the team as a reason for deviations.

PS-Tech states that a key project member left in M10, but that new candidates are interviewed.

TNO states that deliveries for this work package have to date been good but recruiting staff with the correct skills remains a problem. Efforts are ongoing to bring the staffing up to full strength.

TRAIL has not planned any efforts for this first period of the project. Their contribution is required in the later phases of the project.

Other partners reported no significant deviations from Annex 1 (DoW).

Details see in Annex 1 Beneficiary Reports M1 - M12.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	178 of 269

### ***Collaboration with other projects***

Some partners (e.g. AIT) also participate in other ARTEMIS JU projects such as MBAT. These partners try to build on the experience gathered in this project.

Furthermore, Task 6.3.3 has investigated the results of the MBAT project together with partners of the MBAT consortium.

### ***Statement on the dissemination activities and exploitation perspectives***

Extension of MSDs with Real-Time Constraints for modelling requirements with real-time annotations (GT-VMT 2014 publication)

### ***Corrective actions***

There is only one corrective action suggested by ITKE. They will try to have a stronger concentration on required brick features.

## **3.6.4 WP 604 Tools for Safety Engineering (Lead: AIT)**

### ***Project objectives for the period M1- M12***

The main objective of this work package is to provide tools and methods for safety analysis and early safety validation of systems and components and to prepare them for integration in the RTP and for use in CRYSTAL use cases.

For reporting period M1-M12, the main goal was to clarify the use cases for the bricks in WP604 and to elicitate requirements and derive specifications for the bricks driven by the needs of the use cases. With the availability of the specifications in deliverable D604.011 ("Specification, Development and Assessment for Safety Engineering – V1"), implementation of improvements was to be started.

Where possible, e.g. for already clarified needs, independent from use case details, it was intended to start implementation work even earlier.

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

AIT initiated a kick-off and coordinated work on the preparation of deliverable D604.011 in task T6.4.0 (WP lead), identified the adaption needs for WEFAC in the AVL use case in task T6.4.1 (WEFAC brick), identified the needs for MB RAMS in the TRAIL use case in task T6.4.2 (MB RAMS brick) and identified the adaption needs for MoMuT::UML in the TRAIL use case in task T6.4.3 (MoMuT::UML brick). This was reported in D604.011. An initial integration scenario for the TRAIL use case, heavily drawing from prior results in MBAT and SafeCer, has been prepared and presented at the interim review. AIT further participated in the RTP/IOS consolidation meeting, Nov. 13, Munich.

EADS/CAS participated in and contributed to WP604 WebEx meetings.

EADS IW-G contribution to deliverable D604.011 and participated in meetings with Airbus and Cassidian representatives to clarify needs related to Safety Bricks

TUG implemented and enhanced the tools MoMuT::REQs and MoMuT::TA in task T6.4.3 (MoMuT::UML brick). Both tools had their origins in the MBAT Project and were improved and adopted to challenges introduced by the CRYSTAL use cases.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	179 of 269

FBK has worked in Task 6.4.4 on the analysis and development of extensions of the NuSMV model checker. In particular, it has explored the integration of contract-based compositional design techniques and safety analysis, with the goal of automatically generating hierarchical fault trees. In addition, FBK has analysed the integration of the extended version of the NuSMV model checker with Crystal Use Case 2.8, and provided an outline of the integration for the generation of Fault Trees, starting from models written in the Altarica language.

FhG had team members trained in OSLC and worked on an analysis of Safety-Analysis-Tool interactions with respect to the implementation of OSLC-interactions: Many kinds of interactions are reasonable. We decided which interaction we want to do with OSLC. Further, the open safety model (OSM) was refactored. It was developed in previous work in order to support the interaction between a set of Safety-Analysis-Tools. Properties of these Tools are hard-coded in the OSM. In order to achieve tool-interoperability, we developed a concept for removing tool-specifica from the OSM.

TECNALIA has worked in an initial specification of an Autonomous Fault Tolerant System Design Methodology (Task 6.04.21). In WP6.04, TECNALIA has prepared an initial high level specification of the Autonomous Fault Tolerant System Design Methodology contributing with this work to Deliverable D.604.011.

GMV has participated in the elaboration of the deliverable D604.011, evaluating the industrial applicability of safety-analysis frameworks for safety assessment with respect to the dependability and safety requirements extracted from ESA

IFX-UK originally planned to work in task T6.4.10 on URML analysis (URML is an UML extension which was defined in the VeTess project). However it was decided that due to no long term support planning on the extension we would not use this. Therefore this work on the Brick 3.99 would be deprecated and a new Brick was proposed to support a semi-formal safety extension for semi-formal notation as recommended within the ISO26262 standard. This work is now part of task T6.4.11 and so far we have identified a semi-formal NL notation called the Claims language which was released as part of the 1991 IT security standard ITSEC. The work to extend this is being worked on currently within the VeTess project and a boilerplate will need to be written. Due to the non-availability of the DODT from the CESAR project we are investigating usage of the REUSE tool to implement a Boilerplate currently.

The Cross Domain Data Analyser has been renamed DAD - Data Analyser Dashboard. The Requirements are currently under review and a sister tool external to the CRYSTAL project called MoM (Measure Of Metrics) is currently being released, the DaD tool will make use of shared resources .. namely the KID (Knowledge and Information Database) .. which is being implemented for use case 3.3.

ITKE worked on the development of concepts for use case 4.2

All4Tec worked in task T6.4.18 on the development of a first release of the brick Safety Architect for CRYSTAL. This release implements the safety analyses as required by ALSTOM with FMECA reports in the ALSTOM format

MU worked on: experimental implementation allowing analysis and verification of SIMULINK diagrams with respect to the specification given as a set of LTL (Linear Temporal Logic) formulae; evaluation on selected SIMULINK diagrams; analysis of applicability of model checking to the problem of safety analysis; considering probabilistic fault injections, and application to analysis of minimal cut set.

Together with ITKE, TNO had several phone conversations and exchange of documents to define the focus of the brick development work. TNO represented the WP402 use case in WP604, and created core requirements for safety risk management based on its analysis in WP402. ITK created a discussion paper based on the core requirements which was then further discussed at Philips. TNO created a long list of possible technical items for improvement and prioritized it.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	180 of 269

The core improvements are in our view:

- supporting the use of market surveillance information in safety risk management and engineering ('experience feedback')
- creating 2-way fault trees (cause-effect nets) for finding a cause for a field incident and for finding possible safety risks for a part under design.
- eliminating a lot of manual work in safety risk management and certification. This might be done using the Polarion tooling that ITKE uses intensively.

This was laid down also in contributions to deliverables D401.010 and D402.901 (main author Philips).

Siemens worked on analysis of safety tools needs with respect to development processes for software intensive systems.

### **Tangible results**

Deliverable D604.011 has been prepared by all brick providers together and contains specifications for all the bricks of the WP.

Additionally, implementation for the bricks has started. For the following bricks, this already lead to tangible results: several implementation tasks where already started and produced results:

MoMuT::UML (AIT & TUG):

- Support for additional UML constructs, as well as changes to the backend engine to better cope with the complexity of the models. (AIT)
- Extended bounded language inclusion problem from deterministic timed automata to non-deterministic and with silent transitions timed automata, as these models represent more realistic systems. (AIT together with TUG, prepared for publication, evaluation implementation)
- MoMuT::UML implementation (performance improved, including set-up and maintaining a build process for creating binaries for both the enumerative and the symbolic back-end for both 64 bit Windows and 64 bit Linux platforms. For the enumerative back-end Ulysses a new feature dealing with partial order reduction has been implemented. (AIT)
- A simulator for MoMuT::REQs allowing to execute the requirements model. (TUG)

NuSMV (FBK):

- Improvement of the NuSMV model checker for safety assessment - generation of Fault Trees.
- Planning of the integration with Use Case 2.8.

DAD (IFX-UK):

- Design for the DAD is under review. The Database is currently single site and we are moving it into a multisite tool.

Safety Architect (All4Tec):

- First release of the prototype is operational

### **Reasons for deviations**

AIT: For stop of work on MoMuT::SCADE: TRAIL decided not to use SCADE anymore. Focus will be laid on T6.4.3 instead.

EADS/IW-G: Late clarification of needs with Airbus and Cassidian. In any case, the use of effort is not linear for this Work Package. The main effort consumption is expected at later phases of the WP.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	181 of 269

EADS IW-UK: no activities so far - these activities are linked to Airbus Group Use Cases WP2.1 and WP2.3 and are not scheduled yet

IFX-UK: changed bricks: As mentioned URML was developed by Siemens research in New York with a PhD student from Germany. Whilst being a very good solution the level at which Infineon's requirements are (signal level) doesn't lend to a Model based Requirements solution and also the URML extension has no long term support or maintenance roadmap currently.

### ***Reasons for failing to achieve critical objectives***

Some of the use cases are less final in their definition than originally expected. While work on the bricks has started, in parts even earlier or with more resources than planned, the working style in several use cases will be more iterative than originally envisioned. There is no negative impact on the quality and timeliness of the results expected. No conflicts with the availability of resources have been reported by the brick partners.

### ***Use of resources***

Efforts reported where spent on the activities reported above and are mostly according to plan, with the following exceptions:

AIT - more efforts spent (22 vs 15):

A number of bricks extensions and improvements identified as relevant for the use cases have been started early due to higher availability of human resources. For instance, extending the bounded language inclusion problem in MoMuT from deterministic timed automata to non-deterministic timed automata with silent transitions for better real-time support.

EADS IW-G – less efforts spent (1.5 vs 4.67):

Work started later because of dependencies on use cases.

EADS IW-UK – less efforts spent (0 vs 3.3):

Work started later because of dependencies on use cases.

### ***Collaboration with other projects***

Several partners bring in tools and integration know how from other projects, especially MBAT. While there are interactions with other projects, e.g. regarding the IOS itself, there is no connection to other projects specific to the safety tools work package.

### ***Statement on the dissemination activities and exploitation perspectives***

Details see Dissemination & Exploitations Plan V1

### ***Corrective actions***

AIT: Increased efforts for MoMuT::UML will be compensated by the efforts originally planned for the dropped MoMuT::SCADE brick.

IFX-UK: the overspend was on the asureSign work and its extensions, this is due to the fact that it moved at a quicker pace than we expected - this we expect will tail off and we may regain the time later in the project

## **3.6.5 WP 605 AUTOSAR Tools & Components (Lead: TTTECH)**

### ***Project objectives for the period M1- M12***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	182 of 269

The main objective of this work package WP605 is the integration of AUTOSAR based tools and target platforms and their components to the RTP/IOS. Furthermore, this work package will develop technology bricks that support the practical realization of demonstration activities of several use cases mainly in the automotive domain. It will in addition contain all modifications, enhancement and design and development work required according to the work plan described mainly in Use Cases UC3.1, UC3.3, UC3.4 and UC3.5.

For this first reporting period it is the task of this work package to describe in detail the bricks that shall be provided in WP605 and to collect and compile all the requirements and specifications for the individual brick extensions and/or developments. This shall be done in close alignment with the requirements formulated by the use case owners and under consideration of later demonstration activities. The specifications of WP605 bricks will later be used to guide and support all development and implementation work that will be conducted by the contributing partners.

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

The main work conducted in WP6.5 in this reporting period is the collection of core requirements and technical requirements based on the inputs received from the supporting use cases. All bricks were described in the deliverable D605.011 to which all partners have contributed. There also first implementation specifications were described that will provide the basis for the upcoming development work.

#### **Tasks and objectives:**

This table summarizes the objectives for each task and lists involved partners:

<b>Task</b>	<b>Main objectives</b>	<b>Involved partners</b>
Task 6.5.1	In this task, the integration of model based methods onto an AUTOSAR compliant development are studied and tool interfaces for it are developed.	ITKE
Task 6.5.2	The major focus of this task is the specification of a communication interface specification for tools dealing with AUTOSAR and EAST-ADL information.	Volvo
Task 6.5.3	Focus of this task is to manage workflow outside of the TargetLink toolset towards a seamless model based development in an AUTOSAR environment.	ITKE
Task 6.5.4	Main task is to adapt BSW Builder so the tool becomes able to fetch requirements and configuration parameters from other tools.	ARCC
Task 6.5.5	Main task is to adapt RTE Builder so it can fetch the ECU-Extract from other	ARCC



	tools in the partnership.	
Task 6.5.6	Main task is to adapt SWC Builder to the IOS structure so it will be possible to fetch requirements from other tools and also publish some information of the SWC to other tools into the IOS infrastructure.	ARCC
Task 6.5.7	Main task is to adapt ARTOP to the IOS infrastructure so that more tools can be part of the interoperability framework.	ARCC
Task 6.5.8	Main task is to extend the TTEthernet design and development tools so they can be used to configure a System of Systems platform.	TTTech
Task 6.5.9	It is the objective to provide all required software bricks to support a System of Systems platform that fulfils the requirements of WP3.4.	TTTech, AVL-R
Task 6.5.10	The main focus is on the development of a wireless interface for the System of Systems platform supporting the requirements of WP3.4.	TTTech, AVL-R
Task 6.5.11	In this task, tresosStudio is adapted based on the requirements of WP3.6 so that it can be used within the IOS infrastructure.	Elektrobit

Table 3-6: Tasks and objectives in WP 605

**Partner contributions:**

**ARCC** has contributed to Tasks 6.5.4 – 6-5-7 and the following steps have been done:

- Contribution to deliverable D605.011 Specification, Development work for adapting the tools for the workflow in WP3.1.
- First adaptations to the bricks 6.5.4, 6.5.5, and 6.5.6 by adapting tools to handle the new use-cases.

**AVL-R** supported the definition of the SoS platform and analysed the requirements for an implementation of the TTTech developments in AVL development process. AVL-R started with requirements definition and will continue over architecture to development up to testing (V-Cycle).

**Elektrobit** contributed to the deliverable document and participated in work package discussions and will start specification and development in the second project year.

**IFX-UK** analysed the interoperability options of the bricks, documented these findings in the respective documents and supported the other partners in the specification.



**ITKE** worked on the identification of distinct problems in AUTOSAR development and on how tool interoperability can help to alleviate them and supported the use cases concerning brick details.

**OFFIS** supported Task 6.5.2: AUTOSAR/EAST-ADL Interface and contributed to the WP and task discussions.

**TTTech** has coordinated the overall work package and therefore organized meetings, performed regular coordination work, collected inputs and compiled the deliverable D605.011 and acted as intermediary for all SP6 communication.

Based on the requirements obtained from the main related use case UC3.4, TTTech started the definition of the required technology bricks of WP605 in Tasks 6.5.8 – 6.5.10. TTTech also established the feedback loops to the use cases to enable an aligned development of technology bricks and the anticipated demonstrators in the use cases. Furthermore TTTech held a kick-off for WP605, coordinated all different WP605 developments, and organised the ongoing work in this work package. For all tasks in WP605, first descriptions of the technology bricks exist which will be iteratively refined in the following project year.

**VOLVO** has contributed to deliverable D605.011 Specification, Development and Assessment for AUTOSAR Tools & Components with a section on brick 6.5.2 EAST-ADL/AUTOSAR interface.

### ***Tangible results***

The partners have written and compiled the initial brick specifications in Deliverable *D605.011 - Specification, Development and Assessment for AUTOSAR Tools & Components - V1* which has already been submitted.

#### **Task 6.5.1:**

- Identification of distinct problems in AUTOSAR development and how tool interoperability can help to alleviate them
- Start of master thesis in this area regarding one of the approaches

#### **Task 6.5.2:**

An analysis was conducted to understand how the EAST-ADL/AUTOSAR interface is to be used and the EAST-ADL/AUTOSAR interface has been described in detail in the deliverable.

#### **Task 6.5.3:**

TargetLink was studied in detail and a description was provided in D605.011.

#### **Task 6.5.4 – Task 6.5.7:**

- Analysis of the bricks and their potential interfaces with the IOS.
- Adaptation of the tools captured in the bricks to fulfil first requirements received from the use cases.
- Description of BSW builder and detailed analysis of the requirements of the use cases and their potential realisation in the brick.

- Description of RTE builder and detailed analysis of the requirements of the use cases and their potential realisation in the brick.
- Description of SWC builder and detailed analysis of the requirements of the use cases and their potential realisation in the brick.
- Description of ARTOP and detailed analysis of the requirements of the use cases and their potential realisation in the brick.

#### **Task 6.5.8 – Task 6.5.10:**

- The relations of the technology bricks to the use cases were discussed and a mapping which bricks will be demonstrated in which use cases was defined
- The existing parts of the bricks (mainly the existing configuration tools) were analysed for their re-use and extension to meet the WP3.4 requirements.
- Specifications of the bricks were defined based on the requirements delivered by use case 3.4 and potential realisation scenarios were discussed. This includes integration of different technology bricks and existing system parts with the SoS platform.
- Different wireless standards were compared for the SoS Wireless Interface brick.
- The development work of the bricks has started for all bricks.

#### **Task 6.5.11:**

Work on these tasks has not yet started due to delayed delivery of requirements from the requesting work packages.

#### ***Reasons for deviations***

Only deviation from Annex I is a minor resource underspending as described in 2.1.5. This small change is not expected to have an influence on other tasks and will not endanger the timely fulfilment of work package goals.

#### ***Reasons for failing to achieve critical objectives***

Critical objectives have been achieved.

#### ***Use of resources***

Some partners show a very small underspending of resources. This is mainly due to the more complex and delayed definition of the use case requirements that shall drive the brick developments. Volvo has concentrated on the specification of the use case in WP 3 (Task 3.1), therefore many resources were spent there instead of in this work package. Similar, the work of Elektrobit in WP6.5 has not yet started due to late results and requirements coming from use case WP3.6. For both partners, this situation is expected to level again in the coming project year because of the required brick development work which will be carried out with increased efforts.

Details see in Annex 1 Beneficiary Reports M1 - M12.

#### ***Collaboration with other projects***

Some partners also participated in other ARTEMIS JU projects such as MBAT. These partners try to build on the experience gathered in this project. With EMC<sup>2</sup>, a new large ARTEMIS JU project has recently started, in which selected partners (e.g. TTTech, Volvo) participate and will provide communication interfaces there.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	186 of 269

### **Statement on the dissemination activities and exploitation perspectives**

This industry driven work package aims at developing solutions with a clear relevance to future costumers. The definition and initial developments of the bricks have started, but are not yet ready for a broader exploitation. However, this exploitation is planned to start once tangible outputs can be presented. Furthermore, many partners are regular attendees of broad-reach dissemination events such as ICT week, Hipeac and similar events as well as trade fairs, where the developments of this work package shall be highlighted.

### **Corrective actions**

Not applicable at the moment.

## **3.6.6 WP 606 Heterogeneous Simulation (Lead: FhG)**

### **Project objectives for the period M1-M12**

The objective of this work package is to enable an integrated simulative evaluation of systems that are specified by heterogeneous models. This requires on one hand the integration of models that are defined in different formalisms. On the other hand, integration of simulation tools is necessary. The following concrete objectives were defined for WP 6.6 and are handled here as sections:

#### **Provide methods, techniques and guidelines for heterogeneous modelling of systems covering functional, safety, behavioural, analysis, and error models for maximum reuse:**

A first approach regarding the modelling of heterogeneous systems and simulation scenarios has been documented in Deliverable D6.6.2-1. We propose simulation model characterisation as a means for reusability which provides a further expansion of metadata as defined in FMI.

#### **Support execution of heterogeneous models to evaluate for example error propagation and emergent behaviour through a framework that assembles and executes different models**

One proposed solution that enables the heterogeneous simulation of simulation scenarios is the Fraunhofer FERAL framework. As part of this project, the FMI interface of this framework has been extended to host Model Exchange models generated by Open Modelica, as well as the integration of native Simulink models that do not conform to the FMI standard. Furthermore, three numeric solvers (ODE1, ODE4, ODE4/5) of the Feral framework are being integrated with the FMI host interface to enable solving of FMI model exchange models that do not contain their own solvers.

#### **Support traceability and consistency checking of heterogeneous system models.**

Requirements for traceability and consistency checking have been collected and documented as refined requirements and technical items.

#### **Provide a connection approach from analysis tools to modeling tools that enables modelsanalysis directly from modeling environments.**

After collecting requirements from WP 2.1, the development of a prototype Simulink toolbox is under consideration. This would enable the development of heterogeneous simulation scenarios from within the Simulink modelling environment, as well as the debugging of algorithms in context of simulation scenarios. The evaluation of the impact of the specific Simulink execution model and the ability to integrate this model with the FERAL simulation model is currently ongoing work.

### **Work Package progress and achievements during period M1-M12**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	187 of 269

### ***Progress towards objectives***

All partners of work package 6.06 collaborated in this reporting period on the collection of core requirements, technical requirements, and a preliminary list of technical items for the project based on the bricks respective partners are working on. The activities are coordinated by bi-weekly phone conferences. The core findings are documented in the deliverables 6.6.1-1 (Specification, Development and Assessment for Heterogeneous Simulation) and 6.6.2-1 (Heterogeneous Simulation Approach).

Fraunhofer IESE addresses together with EADS and TNO the EADS public aircraft de-icing use-case. In the first year of the Project (M1-M12), Fraunhofer IESE focused on the evaluation of existing simulation technologies and additional approaches that are necessary to create a holistic system simulation in addition to the FMU interface that was already considered in the proposal. To solve this, brick descriptions were evaluated and requirements to simulation scenarios were collected. Fraunhofer will therefore focus on two scenarios: Evaluation of the cabin use-case together with Airbus, as well as the public EADS case study.

The latter requires the development of an interface, which adds metadata to models to enable looking up of matching simulation models and their combination into simulation scenarios. This will also require the development of a model repository service, which will either be realized as plugin to modelling tools, or as a specialized server that maintains available simulation models. In the reporting period, focus was on the integrated execution of simulation models, which was ranked highest priority. Model repository and scenario development will be addressed at a later point.

The RGB use-case is mainly addressed by TNO, RGB, and ITI. Here scriptable testing with HiL simulation is proposed and fault injection models are explored. TNO studied and experimented with the FMI interface for real time co-simulation of Matlab and Modelica or Matlab and other tools. TNO intends to align the FMI model metadata with simulation model characterization (as developed in work package 6.11). ITI collaborating with RGB and TNO has specified the brick B4.06 (integration of B4.06 and B4.17). First drafts of IOS requirements and specification for this brick have been proposed in the deliverable 6.6.1-1.

After a thorough requirement analysis of work package 4.03, TU/e has been studying the possible uses of the tools Gazebo (see brick B4.10) and Orocos (see brick B4.11) with regards to their contribution to the hardware-in-the-loop simulation. Exploration of these tools is being made by the Robotics group, where both are used on the @Home Service Robot. There, Gazebo is used to visualize and interact with simulated environments for the robot, and Orocos is used to create a reusable component-based environment, capable of managing in real time the controllers used in the robot. Further study was made on how to connect these two tools directly, without depending on middleware, such as ROS. Tests have been made using a yet unfinished plugin to connect Gazebo and Orocos. The integration and use of this plugin is still complex and not consistent but early results suggest that it can be done, although Gazebo is not a tool developed for real-time systems.

The objective of task 6.6.4 which PHILIPS is working on is the development of bricks to support hardware in the loop testing. This task especially contributes to bricks B4.06, B4.10, B4.11, and B4.17. It integrates modelling and simulation environments into the CRYSTAL RTP and thus enables hardware-in-the-loop (HiL) testing. PHILIPS has been detailing out the requirements for HiL simulation & support tool development, and did experiments with models in Matlab/Simulink and evaluated Gazebo and Orocos to provide early feedback on the usability of the simulators.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	188 of 269

Evaluate. PHILIPS also supports TU/e and TNO with the development of a method and prototype for an automatic generation of a HiL interface.

### ***Tangible results***

- Extension of Fraunhofer FERAL Simulation Framework to support fault injection testing, as well as development of initial fault models.
- Extension of FERAL FMU interface to integrate FERAL numeric solvers with FMU simulation components.
- Integration of Simulink legacy Simulation components with FMU simulation components.

### ***Reasons for deviations***

TNO wanted to add brick 4.9a “Performance simulation” to WP606 “Heterogeneous simulation”, because this addition makes sense from a technical point of view. As the activities in the healthcare work packages start, the interests of the use cases did become more clear. Barco (use case WP405) indicated that “Performance simulation” is more important for them than hardware-in-the-loop simulation. Both are good examples of “Heterogeneous simulation”, the focus of WP606. In addition, two related medical use cases are added for which hardware-in-the-loop is quite important.

We do not expect this minor change to have a negative impact on any bricks or work packages. The impact is primarily on the activities of TNO. A positive impact is the better representation of use case WP405 Barco software centric display in WP606.

### ***Reasons for failing to achieve critical objectives***

Not applicable.

