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TIMMO-2-USE

Timing Model – Tools, algorithms, languages, methodology, USE cases

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Document History

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Table of contents

1 Executive Summary

The major work results of the work package 1 are:

1. The set of *requirements* is an essential input for conducting the work in the various work packages.
2. The set of *use cases* is important for gaining a common understanding about the objectives of the TIMMO-2-USE project. In addition the use cases, like the requirements, are an important input for conducting the work in the various work packages.
3. The *state-of-the-art analysis* provides a basis for conducting the work in the various work packages. It especially for determines which of the existing/available approaches could be utilized and enhanced to satisfy the given requirements, or proposing new techniques in order to manage time information in the various steps of today's and future's development processes.

2 Introduction

Purpose

The purpose of this document is to describe the work carried out in work package 1 in phase 1 of the TIMMO-2-USE funded research project. In particular, it provides additional information and background on the work carried out in the work package 1 with regard to specifying requirements, describing use cases, and conducting the state-of-the-art analysis.

Scope

The scope of this document is the work conducted in work package 1 during the first phase of the TIMMO-2-USE funded research project.

Abbreviations and Acronyms

The table below lists all abbreviations and acronyms used in this document.

Abbreviation Acronym	Description
ATESST	Advancing Traffic Efficiency and Safety through Software Technology http://www.atesst.org
AUTOSAR	AUTomotive Open System ARchitecture http://www.autosar.org
EAST-ADL	Embedded Architectures and Software Technologies - Architecture Description Language http://www.east-adl.org
FPP	Full Project Proposal
MAENAD	Model-based Analysis & Engineering of Novel Architectures for Dependable Electric Vehicles http://www.maenad.eu
SOTA	State-of-the-art [Analysis]
TIMMO	TIMing MOdel http://www.timmo.org

Structure of this document

The document consists of eight chapters. The chapter “Executive Summary” provides a brief summary about the results of the work conducted in work package 1. The chapter “Introduction” explains the purpose, scope, and structure of this document. The chapter “Prerequisites” describes the prerequisites agreed on which are important for the course of the TIMMO-2-USE project. The chapter “Approach” explains the approach taken to specify requirements that are important for the work carried out in the various work packages. In addition, it describes the way the use cases have been identified. The chapter “Requirements” provides further information about the requirements elicitation process. The chapter “Use Cases” provides more and detailed information about how the use cases were identified and described. The chapter “State-of-the-Art Analysis” provides a brief introduction into the state-of-the-art analysis conducted in TIMMO-2-USE.

And last but not least, the chapter “References” lists important documents the reader of this document shall be aware of.

Structure of the Deliverable D1

The Deliverable D1 consists of several parts – each of these parts is a separate document. The primary reason for this structure is that the

documents containing the requirements and the description of the use cases are generated using SPARX Systems Enterprise Architect UML Modeling Software. In order to unambiguously identify these parts the following scheme has been chosen:

D1 The document which represents the “core” deliverable D1 and provides additional information and background on the work carried out in the work package 1 (this document).

D1.1 The document which contains the requirements specified during the course of work package 1.

D1.2 The document which contains the description of the use cases identified during the course of the work package 1.

D1.3 The document which contains the state-of-the-art (SOTA) analysis conducted during the course of work package 1.

3 Prerequisites

This chapter describes the prerequisites the TIMMO-2-USE partners agreed on for any work being conducted during the course of this project.

The TIMMO-2-USE partners agreed to establish a sound basis for the work to be carried out in the various work packages. Due to this some decisions were taken at the beginning of the work package 1 regarding the modeling languages to be used in the TIMMO-2-USE project. Like in the TIMMO funded research project, which was the predecessor of the TIMMO-2-USE project, the TIMMO-2-USE project decided to utilize the Automotive Open System Architecture (AUTOSAR) and EAST-ADL for modeling software-intensive systems on various levels of abstraction. In order to avoid any confusion during the course of the TIMMO-2-USE project the specific releases were chosen as described below.

Automotive Open System Architecture AUTOSAR

AUTOSAR is an open and standardized automotive software architecture, jointly developed by automobile manufacturers, suppliers, and tool vendors. The AUTOSAR Release 4.0 Revision 1 is the first version providing capabilities to express timing constraints and guarantees. These capabilities are called the AUTOSAR Timing Extensions.

The above mentioned AUTOSAR release was published beginning of 2011. Currently, this release is being revised and prepared for publication in March 2011 time frame, then becoming the official AUTOSAR Release 4.0 Revision 2.