### ***Use of resources***

Details see in Annex 1 Beneficiary Reports M1 - M12

### ***Collaboration with other projects***

The FERAL simulation framework is used as well in context of the ARAMIS project, which is a publically funded project by the German government. The context of ARAMIS is the development of platforms for safety critical embedded applications. Here, the focus is on the simulation of next generation multi-core processors, which complements the work of CRYSTAL that focuses on the simulation of functional behaviour and fault injections regarding communication networks.

### ***Statement on the dissemination activities and exploitation perspectives***

System level simulation and the linking of simulation models is still an important aspect for industry and research. Exploitation plans are currently driven by the development of domain and customer tailored simulation solutions that enable virtual validation of system models in context of simulated scenarios.

### ***Corrective actions***

Not applicable at this point.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	189 of 269

### 3.6.7 WP 607 Requirements Based Engineering (RBE) (Lead: REUSE)

#### ***Project objectives for the period M1- M12***

The main objectives of this work package are focused on providing bricks to cover the Engineering methods described mainly in UC2.3 and UC2.4. Namely, those objectives and bricks are the following:

- Requirements quality: extending the CCC approach defined in the CESAR project with new ideas and new tools
- Develop a boilerplate and pattern-based approach: this will enhance the authoring capabilities for the requirements owners aiming a better requirements quality and, at the same time, will represent the source of the formalization associated with every requirement
- Describe and develop the bricks Requirements Quality Analyzer (RQA) and Requirements Authoring tool (RAT): both with the goal of improving the quality of requirements and requirements documents
- Define methods to check the quality of a requirements specification by checking consistency and completeness against other well-known assets: for this purpose, both the information coming from the ontology, but also some information coming from SysML models will be gathered and analysed against the formal representation of the requirements
- Requirements retrieval and reuse: based on the domain information stored in the ontology, every requirement will be stored in terms of a semantic graph. This kind of graphs are the source for a semantic search engine which, in turn, will be the basis for a requirements reuse system
- Develop tools for managing all ontology layers needed for the above mentioned goals: this will be done in form of the knowledgeMANAGER (kM) brick
- Development of the proper IOS interface that could make possible the scenarios described in the engineering methods proposed by our industrial partners

Once the overall goals of the work package (for the whole CRYSTAL project duration) have been summarized, we can better describe the goals covered during the reporting period M1-M12:

- Training of the involved partners (both brick providers and industrial partners) in the concepts and tools described above
- Installation of the abovementioned bricks (in the state they are now in the market, as a background) to all the involved partners
- Identification of the core requirements for those bricks (the evolution of the bricks according to the goals of the WP)
- Alignment of the Technical Core Requirements of the bricks with the user needs coming from UC2.3 and UC2.4
- Identification of the Technical Refined Requirements and the Technical Items (TIs) related to the work package
- Definition of the methodological approaches: ontology-based approach, boilerplate approach and pattern-based approach

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	190 of 269



- Definition of the extensibility mechanisms in the RQA brick so that any third party could seamlessly develop, deploy and integrate their own quality metrics on top of RQA. Such mechanism has been agreed with OFFIS and UC3M, the other technology partners involved in WP607
- Definition of the IOS needs around RQA, RAT and kM. For the reported period:
  - o Access to the vocabulary and vocabulary relationships in a domain ontology
  - o Access to the level of quality assessed by RQA for a requirement
- Release of the first version of deliverables:
  - o D607.021, D607.031, D607.041: describing the “as-is” of the main background bricks related to WP607
  - o D607.011: describing the approach that will be followed by this WP in order to address the CCC quality principles

### ***Work Package progress and achievements during period M1-M12***

#### ***Progress towards objectives***

##### **T6.7.1 – Ontology approach**

The main concepts of this ontology approach have been included into D607.011. This ontology is a core element for the whole work package. Hence, this approach has been accurately reviewed and agreed by all partners.

Furthermore, the outcome of the definition of such approach is also an input for the definition of the needs and requirements related to the knowledgeMANAGER brick (D607.041).

This approach, together with the technical core and refined requirements of different bricks and TIs somehow related to ontologies, have been also described.

Contacts with ontology work packages, mainly UC209 have been established in order to gain a common understanding of the role of ontologies in the overall CRYSTAL project.

##### **T6.7.2 – Boilerplate approach**

This approach describes the way requirements are represented as sequences of syntactic and semantic items. This approach is using concepts coming from the ontology approach and represents the basis for the pattern based approach. Hence, the outcome of this approach also includes requirements for:

- knowledgeMANAGER: as the tool to manage ontologies, boilerplates and patterns
- Requirements Authoring Tool: since this tool implements those sequences of syntactic/semantic items to enhance the authoring capabilities of the requirements management systems

This approach, together with the technical core and refined requirements of different bricks and TIs related to boilerplates have been written and approved among the involved partners.

##### **T6.7.3 – Pattern approach**

Once the requirements have been matched with one or many boilerplates, a series of formalization steps must be performed in order to allow for high-value quality analysis (either correctness, consistency or completeness).

This approach, together with the technical core and refined requirements of different bricks and TIs related to boilerplates have been written and approved among the involved partners.

##### **T6.7.4 – Development of Requirements Quality Analyzer (RQA)**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	191 of 269



The technical core and refined requirements for RQA have been written and approved among the involved partners. These requirements have been aligned with the needs coming from UC2.3 and UC2.4, as well as the outcome of the ontology, boilerplate and pattern approaches.

Some new metrics for improving the correctness of requirements have been implemented.

An extensibility mechanism has been defined and agreed. This will allow third parties to add their own CCC metrics with no major impact for neither the end users nor the developers of both RQA and the new metrics.

An IOS service to share the quality configuration of a requirement has been designed and is almost ready to be public.

#### **T6.7.5 Development of Requirements Authoring Tool (RAT)**

The technical core and refined requirements for RQA have been written and approved among the involved partners. These requirements have been aligned with the needs coming from UC2.3 and UC2.4, as well as the outcome of the ontology, boilerplate and pattern approaches.

A new user interface, more easy-to-use for the end user, has been developed. This will allow to reach the TRL expected for the brick tools.

#### **Development of knowledgeMANAGER (kM)**

The technical core and refined requirements for RQA have been written and approved among the involved partners. These requirements have been aligned with the needs coming from UC2.3 and UC2.4, as well as the outcome of the ontology, boilerplate and pattern approaches.

Following some recommendations coming from the involved partners, the user interface of kM is being redesigned. This new design is taking into account some usability aspects reported by some partners as well as new findings from the ontology, boilerplate and pattern approaches.

An IOS service to share vocabulary and thesaurus information has been designed and is almost ready to be public.

### **Contributions from the partners**

#### **REUSE**

- As leader of the whole work package, REUSE has coordinated the work and the relationship with UC2.3 and UC2.4.
- REUSE has collaborated in the first development of all the approaches.
- REUSE has participated in a series of conferences and F2F meeting dealing with both, technology providers of SP6 and also UC owners meetings from SP2
- REUSE has led the identification and alignment of core and refined requirements.
- REUSE has designed and developed all the changes described so far for the technology bricks
- REUSE has trained all the partners regarding the technology bricks included in the work package
- REUSE has performed some dissemination activities and is planning new activities for the next reporting period
- REUSE has written the deliverables D607.011, D607.021 and D607.031
- REUSE has collaborated in deliverable D607.041
- REUSE has established contact and alignment with ontology-based work packages

#### **EADS-CAS**

- Training and familiarization with Requirements Quality Suite.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	192 of 269

- Participation / contribution to WP607 WebEx and F2F meetings.
- Review of D607.021 (Requirements Quality Analyzer) on Nov 05, 2013.
- EADS-CAS has performed some internal dissemination and exploitation activities. The approach was presented in several meetings with other organizational units. Two workshops were conducted with a team located in Manching to assess the applicability of the approach to another avionic project.

## **EADS IW G**

Mainly for informal discussions with WP67 leader and representatives

## **OFFIS**

- OFFIS has received intensive technical training on the RQS tools and techniques
- OFFIS provided methods and tools for the formalization of requirements
- Work on the integration of the OFFIS requirements analysis methods into the RQS tool chain has been performed
- OFFIS evaluated the possibility to integrate the pattern-based RSL into RQS by prototypically integrating one pattern of the RSL into existing RQS tool to demonstrate seamless requirement formalization process.
- OFFIS was a co-author on several deliverables, namely D607.011, D607.031, D607.041, and D.607.021.

## **SAGEM**

The main activities of Sagem have been:

- Training and familiarization with Requirements Quality Suite.
- Participation / contribution to WP607 WebEx and F2F meetings.
- Review of D607.021 Requirements Quality Suite documents.
- Test and first evaluation of the current Requirements Quality Suite and identification of needs for improvements for taking into account more CESAR completeness/correctness/consistency criteria.
- Contribution to the definition of requirements for the enhanced Requirements Quality Suite.

## **UC3M**

- UC3M has been working in the ontology definition, structure, methodology and process. Also worked in the boilerplates brick advances in the formalization activities. UC3M has studied and analysed the CESAR project CCC specification. UC3M has studied the user needs based on IOS. UC3M has collaborated in: the first development of all the approaches, the identification and alignment of technical core and refined requirements, planning of dissemination activities for the next year, and collaborated in deliverables D607.011, D607.021, D607.031 and D607.041.
- UC3M collaborated with the deliverables in the work package for ontology representation, boilerplates, formalization and requirements assessment. A research of some OSLC services concerning Requirements Quality and Ontology Management has been made as well.
- The people involved in the project participated in meetings, workshops with users and analysis of documents; as well as the planning and the design of deliverables.

## ***Tangible results***

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	193 of 269

- Deliverable D607.011, D607.021 and D607.031: including the “as-is” of the technology bricks
- Deliverable D607.041: describing the new methodological approaches
- Review of deliverables: D204.010 and D206.021
- Technical core and refined requirements
- First IOS services
- Extensibility mechanism for new CCC metrics
- UI enhancements for RAT
- Development of some boilerplates and patterns to cover the user needs
- Contact and alignment with ontology-based work packages
- Dissemination activities

### ***Reasons for deviations***

Due to internal debates among the best way to describe the CCC approach. Deliverable D607.041 was delivered with a deviation of several weeks. No major impact on other deliverables or tasks has been noticed.

### ***Reasons for failing to achieve critical objectives***

All critical objectives planned for this period have been achieved.

### ***Use of resources***

EADS CAS: Less effort spent as planned due to the delayed ramp-up of the project. No impact on project objectives expected, since the deviation will be recovered in the next reporting period.

EADS IW G: We expect to spend more effort on this Work Package when IOS compliant WP607 bricks become available and can be integrated into WP208 SEE environment.

OFFIS: parental leave of a project member was causing slight reduction of effort. No risk for reaching defined objectives.

UC3M: founding arrived late from the National Funding Authorities, so personal could not be contracted on time and we will increase efforts during the second and third year of the project.

### ***Resources used for***

- Production and review of deliverables: D607.011, D607.021, D607.031 and D607.041
- Revision of other deliverables: D204.010
- Unofficial review of WP206.021
- Identification of requirements from UC2.3, UC2.4 and from some CESAR results (the CCC approach)
- Contact and alignment with ontology-based work packages
- Contact and alignment with IOS-related team
- Dissemination activities
- Training and installation of the technology background
- Enhancements in some of the technology foreground
- Agreement and design of the extensibility mechanisms
- Development of some boilerplates and patterns to cover the user needs

Details see in Annex I use of resource of each beneficiary

### ***Collaboration with other projects***

Excellent information flow has been established with ARTEMIS JU project MBAT since some partners (EADS-CAS, EADS-IW-G and OFFIS) are also actively involved in MBAT. An example is the exchange on the pattern-based requirements consistency analysis approach developed in MBAT. In addition, we build on results achieved in the ARTEMIS JU project CESAR (e.g. related with requirements formalization and use of ontologies – same partners mentioned above plus SAGEM).

EADS-CAS participates in the national research project SPES-XT on method development and exploitation on embedded systems. Information flow has been established recently. SPES-XT participants have been invited to a CRYSTAL dissemination workshop.

### ***Statement on the dissemination activities and exploitation perspectives***

#### **Dissemination activities**

- REUSE: INCOSE Workshop: June 2013
- REUSE: INCOSE Tool Vendor Challenge: June 2013

In addition, industrial partners have performed internal dissemination activities.

#### **Exploitation perspectives**

REUSE and the industrial partners still foresee a great value in the improvements made to the tools RQA, RAT and kM in general, and their interoperability features in particular.

#### **Corrective actions**

N/A

## **3.6.8 WP 608 Product Lifecycle Management (Lead: SISW)**

### ***Project objectives for the period M1- M12***

Overview of Work Package Objectives for the M1-M12 reporting period  
European companies face the challenge to invent, design and manufacture more and more complex products that create value for their customers. These innovative products need new engineering methods to manage complexity and ensure the safety and reliability of operation. One engineering method to face the challenge of complexity is systems engineering. Being able to efficiently manage complexity that is creating value of their products is becoming a key differentiator for companies. European companies have been leading in this area and need to further push forward to keep this lead. This analysis will be conducted by collecting the needs of the domains in the CRYSTAL project and deriving a common subset of functionality. The CRYSTAL project proposes the following RTP implementation strategy and vision to achieve a common reference technology platform which is applicable and reusable across industrial domains.

In the first phase (Requirements Gathering - M1-M12) of this work package the Product Lifecycle Management requirements of an advanced systems engineering environment were collected and analysed. A limited field study was done by Siemens PLM Software at the Hannover Fair 2014 in order to verify the initially assumed challenges for small and medium businesses by the rising complexity of products and the need for a design and verification process that system engineering

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	195 of 269

represents. The conducted interviews were also used to verify the scope of our selected lifecycle topics for the IOS and our prioritization procedure.

“Data Service Providers” like Siemens and PTC confirmed that:

- the traceability of changes, roles and rights management, variants and configuration,
- the tracking of alternatives that were made,
- the documentation of the progress of the systems engineering process (dashboards etc),
- the ability to manage complex workflows (supporting collaboration of distributed engineering teams),
- the support of a decision making process that follows rules

need to be supported in a “Product Lifecycle enabled” systems engineering environment.

Furthermore domain specific authoring tools (Engineering Tool Functions) have able to be easily connected to such a solution.

The results of this phase were shared and synchronised with work page WP601 and are now becoming part of a common “Interoperability Specification”. The concern was raised by SISW and PTC that the focus of the CRYSTAL project on OSLC as the only implementation technology does not represent the reality of the IT landscape that exists at the current customers of SISW and PTC. In order to assure the wider acceptance of a standard that is developed in the CRYSTAL project the industrial reality and the way commercial software providers prioritize investments needs to be considered. From the viewpoint of the WP608 project leader this is a critical issue.

### ***Work Package progress and achievements during period M1-M12***

This section gives details for each work package the work performed and progress achieved.

#### ***Progress towards objectives***

SISW: according to plan. The first deliverable was the collection of PLM related requirements for the functionality of an IOS. Specification, Development and Assessment for Product Lifecycle Management CRYSTAL\_D\_608\_011\_v3-0.doc. This mostly was based on the Aerospace use case. A thorough analysis of the engineering methods required to fulfil the use case leads to a table. The analysis allows to prioritize the list of requirements towards the specification of the IOS.

In the discussion with Alenia we decided to regroup the deliveries in order to have a better and more streamlined structure

ALA: Contribution to PLM / Process related requirements collection. The first deliverable of WP 608 has been reviewed in order to identify an extended set of topics to be covered in the next period. The objectives of task T608.10 have been updated and a dedicated amendment proposal has been prepared. In the context of the selection process for technologies and requirements to be studied, a set of topics of interest has been prepared and delivered to the WP Leader.

The finalized Specification document, WP608\_11 has been reviewed. A further set of topics to be considered for project's second milestone has been defined and notified to the WP Leader.

EADS-CAS: Task T685. Alignment of needs between WP203 and WP608. Industrial needs from WP203.

EADS-IW G: No work performed so far from EADS IW G. No results so far. Due to the decision with other partners to use the WP208 use case as piloting use case and concentrate on the quick development of a first WP208 SEE demonstrator, we had to spend more effort on WP208 and take this effort from elsewhere.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	196 of 269

The SEE demonstrator development roadmap required a focus on ALM related tasks in the first place. The integration with PLM is still an important topic but will occur after a first successful development of an ALM brick has been achieved.

Consequently, the effort for the ALM related Work Package WP611 is higher in this first phase of the project, while the effort for the PLM related Work Package 608 is lower than initially planned. EADS-IW UK: No activities so far. These activities are linked to Airbus Group Use Cases WP2.1 and WP2.3 and are not scheduled yet.

SESM: no information – not participating

SYS: Task 6.8.1 PLM requirements gathering. Contributed to the requirements gathering Task 6.8.2 PLM IOS/RTP architecture and system design. Focus on architecture for integrating IOS concepts into the SystemWeaver SEE. Task 6.8.3 PLM IOS/RTP proof of concept. Prototyping OSLC. Prototyping variability concepts. Task 6.8.3 PLM IOS/RTP proof of concept Results: OSLC prototype implementation in SystemWeaver. Variability management prototype in SystemWeaver

UNIFIED-II: Analysis of relevant tools (e.g., IBM Rational DOORS, IBM Rational Rhapsody) and standards () in the field of Embedded Systems Lifecycle Management. Preliminary study for supporting technology selection.

PHILIPS: Task 6.8.4

The major objective of this task is to improve interoperability with other tools which are usually used in tight collaboration with HP Quality Center related to WP3.4

Activities:

- Analyse use cases 3.4 and 4.1 for requirements HP QC
- Develop EngineeringMethod Verify Requirements
- Study existing implementations of HP QC OSLC interfaces
- Define IOS services for HP QC

QlikView:

Collect the type of data and information that is necessary to efficiently support the development processes and collect the requirements of the use cases on QlikView and similar dashboard and data mining functionality and harmonize and prioritize these requirements:

- Rational Team Centre
- Safety risk management
- system performance measuring

Results:

- Detailed description of EngineeringMethod Verify Requirements
- First draft IOS description for HP QC
- QlikView requirements for Rational Team Centre, Safety risk management, system performance measuring



FhG-F: no progress toward objectives

IST: no progress toward objectives

RGB: RGB has collaborated with ITI in the establishment of the specifications for the B4.16. A draft version of the IOS requirements coming from the use case 4.06 for B4.16 has been obtained.

Barco: Application Lifecycle Management, variant how to keep track of different versions of the models within Gerrit/Git environment, how to generate documents conform the V-model to be compliant with IEC 62304. Interaction and alignment with CRYSTAL partners using PCT Integrity. Input to WP608 brick based on the Barco activities started in WP404 and WP405.

ITI: In this WP ITI during this period has worked in two different lines. On one hand has collaborated with AVL and Philips in order to determine the IOS requirements to be supported by the brick B4.12. On the other hand has collaborated with RGB in set the specifications for the B4.16.

A draft version of the IOS requirements coming from the use cases for B4.12 and B4.16 has been obtained. ITI has also contributed to the first version of D608.011.

AVL: Task 6.8.4: Collaboration with ITI regarding OSLC integration of HP QualityCenter established. Task 6.8.4: First experimental OSLC adapter for HP QualityCenter implemented

PTC: no progress toward objectives

### ***Tangible results***

See the above work package descriptions that indicate the achieved results.

### ***Reasons for deviations from Annex I***

While the “skilled resource availability” impacts the volume of outcome of some parts of this work package the focus and prioritization that was applied as a countermeasure prevented a negative impact to other parts of the project.

### ***Reasons for failing to achieve critical objectives***

For SISW the availability of resources was a constant challenge during the first year of the project. The effort that was estimated in the project proposal was higher than expected and the complexity leads to the need for very highly skilled resource requirement. This resource requirement could only be fulfilled through certain periods due to engagements of the resources in ongoing customer project. Adjustment of the highly set internal expectations needed to be made in the case of SISW.

### ***Use of resources***

In general the planned efforts match the efforts taken.

### ***Collaboration with other projects***



Depending on the subject of the work package communication takes place. But the general impression is that this communication is very limited and should be improved in order to prevent reinventing the wheel.

#### **Statement on the dissemination activities and exploitation perspectives**

The participants of WP608 have not big dissemination activities due to the early stage of the project and the limited results at this stage.

#### **Corrective actions**

No corrective actions needed.

### **3.6.9 WP 609 Multi-viewpoint Engineering (Lead: Obeo)**

#### **Project objectives for the period M1- M12**

As Systems and software complexity is increasing, it requires appropriate means to describe and design these systems. To define the architecture of a system, the various stakeholders with their own concerns, contribute to its description. For instance, the safety engineer does not have the same concerns as the head of product line. An architecture description allows everyone to understand and demonstrate that the architecture of the system meets its concerns, and their related requirements. The major reference for specifying how the architecture descriptions are expressed is the standard [ISO / IEC 42010] 1 published in July 2011.

**The objective of this work package is to provide a set of bricks (the Core Technology Kit) for building and executing Integrated Engineering Model Based Environments (IEMBE).** An IEMBE is composed of a set of tools allowing engineers to define the architecture, design, develop a system and / or its components (subsystems, software, equipment, etc.) for a given domain, as well as dedicated viewpoints to deal with aspects such as dependability, performance, etc.

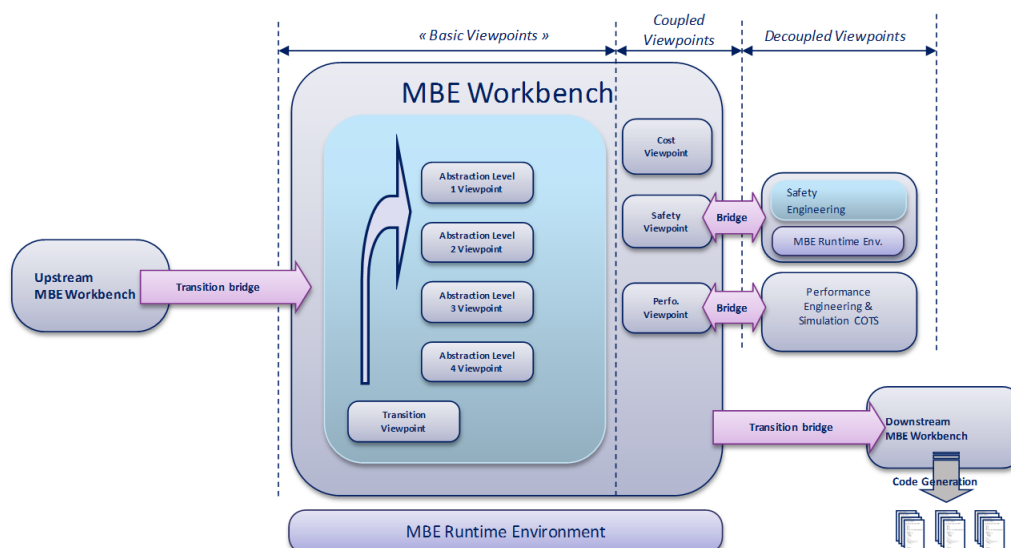


Figure 3-9: Example of Integrated Engineering Model Based Environment

The Core Technology Kit supports two levels of usage as shown in the figure above:

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	199 of 269

- the MBE Development Environment when the IEMBE is configured
- the MBE Runtime Environment when the IEMBE is used

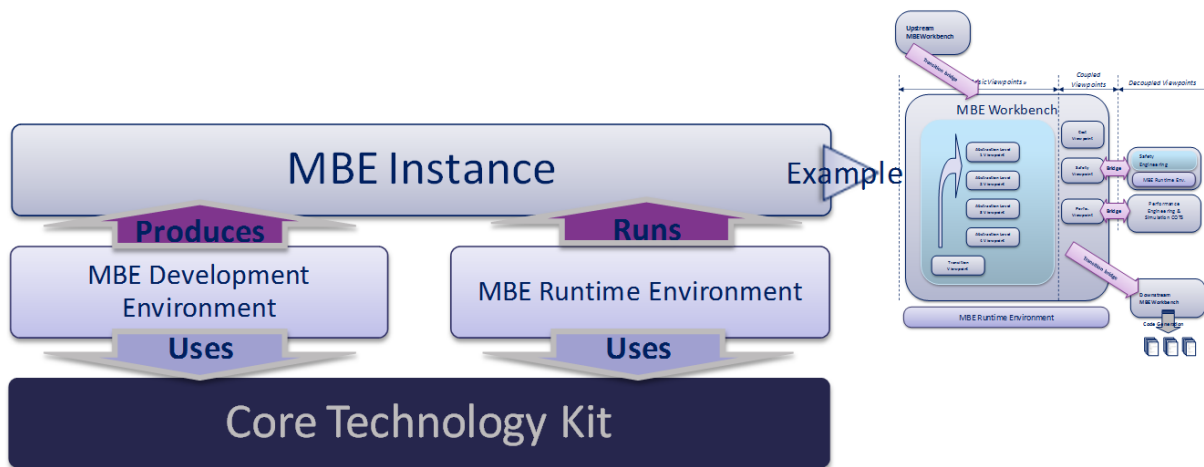


Figure 3-10: General architecture schema

The Core Technology Kit supports development and implementation of major types of tools for model driven engineering: graphical editing of models, data entry model, model transformation, generation of information from modelling, verification and analysis of models, synchronization between models.

These components must be integrated, consistent, and provide capabilities to be used in a multi-viewpoint environment (extensibility, inheritance, composition, etc.) or used independently.

While the Core Technology Kit and its components have a meaning as Eclipse projects, some components or the IEMBE itself may fit better within the Polarsys platform (<http://wiki.eclipse.org/Polarsys>), whose guidelines are set by industry in coordination with tool providers and academics.

### **Work Package progress and achievements during period M1-M12**

#### **Progress towards objectives**

During this period M1-M12, the following progresses were made:

#### **Task 6.9.1 - MBE Development & Execution Environments**

- Definition and implementation of the MBE Development Environment (DE) that provides a textual DSLs to describe architecture frameworks and viewpoints, including the description of the meta-models, diagrams, UIs, services, packaging & configurations.
- Development of the generators that generate AF & VP from their DSL descriptions (targeting Sirius).
- Development of the MBE Execution Environment (EE) that manages the artifacts produced by the MBE DE, including dynamic viewpoint extension, viewpoint activation/deactivation capabilities.
- Development of the MBE Core Technology Kit (CTK) that gathers a set of MDE technologies/tools used at development and execution times, including, in a first stage, a message reporter, a resource reuse tool and the integration of Sirius, Composer, Transposer and Accuracy.
- Development of a test case for MBE DE & EE: "Simple Component" architecture framework and safety and performance viewpoints.

- Open Sourcing of the MBE DE & EE in Eclipse under the name Kitalpha.

#### **Task 6.9.2 - Open Source component for editing models by graphical views and Web rendering**

- Refactoring and open sourcing actions in Eclipse under the name Sirius as well as the associated branding required material for this new technology project
- Definition and implementation of improvements on the Sirius technology to scale with large models
- Definition and implementation of a set of functional improvements on Sirius according to use case needs (see D609.901 deliverable for more details)
- Definition and implementation of an Ecore graphical modelling environment (EcoreTools 2) using Sirius
- Support for project partners as well as community users for Sirius adoption
- Start of definition and implementation of modularization activities to reach better interoperability and integration for Sirius (still ongoing)
- Start of definition and technology prototyping for Web rendering for models viewing and editing
- Dissemination activities with the help of other project partners

#### **Task 6.9.3 - Open Source component for generating GUI presentation of business data**

- Implementation of the Meta-model defined in the documentation titled by "Presentation Modelling Framework": PMF V 1.2 – CRYSTAL. The meta-model is the key module of PMF, which provides the capability to design the application UI in abstract model.
- Integration with EGF to allow the developers of PMF to extend the code generators not only by using all supported template code engines such as JET or Acceleo, but also by any programming languages such as Java, Ant or JRuby.
- Integration with XWT using EGF to generate the first UI in XWT for eclipse. During the integration we have developed some generators to produce the codes for basic UI Widget such as Text, Button, CheckBox, Combox, List, Table, RichText, CalendarChosser and CDateTime.
- Generation of Properties View. As a modelling engineering component, PMF should provide a set of tools to simplify the developer's life. The Properties View for the PMF model is one of most used view parts in eclipse for the model edition. This module is in fact the first application of PMF. The Properties View is modelled in the PMF meta-model and generated by the integration with EGF and XWT.

By now, only the static UI and some basic Data Bindings are implemented.

#### **Task 6.9.4 - MBE technologies**

- Implementation of the Transposer technology framework that aims to master complex model transformations, through transformation mapping declaration, mapping rules inference & scheduling mechanisms and transformation workflow contribution mechanisms.
- Implementation of the Composer technology framework that aims to separate generation and organization concerns for model-to-text generations through generation strategies declaration & execution, and generation workflow contribution mechanisms.

- Implementation of the Accuracy technology framework that aims to ease validation and analysis rules implementation by providing the capability to add OCL and Java constraints, based on EMF Validation, without rebuilding the modeling workbench, and by providing the capability to activate/deactivate groups of rules.
- Development of test cases for Transposer, Composer and Accuracy.

#### T 6.9.5 – Model co-evolution

- State of the art of Model co-Evolution that highlights the following concerns: considering the variety of the existing viewpoints, how to ensure the global consistency - and, more generally, communication - between the different views of the designed system? When each of the views is being mapped to a model, this issue requires at least synchronizing heterogeneous models.
- Identification and definition of a set of operational use cases to elicit the model co-evolution needs and to drive the innovation and implementation activities for this new technology.
- Identification of the current blocking limitation of the existing model transformation technologies: iterative synchronization, interactive update and bidirectional transformation needs are not addressed, or not well-addressed and, when providing high level abstraction concepts, only limited expressiveness and traceability means are provided.
- Definition of a set of 20 high level requirements.
- Definition of a first declarative transformation & co-evolution framework (ATL concepts generalization oriented).
- Prototyping of this framework and execution engine, based on EMF & EMF Diff/Merge technologies.
- Validation of the first prototype on one of the defined use cases.

#### T 6.9.6 – Integration of requirement management for multi-viewpoint engineering

- Preliminary study on integration of requirement management within a MBE environment using the ReqIF language and a simplified requirement language
- Prototyping of these two viewpoints

#### **Tangible results**

The main tangible results for WP6.9 are :

- Sirius Brick (task 6.9.2) is available on <http://www.eclipse.org/sirius>, very good welcome of the community and many improvements made on Sirius
- The technical note on the current practices in term of avionics analysis has been written and is very valuable as input for this WP.
- First specifications
  - AF & VP DSL-based MBE DE 1st prototype, with generators & packaging
  - AF & VP MBE EE 1st prototype
- 1st implementation of Composer, Transposer, Accuracy technology frameworks
- MBE CTK 1st prototype
- 1st integration into the MBE CTK of the Sirius, Composer, Transposer, Accuracy technology frameworks
- 1st early prototype of the Model co-evolution technology
- New Eclipse project KitAlpha

- Kitalpha presented to the Eclipse Polarsys & Automotive Working Groups
- Talks about Sirius at Eclipse Conferences
- The state of the art of Model co-Evolution

### **Reasons for deviations**

Despite issues described under chapter 2.1.5, there is very little deviation from Annex I. The only tangible one is for task 6.9.6 for Obeo, because of a late start. Obeo has taken corrective action on resources so that the delay disappears in the next year. All other tasks are in line and the delay on the last task has no impact on other tasks.

### **Reasons for failing to achieve critical objectives**

No failing of achievable objectives foreseen

### **Use of resources**

Most of the partners show a small underspending in term of resources on this work package. There are two reasons for that:

- First, for the French partners only, contractual difficulties with the French authorities have brought some delays on staffing
- Those delays have brought some delays in the work package kick-off

As for now, and although contractual issues are not yet solved, everything is up and running for the work package. Most of the sub-tasks have started on time and show good progress and the deviation for resources at M12 is reasonable and will be fulfilled in the next periods.

### **Collaboration with other projects**

Not applicable.

### **Statement on the dissemination activities and exploitation perspectives**

The following dissemination activities have taken place during the M1-M12 period:

Type	Title	Event	Partner	Date
Presentation	Sirius By Example: Build Your Own Diagram, Table and Tree Editors in 20 Minutes	Eclipse Con Europe	Obeo, TGS	29/10/2013
Presentation	Turning Eclipse into an Arduino programming platform for kids	Eclipse Con Europe	Obeo	29/10/2013
Presentation	Sirius: Changing the Game of Systems Architecture	Eclipse Con Europe	Obeo	29/10/2013
Workshop	Let's get Sirius	Eclipse Con Europe	Obeo	29/10/2013
Others	Eclipse Newsletter dedicated to Sirius	Emailing	Obeo	10/11/2013
Website	Sirius Website and logo		Obeo	27/10/2013
Presentation	Sirius role-playing game: Build diagram, table and tree editors in 20 minutes!	Eclipse Con America	Obeo, TGS	17/03/2014
Presentation	EcoreTools 2.0: The Luna revival	Eclipse Con America	Obeo	17/03/2014
Presentation	Turning Eclipse into an Arduino programming platform for kids	Eclipse Con America	Obeo	17/03/2014
Presentation	Uses Cases of PolarSys technologies for Architects	Eclipse Con America	Obeo	17/03/2014
Workshop	Sirius Roadshow - Paris	Workshop (France)	Obeo	27/03/2014
Workshop	Sirius Roadshow - Nantes	Workshop (France)	Obeo	03/04/2014
Workshop	Sirius Roadshow - Toulouse	Workshop (France)	Obeo	10/04/2014

Workshop	Let's get Sirius	Eclipse Con America	Obeo	19/03/2014
Others	Obeo Newsletter on Sirius	Emailing	Obeo	24/10/2013
Presentation	Kitalpha presentation to Polarsys & Automotive Eclipse IWG	EclipseCon Europe 2013 - Industry Working Groups	TGS	28/10/2013
Presentation	Kitalpha Open Sourcing announcement to Polarsys IWG	Eclipse Polarsys meeting - Industry Working Group	TGS	25/06/2013

### **Corrective actions**

Not applicable

## **3.6.10 WP 610 Variability Management (Lead: Tecnalia)**

### **Project objectives for the period M1- M12**

The objective of this work package is to provide the required methods and tools to ensure the correct implementation of product line engineering techniques within the industrials demonstrators. This requires a focus on the special needs of embedded systems engineering as well as the alignment to the development process for safety-critical systems. Variability concepts are in general domain independent and are therefore applicable to all Crystal domains. WP6.10 must provide support for the pilots applications in the following directions:

- Provide methods, techniques and guidelines for variability management in safety-critical system families covering the full system life cycle
- Provide full traceability of variability to actual development artifacts (Requirements, Architecture, Design, Software, test cases and procedures) and ensure consistency between all development artifacts in the product derivation process
- Provide multi-viewpoint variability modeling support to ensure consistency between various technical models (software, electronics, and mechanics) in the context of automatic testing.
- Provide support for enabling different levels of abstractions in the variability representation and interpretation (different type of users need to view variability in different manners)
- Provide the tooling and methods for domain specific language development and code generation for variability hotspots in safety-critical embedded systems

### **Work Package progress and achievements during period M1-M12**

#### **Progress towards objectives**

##### **Task 6.10.1 Consolidated Crystal Variability Management**

Within this task the various activities for the brick development are coordinated and consolidated into a Crystal Variability Management approach.

#### **Objectives:**

Get a common understanding on the variability management needs of the use cases and the respective SoTA/P. Identify interrelations between the bricks of WP6.10 and to other related SP6 bricks. Exploit potential synergies. Provide a consolidated Crystal Variability Management approach.

#### **Integration activities:**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	204 of 269



- Ongoing improvements of variability management SoTA/P in related projects like MBAT and VARIES will be investigated and integrated
- Interrelations among the bricks of WP6.10 and to other related SP6 bricks are identified, esp. related tools in the CRYSTAL RTP
- Collect requirements from the different use cases

#### Improvement work:

Get a consolidated Crystal variability management approach and not just single variability management bricks.

TECNALIA, as WP6.10 leader, has coordinated the activities within WP6.10. In this direction from M1 – May 2013 till M4 – August 2013 heavy work was devoted to actually coordinate the actual specification of the industrial cases needs towards WP6.10 bricks. At the same time TECNALIA has contributed both to D610.011 Crystal Variability Management - V1 as well as D610.031 Brick System Family Engineering Framework - V1. At the same time coordination among WP6.10 members and industrial sub-projects has been performed. The management of the WP6.10 has been established and there are biweekly Telcos for coordinating and tracking the work within WP610.

Regarding the milestones for WP6.10, Tecnalía has contributed both to D610.011 Crystal Variability Management - V1 as well as D610.031 Brick System Family Engineering Framework - V1. Within deliverable D610.031 Brick System Family Engineering Framework TECNALIA proposed at a first stage the use of PLUM for variability Management, however it was decided later on that this first version of D610.031 was actually focusing on engineering methods and not tools. In line with this TECNALIA will accomplish the enhancement of PLUM within the project during 2014-2015 to satisfy the user requirements.

#### BARCO

##### Progress towards objectives:

Variability Management, variability management in the ALM tool chain and link this with SW component design process. Alignment with WP610 partners

#### Results

Deliverable D610.011 "Crystal Variability Managemnt V1"

#### **Task 6.10.2 System Family Engineering Framework brick development (lead: FhG-I)**

The System Family Engineering brick provides a customizable method, respective techniques and guidelines to engineer families of high-integrity (including safety-critical) systems. It will be based on Fraunhofer PuLSE and relevant SoTA/P in Product Line Engineering. Specific features that will be added are: planning (esp.scoping) and specification of high-integrity families (including techniques and guidelines to cover safety issues), modularization approaches and orthogonal variability management.

##### Objectives:

The framework will provide a method, techniques and guidelines on how to manage variability holistically on the systems level and subordinate levels in high-integrity, multi-discipline, and system-of-systems settings.

Support especially the early planning (aka. scoping) and specification of high integrity system families, as well as their quality assurance and safety certification related activities. Investigate the

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	205 of 269



synergies between variability modelling, feature-modelling and ontology-based approaches and exploit them.

Integration activities:

- The variability management approaches developed in CESAR as well as Fraunhofer PuLSE framework will form the basis for this brick.
- Ongoing improvements of variability management SoTA/P in related projects like MBAT and VARIES will be investigated and integrated.
- Related tools in the CRYSTAL RTP will be identified and supported by the brick.

Improvement work:

Support for high integrity systems in multi-discipline, and System-of-systems settings will be added to current

SoTA/P in variability management.

### **Progress towards objectives:**

IBM-UK in Dec 2013 M8 decided to contribute and so begin to engage during M10 to understand partner needs. Propose and run a survey within the project to identify mayor keystones for supporting the project partners in variability management/reuse/product lines. The main target is to go beyond the bricks and identify potential issues that can be carried out within WP6.10 and can provide support for different partners.

Since the main focus of the involved use cases changed, we merged brick Task 6.10.4 lead by VIF, with the Systems family engineering brick. Doing so, we can collect more requirements from the partners and provide a more holistic variability solution. We started a close collaboration with the automotive (and also health-care) domain in order to establish a common understanding and develop a process to gather the requirements. So far we have identified two types of challenges concerning variability: 1) Tool complexity: Variability is a cross-cutting aspects throughout the entire development process. This means that all tools in a tool chain have to understand the same variability concepts and that this is also a main issue for interoperability. Another solution would be the use of an additional variant management tool, which then in turn has to provide interfaces to all tools in the tool chain. In any way, interoperability support for variability issues is one major concern. 2) Artifact complexity: Including variability in the different development artifacts means that they are getting more complex. Especially if variability is introduced as an add-on. This means that there needs to be some guidance how to structure artifacts in a way that the complexity is still manageable.

FhG

Progress towards objectives:

- \* Alignment of needs and ongoing developments with other WP6.10 partners in regular webmeetings.
- \* For System Family Engineering Framework Brick further interested UCs have been identified and analyzed for their needs.
- \* Variant Analysis tool and approach has been specified in D610.011
- \* A external survey on the industrial needs for Variability Management has been conducted.
- \* State of the Art and Practice of Variability Management have been revised for major new approaches.
- \* Contribution of System Family Engineering Framework has been elaborated and possible content has been structured.
- \* Coordination and compilation of D610.031 System Family Engineering Framework deliverable.
- \* Compilation of an overview slide set on main variability management approaches and tools and presentation to automotive UC.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	206 of 269

**Results:**

- \* Needs from UC 2.3 and UC 3.4 have been elicited
- \* D610.031 compiled and delivered
- \* First structure for System Family Engineering Framework exists
- \* Interest group for System Family Engineering Framework has been extended

**EADS-IW****Progress towards objectives:**

Few informal exchanges with WP6\_10 partners

Due to the decision with other partners to use the WP208 use case as piloting use case and concentrate on the quick development of a first WP208 SEE demonstrator, we had to spend more effort on WP208 and take this effort from elsewhere.

Among others, we decided to take the effort from WP6\_10, since Product Line Engineering aspects were not in the focus of the development of the first WP208 SEE Demonstrator.

**EADS-CAS****Progress towards objectives:**

- Alignment of needs between WP203 and WP610
- Discussion concerning DSL brick with Siemens.
- Participation / contribution to WP610 WebEx meetings with FhG IESE.

**Results:**

Industrial needs from WP203

**Task 6.10.3 Variant Analysis brick development (lead: FhG-I)**

Variant Analysis is an approach and tool developed by FhG to identify commonality and variability in the engineering artefacts (in particular code) of existing system variants in an efficient and effective way. It compares several variants in parallel and supports an interactive multi-level commonality-variability-analysis. The tool has been mainly applied on large code-bases.

**Objectives:**

The Variant Analysis tool shall be provided to the respective use cases to assess the reuse potential in existing artefacts. A special focus will be on the support of requirements, design models and test artefacts. Necessary tool extensions are developed if required.

**Integration activities:**

- Integrate the tool into the CRYSTAL RTP
- Support the artefact types used in the respective use cases

**Improvement work:**

Elaborate support for commonality variability analyses in requirements, design models and test artefacts.

**Results**

Deliverable D610.011 "Crystal Variability Management V1": provided "Variant Analysis Brick Brick" chapter 2.

**Task 6.10.4 Automatic testing (SIL, HIL)(lead: VIF)**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	207 of 269

This task was merged into Task 6.10.2 where testing issues will be dealt with.

#### **Task 6.10.5 iGEM (lead: VIF)**

AVL iGEM products line guarantees the correct implementation of the latest legislative code in the emission automation for engine and vehicle testbeds selecting from a huge range of variants. The modular structure of the application allows selecting a set of test applications in advance but also an upgrade or extension later on. iGEM offers high scalability and also allows simple adjustments for different testbed configurations to be made based upon individual user needs.

##### **Objectives:**

The major objective of this task is to improve interoperability with other tools which are usually used in tight collaboration with iGEM. A use case for such a collaboration will be developed in WP3.4.

##### **Integration activities:**

In order to improve collaboration as described above, iGEM should be seamlessly integrated into the CRYSTAL interoperability standard, with a special focus on interoperability with bricks that are used in WP3.4. AVL and ViF will work closely together in order to achieve a successful integration in agreement with the task leader.

##### **Improvement work:**

No special improvements on the tools itself are planned except those which become necessary in order to comply with the CRYSTAL interoperability standard and the necessary features in order to be used in the related use case defined by WP 3.4

##### **AVL**

\*) AVL is currently working on concepts how to integrate iGEM into its toolchain defined in WP3.4.

##### **Results**

Deliverable D610.011 "Crystal Variability Management V1": provided " AVL iGEM Brick" chapter 3.

#### **Task 6.10.6 TFMS (lead: VIF)**

AVL TestFactory Management Suite™ (TFMS) is a comprehensive system for the standardization and automation of the core processes in the test field in the domain of automotive. Based on the variability of test bed systems, the system's main task is the efficient management of all data relating to test orders, test equipment and units under test.

##### **Objectives:**

The major objective of this task is to improve interoperability with other tools which are usually used in tight collaboration with TFMS. A use case for such a collaboration will be developed in WP3.4. A special focus of collaboration will be the interoperability with the brick Simulation Model Backbone Database (B3.83), which will be developed in WP6.13.

##### **Integration activities:**

In order to improve collaboration as described above, TFMS should be seamlessly integrated into the CRYSTAL interoperability standard, with a special focus on interoperability with brick B3.83 (WP6.13) as well as with bricks that are used in WP3.4. AVL and ViF will work closely together in order to achieve a successful integration in agreement with the task leader.

##### **Improvement work:**

No special improvements on the tools itself are planned except those which become necessary in order to comply with the CRYSTAL interoperability standard and the necessary features in order to be used in the related use case defined by WP 3.4

---

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	208 of 269

## Results

Deliverable D610.011 "Crystal Variability Management V1": provided "AVL TFMS Brick" chapter 4.

### Task 6.10.7 AVL Creta (lead: VIF)

As a central calibration data management system of xCU parameters, AVL CRETA™ allows the central storage, conflict-free merging and traceable documentation of calibration datasets and variants during series calibration projects.

#### Objectives:

The major objective of this task is to improve interoperability with other tools which are usually used in tight collaboration with AVL Creta. A use case for such collaboration will be developed in WP3.4. A special focus of collaboration will be the interoperability with the brick Simulation Model Backbone Database (B3.83), which will be developed in WP6.13.

#### Integration activities:

In order to improve collaboration as described above, AVL Creta should be seamlessly integrated into the

CRYSTAL interoperability standard, with a special focus on interoperability with brick B3.83 (WP6.13) as well as with bricks that are used in WP3.4. AVL and ViF will work closely together in order to achieve a successful integration in agreement with the task leader.

#### Improvement work:

No special improvements on the tools itself are planned except those which become necessary in order to comply with the CRYSTAL interoperability standard and the necessary features in order to be used in the related use case defined by WP 3.4

#### AVL

- \*) Integration concept of CRETA in WP3.4 tool chain is defined.
- \*) Interoperability concept based on OSLC is defined
- \*) First prototype of OSLC adapter for Creta is implemented.

## Results

Deliverable D610.011 "Crystal Variability Management V1": provided "AVL CRETA/CAMEO Brick" chapter 5.

### Task 6.10.8 Domain Specific Language & automatic code generation brick development

Siemens has led the activities within this brick/task.

This brick will provide a domain-specific language tool suite comprising existing open source tooling, additionally developed components, and guidelines specifically tailored towards safety-critical embedded systems development.

#### Activities:

- Review technical specifications of bricks;
- Support exploration of possibilities for integration of textual and graphical editing of models
- experiment on provided implementations for the WP4.1 use case; provide early feedback.

### Progress towards objectives

The TU/e is currently investigating a number of language workbenches to develop DSLs to see how they support modularity. Another research in cooperation with TNO is on integration of textual

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	209 of 269

and graphical editing of models. A prototype for Xtext and GMF has been developed based on EMF.

Based on the healthcare engineering methods, we have identified five main DSL topics to work on.

These are described in D610\_011\_Crystal\_Variability\_Management. SIEMENS, TNO and TU/e have made contributions to the following two topics:

- Integration of textual and graphical editing  
To explore the technical possibilities for integration textual and graphical editing in Eclipse, we have set up an assignment for a M.Sc. graduation project. Together with Mark van den Brand (TU/e), we are now coaching a M.Sc. student that is working on this assignment.

#### --- Modularity of DSL instances -----

For modularization of DSL instances, we have developed an import mechanism to split large instances into smaller ones. This mechanism differs from the standard Xtext mechanisms in the following ways: it is based on URIs and it works recursively. In particular it supports multiple imports of the same file, and cyclic imports between files, which are very convenient in practice.

SIEMENS also participates in Know-how ramp-up for mbeddr DSL workbench and in the elaboration of a reference process for Safety Assessment and Certification (as input to one of the next deliverable version)

#### Meetings:

- DSL Workshop in Eindhoven Feb 17, 2014 to kickoff/align brick contributions

#### Results

The TU/e has organized a workshop for participants (TNO, Siemens, Philips, TU/e) in the B4.4. A number of future research directions have been discussed. The focus is on modularity in DSLs and the integration of textual and graphical editing of DSL models.

PHILIPS has Support TNO in the technique for modularization that is applied in TECH\_REF\_REQ\_0024.

Deliverable D610.011 "Crystal Variability Management V1": provided "DSL Brick" chapter 6

#### **Task 6.10.9 Automatic Test Cases Generation For Space Application brick development** (lead: Orbital)

Orbital is an international specialist in the validation & verification arena for critical systems. We will apply our knowledge to reduce cost of V&V in the space field aligning the variability management with the ESA standards. Our tool set proposed will extract automatic test generation from initial requirements thus reducing cost of V&V campaigns. A specific set of requirement language will be set and used to define the initial requirements so the automatic test cases generation tool can take place

Within D60.011 "Crystal Variability Management" elaboration process, a heavy IOS dependence was detected for AUGER brick, binding the development of the tool to the activities in external IOS work packages. It was decided to base IOS interfaces specification on existing work of OSLC community.

---

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	210 of 269

## Results

Deliverable D610.011 "Crystal Variability Management V1": provided "AUGE Brick" chapter 7.

### **Tangible results**

During the reporting period main work has been identifying the industrial needs for the different partners and for the bricks. In this direction the main results are the following:

- D610.011 "Crystal Variability Management V1"
- D610.031 "System Family Engineering Framework"

### **Reasons for deviations**

N/A

### **Reasons for failing to achieve critical objectives**

N/A

### **Use of resources**

See Annex I Beneficiary Reports

### **Collaboration with other projects**

N/A

### **Statement on the dissemination activities and exploitation perspectives**

Dissemination and exploitation activities are described in the Report and Planning on Dissemination Activities and Exploitation Plan.

### **Corrective actions**

N/A No major deviations found

## **3.6.11 WP 611 Software Development Lifecycle (SDLC) Management Brick Community (Lead: IBM UK)**

### **Project objectives for the period M1- M12**

This is a work package within WP 6.the Crystal Bricks Work Package.