Relevant AUTOSAR releases during the course of the TIMMO-2-USE project are:

- AUTOSAR Release 4.0 Revision 1

- AUTOSAR Release 4.0 Revision 2[1]

EAST-ADL

The very first release of the EAST-ADL was published in 2004 as a result of the funded research project EAST EEA specifically for the purpose to be used in the automotive industry. Since its first publication this architecture description language has been improved by several other successive funded research projects, mainly by the ATESST and ATESST 2 projects.

EAST-ADL is an architecture description language introducing four levels of abstraction: Vehicle Level, Analysis Level, Design Level, and Implementation Level. Each of these levels deals with a specific abstraction of the system subject to development, ranging from the description of features and their variants to concrete implementation, like C programming language functions, which realize the given features. It should be noted that the capabilities provided by AUTOSAR are used on the EAST-ADL Implementation Level to describe the various aspects of a software system.

The latest release of the EAST-ADL was published at the end of the ATESST 2 project in June 2010. This release adopted the Timing Augmented Description Language TADL proposed by the ITEA project TIMMO (TIMing Model) that ended in September 2009. At the moment the MAENAD funded research project starts to improve and enhance the EAST-ADL. During the course of the TIMMO-2-USE and MAENAD projects the members of the corresponding work packages will meet and exchange status information on the progress made to improve the EAST-ADL language. The main reason for that is to ensure consistency between the various parts – Structure and Timing – of the EAST-ADL language.

Relevant EAST-ADL releases during the course of the TIMMO-2-USE project are:

- EAST-ADL 2 ATESST 2 June 30th, 2010
- EAST-ADL 2 from MAENAD[2]

Modeling with Enterprise Architect

For modeling respectively documenting requirements the Enterprise Architect UML Modeling Software from SPARX Systems was selected. A “Getting Started Guide” has been created to enable partners rapidly to use this UML Modeling Software for this purpose.

The idea behind this decision is to be able to trace requirements down to their solutions, because the language is modeled using this tool, too. With regard to methodology a decision was not taken, but

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[1] The publishing of the AUTOSAR Release 4.0 Revision 2 is scheduled for March 2011 time frame.

[2] The MAENAD funded research project started in September 2010 and is currently reviewing and performing a first straightening of the EAST-ADL specification from the ATESST 2 funded research project.

will be taken in the course of work package 4 “Methodology”. For more details see chapters “Requirements” and “Use Cases”.

4 Approach

This chapter describes the approach taken to specify the requirements that are considered to be the basis for the various work packages in the TIMMO-2-USE project and the way relevant use cases were identified.

4.1 Use Cases and Requirements

The TIMMO-2-USE project strives for significantly increasing the automation during development process cycles and supporting collaboration between various stakeholders involved with regard to process timing information. In order to accomplish this TIMMO-2-USE addresses the specification, transition, transformation, and exchange of relevant timing information – timing requirements and timing properties – throughout different steps of the development process also taking into account the AUTOSAR-based development steps in later phases of such development process. In particular, it bridges the gap between the continuous control domain (functional) and the software domain (implementation). The introduction of an enhanced expressiveness greatly improves and strengthens the methodology with respect to the derivation and tracing of different types of timing information with true design process improvements, like collaboration support, variability management, and virtual system integration.

Therefore, the identification of typical use cases occurring frequently and the requirements evolving from those use cases are crucial for the course of the TIMMO-2-USE project. Mainly because such use cases reflect typical development scenarios in the automotive industry they are important to be scrutinized.

Requirements

Several steps were taken to obtain and refine requirements during the course of the work package 1. In a first step a number of categories were defined in order to group requirements. The categories that were defined are:

- Functional
- Non-Function
- Reliability
- Safety
- Robustness
- Fault Tolerance
- Collaboration Support
- Variability Management

- Virtual System Integration
- Use Case
- Validation

The category “Use Case” is used to mark a requirement that leads the definition of a use case. Such requirements were examined carefully with regard to their scope. Based on the result of this analysis a set of *Main Use Cases* was defined. The purpose of these Main Use Cases is described in detail later in this section.

In further steps these Main Use Cases were reviewed and further requirements were defined related to topics that shall be addressed in the work packages 2 through 5 (Language, Algorithms and Tools, Methodology, and Validation). The idea is that the work package specific requirements shall guide the definition of work tasks in the specific work packages.

Of course, the requirements that were identified during the TIMMO project have been reviewed as well. In particular, those requirements which have not been satisfied or have been only partly satisfied were considered again.

Use Cases

Two classes of use cases have been defined throughout the course of the work package 1:

- Main Use Cases
- Specific Use Cases

The purpose of these classes of use cases is described in the following paragraphs.