The main objective of this work package is to facilitate a self-organising community of software development "brick" providers and consumers to support the industry domain demonstrators. Bricks, within Crystal, are tools that support the Crystal Interoperability Specification (IOS).

The focus concerns of WP6.11 are bricks for Application Lifecycle Management (ALM) within the Software Development lifecycle (SDLC), examples of ALM domains are:

- Requirements Management
- Architecture and Performance Management
- Software Modelling and Engineering
- Quality Management
- Change Management



## - Software Configuration Management

For instance in Aerospace domain use cases (WP2.1 – Airbus ECS, and WP2.3 – Cassidian WP6.11 aims to aid the realisation of SDLC bricks to enable the Aerospace system specification, modelling and analysis frameworks, such as shown earlier as needed by Cassidian (now Airbus Defence & Space) and Airbus; such bricks can enable a collaborative lifecycle management environment, through Workflow Management, Traceability of Lifecycle Artefacts, Configuration and Change Management, Product Lines and Variation Management in conjunction with requirements specification, modelling and analysis tools.

NOTE at M12: To meet the usage within the partner use-cases and within its portfolio IBM UK and IBM NL extended the scope of its efforts in WP6.11 to include Systems and Software Development Lifecycle.

### **Work Package progress and achievements during period M1-M12**

This section gives details for each work package the work performed and progress achieved.

#### **Progress towards objectives**

Progress to committed deliverables

D6.11.11 Produced for M9 and updated for M12.

NOTE: At M8 the WP6.11.1, 2 and 3 deliverables were restructured in line with other WP6.X workgroups.

D6.11.51 Produced for M9

#### **Tangible results**

The scope of the first use cases and Engineering methods emerging from the partners was more around Systems development – hence that has been a major focus to M9 especially, since M9 there has been some attention to Software lifecycle especially from Healthcare. A more balanced situation is anticipated.

IBM UK as WP6.11 lead promotes and focuses work around the Engineering methods and IOS as the primary ways to learn of the demands on the systems and software lifecycle. Since M8 only IBM UK, IBM NL and TNO are active as brick owners in WP6.11.

Demonstrator for Public Aero Use Case WP2.08 Engineering method “Change Impact Analysis” for M9 and now through dissemination to include YouTube video posting.  
<https://www.youtube.com/watch?v=zeFiGSwMsUc>

This was produced in close and joint collaboration with Airbus and Alenia. Fully demonstrates the power of IOS based tool interoperability and highlights the role of Crystal to extend today's capability.

Second demonstrator for Change Impact Analysis produced for M12 with Airbus and Alenia but material not through dissemination fully at time of writing.

IBM NL led a demonstrator for Verify design against requirements for Healthcare use case 4.1. Not yet ready for dissemination.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	212 of 269



Within WP6.11.51 a technique was developed to model the Engineering methods to draw out common requirements and IOS enablers, this is currently being applied to additional EMs from the Public Aero and Healthcare 4.1 but not yet available fully at M12. This will require an update as the Crystal Technical Management process has matured in recent weeks.

Initial findings have been carried forward to the draft IOS “V1.0 “

IBM UK as WP lead aims to co-ordinate its activities and the efforts of WP6.11 with WP6.8 and WP6.10.

#### ***Reasons for deviations from Annex I***

Certain partners reduced their effort significantly in WP6.11 as a result WP6.11 was updated in agreement with the Project Office and Steering Board in M8, certain deliverables were removed due change in support amongst the partners.

#### ***Reasons for failing to achieve critical objectives***

The deliverables were refocused at M8 due to significantly reduced partner resource and withdrawal by certain partners. Despite this significant results in terms of demonstrators have been achieved.

#### ***Use of resources***

The consortia agreement was available until November 2013 as a result IBM's resource is about 50% of original plan due to delayed input from industry use-cases.

#### ***Collaboration with other projects***

Within the confines of the respective agreements IBM UK aims to align its activities with partners across MBAT and CRYSTAL.

#### ***Statement on the dissemination activities and exploitation perspectives***

Through WP6.11 IBM has actively supported multiple dissemination events and activities, including the Artemis conference in Stockholm, December 2013.

#### ***Corrective actions***

IBM UK is currently re-estimating resource outlook for WP6.11, the results are not available at this time and some additional will be needed after M15 once the full scope of the industry use case needs are available and assessed.

### **3.6.12 WP 612 Validation Models (Lead: MATE)**

#### ***Project objectives for the period M1- M12***

To validate a complex industrial systems, starting from the system requirements, test scenarios should be defined by V&V team (independent from the development team), usually using a model describing the system itself. This model often doesn't allow any automatic verification of its feasibility. Any change of the requirements implies the manual identification of the tests impacted by this change and then a modification of the tests themselves. Moreover it's not possible to

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	213 of 269

define, automatically, system tests from the model itself, but this definition of test cases is made manually, starting from a model that is only a representation of the system behaviour. To reduce costs related to these activities it's necessary to improve the integration between the different steps of the V&V process. Using the tool chain and the methodology refined in this WP, the industrial process will integrate naturally the modeling phase in the test definition, once the model is defined, and the test cases are semi-automatically generated from it, with a limited effort by V&V team. The traceability of the model, both on system requirements and on generated tests, supports the users in the analysis of the impact of modification in system requirements during the whole life cycle of the system, reducing time needed to modify test cases after changes in requirements. Furthermore, the automatic traceability between requirements and tests simplifies the maintenance of entire test suite and the analysis of the test results, speeding up the identification of requirements or parts of the system not right implemented.

### **Work Package progress and achievements during period M1-M12**

#### **Progress towards objectives**

During this period M1-M12, all the objectives were followed. WP 612 partners have identified and defined concepts relevant to validate a complex industrial system. In detail WP 612 partners' objectives were focused in describing use cases of the bricks. All the technical and methodology bricks have been presented into the deliverable D612.011 that has been completed and submitted in time according to project schedule. With these activities, the partners also contributed to the optimization of use of their bricks in the use cases. Then each partner has analyzed the methods and technologies to achieve the objectives of the WP 612.

This table shows objectives for each task in order to achieve WP 612's goal:

<b>Task</b>	<b>objectives</b>	<b>partners</b>
Task 6.12.1	In this task, the main objective is the validation process of embedded systems particularly in the automotive systems.	CTH
Task 6.12.2	The major focus of this task is the improvement or the extension of already existing modeling tools and languages in order to make them applicable on real industrial systems and reduce cost and effort of testing activities.	Mate UNIFED-II SUN
Task 6.12.3	The focus of this task is the "translation" of the test scenarios, written in a generic meta-language that can be adopted in any industrial domain in the IOP language, defined by UNISIG consortium to allow the execution of interoperable tests in a multi-suppliers environment	Mate ASTS
Task 6.12.4	The focus of this task is to allow, in the integrated V&V environment, a quick and easy analysis of the errors	Mate ASTS

	identified in the V&V activities	
Task 6.12.5	Main objective of this task is the automatization of the post processing to manipulate large amount of data. Fully integrated in the automation system it enables a direct online processing while the tests are running.	AVL-R
Task 6.12.6	This task focuses on Embedded Verification Platform for the verification and validation of an Controls application.	AVL-R
Task 6.12.7	Main objective of this task is the implementation of Requirements Engineering for Quality purposes and for ISO26262 compliance. This involves integrating a variety of tooling solutions into a common format for identifying linkage down the V-model from Requirements -> proof of implementation.	IFX-UK

Table 3-7: Tasks and objectives WP612

**Partners' progress towards objectives follow:****ASTS:**

- Assessment of the work of tool providers towards the fulfilment of ASTS requirements.

**CTH:**

- Foundations have been laid to elicitate requirements as well as state of the art/practice. First results in a validation method have been achieved.

**AVL-R:**

- AVL-R will define the requirements, and develop and implement the embedded verification platform which base on the current existing specific test framework.

**IFX-UK:**

- Specification, Development and Assessment for Validation Models - V1 D612.011. All bricks were analysed and written up and into the deliverable. The B3.91 asureSign brick has been integrated into the Infineon tool landscape also during this time and the flow to integrate it seamlessly to implement a requirement-driven verification methodology is on-going.
- Reqlf has yet to be looked at although the internal schema ARQE.xml has been donated to the consortium and is currently being extended to support asureSign.
- Documentum is currently not being analysed as that will be the final tooling.
- Reqtify we are under discussions with in relation to building an interface between Reqtify and asuresign

- ClearQuest: we will investigate this at a later stage. There is currently a move to Jira so we may move the change management tool to Jira, which is more web based solution and is more likely to fit in with the concept of the project
- B3.86 Requisite Pro - we will also investigate this later in the project as Visure is currently in a roll out stage and if this is rolled out then we will move onto Visure instead - RequisitePro is currently being phased out by IBM

#### MATE:

- Mate, as WP leader, has coordinated the activities of the WP6.12 and the respective deliverables. With this respect, we have been able to deliver the requested deliverables taking into account the contributions provided by all the WP partners.
- We also analysed the more appropriate set of technologies for the implementation of three tools: RailModel, IOP Test Writer, Log Analyzer. We have also worked on OSLC prototyping in order to implement interoperability, consistency of data and data integration for integration of tools and we are waiting more detailed directions from WP6.02 to move this prototype into IOS and RTP.

#### SUN:

- T6.12.2: Rail model implementation and assessment SUN unit contributed to this task by supporting the definition of a language for the specification of rail signalling systems. SUN is also working on the design of proper transformational tools to support the automatic test case generation.

#### UNIFED-II:

- The contribution of UNIFEDII to WP6.12 addresses the objective of reducing the validation and test effort, in particular the time needed for the definition of system level tests. Specifically, in task T6.12.2 (Rail model implementation and assessment) UNIFEDII in collaboration with SUN is developing a test case generation process and a hierarchical state machines formalism to be used in verification contexts. The language peculiarity mainly resides in the semantics of fork-and-join which allows dynamic (bounded) instantiation of machines (processes).

#### WP 612 participants collaborate in order to:

- Analyze models and languages for requirement specification and methodologies for requirements verification (Mate, UNIFEDII, SUN with support of ASTS).
- Analyze the technologies for implementation of RailModel tool, IOP Test Writer tool and Log Analyzer tool (Mate, ASTS).
- Define the specifications of RailModel tool (Mate, UNIFEDII, ASTS) .

### **Tangible results**

#### AVL-R:

- First investigations about IOS done.
- First implementations within the implemented tool environment done, but not really tested.

#### CTH:

- State of research survey in model-based validation and verification

- State of practice survey in modeling, validation methods, and industry needs (web survey with 121 participants) together with WP 6.3.
- Trace based real-time verification of monitored system behaviour (publication at GT-VMT 2014) together with UC 3.4 and WP 6.3

## IFX-UK:

- Documentation of the Data flow within Infineon and how all of the Bricks interface has been delivered

## MATE:

- First prototype of the tool RailModel (modelling tool) has been realized with an ad-hoc (not final) modelling language defined by UNIFED for verification of railway control systems.

## SUN:

- T6.12.2: Rail model implementation and assessment - Some preliminary results of the activities within CRYSTAL projects are going to be published in "Towards Model-Driven V&V assessment of railway control systems" that as been accepted for publication into the Journal of Software Tools and Technology Transfer.

## UNIFED-II:

- Syntax and semantics of the constructs to model the control flow. A first application to UC5 modeling has been made. First results related to the test case generation process definition have been described in a paper accepted for publication on the International Journal on Software Tools for Technology Transfer (STTT).

**Reasons for deviations**

No deviations.

**Reasons for failing to achieve critical objectives**

N.A.

**Use of resources**

No deviation between planned and performed use of resource

**Collaboration with other projects**

N/A

**Statement on the dissemination activities and exploitation perspectives**

The dissemination activities of WP612 in period M1-M12 follow:

Partner	Dissemination	Date
CTH	Paper on scenario-based modelling and trace based verification of real-time behaviour of embedded systems accepted and presented at the 13th International Workshop on Graph Transformation and Visual Modeling Techniques (GT-VMT 2014)	4/6/2014

IFX-UK	Presentation on Intelligent Requirements engineering - CRYSTAL mention on improving tool interaction.	10/16/2013
IFX-UK	External discussions on linkedin relating to work being done under CRYSTAL	4/8/2014
SUN ASTS UNIFED-II	Journal paper entitled: "Towards Model-Driven V&V assessment of railway control systems" on International Journal of Software Tools and Technology Transfer (STTT).	Accepted for publication.

**Corrective actions**

N.A.

**3.6.13 WP 613 Simulation Models (Lead: AVL)****Project objectives for the period M1- M12**

Simulation models still have an increasing impact within a huge variety of development processes. In typical HIL or SIL environments, for instance, simulation models replace real-world objects in order to allow rapid prototyping or test frontloading. Powerfulness simulation tools such as MathWorks Simulink lead to great flexibility regarding the operation purpose of simulation models. As a consequence, simulation models can be used in very early as well as in very late development process stages. This, however, leads to the problem that some demanding characteristics and constraints of simulation models (such as simulation accuracy, real-time constraints, etc.) differs significantly in the various development stages and thus often hinder model-reuse and model development collaboration. Besides this, a lack of model development collaboration activities is still often found between different projects. Even if participants of the projects are aware of each other, there is often no straightforward access to the applied simulation model in order to analyse them regarding their potential of reuse.

The major objective of this work package is therefore to significantly improve collaboration and re-use of simulation models or, where constraints such as mentioned above hinder the development and use of consolidated simulation models, setting models with similar purposes in corresponding relation to each other. In addition, the simulation models should be more straightforward accessible and findable in terms of their purpose to significantly improve project and model development collaboration. This includes especially the possibility to apply requirement and variability management and is thus be related to the work packages 6.7 and 6.10 of this SP. Finally, an improved degree of automation and a reduced set of development overhead should be other key results of this work package. Of course, all collaboration aspects which include other tools and/or technological bricks have to fully comply with the interoperability specification defined in work package 6.1.

**Work Package progress and achievements during period M1-M12****Progress towards objectives**

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	218 of 269

In general it has to be said that most of the activities of this WP were dependent of the use case definition in the various domains, which is considered to be the most important input of WP6.13. This has been achieved successfully for most tasks with the exception of T6.13.3, whereas the related use case (WP3.4) has not defined its related needs yet (this is planned to happen in the next project period). Due to these dependencies, significant efforts in this WP during the first period were spent on the evaluation of the use case needs. Thus many implementation activities have not started yet but are planned to be performed in the next project period. However, T6.13.1 (Simulation model data backbone) is an exception here, where prototype enhancements are implemented by AVL and IOS integration is done by AVL with tight collaboration with VIF.

- T6.13.1 Simulation model data backbone  
AVL coordinated successfully the mapping UC needs to this brick, which is described by a corresponding deliverable. AVL was supported here especially by AVL-R, VIF, FhG and IST. There was a special focus on mapping to WP3.4. Based on the use case needs defined by this WP, AVL coordinates several brick enhancements and prototype implementations based on this mapping with a tight collaboration with VIF.
- T6.13.2 MathWorks Simulink  
AVL supported VIF and ITKE with the successful the mapping UCs needs to this brick, which is described by a corresponding deliverable.
- T6.13.3 IOS and AVL TBSimu integration  
Mapping of UC needs to brick was not possible, since UC definitions do not include yet this brick.
- T6.13.4 IOS and AVL ArteLab integration  
AVL supported VIF and IST with the successful the mapping UC needs to this brick, which is described by a corresponding deliverable. Some tool enhancement concepts have been developed.

### **Tangible results**

- UC mapping: With exception of T6.13.3, UC mapping was performed successfully and led to a corresponding description in form a deliverable document (AVL, AVL-R, VIF, ITKE, IST).
- Prototype Implementation for T6.13.1:
  - Brick functionality was essentially enhanced to fulfil the UC needs. Architecture enhancements of the simulation model data backbone allow now the storage of more data categories via a data category plugin concept. These concepts were verified by an AVL Cruise integration prototype. All these activities were performed by AVL entirely and were described by a corresponding deliverable.
  - Furthermore, several OSLC adapters were written to interlink data from the simulation model data backbone with other tools mostly driven by the UC needs of WP3.4. These activities were performed mostly in tight collaboration of AVL and VIF. IOS integration approaches were also supported by TUG, by transferring results from the MBAT project to CRYSTAL.
- Implementation concepts for T6.13.4
  - concepts essential extensions for ArteLab have been developed in the realm of co-simulation approaches (AVL, FhG, IST).

### **Reasons for deviations**

No major deviations detected, with the exception of the delayed start of T6.13.3. To compensate that regarding the overall planning, efforts have been shifted to the remaining tasks, especially on T6.13.1. Consequently, planning is updated to put more efforts on T6.13.3 at a later project period.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	219 of 269



***Reasons for failing to achieve critical***

Use case definition is considered to be iterative in the CRYSTAL project. Consequently, not every use case aspects have been defined after the first iteration period. This affects T6.13.3, which is not started yet, but is expected to be at a later project period with increased effort.

***Use of resources***

No major deviation even due to the delayed T6.13.3 through shifting more efforts to other tasks.

***Collaboration with other projects***

Within the corresponding workshops closely at AVL several IOS topics were addressed. TUG presented their current IOS integration within MBAT and discussed and advised on several different IOS implementation approaches. These experiences are currently incorporated in current prototype activities in WP6.13.

***Statement on the dissemination activities and exploitation perspectives***

No activities so far.

***Corrective actions***

Not applicable

### **3.7 Beneficiary Report**

See Annex 1 Beneficiary Reports M1 - M12

## 4 Deliverables and milestones tables

### Deliverables

This list includes all the deliverables due in this reporting period, as indicated in Annex I of the JU Grant Agreement.

Deliverables that are of a nature other than written "reports", such as "prototypes", "demonstrators" or "others", are also reported as accompanied by a short report, so that the Joint Undertaking has a record of their existence.

This list already considers the deliverable consolidation, proposed in the request for amendment: Deliverables that have been cancelled or regrouped with another one are indicated as such in the column "Comments".

New deliverables that are proposed are indicated in the column "Comments".

This table shows all deliverables from the beginning of the project.

Deliverable	Deliverable name	WP no.	Lead	Nature	Level	Delivery date from Annex I (proj month)	Delivery date shift (proj month)	Actual / Forecast delivery date	Delivered [yes/no]	comments
D101.011	Periodic Progress Report	1_1	AVL	R	CO	9	13	31.05.14	no	shift to M13 according to amendment
D101.012	Periodic Progress Report	1_1	AVL	R	CO	20	25	31.05.15	no	shift to M25 according to amendment
D101.013	Periodic Progress Report	1_1	AVL	R	CO	32	37	31.05.16	no	shift to M37 according to amendment
<del>D101.014</del>	<del>Periodic Progress Report</del>	<del>1_1</del>	<del>AVL</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	-		deleted requested in amendment
D101.020	Quality Plan	1_1	AVL	R	CO	3	3	31.07.13	yes	
D101.030	Project Handbook	1_1	AVL	R	CO	3	3	31.07.13	yes	
D102.010	Dissemination Plan V1	1_2	AVL	R	PP	3	9	31.01.14	yes	shifted to M9
D102.020	Public Website including Dissemination Material	1_2	AVL	R	PU	4	4	30.09.13	yes	delayed*
D102.030	Report and Planning of Dissemination Activities V1	1_2	AVL	R	PP	9	12	30.04.14	yes	shift: Due to the realignment of the reporting periods from M9 to M12
D102.040	Exploitation Plan V1	1_2	AVL	R	CO	9	12	30.04.14	yes	shift: Due to the realignment of

										the reporting periods from M9 to M12
D102.050	CRYSTAL Global Glossary	1_2	POLITO	R	PU	20	20	31.12.14	no	
D102.060	CRYSTAL Sustainability Model V1	1_2	AVL	R	PP	20	20	31.12.14	no	
D102.070	Exploitation Plan V2	1_2	AVL	R	CO	20	24	30.04.15	no	shift to M24 according to amendment
D102.080	Report and Planning of Dissemination Activities V2	1_2	AVL	R	PP	20	24	30.04.15	no	shift to M24 according to amendment
D102.090	CRYSTAL Sustainability Model V2	1_2	AVL	R	PP	32	36	30.04.16	no	shift to M36
D102.100	Report on Dissemination Activities V3	1_2	AVL	R	PP	36	36	30.04.16	no	
D103.010	CRYSTAL metrics definition	1_3	OFFIS	R	CO	20	20	31.12.14	no	
D103.020	Assessment of project objectives	1_3	OFFIS	R	CO	36	36	30.04.16	no	
<del>D200.011</del>	<del>SP2 management report – V1</del>	<del>2_0</del>	<del>A-F</del>	<del>R</del>	<del>CO</del>	<del>9</del>	<del>9</del>	<del>31.05.14</del>	-	deleted according to amendment
<del>D200.012</del>	<del>SP2 management report – V2</del>	<del>2_0</del>	<del>A-F</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	<del>31.05.15</del>	-	deleted according to amendment
<del>D200.013</del>	<del>SP2 management report – V3</del>	<del>2_0</del>	<del>A-F</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	<del>31.05.16</del>	-	deleted according to amendment
<del>D200.014</del>	<del>SP2 management report – V4</del>	<del>2_0</del>	<del>A-F</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	-		
D201.011	Requirements - V1	2_1	A-G	R	CO	9	9	31.01.14	yes	
<del>D201.012</del>	<del>Requirements – V2</del>	<del>2_1</del>	<del>A-G</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted according to amendment part of D201.902
<del>D201.013</del>	<del>Requirements – V3</del>	<del>2_1</del>	<del>A-G</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted according to amendment part of D201.903
D201.021	Demonstrator - V1	2_1	A-G	D	RE	9	9	31.01.14	yes	
<del>D201.022</del>	<del>Demonstrator – V2</del>	<del>2_1</del>	<del>A-G</del>	<del>D</del>	<del>RE</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of D201.902
<del>D201.023</del>	<del>Demonstrator – V3</del>	<del>2_1</del>	<del>A-G</del>	<del>D</del>	<del>RE</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of D201.903
<del>D201.024</del>	<del>Demonstrator – V4</del>	<del>2_1</del>	<del>A-G</del>	<del>D</del>	<del>RE</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of D201.903
<del>D201.031</del>	<del>Assessment report – V1</del>	<del>2_1</del>	<del>A-G</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of D201.902
<del>D201.032</del>	<del>Assessment report – V2</del>	<del>2_1</del>	<del>A-G</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of D201.903
D201.902	Use-Case Development Report - V2	2_1	A-G	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D201.903	Use-Case Development Report - V3	2_1	A-G	R	CO	36	36	30.04.16	no	new deliverable acc. to

# Project Periodic Report



										amendment
D202.010	Use Case Description	2_2	ALA	R	RE	3	3	31.10.13	yes	
D202.021	Requirement Specification - V1	2_2	ALA	R	RE	9	9	31.01.14	yes	
D202.022	Requirement Specification - V2	2_2	ALA	R	RE	20	20	-	-	deleted, part of D202.902
D202.031	SEE Specification - V1	2_2	ALA	R	RE	9	9	31.01.14	yes	
D202.032	SEE Specification - V2	2_2	ALA	R	RE	32	32	-	-	deleted, part of D202.903
D202.040	SEE Prototype Implementation	2_2	ALA	R	RE	20	20	-	-	deleted, part of D202.902
D202.050	SEE Manual First version	2_2	ALA	R	RE	20	20	-	-	deleted, part of D202.902
D202.060	SEE First version	2_2	ALA	D	RE	20	20	-	-	deleted, part of D202.902
D202.070	SEE Manual Final version	2_2	ALA	R	RE	32	32	-	-	deleted, part of D202.903
D202.080	SEE Final version	2_2	ALA	D	RE	32	32	-	-	deleted, part of D202.903
D202.090	Assessment report (first version)	2_2	ALA	R	RE	20	20	-	-	deleted, part of D202.902
D202.100	Assessment report (final version)	2_2	ALA	R	RE	36	36	-	-	deleted, part of D202.903
D202.902	Use-Case Development Report - V2	2_2	ALA	R	RE		22	28.02.15	no	new deliverable acc. to amendment
D202.903	Use-Case Development Report - V3	2_2	ALA	R	RE		36	30.04.16	no	new deliverable acc. to amendment
D203.011	MSE Report - V1	2_3	EADS-CAS	R	CO	9	9	31.01.14	yes	
D203.012	MSE Report - V2	2_3	EADS-CAS	R	CO	20	20	-	-	deleted, part of D203.902
D203.013	MSE Report - V3	2_3	EADS-CAS	R	CO	32	32	-	-	deleted, part of D203.903
D203.014	Final MSE Report	2_3	EADS-CAS	R	CO	36	36	-	-	deleted, part of D203.903
D203.020	First MSE SEE (Prototype)	2_3	EADS-CAS	P	CO	9	9	10.02.14	yes	delayed* (delivered earlier than planned 28.02.2014)
D203.030	Enhanced MSE SEE	2_3	EADS-CAS	D	CO	20	20	-	-	deleted, part of D203.902
D203.040	Final MSE SEE	2_3	EADS-CAS	D	CO	32	32	-	-	deleted, part of D203.903