Main Use Cases

Main use cases[3] have a larger scope with regard to the development process. Typically they cover/span over a large number of development steps or even the entire development process. In addition they consider various aspects with regard to a timing augmented methodology.

As shown in Figure 1 the Main Use Cases defined and described in work package 1 serve as guideline and context for all subsequent work to be conducted in the various work packages. Indeed, they were also used during the course of work package 1 to specify requirements for work packages 2 through 5. Eventually, in work

[3] Even the Main Use Cases are justified by requirements that have been stated during the work performed by work package 1.

package 5 “Validation” the proposed solutions are verified in the context of the given main uses cases.

Following this approach shall ensure that all contributing partners have a common understanding about:

- the objectives to be accomplished in the TIMMO-2-USE project,
- the requirements that are imposed on the various work packages, which means the requirements that shall be satisfied by the results of the particular work package, and
- how the contribution of every partner fits into “the big picture” and supports the various steps in the development process – the Main Use Cases.

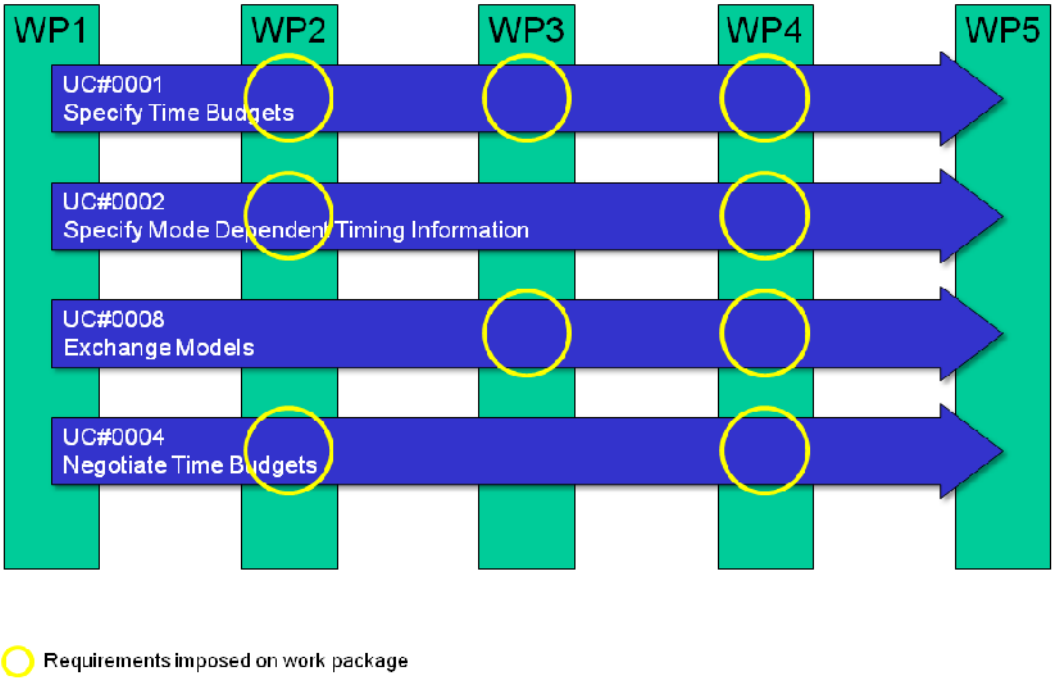

Figure 1: TIMMO-2-USE “The Big Picture” showing the relationship between the work packages and the main use cases. Main use cases evolve from work performed in work package 1 and are a guideline for work performed in other work packages. Eventually the results of the work packages 2 “Language”, 3 “Algorithms and Tools”, and 4 “Methodology” are verified in work package 5 “Validation” exercising the given Main Use Cases. These use cases serve as context for validation.

Specific Use Cases

The TIMMO-2-USE Full Project Proposal already mentions in the description of work package 1 possible use cases. The uses cases were proposed by some members of the consortium and indicate their particular interest in this project. By and large, these use cases focus on very specific aspects of the development process, but rarely having the scope of an entire development process [with regard to dealing with timing information]. The Specific Use Cases focus on aspects that are related to topics supposed to be addressed in specific work packages, like language, methodology, etc. Therefore,

these use cases are called *Specific Use Cases*. It is also expected that a specific use case occurs multiple times in the context of various the Main Use Cases.

The Specific Use Cases were analyzed and further requirements were identified. In subsequent steps every Specific Use Case was associated with one or more Main Use Cases.