# Project Periodic Report



			CAS							
D203.902	Use-Case Development Report - V2	2_3	EADS-CAS	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D203.903	Use-Case Development Report - V3	2_3	EADS-CAS	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D204.010	E-FCS RBE process and toolchain evaluation - V1	2_4	SAGEM	R	CO	9	9	31.01.14	yes	
<del>D204.020</del>	<del>E-FCS RBE process and toolchain evaluation - V2</del>	<del>2_4</del>	<del>SAGEM</del>	<del>R</del>	<del>CO</del>	<del>9</del>	<del>9</del>	<del>31.12.14</del>	-	wrong in DOW, shift to M20 (31.12.2014) according to amendment, part in D203.902
<del>D204.030</del>	<del>E-FCS RBE process and toolchain evaluation - V3</del>	<del>2_4</del>	<del>SAGEM</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of D203.903
D204.902	Use-Case Development Report - V2	2_4	SAGEM	R	CO		22	28.02.15	no	new deliverable acc. to amendment
D204.903	Use-Case Development Report - V3	2_4	SAGEM	R	CO		36	30.04.16	no	new deliverable acc. to amendment
D205.010	Space Use Case Requirements	2_5	TASE	R	CO	9	9	11.03.14	yes	delayed* (further delayed until 13th of March, submission on 11th)
D205.020	CRYSTAL Space Toolset Specification	2_5	TASE	R	CO	12	12	30.04.14	yes	
<del>D205.030</del>	<del>CRYSTAL Space Toolset</del>	<del>2_5</del>	<del>TASE</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of D203.902
<del>D205.040</del>	<del>CRYSTAL Space Toolset Demonstrator</del>	<del>2_5</del>	<del>TASE</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of D203.903
<del>D205.050</del>	<del>CRYSTAL Application to Space Systems</del>	<del>2_5</del>	<del>TASE</del>	<del>R</del>	<del>PU</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of D203.903
D205.902	Use-Case Development Report - V2	2_5	TASE	R	CO		22	28.02.15	no	new deliverable acc. to amendment
D205.903	Use-Case Development Report - V3	2_5	TASE	R	CO		36	30.04.16	no	new deliverable acc. to amendment
D206.010	Multi-Mode Navigation System Analysis, Development Needs, and the Proposed Tool-Chain Functionality	2_6	HON	R	RE	9	9	31.01.14	yes	

D206.021	Architecture of the Tool Chain for the Multi-Mode Navigation System	2_6	HON	R	RE	12	12	30.04.14	yes	
<del>D206.022</del>	<del>Reviewed Architecture of the Tool Chain for the Multi-Mode Navigation System</del>	<del>2_6</del>	<del>HON</del>	<del>R</del>	<del>RE</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 206.902
<del>D206.031</del>	<del>Development of Tools and Tool Adaptors</del>	<del>2_6</del>	<del>HON</del>	<del>P</del>	<del>RE</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 206.902
<del>D206.032</del>	<del>Integrated Tool Chain for the Multi-Mode Navigation Use-Case</del>	<del>2_6</del>	<del>HON</del>	<del>P</del>	<del>RE</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 206.903
<del>D206.040</del>	<del>Demonstration &amp; Assessment of the Integrated Tool Chain on the Multi-Mode Navigation Use-Case</del>	<del>2_6</del>	<del>HON</del>	<del>D</del>	<del>PU</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 206.903
D206.902	Use-Case Development Report - V2	2_6	HON	R	RE	22	22	28.02.15	no	new deliverable acc. to amendment
D206.903	Use-Case Development Report - V3	2_6	HON	R	RE	36	36	30.04.16	no	new deliverable acc. to amendment
D207.010	Use Case Description	2_7	TASF	R	CO	12	12	30.04.14	yes	
<del>D207.020</del>	<del>Interim evaluation report</del>	<del>2_7</del>	<del>TASF</del>	<del>R</del>	<del>CO</del>	<del>24</del>	<del>24</del>	<del>30.04.15</del>		deleted, part of 207.902
<del>D207.030</del>	<del>Final evaluation report</del>	<del>2_7</del>	<del>TASF</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	<del>30.04.16</del>		deleted, part of 207.903
D207.902	Use-Case Development Report - V2	2_7	TASF	R	CO		22	28.02.15	no	new deliverable acc. to amendment
D207.903	Use-Case Development Report - V3	2_7	TASF	R	CO		36	30.04.16	no	new deliverable acc. to amendment
D208.010	CRYSTAL aerospace use case description	2_8	ALA	R	PU	9	9	31.01.14	yes	
<del>D208.021</del>	<del>CRYSTAL aerospace use case data package - V1</del>	<del>2_8</del>	<del>POLITO</del>	<del>D</del>	<del>PU</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 208.902
<del>D208.022</del>	<del>CRYSTAL aerospace use case data package - V2</del>	<del>2_8</del>	<del>POLITO</del>	<del>D</del>	<del>PU</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 208.903
<del>D208.030</del>	<del>CRYSTAL aerospace SEE</del>	<del>2_8</del>	<del>EADS IW-G</del>	<del>P</del>	<del>PU</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 208.902
<del>D208.041</del>	<del>CRYSTAL aerospace use case assessment report - V1</del>	<del>2_8</del>	<del>ALA</del>	<del>R</del>	<del>PU</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 208.902
<del>D208.042</del>	<del>CRYSTAL aerospace use case assessment report - V2</del>	<del>2_8</del>	<del>ALA</del>	<del>R</del>	<del>PU</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 208.903
<del>D208.050</del>	<del>CRYSTAL aerospace SEE (final)</del>	<del>2_8</del>	<del>POLITO</del>	<del>D</del>	<del>PU</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 208.903
D208.902	Use-Case Development Report - V2	2_8	EADS IW-G	R	PU	22	22	28.02.15	no	new deliverable acc. to amendment
D208.903	Use-Case Development Report - V3	2_8	EADS IW-G	R	PU	36	36	30.04.16	no	new deliverable acc. to amendment

D209.010	State of the art for aerospace ontology	2_9	ALA	R	PU	9	9	31.01.14	yes	
D209.021	Aerospace ontology and services definition dossier - V1	2_9	EADS IW-F	R	RE	20	20	31.12.14	no	
D209.022	Aerospace ontology and services definition dossier - V2	2_9	EADS IW-F	R	RE	36	36	30.04.16	no	
<del>D209.031</del>	<del>Aerospace ontology services implementation - V1</del>	<del>2_9</del>	<del>EADS IW-F</del>	<del>R</del>	<del>RE</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 209.902
<del>D209.032</del>	<del>Aerospace ontology services implementation - V2</del>	<del>2_9</del>	<del>EADS IW-F</del>	<del>P</del>	<del>RE</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 209.903
<del>D209.041</del>	<del>Aerospace ontology assessment report - V1</del>	<del>2_9</del>	<del>POLITO</del>	<del>P</del>	<del>RE</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 209.902
<del>D209.042</del>	<del>Aerospace ontology assessment report - V2</del>	<del>2_9</del>	<del>POLITO</del>	<del>R</del>	<del>RE</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 209.903
D210.010	Simulation for PRA use case description	2_10	A-F	R	CO	9	9	31.01.14	yes	
<del>D210.020</del>	<del>Simulation for PRA SEE</del>	<del>2_10</del>	<del>A-F</del>	<del>P</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 210.902
<del>D210.031</del>	<del>Simulation for PRA assessment report - V1</del>	<del>2_10</del>	<del>A-F</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 210.902
<del>D210.032</del>	<del>Simulation for PRA assessment report - V2</del>	<del>2_10</del>	<del>A-F</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 210.903
<del>D210.040</del>	<del>Simulation for PRA SEE (final)</del>	<del>2_10</del>	<del>A-F</del>	<del>D</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 210.903
D210.902	Use-Case Development Report - V2	2_10	A-F	R	CO		22	28.02.15	no	new deliverable acc. to amendment
D210.903	Use-Case Development Report - V3	2_10	A-F	R	CO		36	30.04.16	no	new deliverable acc. to amendment
D211.010	EAT use case description - new titel: Fuel Management Risk Analysis V1	2_11	A-UK	R	CO	9	12	31.03.14	yes	shift to M12 according to amendment, titel and description of deliverable renamed delivered earlier than planned (plan: 30.04.2014)
<del>D211.020</del>	<del>EAT System Prototype</del>	<del>2_11</del>	<del>A-UK</del>	<del>D</del>	<del>CO</del>	<del>20</del>	<del>20</del>	<del>31.10.14</del>	-	deleted, part of 211.902
<del>D211.031</del>	<del>EAT UC WP 2.3.1 Report - V1</del>	<del>2_11</del>	<del>A-UK</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	<del>30.04.15</del>	-	deleted, part of 211.902
<del>D211.032</del>	<del>EAT UC WP 2.3.1 Report - V2</del>	<del>2_11</del>	<del>A-UK</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 211.903
<del>D211.040</del>	<del>EAT System Demonstrator</del>	<del>2_11</del>	<del>A-UK</del>	<del>P</del>	<del>CO</del>	<del>32</del>	<del>32</del>	<del>31.10.15</del>	-	deleted, part of 211.903
D211.902	Use-Case Development Report - V2	2_11	A-UK	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D211.903	Use-Case Development Report - V3	2_11	A-UK	R	CO	36	36	30.04.16	no	new deliverable acc. to



# Project Periodic Report



										amendment
D300.011	Domain Reports – V1	3_0	AVL-S	R	PU	9	9	31.05.14	-	deleted, part of periodic progress report in SP1
D300.012	Domain Reports – V2	3_0	AVL-S	R	PU	20	20	31.05.15	-	deleted, part of periodic progress report in SP1
D300.013	Domain Reports – V3	3_0	AVL-S	R	PU	32	32	31.05.16	-	deleted, part of periodic progress report in SP1
D300.014	Domain Reports – V4	3_0	AVL-S	R	PU	36	36	-	-	deleted requested in amendment
D301.010	Use case definition	3_1	VOLVO	R	CO	6	6	31.10.13	yes	
D301.021	Milestone Report - V1	3_1	VOLVO	R	CO	9	9	31.01.14	yes	
D301.022	Milestone Report – V2	3_1	VOLVO	R	CO	20	20	-	-	deleted, part of 301.902
D301.023	Milestone Report – V3	3_1	VOLVO	R	CO	32	32	-	-	deleted, part of 301.903
D301.030	Work Package Summary Report	3_1	VOLVO	R	PU	36	36	-	-	deleted, part of 301.903
D301.902	Use-Case Development Report - V2	3_1	VOLVO	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D301.903	Use-Case Development Report - V3	3_1	VOLVO	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D302.011	Milestone Report - V1	3_2	DAIMLER	R	CO	9	9	31.01.14	yes	
D302.012	Milestone Report – V2	3_2	DAIMLER	R	CO	20	20	-	-	deleted, part of 302.902
D302.013	Milestone Report – V3	3_2	DAIMLER	R	CO	32	32	-	-	deleted, part of 302.903
D302.020	Work package Summary Report	3_2	DAIMLER	R	PU	36	36	-	-	deleted, part of 302.903
D302.902	Use-Case Development Report - V2	3_2	DAIMLER	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D302.903	Use-Case Development Report - V3	3_2	DAIMLER	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D303.011	Milestone Report - V1	3_3	AVL	R	CO	9	9	31.01.14	yes	
D303.012	Milestone Report – V2	3_3	AVL	R	CO	20	20	-	-	deleted, part of 303.902
D303.013	Milestone Report – V3	3_3	AVL	R	CO	32	32	-	-	deleted, part of 303.903
D303.020	Work package Summary Report	3_3	AVL	R	PU	36	36	-	-	deleted, part of 303.903
D303.902	Use-Case Development Report - V2	3_3	AVL	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment

# Project Periodic Report



D303.903	Use-Case Development Report - V3	3_3	AVL	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D304.011	Milestone Report - V1	3_4	AVL	R	CO	9	9	31.01.14	yes	
<del>D304.012</del>	<del>Milestone Report - V2</del>	<del>3_4</del>	<del>AVL</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 304.902
<del>D304.013</del>	<del>Milestone Report - V3</del>	<del>3_4</del>	<del>AVL</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 304.903
<del>D304.020</del>	<del>Work package Summary Report</del>	<del>3_4</del>	<del>AVL</del>	<del>R</del>	<del>PU</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 304.903
D304.902	Use-Case Development Report - V2	3_4	AVL	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D304.903	Use-Case Development Report - V3	3_4	AVL	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D305.011	Milestone Report - V1	3_5	CRF	R	CO	9	9	31.01.14	yes	
<del>D305.012</del>	<del>Milestone Report - V2</del>	<del>3_5</del>	<del>CRF</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 305.902
<del>D305.013</del>	<del>Milestone Report - V3</del>	<del>3_5</del>	<del>CRF</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 305.903
<del>D305.020</del>	<del>Work package Summary Report</del>	<del>3_5</del>	<del>CRF</del>	<del>R</del>	<del>PU</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 305.903
D305.902	Use-Case Development Report - V2	3_5	CRF	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D305.903	Use-Case Development Report - V3	3_5	CRF	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D306.011	Milestone Report - V1	3_6	Valeo-F	R	CO	9	9	19.05.14	yes	delayed*
<del>D306.012</del>	<del>Milestone Report - V2</del>	<del>3_6</del>	<del>Valeo-F</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 306.902
<del>D306.013</del>	<del>Milestone Report - V3</del>	<del>3_6</del>	<del>Valeo-F</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 306.903
<del>D306.020</del>	<del>Work package Summary Report</del>	<del>3_6</del>	<del>Valeo-F</del>	<del>R</del>	<del>PU</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 306.903
D306.902	Use-Case Development Report - V2	3_6	Valeo-F	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D306.903	Use-Case Development Report - V3	3_6	Valeo-F	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D307.011	Milestone Report - V1	3_7	VIF	R	PU	9	9	31.01.14	yes	
<del>D307.012</del>	<del>Milestone Report - V2</del>	<del>3_7</del>	<del>VIF</del>	<del>R</del>	<del>PU</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 307.902
<del>D307.013</del>	<del>Milestone Report - V3</del>	<del>3_7</del>	<del>VIF</del>	<del>R</del>	<del>PU</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 307.903

# Project Periodic Report



<del>D307.020</del>	<del>Common Automotive development Platform</del>	<del>3_7</del>	<del>VIF</del>	<del>R</del>	<del>PU</del>	<del>36</del>	<del>36</del>	<del>-</del>	<del>-</del>	<del>deleted, part of 307.903</del>
D307.902	Use-Case Development Report - V2	3_7	VIF	R	PU	22	22	28.02.15	no	new deliverable acc. to amendment
D307.903	Use-Case Development Report - V3	3_7	VIF	R	PU	36	36	30.04.16	no	new deliverable acc. to amendment
D308.010	State of the art for automotive ontology	3_8	TUB	R	PU	9	9	31.01.14	yes	change of Lead from DAIMLER to TUB
D308.021	Ontology definition & assessment Report - V1	3_8	TUB	R	RE	20	20	31.12.14	no	change of Lead from DAIMLER to TUB
D308.022	Ontology definition & assessment Report - V2	3_8	TUB	R	RE	32	36	30.04.16	no	change of Lead from DAIMLER to TUB, shift to M36
<del>D400.011</del>	<del>SP4 management report - V1</del>	<del>4_0</del>	<del>PHILIPS</del>	<del>R</del>	<del>CO</del>	<del>9</del>	<del>9</del>	<del>31.05.14</del>	<del>-</del>	<del>deleted, part of periodic progress report in SP1</del>
<del>D400.012</del>	<del>SP4 management report - V2</del>	<del>4_0</del>	<del>PHILIPS</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	<del>31.05.15</del>	<del>-</del>	<del>deleted, part of periodic progress report in SP1</del>
<del>D400.013</del>	<del>SP4 management report - V3</del>	<del>4_0</del>	<del>PHILIPS</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	<del>31.05.16</del>	<del>-</del>	<del>deleted, part of periodic progress report in SP1</del>
<del>D400.014</del>	<del>SP4 management report - V4</del>	<del>4_0</del>	<del>PHILIPS</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	<del>-</del>	<del>-</del>	<del>deleted requested in amendment</del>
D400.020	System engineering performance analysis report V1	4_0	PHILIPS	R	CO	12	12	30.04.14	yes	new deliverable acc. to amendment
D400.021	System engineering performance analysis report V2	4_0	PHILIPS	R	CO	24	24	30.04.15	no	new deliverable acc. to amendment
D400.022	System engineering performance analysis report V3	4_0	PHILIPS	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D401.010	Use Case definition	4_1	PHILIPS	R	CO	6	6	11.11.13	yes	delayed*
D401.021	Prototyping IOS concepts - V1	4_1	PS-Tech	D	CO	9	9	28.02.14	yes	delayed*
<del>D401.022</del>	<del>Prototyping IOS concepts - V2</del>	<del>4_1</del>	<del>IBM NL</del>	<del>D</del>	<del>CO</del>	<del>20</del>	<del>20</del>	<del>-</del>	<del>-</del>	<del>deleted, part of 401.902</del>
<del>D401.030</del>	<del>Building SEE</del>	<del>4_1</del>	<del>TNO</del>	<del>R</del>	<del>CO</del>	<del>24</del>	<del>24</del>	<del>-</del>	<del>-</del>	<del>deleted, part of 401.903</del>
<del>D401.040</del>	<del>SEE and Bricks assessment</del>	<del>4_1</del>	<del>PHILIPS</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	<del>-</del>	<del>-</del>	<del>deleted, part of 401.903</del>
D401.901	Use-Case Development Report - V1	4_1	PHILIPS	R	CO	12	12	30.04.14	yes	new deliverable acc. to amendment
D401.902	Use-Case Development Report - V2	4_1	PHILIPS	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment

# Project Periodic Report



D401.903	Use-Case Development Report - V3	4_1	PHILIPS	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D402.010	Use Case definition	4_2	PHILIPS	R	CO	6	6	15.11.13	yes	delayed*
<del>D402.021</del>	<del>Prototyping IOS concepts - V1</del>	<del>4_2</del>	<del>TNO</del>	<del>R</del>	<del>CO</del>	<del>9</del>	<del>9</del>	<del>30.04.14</del>	-	deleted, part of 402.901
<del>D402.022</del>	<del>Prototyping IOS concepts - V2</del>	<del>4_2</del>	<del>TNO</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	<del>30.04.15</del>	-	deleted, part of 402.902
<del>D402.030</del>	<del>Building SEE</del>	<del>4_2</del>	<del>IBM NL</del>	<del>R</del>	<del>CO</del>	<del>24</del>	<del>24</del>	-	-	deleted, part of 402.903
<del>D402.040</del>	<del>SEE and Bricks assessment</del>	<del>4_2</del>	<del>PHILIPS</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 402.903
<del>D402.050</del>	<del>SEE and Bricks assessment</del>	<del>4_2</del>	<del>PHILIPS</del>	<del>R</del>	<del>PU</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 402.903
D402.901	Use-Case Development Report - V1	4_2	PHILIPS	R	CO	12	12	30.04.14	yes	new deliverable acc. to amendment
D402.902	Use-Case Development Report - V2	4_2	PHILIPS	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D402.903	Use-Case Development Report - V3	4_2	PHILIPS	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D403.010	Use Case definition	4_3	PHILIPS	R	CO	6	6	31.10.13	yes	
<del>D403.021</del>	<del>Prototyping IOS concepts - V1</del>	<del>4_3</del>	<del>TU/e</del>	<del>D</del>	<del>CO</del>	<del>9</del>	<del>9</del>	<del>30.04.14</del>	-	deleted, part of 403.901
<del>D403.022</del>	<del>Prototyping IOS concepts - V2</del>	<del>4_3</del>	<del>TU/e</del>	<del>D</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 403.902
<del>D403.030</del>	<del>Building SEE</del>	<del>4_3</del>	<del>TU/e</del>	<del>R</del>	<del>CO</del>	<del>24</del>	<del>24</del>	-	-	deleted, part of 403.903
<del>D403.040</del>	<del>SEE and Bricks assessment</del>	<del>4_3</del>	<del>PHILIPS</del>	<del>R</del>	<del>CO</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 403.903
D403.901	Use-Case Development Report - V1	4_3	PHILIPS	R	CO	12	12	30.04.14	yes	new deliverable acc. to amendment
D403.902	Use-Case Development Report - V2	4_3	PHILIPS	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D403.903	Use-Case Development Report - V3	4_3	PHILIPS	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D404.010	Requirements tooling report	4_4	BARCO	R	CO	12	12	30.04.14	yes	
<del>D404.020</del>	<del>IOS definition document</del>	<del>4_4</del>	<del>BARCO</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 404.902
<del>D404.030</del>	<del>Integrated tool chain</del>	<del>4_4</del>	<del>IBM NL</del>	<del>R</del>	<del>CO</del>	<del>24</del>	<del>24</del>	-	-	deleted, part of 404.903

D404.040	Assment report	4_4	BARCO	R	CO	36	36	-	-	deleted, part of 404.903
D404.050	Tool chain demonstrator	4_4	BARCO	D	CO	36	36	-	-	deleted, part of 404.903
D404.902	Use-Case Development Report - V2	4_4	BARCO	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D404.903	Use-Case Development Report - V3	4_4	BARCO	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D405.010	Tool and methodology report	4_5	BARCO	R	CO	12	12	30.04.14	yes	
D405.020	IOS definition document	4_5	BARCO	R	CO	20	20	-	-	deleted, part of 405.902
D405.030	Integrated tool chain	4_5	IBM NL	D	CO	24	24	-	-	deleted, part of 405.903
D405.040	Assessment report	4_5	BARCO	R	CO	36	36	-	-	deleted, part of 405.903
D405.050	Tool chain demonstrator	4_5	BARCO	D	CO	36	36	-	-	deleted, part of 405.903
D405.902	Use-Case Development Report - V2	4_5	BARCO	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D405.903	Use-Case Development Report - V3	4_5	BARCO	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D406.010	Tool and methodology report	4_6	ITI	R	CO	12	12	30.04.14	yes	
D406.020	IOS definition document	4_6	RGB	R	CO	20	20	-	-	deleted, part of 406.902
D406.030	Integrated tool chain	4_6	RGB	D	CO	24	24	-	-	deleted, part of 406.903
D406.040	Assessment report	4_6	RGB	R	CO	36	36	-	-	deleted, part of 406.903
D406.902	Use-Case Development Report - V2	4_6	RGB	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D406.903	Use-Case Development Report - V3	4_6	RGB	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D407.010	State of the art for healthcare ontology	4_7	TNO	R	PU	9	9	31.01.14	yes	
D407.021	Ontology definition - V1	4_7	ITI	R	RE	20	20	31.12.14	no	change of Lead from TU/e to ITI
D407.022	Ontology definition - V2	4_7	TNO	R	RE	36	36	30.04.16	no	change of Lead from TU/e to TNO
D407.031	Ontology roll-out to UC and IOS - V1	4_7	ITI	P	RE	20	20	-	-	deleted, part of 407.021
D407.032	Ontology roll-out to UC and IOS - V2	4_7	ITI	P	RE	36	36	-	-	deleted, part of 407.022
D407.041	Adoption of automation mechanism - V1	4_7	TNO	R	RE	32	32	-	-	deleted, part of 407.022
D407.042	Adoption of automation mechanism - V2	4_7	TNO	R	RE	36	36	-	-	deleted, part of 407.022

# Project Periodic Report



D407.050	Ontology Assessment Report	4_7	TNO	R	RE	36	36	-	-	deleted, part of 407.022
D500.011	Milestone report V1	5_0	ASTS	R	CO	9	9	31.05.14	-	deleted, part of periodic progress report in SP1
D500.012	Milestone report V2	5_0	ASTS	R	CO	20	20	31.05.15	-	deleted, part of periodic progress report in SP1
D500.013	Milestone report V3	5_0	ASTS	R	CO	32	32	31.05.16	-	deleted, part of periodic progress report in SP1
D500.014	Milestone report V4	5_0	ASTS	R	CO	36	36	-	-	deletion requested in amendment
D501.010	Data and Methodologies report	5_1	ASTS	R	CO	9	9	12.02.14	yes	delayed* (delivered earlier than planned 28.02.2014)
D501.020	Use Case Requirements Specifications	5_1	MATE	R	CO	9	9	12.02.14	yes	delayed* (delivered earlier than planned 28.02.2014)
D501.030	RTP interface requirement	5_1	MATE	R	CO	20	20	-	-	deleted, part of 501.902
D501.040	Integration Description and Report	5_1	ASTS	R	CO	32	32	-	-	deleted, part of 501.903
D501.050	Demonstration	5_1	ASTS	D	CO	32	32	-	-	deleted, part of 501.903
D501.060	Demonstration of Use Case on public data	5_1	ASTS	D	CO	32	32	-	-	deleted, part of 501.903
D501.902	Use-Case Development Report - V2	5_1	ASTS	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D501.903	Use-Case Development Report - V3	5_1	ASTS	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D502.010	Use case definition	5_2	TRAIL	R	CO	6	6	04.11.13	yes	delayed*
D502.020	Bricks interface requirements	5_2	AIT	R	CO	9	9	30.04.14	yes	delayed*
D502.031	Implementation and integration report V1	5_2	TRAIL	R	CO	20	20	-	-	deleted, part of 502.902
D502.032	Implementation and integration report V2	5_2	TRAIL	R	CO	32	32	-	-	deleted, part of 502.903
D502.040	Demonstrator	5_2	TRAIL	D	CO	32	32	-	-	deleted, part of 502.903
D502.902	Use-Case Development Report - V2	5_2	TRAIL	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D502.903	Use-Case Development Report - V3	5_2	TRAIL	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment

D503.010	Use case definition	5_3	ALS	R	CO	6	6	15.11.13	yes	delayed*
D503.020	IOS needs for RTP specification	5_3	ALS	R	CO	8	8	31.12.13	yes	
D503.030	IOS design requirements	5_3	ALS	R	CO	12	12	30.04.14	yes	
<del>D503.040</del>	<del>Integration Description and Report</del>	<del>5_3</del>	<del>ALS</del>	<del>R</del>	<del>CO</del>	<del>28</del>	<del>28</del>	-	-	deleted, part of 503.903
<del>D503.050</del>	<del>Demonstration</del>	<del>5_3</del>	<del>ALS</del>	<del>D</del>	<del>CO</del>	<del>34</del>	<del>34</del>	-	-	deleted, part of 503.903
D503.902	Use-Case Development Report - V2	5_3	ALS	R	CO	22	22	28.02.15	no	new deliverable acc. to amendment
D503.903	Use-Case Development Report - V3	5_3	ALS	R	CO	36	36	30.04.16	no	new deliverable acc. to amendment
D504.010	State of the art for RAIL ontology	5_4	ASTS	R	RE	9	9	31.03.14	yes	delayed*, decision made in Brussels review due to internal resource problems
D504.021	Ontology definition - V1	5_4	ASTS	R	RE	20	20	31.12.14	no	
D504.022	Ontology definition - V2	5_4	ASTS	R	RE	36	36	30.04.16	no	
<del>D504.031</del>	<del>Ontology roll out to UC and IOS - V1</del>	<del>5_4</del>	<del>ASTS</del>	<del>P</del>	<del>RE</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 504.021
<del>D504.032</del>	<del>Ontology roll out to UC and IOS - V2</del>	<del>5_4</del>	<del>ASTS</del>	<del>P</del>	<del>RE</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 504.022
<del>D504.041</del>	<del>Implementation of automation mechanism - V1</del>	<del>5_4</del>	<del>ASTS</del>	<del>R</del>	<del>RE</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 504.022
<del>D504.042</del>	<del>Implementation of automation mechanism - V2</del>	<del>5_4</del>	<del>ASTS</del>	<del>R</del>	<del>RE</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 504.022
<del>D504.051</del>	<del>Report of Assessment - V1</del>	<del>5_4</del>	<del>ASTS</del>	<del>R</del>	<del>RE</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 504.022
<del>D504.052</del>	<del>Report of Assessment - V2</del>	<del>5_4</del>	<del>ASTS</del>	<del>R</del>	<del>RE</del>	<del>36</del>	<del>36</del>	-	-	deleted, part of 504.022
D600.010	Bricks Engineering Process Template	6_0	EADS IW-UK	R	RE	9	9	31.01.14	yes	
D601.010	State of the art – Interoperability	6_1	EADS IW-UK	R	RE	4	4	30.09.13	yes	delayed*
D601.021	Interoperability Specification - V1	6_1	EADS IW-UK	R	PP PU	12	13	31.05.14	yes	Dissemination Level has to be set to PU according to amendment delay* until M13
D601.022	Interoperability Specification - V2	6_1	EADS IW-UK	R	PP	24	24	30.04.15	no	Dissemination Level has to be set to PU according to amendment



# Project Periodic Report



D601.023	Interoperability Specification - V3	6_1	EADS IW-UK	R	PP PU	36	36	30.04.16	no	Dissemination Level has to be set to PU according to amendment
D601.031	Report on Standardisation Work - V1	6_1	AVL	R	RE	12	13	31.05.14	yes	Delay* until M13
D601.032	Report on Standardisation Work - V2	6_1	AVL	R	RE	24	24	30.04.15	no	
D601.033	Report on Standardisation Work - V3	6_1	AVL	R	RE	36	36	30.04.16	no	
D602.011	Meta-model specification - V1	6_2	OFFIS	R	PU	9	9	31.01.14	yes	
D602.012	Meta-model specification - V2	6_2	OFFIS	R	PU	20	20	31.12.14	no	
D602.021	Platform Builder Specification - V1	6_2	ALA	R	RE	20	20	31.12.14	no	
D602.022	Platform Builder Specification - V2	6_2	ALA	R	RE	32	32	31.12.15	no	
D602.031	Platform Builder prototype - V1	6_2	ITI	D	RE	20	20	31.12.14	no	
D602.032	Platform Builder prototype - V2	6_2	ITI	D	RE	32	32	31.12.15	no	
D603.011	Specification, Development and Assessment for System Analysis and Exploration - V1	6_3	VIF	R	CO	9	9	31.01.14	yes	
<del>D603.012</del>	<del>Specification, Development and Assessment for System Analysis and Exploration - V2</del>	<del>6_3</del>	<del>VIF</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 603.902
<del>D603.013</del>	<del>Specification, Development and Assessment for System Analysis and Exploration - V3</del>	<del>6_3</del>	<del>VIF</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 603.903
D603.902	Specification, Development and Assessment Report V2	6_3	VIF	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D603.903	Specification, Development and Assessment Report V3	6_3	VIF	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D604.011	Specification, Development and Assessment for Safety Engineering - V1	6_4	AIT	P	CO	9	9	07.02.14	yes	delayed*
<del>D604.012</del>	<del>Specification, Development and Assessment for Safety Engineering - V2</del>	<del>6_4</del>	<del>AIT</del>	<del>P</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 604.902
<del>D604.013</del>	<del>Specification, Development and Assessment for Safety Engineering - V3</del>	<del>6_4</del>	<del>AIT</del>	<del>P</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 604.903
<del>D604.021</del>	<del>Internal on demand: Specification, development, and assessment of tools for safety engineering - Publishable versions - V1</del>	<del>6_4</del>	<del>AIT</del>	<del>R</del>	<del>PU</del>	<del>9</del>	<del>9</del>	-	-	It is explicitly stated in the DOW that this deliverable are "internal on demand". It was a mistake by

										the coordinator to enter it into the NEF and it should be removed. According to amendment.
D604.022	<del>Internal on demand: Specification, development, and assessment of tools for safety engineering—Publishable versions—V2</del>	6_4	AIT	R	PU	20	20	-	-	It is explicitly stated in the DOW that this deliverable are "internal on demand". It was a mistake by the coordinator to enter it into the NEF and it should be removed. According to amendment.
D604.023	<del>Internal on demand: Specification, development, and assessment of tools for safety engineering—Publishable versions—V3</del>	6_4	AIT	R	PU	32	32	-	-	It is explicitly stated in the DOW that this deliverable are "internal on demand". It was a mistake by the coordinator to enter it into the NEF and it should be removed. According to amendment.
D604.902	Specification, Development and Assessment Report V2	6_4	AIT	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D604.903	Specification, Development and Assessment Report V3	6_4	AIT	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D605.011	Specification, Development and Assessment for AUTOSAR Tools & Components - V1	6_5	TTTech	R	CO	9	9	31.03.14	yes	delayed* further delayed until end of March
D605.012	<del>Specification, Development and Assessment for AUTOSAR Tools &amp; Components—V2</del>	6_5	TTTech	R	CO	20	20	-	-	deleted, part of 605.902
D605.013	<del>Specification, Development and Assessment for AUTOSAR Tools &amp; Components—V3</del>	6_5	TTTech	R	CO	32	32	-	-	deleted, part of 605.903
D605.902	Specification, Development and Assessment Report V2	6_5	TTTech	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D605.903	Specification, Development and Assessment Report V3	6_5	TTTech	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D606.011	Specification, Development and Assessment for Heterogeneous Simulation - V1	6_6	FhG	R	CO	9	9	31.01.14	yes	

# Project Periodic Report



D606.012	<del>Specification, Development and Assessment for Heterogeneous Simulation – V2</del>	<del>6_6</del>	<del>FhG</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 606.902
D606.013	<del>Specification, Development and Assessment for Heterogeneous Simulation – V3</del>	<del>6_6</del>	<del>FhG</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 606.903
D606.021	Heterogeneous Simulation Approach - V1	6_6	FhG	R	CO	9	9	31.01.14	yes	
D606.022	<del>Heterogeneous Simulation Approach – V2</del>	<del>6_6</del>	<del>FhG</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 606.902
D606.023	<del>Heterogeneous Simulation Approach – V3</del>	<del>6_6</del>	<del>FhG</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 606.903
D606.902	Specification, Development and Assessment Report V2	6_6	FhG	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D606.903	Specification, Development and Assessment Report V3	6_6	FhG	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D607.011	Specification, Development and Assessment for Requirements based Engineering - V1	6_7	REUSE	R	CO	9	9	07.02.14	yes	delayed*
D607.012	<del>Specification, Development and Assessment for Requirements based Engineering – V2</del>	<del>6_7</del>	<del>REUSE</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 607.902
D607.013	<del>Specification, Development and Assessment for Requirements based Engineering – V3</del>	<del>6_7</del>	<del>REUSE</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 607.903
D607.021	Requirements Quality Analyzer - V1	6_7	REUSE	P	CO	7	7	29.11.13	yes	slightly delayed by one day
D607.022	<del>Requirements Quality Analyzer – V2</del>	<del>6_7</del>	<del>REUSE</del>	<del>P</del>	<del>CO</del>	<del>17</del>	<del>17</del>	-	-	deleted, part of 607.902
D607.023	<del>Requirements Quality Analyzer – V3</del>	<del>6_7</del>	<del>REUSE</del>	<del>P</del>	<del>CO</del>	<del>29</del>	<del>29</del>	-	-	deleted, part of 607.903
D607.031	Requirements Authoring Tool - V1	6_7	REUSE	P	CO	7	7	29.11.13	yes	slightly delayed by one day
D607.032	<del>Requirements Authoring Tool – V2</del>	<del>6_7</del>	<del>REUSE</del>	<del>P</del>	<del>CO</del>	<del>17</del>	<del>17</del>	-	-	deleted, part of 607.902
D607.033	<del>Requirements Authoring Tool – V3</del>	<del>6_7</del>	<del>REUSE</del>	<del>P</del>	<del>CO</del>	<del>29</del>	<del>29</del>	-	-	deleted, part of 607.903
D607.041	knowledgeMANAGER - V1	6_7	REUSE	P	CO	7	7	29.11.13	yes	slightly delayed by one day
D607.042	<del>knowledgeMANAGER – V2</del>	<del>6_7</del>	<del>REUSE</del>	<del>P</del>	<del>CO</del>	<del>17</del>	<del>17</del>	-	-	
D607.043	<del>knowledgeMANAGER – V3</del>	<del>6_7</del>	<del>REUSE</del>	<del>P</del>	<del>CO</del>	<del>29</del>	<del>29</del>	-	-	
D607.902	Specification, Development and Assessment Report V2	6_7	REUSE	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D607.903	Specification, Development and Assessment Report V3	6_7	REUSE	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment

# Project Periodic Report



D608.011	Specification, Development and Assessment for Product Lifecycle Management - V1	6_8	SISW	R	CO	9	9	05.02.14	yes	delayed*
D608.012	Specification, Development and Assessment for Product Lifecycle Management - V2	6_8	SISW	R	CO	20	20	-	-	deleted, part of 608.902
D608.013	Specification, Development and Assessment for Product Lifecycle Management - V3	6_8	SISW	R	CO	32	32	-	-	deleted, part of 608.903
D608.020	Interoperability Specification - Domain Specific Auto (PLM Part)	6_8	SISW	R	PP	12	12	-	-	deleted, part of 608.902
D608.030	Systems Design and Architecture of IOS Interface for B6.8.1	6_8	SISW	R	PP	18	18	-		deleted, part of 608.902
D608.040	Teamcenter specific IOS/RTP interface implementation specification	6_8	SISW	D	PP	22	22	-		deleted, part of 608.902
D608.050	Teamcenter IOS/RTP interface demonstrator	6_8	SISW	D	PU	26	26	-		deleted, part of 608.903
D608.060	Engineering Process Run-time Specification	6_8	SISW	R	PU	11	11	31.03.14		deleted, part of 608.902
D608.070	Engineering Process Run-time first version implementation	6_8	SISW	D	RE	15	15	-		deleted, part of 608.902
D608.080	Engineering Process Run-time second version implementation	6_8	SISW	D	RE	29	29	-		deleted, part of 608.903
D608.903	Specification, Development and Assessment Report V3	6_8	SISW	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D608.902	Specification, Development and Assessment Report V2	6_8	SISW	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D609.010	Tasks Specification Report	6_9	Obeo	R	CO	12	12	-	-	deleted, part of 609.901
D609.020	MVE - Environment for the development of MBE solutions - State of the art	6_9	TGS	R	CO	12	12	-	-	deleted, part of 609.901
D609.030	MVE - Model co-evolution - State of the art	6_9	TGS	R	CO	12	12	-	-	deleted, part of 609.901
D609.041	MVE - Environment for the development of MBE solutions - Prototype - V1	6_9	TGS	P	CO	12	12	-	-	deleted, part of 609.901
D609.042	MVE - Environment for the development of MBE solutions - Prototype - V2	6_9	TGS	P	CO	24	24	-	-	deleted, part of 609.902
D609.043	MVE - Environment for the development of MBE solutions - Prototype - V3	6_9	TGS	P	CO	36	36	-	-	deleted, part of 609.903

D609.051	MVE – Multi Viewpoints Graphical Modelling environment – Prototype – V1	6_9	Obeo	P	CO	12	12	-	-	deleted, part of 609.901
D609.052	MVE – Multi Viewpoints Graphical Modelling environment – Prototype – V2	6_9	Obeo	P	CO	24	24	-	-	deleted, part of 609.902
D609.053	MVE – Multi Viewpoints Graphical Modelling environment – Prototype – V3	6_9	Obeo	P	CO	36	36	-	-	deleted, part of 609.903
D609.061	MVE – GUI generation – Prototype – V1	6_9	SOYATEC	P	CO	12	12	-	-	deleted, part of 609.901
D609.062	MVE – GUI generation – Prototype – V2	6_9	SOYATEC	P	CO	24	24	-	-	deleted, part of 609.902
D609.063	MVE – GUI generation – Prototype – V3	6_9	SOYATEC	P	CO	36	36	-	-	deleted, part of 609.903
D609.071	MVE – Model Transformation, Generation, validation and Analysis – Prototype – V1	6_9	TGS	P	CO	12	12	-	-	deleted, part of 609.901
D609.072	MVE – Model Transformation, Generation, validation and Analysis – Prototype – V2	6_9	TGS	P	CO	24	24	-	-	deleted, part of 609.902
D609.073	MVE – Model Transformation, Generation, validation and Analysis – Prototype – V3	6_9	TGS	P	CO	36	36	-	-	deleted, part of 609.903
D609.081	MVE – Model co-evolution – Prototype – V1	6_9	TGS	P	CO	12	12	-	-	deleted, part of 609.901
D609.082	MVE – Model co-evolution – Prototype – V2	6_9	TGS	P	CO	24	24	-	-	deleted, part of 609.902
D609.083	MVE – Model co-evolution – Prototype – V3	6_9	TGS	P	CO	36	36	-	-	deleted, part of 609.903
D609.091	MVE – Integration of requirement management – Prototype – V1	6_9	Obeo	P	CO	12	12	-	-	deleted, part of 609.901
D609.092	MVE – Integration of requirement management – Prototype – V2	6_9	Obeo	P	CO	24	24	-	-	deleted, part of 609.902
D609.093	MVE – Integration of requirement management – Prototype – V3	6_9	Obeo	P	CO	36	36	-	-	deleted, part of 609.903
D609.100	MVE – GUI generation – Web specification	6_9	SOYATEC	R	CO	24	24	-	-	deleted, part of 609.902
D609.901	Specification, Development and Assessment Report V1	6_9	Obeo	R	CO	12	12	30.04.14	yes	new deliverable acc. to amendment
D609.902	Specification, Development and Assessment Report V2	6_9	Obeo	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D609.903	Specification, Development and Assessment Report V3	6_9	Obeo	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment

D610.011	Crystal Variability Management - V1	6_10	Tecniaia	R	CO	9	9	28.02.14	yes	delayed*
<del>D610.012</del>	<del>Crystal Variability Management - V2</del>	<del>6_10</del>	<del>Tecniaia</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 610.902
<del>D610.013</del>	<del>Crystal Variability Management - V3</del>	<del>6_10</del>	<del>Tecniaia</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 610.903
<del>D610.021</del>	<del>Consolidated Crystal Variability Management - V1</del>	<del>6_10</del>	<del>Tecniaia</del>	<del>R</del>	<del>CO</del>	<del>9</del>	<del>9</del>	<del>n.a.</del>		merge with D610.011 according to amendment
<del>D610.022</del>	<del>Consolidated Crystal Variability Management - V2</del>	<del>6_10</del>	<del>Tecniaia</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-		deleted, part of 610.902
<del>D610.023</del>	<del>Consolidated Crystal Variability Management - V3</del>	<del>6_10</del>	<del>Tecniaia</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-		deleted, part of 610.903
D610.031	Brick System Family Engineering Framework - V1	6_10	FhG	R	CO	9	9	31.01.14	yes	
<del>D610.032</del>	<del>Brick System Family Engineering Framework - V2</del>	<del>6_10</del>	<del>FhG</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 610.902
<del>D610.033</del>	<del>Brick System Family Engineering Framework - V3</del>	<del>6_10</del>	<del>FhG</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 610.903
D610.902	Specification, Development and Assessment Report V2	6_10	Tecniaia	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D610.903	Specification, Development and Assessment Report V3	6_10	Tecniaia	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D611.011	Specification Development and Assessment for Software Development Lifecycle Management - V1	6_11	IBM UK	R	CO	9	9	31.01.14	yes	
<del>D611.012</del>	<del>Specification Development and Assessment for Software Development Lifecycle Management - V2</del>	<del>6_11</del>	<del>IBM UK</del>	<del>R</del>	<del>CO</del>	<del>20</del>	<del>20</del>	-	-	deleted, part of 611.902
<del>D611.013</del>	<del>Specification Development and Assessment for Software Development Lifecycle Management - V3</del>	<del>6_11</del>	<del>IBM UK</del>	<del>R</del>	<del>CO</del>	<del>32</del>	<del>32</del>	-	-	deleted, part of 611.903
<del>D611.020</del>	<del>A SDLC community program of community calls</del>	<del>6_11</del>	<del>IBM UK</del>	<del>O</del>	<del>PU</del>	<del>6</del>	<del>6</del>	-		deleted requested in amendment obsolete
<del>D611.030</del>	<del>A web/wiki built up and maintained by the community providing a focus for the application of IOS towards SDLC</del>	<del>6_11</del>	<del>IBM UK</del>	<del>O</del>	<del>PU</del>	<del>9</del>	<del>9</del>	<del>n.a.</del>		deleted requested in amendment obsolete
<del>D611.040</del>	<del>A summary report of IOS application to SDLC after each iteration</del>	<del>6_11</del>	<del>IBM UK</del>	<del>R</del>	<del>PU</del>	<del>17</del>	<del>17</del>	-		deleted requested in amendment obsolete
D611.051	A summary of the feedback from assessment of IBM Systems and Software Engineering Solution - V1	6_11	IBM UK	R	PU	9	9	31.01.14	yes	

# Project Periodic Report



D611.052	A summary of the feedback from assessment of IBM Systems and Software Engineering Solution – V2	6_11	IBM UK	R	PU	20	20	-	-	deleted, part of 611.902
D611.053	A summary of the feedback from assessment of IBM Systems and Software Engineering Solution – V3	6_11	IBM UK	R	PU	32	32	-	-	deleted, part of 611.903
D611.902	Specification, Development and Assessment Report V2	6_11	IBM UK	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D611.903	Specification, Development and Assessment Report V3	6_11	IBM UK	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D612.011	Specification, Development and Assessment for Validation Models - V1	6_12	MATE	R	CO	9	9	31.01.14	yes	
D612.012	Specification, Development and Assessment for Validation Models – V2	6_12	MATE	R	CO	20	20	-	-	deleted, part of 612.902
D612.013	Specification, Development and Assessment for Validation Models – V3	6_12	MATE	R	CO	32	32	-	-	deleted, part of 612.903
D612.902	Specification, Development and Assessment Report V2	6_12	MATE	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D612.903	Specification, Development and Assessment Report V3	6_12	MATE	R	CO	32	32	31.12.15	no	new deliverable acc. to amendment
D613.011	Specification, Development and Assessment for Simulation Models - V1	6_13	AVL	R	CO	9	9	14.03.14	yes	delayed*
D613.012	Specification, Development and Assessment for Simulation Models – V2	6_13	AVL	R	CO	20	20	-	-	deleted, part of 613.902
D613.013	Specification, Development and Assessment for Simulation Models – V3	6_13	AVL	R	CO	32	32	-	-	deleted, part of 613.903
D613.021	Development of the simulation model data backbone as described in T6.13.1 – V1	6_13	AVL	P	CO	9	9	14.03.14	-	deleted, part of 613.011
D613.022	Development of the simulation model data backbone as described in T6.13.1 – V2	6_13	AVL	P	CO	20	20	-	-	deleted, part of 613.902
D613.023	Development of the simulation model data backbone as described in T6.13.1 – V3	6_13	AVL	P	CO	32	32	-	-	deleted, part of 613.903
D613.902	Specification, Development and Assessment Report V2	6_13	AVL	R	CO	20	20	31.12.14	no	new deliverable acc. to amendment
D613.903	Specification, Development and Assessment Report V3	6_13	AVL	R	CO	32	32	31.12.15	no	new deliverable acc. to





										amendment
--	--	--	--	--	--	--	--	--	--	-----------

\*delayed: partner need more time to provide the deliverable with excellent quality. The consequences of this delay have been assessed and the new submission date had no negative impacts on other deliverables or project objectives.

Table 4-1: List of deliverables

### Milestones

Milestone no.	Milestone name	Work package no	Lead beneficiary	Delivery date from Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
M1	Use Case Specification V1	SP1, SP2, SP3, SP4, SP5		M9	YES	M9	Some deliverables were slightly delayed. The delay has no impact on the overall project objectives
M2	1st Platform Phase V2	SP1, SP2, SP3, SP4, SP5, S6		M20		M20	
M3	Enhanced Platform Phase V3	SP1, SP2, SP3, SP4, SP5, S6		M32		M32	
M4	Final Evaluation	SP1, SP2, SP3, SP4, SP5, S6		M36		M36	

Table 4-2: Milestones

**List of publications**

<b>No.</b>	<b>Title</b>	<b>Author(s)</b>	<b>Title of the periodical or the series</b>	<b>Number , date or frequency</b>	<b>Year of publication</b>	<b>Place of publication</b>	<b>Relevant pages</b>	<b>Permanent identifier [1] if available</b>	<b>Is open access provided? [2]</b>
1	Detecting performance bad smells for Henshin model transformations	Matthias Tichy, Christian Krause, Grischa Liebel	Proceedings of the Second Workshop on the Analysis of Model Transformations (AMT 2013), Miami, FL, USA, September 29, 2013		2013				Yes
2	Requirements Authoring: towards the concept of standard requirement	José M. Fuentes, Anabel Fraga, Juan Llorens, Luis Alonso, Gonzalo Génova			2014				No
3	Budget allocations for hierarchical fixed-priority scheduling of sporadic tasks with deferred preemptions upon EDP resources	M.M.H.P. van den Heuvel, R.J. Bril and J.J. Lukkien	6th Workshop on Compositional Theory and Technology for Real-Time Embedded Systems		2013				Yes

Table 4-3: List of publications

## 5 Project Management

### 5.1 Consortium management tasks and achievements

#### 5.1.1 Definition of project roles and responsibilities

To enable the efficient coordination of the CRYSTAL project it has been essential to establish project roles (technical coordinator, administrative manager, sub project leader, work package leaders, work package members) and project bodies (General Assembly, Steering Board and Technical Board). Further, dedicated responsibilities have been allocated to these project roles and project bodies and the interdependencies among them have been defined. Thereby, a clear distribution of tasks and duties is guaranteed.

##### Coordinator

The key management role in CRYSTAL is the role of the Coordinator. The position of the Coordinator has been split into the role of a technical coordinator and the role of an administrative manager to comply ideally with the management requirements of a research project with 71 project partners. The technical coordinator, Christian El Salloum, is responsible for the scientific and technical coordination of the overall project work, the liaison between the sub projects and the monitoring of the project progress. The administrative manager, Annemarie Hamedler, is handling all contractual, financial and administrative issues of CRYSTAL. Both are responsible for the communication with the Project Officer, Mr. Antonio Vecchio. The technical coordinator and the administrative manager are working closely together to ensure each other an overall project picture. Thereby the project management process is supporting the implementation of the project goals.

##### Steering Board

The Steering Board is the strategic body within the consortium and has the following responsibilities:

- Monitoring of the project progress, work plans, project schedule and deliverables
- Assuring cooperation and integration between the sub projects as defined in the work plan
- Performing risk analysis and preparing contingency plans
- Conducting periodic progress meetings at least on a 6 monthly basis via face-to-face or WebEx
- Prepare strategic decisions which need to be taken in the General Assembly.

##### Technical Board

The Technical Board (TB) constitutes the operative coordination team of the project. It is responsible for technical synchronization across the individual sub projects. The TB is composed of the SP leaders and co-leaders (Engineering Domain Leaders, IOS Bricks Leader (overall representative for WP6.3 – WP6.13), IOS Platform Builder Leader, IOS Standardization Leader), the Dissemination & Exploitation Leaders, the Administrative Project Manager and the Technical Coordinator. It will meet at least every two month (WebEx or face-to-face). Main tasks are the coordination of the different SP activities and the interaction between the SPs. This includes the identification and prioritization of shared objectives between Sub-Projects and derived technical requirements. The TB will discuss and agree on technology bricks (meta-models, methods, and tools..., as defined in the Technical Annex of the CRYSTAL GA) and propose solutions to the Steering Board. The TB coordinates the observation, evaluation and establishment of standards.

## SP and WP Leaders

Sub Project leaders are all members of the Technical Board (TB) and they are chairing their own overall sub project meetings. They are responsible for the successful development and results of the whole sub projects. Sub project leaders are hierarchical at a higher level as work package leaders. Work package leaders deal with the technical development and overall coherence and technical implementation of the project outputs.

## General Assembly

The General Assembly is composed of one representative of each partner for the purpose of high-level decision-making. The GA will discuss and decide on overall project management - and strategic management issues. Typical subjects for GA meetings are: project status and evolution, review of resource status, major changes in the project program including re-distribution of budget, major changes in dissemination and exploitation strategy and co-operation with third parties and related projects. Decisions of the GA will be taken on the basis of voting as regulated by the APCA, and is binding for all partners. Each partner will have one vote, with decisive vote for the coordinating partner in case of a draw. In case of conflicts between parties, major technical or organizational problems and similar serious events arising during the lifetime of the project, each partner has the right to call for an extraordinary meeting to describe the problem to the GA.

## Responsibility Matrix

The following matrix is detailing the degree of involvement in the execution of project tasks and contractual obligations. The respective responsibilities are attributed on the level of the relevant body or role.

Responsibility Matrix										
Roles & Boards	Technical Coordinator (C. El Salloum )	Administrative Project Manager (A. Hamedler)	Dissemination Lead	SP Leader	WP Leader	WP partner	Technical Board	Steering Board	General Assembly	Each project partner
Tasks										
<b>Project Work</b>										
Coordination of subproject				R						
Preparation of SP project progress reports				R	C					
Distribution/allocation of work within work package					R	R				
Coordination of work package					R					
Carry out WP work						R				
Controlling WP work / achievement of WP milestones					R					

Preparation of WP project progress reports					R	C				
Review of internal project progress reports	R			R						
Monitor compliance of project partners with contract obligations	R	R		R	R					
Monitor technical activities	R			R	R		R			
Notification of delay in project performance				R	R	R				
Timely completion of project deliverables					R	C				
Collection of project deliverables		R			C					
Quality control of project deliverables	R	R		C	R					
Adjustment of project deliverables					R	C				
Submission of project deliverables to ARTEMIS JU		R								
Decision on change/exchange of work packages							C	C	R	
<b>Project Administration</b>										
Intermediary for communication with ARTEMIS JU	R	R								
Collection of data for periodic technical report		R								
Provide data for periodic technical report				R	R	R				R
Submission of periodic technical report		R								
Preparation of financial statement										R
Submission of financial statement to National Funding Agencies										R
Provision of contact details of responsible project staff										R
Information of change in contact details										R
Information of change in legal name, address, legal representatives										R
Maintenance of contact details		R								C
Maintenance document repository		R								
Provision of any data requested by Coordinator on behalf of JU/ARTEMISIA										R
Preparation of SB, TB and GA meetings	R	R								
Transmission of SB, TB and GA minutes	R	R								
<b>Project PR &amp; Dissemination</b>										
Set up & maintenance of project homepage			R							
Preparation of press releases	C		R	C	C			C		C
Decision on press releases								R		
Notification of intended paper publication										R
Circulation of intended paper publication		R								
Highlight JU financial support in any project related publicity (publications, seminars, press release) and display the Joint Undertaking's logo & the European Emblem										R

## Legend

R .....Responsible

C .....Contribution

### 5.1.2 Project Start

For a successful start of the CRYSTAL project, a kick off meeting has taken place in Vienna, Austria, on May 2 and 3, 2013. At this meeting adequate structures and processes for the smooth execution of the CRYSTAL project have been introduced and a common overall project picture has been established. Further, this meeting offered the possibility to build personal relationships between the project partners. Since most project work is conducted by electronic means, it has been essential that project partners personally met during the project start phase and have established contact on a personal basis.

### 5.1.3 Project Handbook

To provide guidelines for the day-to-day operation of the CRYSTAL project a project handbook has been set up at project start and was submitted to ARTEMIS JU as Deliverable D101.030. This project handbook is constantly updated. The Project Handbook contains information on contact data, responsibilities, the communication structure, process flows, meeting and reporting rules and shall support project partners in identifying responsibilities and processes.

### 5.1.4 Communication and Collaboration Support

To support the smooth communication of project partners and to ensure that all information spread by the Coordinator and the SP and WP leaders reaches the responsible contact persons, mailing lists have been set up and are constantly updated by the Coordinator. A general mailing list is dedicated to items that are of interest for all partners e.g. information and requests from JU, meeting preparation...), another mailing list is covering the communication between the members of the General Assembly. Further, a separate mailing list has been established for each sub project and each work package to facilitate the exchange between the concerned project partners.

The general mailing list is primarily used by the Coordinator to issue regular mailings providing the project partners with relevant information (contractual requirements, deliverable schedule and deadlines, publications, review...) and, if necessary, asking project partners for respective actions to be taken.

The CRYSTAL SharePoint platform, a shared workspace system, has been developed by the Coordinator to enable efficient group collaboration and the management, exchange and storage of project documents and deliverables. The platform is used for all administrative management tasks in the project execution including:

- deliverable review process
- tracking of dissemination activities
- tracking of exploitation activities
- organization of meetings and workshops
- reporting (costs, efforts and results)

Furthermore, the technical management process of CRYSTAL is implemented on the platform. The Coordinator is maintaining the CRYSTAL SharePoint platform and administrating the login data for project partners.

### 5.1.5 Contractual Issues

With respect to contractual issues, it can be reported that the Coordinator has successfully closed the negotiations of the Artemis Project Consortium Agreement (APCA). Further, the Artemis Grant



Agreement has been signed and entered into force on January 20th, 2014. By February 3rd, 2014 the Accession Forms of 27 partners have been countersigned.

### 5.1.6 Quality Management

The quality management is led by the Technical Coordinator and the Administrative Project Manager who are responsible for quality assurance throughout the project. Quality in this context can be seen as meeting the project expectations achieved by way of deliverables and activities performed to produce those deliverables. In particular, Quality Management within CRYSTAL is oriented towards the following objectives:

- Assure conformance of processes and tasks with the Description of Work and Grant Agreement and its Annexes
- Supervise project plan correspondence of effort and delivery dates

The major means to achieve this goal is the project structure with precisely defined responsibilities for the individual roles (WP & SP leaders, Technical Board, Steering Board, Technical Coordinator, and Administrative Project Manager), the deliverable review process and the internal and external reporting process. WP1.3 is responsible for strategic quality management and the corresponding realization in all SPs. In particular, the quality management of this project is based on the following:

- Quality Assurance activities have to be implemented throughout the entire project by the entire CRYSTAL consortium. This means that every project partner shall review his own results before transmitting them to someone else.
- The quality control of the deliverables is established by the CRYSTAL deliverable review process.
- Continuous internal reporting shall ensure a holistic project view of all project partners
- Issues arising in the course of the quality control that might pose a risk or increase the probability of a risk will be reported to the Technical Coordinator.

## 5.2 Review Process for deliverables

The review process for deliverables is a major part of the CRYSTAL quality assurance process. CRYSTAL employs a two stage review process for each deliverable as depicted below. In the first stage the deliverable is reviewed by at least one assigned reviewer within the WP, and in the second stage, the deliverable is reviewed by at least two assigned reviewers outside the WP (SP6 deliverables should be reviewed by at least one reviewer of SP2–SP5.). Feedback from the assigned reviewers is mandatory, while all the other project members are also free to provide feedback.

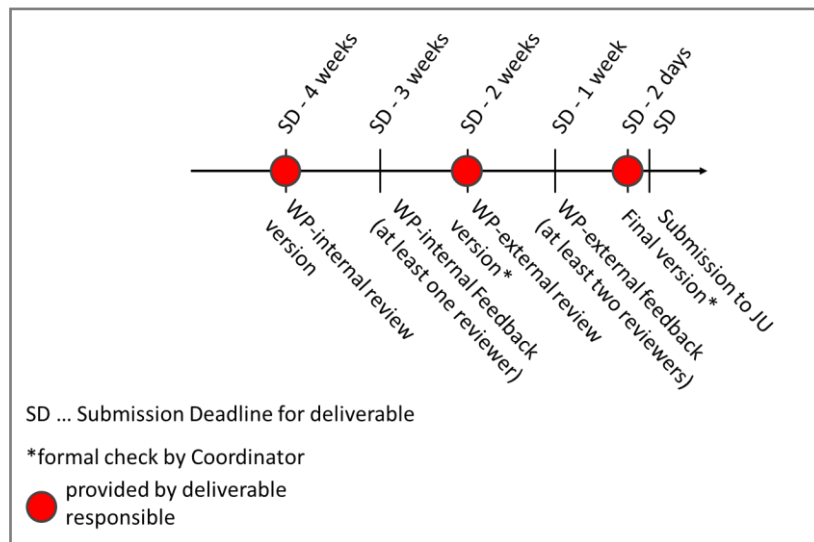


Figure 5-1: Review Process

The duties of the WP leader with respect to deliverables are:

- Coordinate the assignment of the deliverable responsible and reviewers
- Coordinate the creation of deliverables on work package level
- Ensure completion of deliverables on time, within budget and with high quality
- Monitor the progress of deliverables
- Report any anticipated or actual delay of a deliverable to the SP leader

Each deliverable is assigned to a Deliverable Responsible who is appointed by the partner who has the deliverable lead. The duties of the Deliverable Responsible are:

- Plan and schedule the deliverable creation such that the review versions and the final version can be provided in time
- Coordinate the members contributing to the deliverable, collect their inputs and assure consistency
- Integrate all contributions and provide the first review version
- Integrate the feedback of the first review round (WP internal review) and provide the second review version
- Integrate the feedback from the second review round (WP external review) and provide the final version

After having been notified by the Deliverable Responsible that the deliverable is ready for review, the Reviewer should provide its feedback directly to the Deliverable Responsible within 7 days.

The Coordinator performs a final formal check of the final document, generates a PDF file, and submits the deliverable to the ARTEMIS JU. In addition, the Coordinator maintains and monitors the list of deliverables.

### 5.3 Progress Monitoring & Controlling

The work package activities, progress, schedule and status are monitored every four month. Therefore, the work package leaders provide the SP leaders with an internal report via the CRYSTAL SharePoint platform, and the SP leaders generate an SP report based on the WP reports of the sub project. The progress reports are accessible by all project partners to ensure that

interfaces are synchronized. In addition, every four month all project partners are requested to provide an overview of their person-month effort. Thereby any excessive expenditure can be identified at an early stage.

#### 5.4 Problems which have occurred and how they were solved or envisaged solutions

In the first month of the project execution, it became clear that collaboration and communication between SP6 and the application SPs (SP2-SP5) is one of the most crucial cornerstones in the entire execution of the CRYSTAL project, in particular, considering the large number of involved partners.

To tackle this challenge, the SP6 lead and the coordinator have developed, with the support of the technical board, the CRYSTAL technical management process. This process is a refinement of solutions of former projects like CESAR or MBAT. It defines the roles and responsibilities of all stakeholders (use case owners and technology providers), the collaboration and the communication structure between SP6 and the application SPs (SP2-SP5) and establishes full traceability among all involved artefacts in the development process.

The process is already implemented on the CRYSTAL SharePoint platform and will be started at M9 after the first project milestone has been reached and the first versions of the use case definitions are available.

#### 5.5 Risk Management

During proposal phase the risk management has already been started by establishing a risk-contingency-plan (see Part B, p. 379, Section 3.1.5 Significant risks and associated contingency plan of the Technical Annex). To assure the achievement of project objectives and make the CRYSTAL project a success it is necessary to constantly monitor and reassess defined and potentially emerging (new) risks and adapt the risk plan and evaluate the effectiveness of measures taken to reduce risks. Thus, the WP and SP Leaders, the Technical Board and the Steering Board will dynamically identify potential risks and describe them by using the risk analysis form.

The coordinator set up a process based on the CRYSTAL SharePoint, which facilitates project-wide risk management in a transparent way with minimal overhead. The process allows each WP report any identified risk to the coordinator. The identified risks will be collected by the coordinator, and will be discussed in the technical board meetings where an overall assessment takes place and appropriate counter measures are developed.

#### 5.6 Changes in the consortium

After the start of the project and for internal reasons, both SELEX ES and SESM decided to withdraw from the project. The consortium was able to reallocate the efforts and tasks among the Italian cluster without any negative impact on the overall project objectives.

Verum has declared bankruptcy, and thus has to be removed from the consortium. The consortium is still working on a solution for the reallocation of the Verum tasks.

Both proposed reallocations will be part of a request for amendment to the JU Grant Agreement which is currently under preparation.

#### 5.7 List of project meetings, dates and venues

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	250 of 269

Date	Subject	Type	Location
2.-3.5.2013	CRYSTAL Kick-off Meeting	F2F	Vienna
13.05.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
27.05.2013	CRYSTAL APCA V3.0 Discussion	WebEx	WebEx
10.06.2013	CRYSTAL APCA V4.0 Discussion	WebEx	WebEx
14.06.2013	Crystal: Healthcare kick-off meeting	F2F	Best
17.06.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
18.-19.06.2013	CRYSTAL-IOS Workshop	F2F	Munich
24.06.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
01.07.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
08.07.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
9-10.7.2013	Kick-off WP6.2	F2F	Turin
05.07.2013	CRYSTAL IOS "Engineering Method Template" - Online Review of the draft template	WebEx	WebEx
15.07.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
22.07.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
29.07.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
12.08.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
19.08.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
20.08.2013	SP3 WPL Meeting	WebEx	WebEx
22.08.2013	CRYSTAL Technical Project Management Meeting	WebEx	WebEx
22.08.2013	CRYSTAL SP3 Domain Status Review	WebEx	WebEx
26.-28.08.2013	WP6.7 Workshop - WP6.7/UC2.4: common techniques for covering the CCC criteria	F2F	Madrid
28.08.2013	Technical Board WebEx Meeting	WebEx	WebEx
02.09.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
11.09.2013	CRYSTAL Consortium Agreement Meeting	WebEx	WebEx
16.-17.09.2013	WP6.7 Workshop - training all the industrial partners involved in WP6.7/UC2.4	F2F	Madrid
19.-20.09.2013	SP2 Workshop	F2F	Toulouse
19.09.2013	Kick-off WebEx for the Automotive Ontology Work Package 3.8	WebEx	WebEx
25.-26.11.2013	CRYSTAL Working and Consolidation Event	F2F	Munich
15.10.2013	CRYSTAL WP6.3. Deliverable writing process	WebEx	WebEx
09.10.2013	Review of the Healthcare use cases	F2F	Philips
07.11.2013	CRYSTAL WP604 - deliverable coordination online conference	WebEx	WebEx
3.-4.12. 2013	Artemis & ITEA Co-Summit	F2F	Stockholm
17.12.2013	CRYSTAL Technical Board Meeting	WebEx	WebEx
21.01.2014	CRYSTAL Technical Board Meeting	WebEx	WebEx
10.-11.02.2014	Interim Review Meeting	F2F	Brussels

18.02.2014	CRYSTAL Technical Board Meeting	WebEx	WebEx
01.-02.04.2014	CRYSTAL Technical Board Workshop	F2F	Munich
15.04.2014	CRYSTAL Technical Board Meeting	WebEx	WebEx
29.04.2014	CRYSTAL Steering Board Meeting	WebEx	WebEx

Table 5-1: Meeting Overview

## 5.8 Project Planning and Status

The overall project status is mostly according to plan and there are no major deviations. The objectives for M12 encompassed the following activities:

- Devise and implement the process for the administrative management process (SP1) including:
  - deliverable review process
  - tracking of dissemination activities
  - tracking of exploitation activities
  - organization of meetings and workshops
  - reporting (costs, efforts and results)
- Provide a project handbook that serves as a manual for all partners with respect to administrative activities (SP1)
- Create the CRYSTAL Homepage (SP1)
- Devise and implement the technical management process (SP1 and SP6)
  - Define the roles and responsibilities of all stakeholders (use case owners and technology providers)
  - Define the collaboration and the communication structure between SP6 and the application SPs (SP2-SP5)
  - Establish full traceability among all involved artifacts in the development
- Provide state-of-the-art reports the different areas (SP2-SP6)
- Provide a first version of the use case definitions (SP2-SP5)
- Provide a first version of the ontology documents (SP2-SP5)
- Provide a first version of the documents describing the technology bricks (SP6)
- Provide a first version for the meta model for the platform builder (SP6)
- Provide the first version of the IOS specification

All these objectives have been achieved, but some deliverables will be submitted to the JU with a slight delay (see Section 4).

After successfully completing the first phase of the CRYSTAL project according to plan we have investigated the planning for the next phase. The findings of the first phase resulted in a proposal to adapt the description of work (DoW) in order to reach the project objectives in an optimal way. This proposal will be reflected in a request for an amendment to the JU Grant Agreement which is currently under preparation.

## 5.9 Impact of possible deviations from the planned milestones and deliverables, if any

Some deliverables are slightly delayed see Section 4. These delays have been reported to the ARTEMIS JU and their impact has been assessed on WP, SP and Project level. The delays of the individual deliverables have no negative impact on other WPs or on the overall project objectives.

Version	Nature/Level	Date	Page
V1.00	R/CO	2014-05-30	252 of 269

### **5.10 Any changes to the legal status of any of the beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organizations and SMEs**

There has been a transfer from “Personal Space Technologies B.V.” to “PS\_Tech B.V.” with the following details:

- All rights and obligations concerning all projects will be transferred from Personal Space Technologies B.V. (chamber of commerce # KVK 34233213) to PS-Tech B.V.(chamber of commerce # KVK 59177268) .
- PS-Tech B.V. will accept all rights and obligations and discharges Personal Space Technologies B.V. from all duties and obligations.
- For the project partners the result is that the project R&D will take place in the same business group, by the same people, only in a new legal entity.

This transfer will be reflected in a request for an amendment to the JU Grant Agreement which is currently under preparation.

### **5.11 Development of Project Website**

The CRYSTAL Project website is online: [www.crystal-artemis.eu](http://www.crystal-artemis.eu)

Details of the homepage are described in D102.020.

## 6 Explanation of the use of the resources

The explanation of personnel costs, subcontracting and any major direct costs incurred by each beneficiary, such as the purchase of important equipment, travel costs, large consumable items, etc. linking them to work packages can be found in the Annex 1 Beneficiary Report.

Costs and efforts are also provided also in a separate version in Excel to show all details per beneficiary.



Country	Partner	Personal costs (direct)	Travel costs (direct)	durable equipment costs (direct)	Costs for consumables (direct)	costs for subcontracting (direct)	Other costs (direct)	Sum direct costs	Indirect Costs	Overall costs to the JU (direct & indirect costs)
AT	01_AVL	1.148.964,04 €	40.135,61 €	0,00 €	0,00 €	0,00 €	3.860,95 €	1.192.960,60 €	936.405,69 €	2.129.366,30 €
FR	02_A-F	130.000,00 €	2.000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	132.000,00 €	0,00 €	132.000,00 €
DE	03_A-G	121.000,00 €	3.000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	124.000,00 €	5.000,00 €	129.000,00 €
UK	04_A-UK	180.000,00 €	2.000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	182.000,00 €	0,00 €	182.000,00 €
IT	05_ALA	255.000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	255.000,00 €	127.500,00 €	382.500,00 €
FR	06_ALS	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
IT	07_ASTS	50.437,68 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	50.437,68 €	25.218,84 €	75.656,52 €
SE	08_ARCC	70.036,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	70.036,00 €	14.007,00 €	84.043,00 €
SE	09_ARCT	91.200,00 €	1.900,00 €	0,00 €	0,00 €	0,00 €	0,00 €	93.100,00 €	4.164,00 €	97.264,00 €
AT	10_AIT	247.165,59 €	5.923,47 €	0,00 €	13.603,32 €	0,00 €	0,00 €	266.692,38 €	172.991,19 €	439.683,57 €
DE	11_AVL-S	143.806,70 €	7.223,63 €	0,00 €	0,00 €	0,00 €	0,00 €	151.030,33 €	86.053,44 €	237.083,77 €
DE	12_AVL-R	166.117,00 €	5.064,00 €	0,00 €	0,00 €	0,00 €	0,00 €	171.181,00 €	0,00 €	171.181,00 €
BE	13_BARCO	1.025.212,00 €	0,00 €	0,00 €	0,00 €	0,00 €	307.564,00 €	1.332.776,00 €	205.042,00 €	1.537.818,00 €
ES	14_REUSE	77.191,54 €	0,00 €	3.799,00 €	0,00 €	0,00 €	2.667,00 €	83.657,54 €	15.438,31 €	99.095,85 €
IT	15_CRF	61.609,84 €	0,00 €	0,00 €	0,00 €	10.000,00 €	0,00 €	71.609,84 €	30.804,92 €	102.414,76 €
SE	16_CTH	63.595,00 €	10.406,00 €	0,00 €	2.836,00 €	0,00 €	0,00 €	76.837,00 €	29.186,00 €	106.023,00 €
UK	17_CIC	46.968,00 €	2.444,00 €	0,00 €	0,00 €	0,00 €	0,00 €	49.412,00 €	2.540,00 €	51.952,00 €
DE	18_DAIMLER	280.000,00 €	3.000,00 €	0,00 €	0,00 €	0,00 €	0,00 €	283.000,00 €	11.000,00 €	294.000,00 €
DE	19_EADS-CAS	286.562,71 €	4.491,87 €	0,00 €	0,00 €	0,00 €	0,00 €	291.054,58 €	45.936,00 €	336.990,58 €
DE	20_EADS IW-	295.354,45 €	10.688,35 €	0,00 €	0,00 €	0,00 €	5.933,44 €	311.976,24 €	152.222,75 €	464.198,99 €

	G								€	
FR	21_EADS IW-F	24.543,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	24.543,00 €	31.170,00 €	55.713,00 €
UK	22_EADS IW-UK	58.034,00 €	5.246,00 €	0,00 €	0,00 €	0,00 €	0,00 €	63.280,00 €	52.812,00 €	116.092,00 €
FR	23_Elektrobit	58.034,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	108.548,72 €	1.628,30 €	110.177,02 €
AT	24_TUG	27.144,58 €	17,20 €	3884,72 €	0,00 €	0,00 €	0,00 €	27.161,78 €	5.428,92 €	32.590,70 €
IT	25_FBK	77.847,74 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	77.847,74 €	38.923,87 €	116.771,61 €
DE	26_FhG	250.237,00 €	9.435,00 €	0,00 €	550,00 €	0,00 €	8.934,00 €	269.156,00 €	174.833,00 €	443.989,00 €
ES	27_Tecnia	208.719,88 €	0,00 €	0,00 €	295,00 €	0,00 €	7.364,33 €	216.379,21 €	41.743,98 €	258.123,19 €
ES	28_GMV	19.967,25 €	0,00 €	0,00 €	0,00 €	0,00 €	275,00 €	20.242,25 €	3.993,45 €	24.235,70 €
CZ	29_HON	108.255,08 €	4.469,46 €	0,00 €	0,00 €	0,00 €	1.790,04 €	114.514,57 €	22.902,91 €	137.417,49 €
UK	30_IBM UK	70.153,54 €	8.018,72 €	0,00 €	0,00 €	0,00 €	0,00 €	78.172,26,00 €	33.533,59 €	111.705,85 €
UK	31_IFX-UK	283.400,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	283.400,00 €	0,00 €	283.400,00 €
ES	32_ITI	242.988,98 €	0,00 €	0,00 €	0,00 €	22.950,00 €	12.151,99 €	278.090,97 €	48.597,80 €	326.688,77 €
DE	33_ITKE	72.578,12 €	835,04 €	0,00 €	0,00 €	0,00 €	0,00 €	73.413,16 €	148.988,42 €	222.401,58 €
AT	34_VIF	175.518,97 €	6.954,60 €	0,00 €	0,00 €	0,00 €	164,98 €	182.638,55 €	52.937,00 €	235.575,55 €
SE	35_ALL4TEC	165.548,00 €	2.266,00 €	0,00 €	0,00 €	0,00 €	0,00 €	167.814,00 €	112.731,00 €	280.545,00 €
CZ	36_MU	24.855,00 €	6.708,00 €	0,00 €	0,00 €	0,00 €	0,00 €	31.563,00 €	6.056,00 €	37.619,00 €
IT	37_MATE	147.200,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	147.200,00 €	22.080,00 €	169.280,00 €
NL	38_IBM NL	97.301,03 €	4.812,01 €	0,00 €	0,00 €	0,00 €	0,00 €	102.113,04 €	48.650,52 €	150.763,56 €
NL	39_TNO	363.124,92 €	8.798,78 €	0,00 €	1.090,62 €	60.587,50 €	183,67 €	433.785,49 €	575.651,48 €	1.009.436,97 €
FR	40_Obeo	229.341,00 €	7.282,00 €	0,00 €	0,00 €	0,00 €	0,00 €	236.623,00 €	154.168,00 €	390.791,00 €
DE	41_OFFIS	201.188,48 €	17.404,56 €	0,00 €	0,00 €	0,00 €	0,00 €	218.593,04 €	30.068,93 €	248.661,97 €

ES	42_ORB	61.203,00 €	0,00 €	723,50 €	1.316,00 €	0,00 €		63.242,50 €	12.240,00 €	75.482,50 €
DE	43_PTC	25.500,00 €	5.300,00 €	0,00 €	0,00 €	0,00 €	0,00 €	30.800,00 €	5.100,00 €	35.900,00 €
NL	44_PS-Tech	115.078,00 €	0,00 €	0,00 €	0,00 €	0,00 €	3.169,00 €	118.247,00 €	0,00 €	118.247,00 €
NL	45_PHILIPS	2.287.557,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	2.287.557,00 €	907.994,00 €	3.195.551,00 €
IT	46_POLITO	126.789,00 €	2.006,26 €	0,00 €	201,01 €	0,00 €	37.930,00 €	166.926,27 €	0,00 €	166.926,27 €
ES	47_RGB	290.667,00 €	0,00 €	0,00 €	15.000,00 €	0,00 €	0,00 €	305.667,00 €	58.133,00 €	363.800,00 €
FR	48_SAGEM	60.480,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	60.480,00 €	41.126,40 €	101.606,40 €
IT	49_SUN	102.066,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	102.066,00 €	51.033,00 €	153.099,00 €
DE	51_SIEMENS	254.528,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	254.528,00 €	156.787,00 €	411.315,00 €
DE	52_SISW	140.730,86 €	3.958,00 €	0,00 €	0,00 €	0,00 €	0,00 €	144.688,86 €	0,00 €	144.688,86 €
FR	54_SOYATE C	208.684,00 €	17.108,00 €	1.302,00 €	0,00 €	0,00 €	143.176,00 €	370.270,00 €	25.300,00 €	395.570,00 €
SE	55_SYS	120.922,00 €	1.381,00 €	0,00 €	0,00 €	14.698,00 €	0,00 €	137.001,00 €	74.758,00 €	211.759,00 €
NL	56_TU/e	179.089,00 €	7.000,00 €	0,00 €	3.000,00 €	0,00 €	0,00 €	189.089,00 €	192.318,00 €	381.407,00 €
DE	57_TUB	119.414,56 €	5.077,34 €	0,00 €	0,00 €	0,00 €	0,00 €	124.491,90 €	24.898,38 €	149.390,28 €
DE	58_IST	55.463,71 €	1.317,50 €	0,00 €	0,00 €	0,00 €	0,00 €	56.781,21 €	66.556,45 €	123.337,66 €
FR	59_TASF	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
ES	60_TASE	178.060,06 €	0,00 €	0,00 €	0,00 €	0,00 €	10.128,77 €	188.188,83 €	35.612,01 €	223.800,84 €
AT	61_TRAIL	86.533,08 €	2.387,48 €	0,00 €	0,00 €	0,00 €	0,00 €	88.920,56 €	12.513,32 €	101.433,88 €
FR	62_TGS	812.664,06 €	8.133,97 €	0,00 €	0,00 €	0,00 €	0,00 €	820.798,03 €	553.180,94 €	1.373.978,97 €
FR	63_TRT	812.664,06 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	108.699,00 €	73.915,32 €	182.614,32 €
AT	64_TTech	494.735,40 €	2.457,39 €	772,81 €	0,00 €	0,00 €	0,00 €	497.965,60 €	209.525,86 €	707.491,46 €
ES	65_UC3M	29.977,90 €	0,00 €	0,00 €	0,00 €	0,00 €	1.002,94 €	30.980,84 €	6.196,17 €	37.177,01 €
DE	66_ALU-FR	87.281,97 €	233,52 €	0,00 €	0,00 €	0,00 €	0,00 €	87.515,49 €	14.720,69 €	102.236,18 €

IT	67_UNIGE-DITEN	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
IT	68_UNIFED-II	272.945,18 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	272.945,18 €	136.472,59 €	409.417,77 €
FR	69_Valeo-F	30.975,00 €	1.515,18 €	0,00 €	0,00 €	0,00 €	0,00 €	32.490,18 €	21.063,00 €	53.553,18 €
SE	71_VOLVO	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
	<b>SUM</b>	<b>14.600.209,96 €</b>	<b>238.399,94 €</b>	<b>10.482,03 €</b>	<b>37.436,90 €</b>	<b>108.235,50 €</b>	<b>546.296,11 €</b>	<b>14.884.180,43 €</b>	<b>6.149.553,44 €</b>	<b>21.034.033,87 €</b>

Table 6-1: Table of costs in Euro

Some cost statements marked in red (06\_ALS, 59\_TASF, 67\_UNIGE-DITEN, 71\_VOLVO) are missing. They will be provided as soon as possible.

Partner	WP	Plan [PM]	Actual [PM]	Country
01_AVL	WP1_01	22	22,31	AT
01_AVL	WP1_02	3,5	3,45	AT
01_AVL	WP1_03	0,33	0,3	AT
01_AVL	WP3_03	29	29,21	AT
01_AVL	WP3_04	53	51,73	AT
01_AVL	WP3_07	0,5	0,5	AT
01_AVL	WP3_08	0,5	0,5	AT
01_AVL	WP6_01	1,5	1,38	AT
01_AVL	WP6_03	3	3,5	AT
01_AVL	WP6_08	4	3,9	AT
01_AVL	WP6_10	7,5	7,17	AT
01_AVL	WP6_12	2,5	2,5	AT
01_AVL	WP6_13	50,5	50,46	AT
02_A-F	WP1_01	0,55	0,5	FR
02_A-F	WP1_02	0,4	0,35	FR
02_A-F	WP2_00	1	0,8	FR
02_A-F	WP2_08	0,8	0,8	FR
02_A-F	WP2_09	0,76	0,76	FR
02_A-F	WP2_10	4,7	4,7	FR
02_A-F	WP6_01	0,8	0,8	FR
02_A-F	WP6_02	0,22	0	FR
02_A-F	WP6_06	0,22	0	FR
03_A-G	WP2_01	10	9	DE
04_A-UK	WP2_11	8	5	UK
05_ALA	WP1_01	0,8	0,9	IT
05_ALA	WP1_02	3,4	2,7	IT
05_ALA	WP2_02	20,9	21	IT
05_ALA	WP2_08	13,3	14,6	IT
05_ALA	WP2_09	2,3	3,5	IT
05_ALA	WP6_01	1,1	1,7	IT
05_ALA	WP6_02	11,3	14,6	IT
05_ALA	WP6_08	2,5	0,9	IT
06_ALS	WP5_03	11	10,5	FR
07_ASTS	WP1_03	0	0	IT
07_ASTS	WP5_00	2	2	IT
07_ASTS	WP5_01	4,7	4,6	IT
07_ASTS	WP5_04	1,3	1,15	IT
07_ASTS	WP6_12	2,6	2,5	IT

08_ARCC	WP1_03	0,2	0	SE
08_ARCC	WP3_01	3	2	SE
08_ARCC	WP6_05	6,9	6,2	SE
09_ARCT	WP6_03	13	8	SE
10_AIT	WP1_02	0,5	1	AT
10_AIT	WP3_01	2,5	4,5	AT
10_AIT	WP3_03	1	0,5	AT
10_AIT	WP5_01	1,5	1,1	AT
10_AIT	WP5_02	5	3	AT
10_AIT	WP6_01	0,3	0,3	AT
10_AIT	WP6_03	3	3,5	AT
10_AIT	WP6_04	15	22	AT
11_AVL-S	WP1_03	0,68	0,2	DE
11_AVL-S	WP3_00	7,38	7,6	DE
11_AVL-S	WP3_03	10,89	11,51	DE
11_AVL-S	WP3_07	0,55	0,32	DE
12_AVL-R	WP1_03	0,3	0,2	DE
12_AVL-R	WP3_04	9,4	9,4	DE
12_AVL-R	WP3_07	0,7	0,6	DE
12_AVL-R	WP3_08	0,6	0,6	DE
12_AVL-R	WP6_05	3,2	2,8	DE
12_AVL-R	WP6_11	0,9	1	DE
12_AVL-R	WP6_12	9,4	9,4	DE
12_AVL-R	WP6_13	0,9	0,9	DE
13_BARCO	WP1_03	0,25	0,25	BE
13_BARCO	WP4_00	1	1	BE
13_BARCO	WP4_04	34	36	BE
13_BARCO	WP4_05	90	93	BE
13_BARCO	WP6_03	0,5	0,5	BE
13_BARCO	WP6_08	0,5	0,5	BE
13_BARCO	WP6_10	0,5	0,5	BE
13_BARCO	WP6_11	0,5	0,5	BE
14_REUSE	WP1_02	1	0,5	ES
14_REUSE	WP2_04	1	1	ES
14_REUSE	WP6_07	14	14,6	ES
15_CRF	WP3_05	13,5	13,5	IT
15_CRF	WP3_07	0,75	0,75	IT
15_CRF	WP3_08	0,75	0,75	IT
16_CTH	WP1_02	0,3	0,03	SE
16_CTH	WP3_01	4	3,14	SE

16_CTH	WP3_04	2	2,08	SE
16_CTH	WP6_03	4	3,47	SE
16_CTH	WP6_12	3	1,62	SE
17_CIC	WP6_01	6	6	GB
18_DAIMLER	WP3_02	24	22	DE
18_DAIMLER	WP3_07	1	1	DE
18_DAIMLER	WP3_08	1	1	DE
19_EADS-CAS	WP1_01	1	0,9	DE
19_EADS-CAS	WP1_02	1	0,7	DE
19_EADS-CAS	WP1_03	0,2	0,1	DE
19_EADS-CAS	WP2_00	1	0,9	DE
19_EADS-CAS	WP2_03	23,4	20,6	DE
19_EADS-CAS	WP2_08	0,9	0,5	DE
19_EADS-CAS	WP2_09	0,7	0,2	DE
19_EADS-CAS	WP6_04	0,2	0,1	DE
19_EADS-CAS	WP6_07	1,2	0,8	DE
19_EADS-CAS	WP6_08	0,2	0,1	DE
19_EADS-CAS	WP6_10	0,2	0,1	DE
19_EADS-CAS	WP6_11	0,2	0,1	DE
20_EADS IW-G	WP1_02	1,67	3	DE
20_EADS IW-G	WP1_03	0,33	0	DE
20_EADS IW-G	WP2_00	0,67	0,6	DE
20_EADS IW-G	WP2_01	1	1,5	DE
20_EADS IW-G	WP2_03	2,33	0,7	DE
20_EADS IW-G	WP2_08	4	12,5	DE
20_EADS IW-G	WP6_04	4,67	1,5	DE
20_EADS IW-G	WP6_06	4,67	4	DE
20_EADS IW-G	WP6_07	1,67	0,5	DE
20_EADS IW-G	WP6_08	3,33	0	DE
20_EADS IW-G	WP6_10	2,33	0,2	DE
20_EADS IW-G	WP6_11	3,33	5,5	DE
21_EADS IW-F	WP2_09	6	3	FR
22_EADS IW-UK	WP1_02	3	1	UK
22_EADS IW-UK	WP2_01	4	1,5	UK
22_EADS IW-UK	WP2_08	1,7	1	UK
22_EADS IW-UK	WP6_00	2	5	UK
22_EADS IW-UK	WP6_01	9	3	UK
22_EADS IW-UK	WP6_02	3	1	UK
22_EADS IW-UK	WP6_04	3,3	0	UK
22_EADS IW-UK	WP6_06	2	5	UK



22_EADS IW-UK	WP6_08	2,7	0	UK
22_EADS IW-UK	WP6_11	2,7	0	UK
23_Elektrobit	WP3_06	12	8	FR
23_Elektrobit	WP6_05	0	0	FR
24_TUG	WP1_02	1	0,89	AT
24_TUG	WP3_04	1	0,89	AT
24_TUG	WP6_04	4	3,57	AT
24_TUG	WP6_13	1	0,89	AT
25_FBK	WP6_01	3,5	3,5	IT
25_FBK	WP6_02	6,5	6,5	IT
25_FBK	WP6_03	3	3	IT
25_FBK	WP6_04	3	3	IT
26_FhG	WP1_03	0,33	0,2	DE
26_FhG	WP2_01	3,33	3,4	DE
26_FhG	WP2_03	3,33	3,5	DE
26_FhG	WP3_03	5	5,1	DE
26_FhG	WP3_04	5	5,1	DE
26_FhG	WP6_01	3	3	DE
26_FhG	WP6_02	2	2,64	DE
26_FhG	WP6_03	5	4,9	DE
26_FhG	WP6_04	4	4,2	DE
26_FhG	WP6_06	2,67	2	DE
26_FhG	WP6_10	3,33	3,8	DE
26_FhG	WP6_13	3	3	DE
27_Tecnalia	WP2_05	12	12	ES
27_Tecnalia	WP6_04	14,35	14,35	ES
27_Tecnalia	WP6_10	17,3	17,3	ES
28_GMV	WP1_01	0,7	0,7	ES
28_GMV	WP1_02	0,5	0,4	ES
28_GMV	WP2_05	6,6	1,65	ES
28_GMV	WP6_04	0,6	0,6	ES
28_GMV	WP6_09	1,3	0,2	ES
29_HON	WP2_06	40	40	CZ
30_IBM UK	WP1_01	0,1	0,1	UK
30_IBM UK	WP6_01	9,1	4,2	UK
30_IBM UK	WP6_08	0	0	UK
30_IBM UK	WP6_10	0	0	UK
30_IBM UK	WP6_11	7,8	3,1	UK
31_IFX-UK	WP1_02	0,2	0,2	UK
31_IFX-UK	WP3_03	5,2	5,2	UK

31_IFX-UK	WP6_04	9,4	9,7	UK
31_IFX-UK	WP6_05	2,6	2,6	UK
31_IFX-UK	WP6_12	4,4	4,4	UK
32_ITI	WP1_02	0,5	0,2	ES
32_ITI	WP2_05	2,5	2,5	ES
32_ITI	WP4_06	9,5	9,98	ES
32_ITI	WP4_07	4	2,45	ES
32_ITI	WP6_01	10,5	8,8	ES
32_ITI	WP6_02	6,5	12,2	ES
32_ITI	WP6_03	18	19,1	ES
32_ITI	WP6_06	7	6,1	ES
32_ITI	WP6_08	7	6	ES
33_ITKE	WP3_02	11,9	9,7	DE
33_ITKE	WP6_03	2,6	2,1	DE
33_ITKE	WP6_04	1,6	1,3	DE
33_ITKE	WP6_05	0,5	0,4	DE
33_ITKE	WP6_13	0,3	0,3	DE
34_VIF	WP1_02	1	1	AT
34_VIF	WP3_00	1	1	AT
34_VIF	WP3_03	5,67	4	A
34_VIF	WP3_04	6	5	AT
34_VIF	WP3_07	5,67	4,4	AT
34_VIF	WP6_03	6,3	5	AT
34_VIF	WP6_10	6,7	5	AT
34_VIF	WP6_13	6	5	AT
35_ALL4TEC	WP5_01	8	8	FR
35_ALL4TEC	WP6_04	12	12	FR
36_MU	WP2_06	6	6	CZ
36_MU	WP6_04	6	6	CZ
37_MATE	WP5_01	4	4	IT
37_MATE	WP6_03	1	1	IT
37_MATE	WP6_12	38	41	IT
38_IBM NL	WP3_01	0	0,2	NL
38_IBM NL	WP4_01	0	3,5	NL
38_IBM NL	WP4_02	2	0,7	NL
38_IBM NL	WP4_03	2	0,2	NL
38_IBM NL	WP4_04	2	0,7	NL
38_IBM NL	WP4_05	2	2,5	NL
38_IBM NL	WP4_06	0	0,2	NL
38_IBM NL	WP4_07	0	0,2	NL

38_IBM NL	WP6_03	0	0,1	NL
38_IBM NL	WP6_11	4	0,5	NL
39_TNO	WP1_03	0	0	NL
39_TNO	WP4_01	16	15,6	NL
39_TNO	WP4_02	8	11,4	NL
39_TNO	WP4_03	4	4,4	NL
39_TNO	WP4_05	7	4,3	NL
39_TNO	WP4_06	4	3,4	NL
39_TNO	WP4_07	8,7	7,7	NL
39_TNO	WP6_03	20	9,8	NL
39_TNO	WP6_04	2,7	2,3	NL
39_TNO	WP6_06	6	4,8	NL
39_TNO	WP6_10	4	2	NL
39_TNO	WP6_11	5	1,5	NL
40_Obeo	WP1_02	2	2,1	FR
40_Obeo	WP6_02	0,25	0,25	FR
40_Obeo	WP6_09	51	51	FR
41_OFFIS	WP1_01	0,7	0,6	DE
41_OFFIS	WP1_02	0,6	0,5	DE
41_OFFIS	WP1_03	1	1	DE
41_OFFIS	WP2_04	1,2	1,5	DE
41_OFFIS	WP3_01	0,45	1	DE
41_OFFIS	WP3_04	0,45	0,5	DE
41_OFFIS	WP6_01	12	10	DE
41_OFFIS	WP6_02	7	4,5	DE
41_OFFIS	WP6_05	4,5	4	DE
41_OFFIS	WP6_07	18	17,45	DE
42_ORB	WP2_05	12	12	ES
42_ORB	WP6_10	12	12	ES
42_ORB	WP6_11	12	3	ES
43_PTC	WP3_02	1,4	0,9	DE
43_PTC	WP3_03	1,4	0,6	DE
43_PTC	WP3_04	1,5	0,8	DE
43_PTC	WP3_04	0,8	0,7	DE
43_PTC	WP6_11	0,6	0,3	DE
44_PS-Tech	WP4_01	7	5,5	NL
44_PS-Tech	WP6_03	10	8	NL
45_PHILIPS	WP1_01	0,7	0,7	NL
45_PHILIPS	WP1_03	0,7	0,5	NL
45_PHILIPS	WP4_00	9	9	NL

45_PHILIPS	WP4_01	75	88	NL
45_PHILIPS	WP4_02	70	70	NL
45_PHILIPS	WP4_03	70	68	NL
45_PHILIPS	WP4_07	4	0,5	NL
45_PHILIPS	WP6_03	5	5	NL
45_PHILIPS	WP6_06	5	5	NL
45_PHILIPS	WP6_08	11	10	NL
45_PHILIPS	WP6_10	3	3	NL
45_PHILIPS	WP6_11	10	7	NL
46_POLITO	WP1_02	1,5	0,9	IT
46_POLITO	WP2_02	15	9,5	IT
46_POLITO	WP2_08	16	14,8	IT
46_POLITO	WP2_09	5,5	5,5	IT
47_RGB	WP1_03	0,33	0,33	ES
47_RGB	WP4_00	1	1	ES
47_RGB	WP4_06	59	59	ES
47_RGB	WP4_07	1,33	1,33	ES
47_RGB	WP6_03	1,33	1,33	ES
47_RGB	WP6_06	1,67	1,67	ES
47_RGB	WP6_08	1,33	1,33	ES
47_RGB	WP6_11	1,33	1,33	ES
48_SAGEM	WP1_01	0,6	0,7	FR
48_SAGEM	WP2_00	0,2	0,4	FR
48_SAGEM	WP2_04	6	5	FR
48_SAGEM	WP2_09	0,4	0,2	FR
48_SAGEM	WP6_01	0,7	0,7	FR
48_SAGEM	WP6_02	0,5	0,2	FR
48_SAGEM	WP6_07	1,7	2	FR
49_SUN	WP5_01	3,17	2,92	IT
49_SUN	WP6_03	2,67	2,46	IT
49_SUN	WP6_12	21,33	19,7	IT
51_SIEMENS	WP6_01	3,7	3,5	DE
51_SIEMENS	WP6_04	11	8,2	DE
51_SIEMENS	WP6_10	11	9,9	DE
51_SIEMENS	WP6_11	7,3	4,2	DE
52_SISW	WP6_08	36	12	DE
54_SOYATEC	WP6_09	93,6	23	FR
55_SYS	WP1_03	0,3	0,07	SE
55_SYS	WP3_01	12	13	SE
55_SYS	WP6_01	2	1,1	SE

55_SYS	WP6_02	1	0,1	SE
55_SYS	WP6_08	6	35	SE
56_TU/e	WP4_00	6	6	NL
56_TU/e	WP4_02	7	5,5	NL
56_TU/e	WP4_03	22	13,5	NL
56_TU/e	WP4_05	6	5	NL
56_TU/e	WP4_07	2	2	NL
56_TU/e	WP6_06	6	3	NL
56_TU/e	WP6_10	5	1	NL
57_TUB	WP3_02	21	21	DE
57_TUB	WP3_08	1	1	DE
58_IST	WP3_03	3	3	DE
58_IST	WP3_04	3	3	DE
58_IST	WP6_01	3	3	DE
58_IST	WP6_02	2,5	2,5	DE
58_IST	WP6_13	3	3	DE
59_TASF	WP2_07	2	1,56	FR
60_TASE	WP2_05	27	27	ES
60_TASE	WP6_01	1,5	1,5	ES
60_TASE	WP6_10	1,5	1,5	ES
61_TRAIL	WP5_00	1,5	1,4	AT
61_TRAIL	WP5_02	18	9	AT
61_TRAIL	WP6_03	0	0	AT
62_TGS	WP6_09	99	86	FR
63_TRT	WP6_09	36	14	FR
64_TTTech	WP3_00	3,2	2,63	AT
64_TTTech	WP3_04	25,68	25,68	AT
64_TTTech	WP6_05	58,43	58,43	AT
65_UC3M	WP1_02	0	1	ES
65_UC3M	WP2_04	1	1	ES
65_UC3M	WP6_07	22	15	ES
66_ALU-FR	WP3_02	12	18	DE
67_UNIGE-DITEN	WP3_05	7	9	IT
68_UNIFED-II	WP5_01	7,26	7,26	IT
68_UNIFED-II	WP6_01	3,1	2,1	IT
68_UNIFED-II	WP6_02	5	4,3	IT
68_UNIFED-II	WP6_03	2,2	2,2	IT
68_UNIFED-II	WP6_08	1	0,4	IT
68_UNIFED-II	WP6_12	33,4	33,4	IT
69_Valeo-F	WP3_06	11	10	FR

69_Valeo-F	WP3_07	0,1	0,1	FR
69_Valeo-F	WP3_08	0,1	0,1	FR
71_VOLVO	WP1_01	0,7	0,4	SE
71_VOLVO	WP1_02	0,3	0,1	SE
71_VOLVO	WP3_00	1	0,1	SE
71_VOLVO	WP3_01	29	28,6	SE
71_VOLVO	WP3_07	1	0,5	SE
71_VOLVO	WP3_08	1	0,1	SE
71_VOLVO	WP6_01	2	0,2	SE
71_VOLVO	WP6_05	3	0,4	SE
	SUM	2437,92	2192,23	PM

Table 6-2: Table of efforts in person month

---

## **7 For beneficiaries without a corresponding National Grant Agreement, financial statements (Form C)**

Not applicable



---

## 8 Annex

Annex 1 Beneficiary Reports M1 - M12 (pdf version)

Annex 2 Cost statement of each beneficiary and table of efforts (excel version)