Relation between Main Use Cases and Specific Use Cases

In the work package 1 the relationships between Main and Specific Use Cases have been specified. The result of this activity is presented in a relationship matrix as shown in Figure 2.

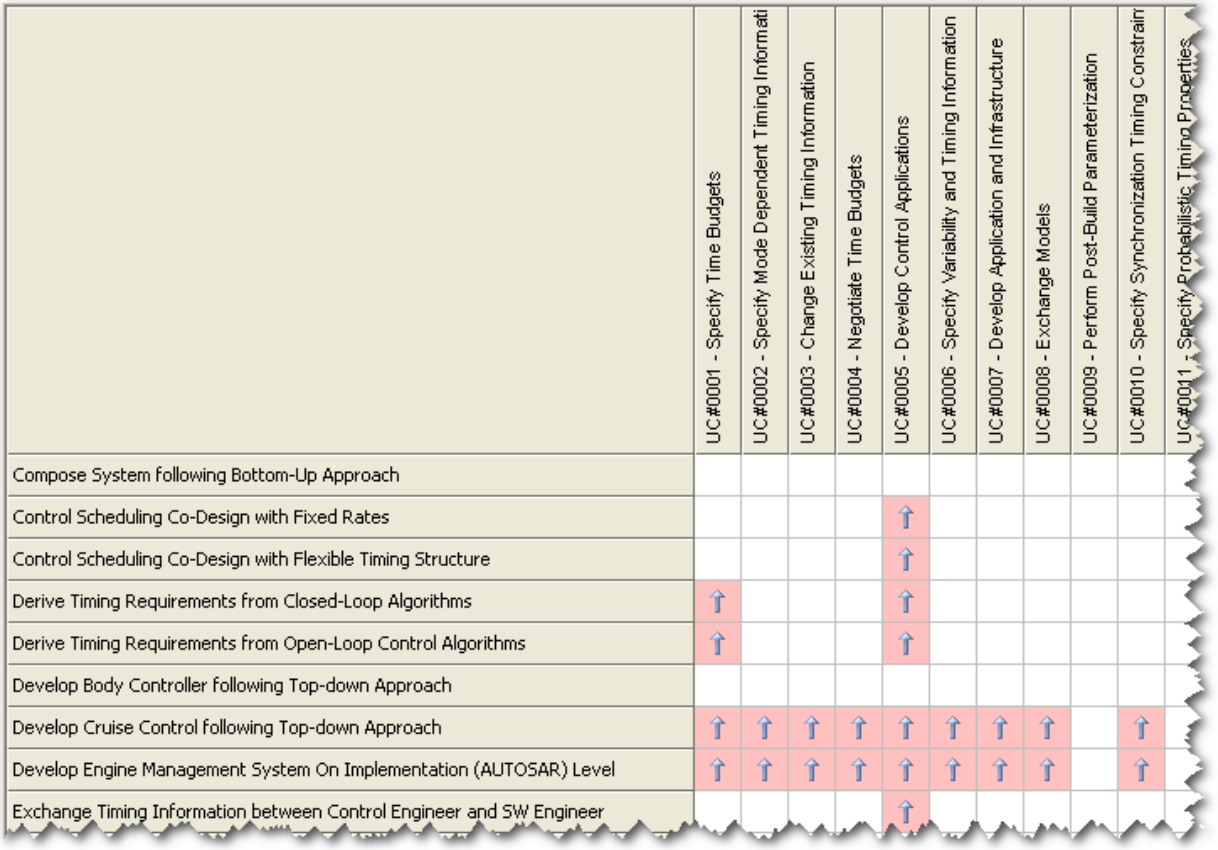

Figure 2: Relationships between Specific Use Cases, which are listed in the left-most column, and the Main Use Cases, which are listed in the top row. The blue arrows in the cells of this relationship matrix indicate that a specific use case is related to a main use case listed in the specific column. For example, the specific use case “Control Scheduling Co-Design with Fixed Rates” relates to the main use case “UC#0005 Develop Control Applications”.

4.2 Supporting the Course of the Project

While work in the work package 1 ends, the work in the work packages 2 through 5 is being started. This shall ensure a smooth transition from the definition process – identifying requirements for

the specific work packages – to the solution process – the work that shall be conducted in the specific work packages.

The first step taken in the work packages 2 through 5 is to review and analyze the requirements specified in work package 1. During this process it may happen that requirements are refined, new requirements are created, or requirements supposed to be satisfied by the reviewing work package are assigned back to other work packages. In order to ensure proper requirements tracing the work package 1 will operate in a kind of watch mode ensuring that all requirements are recorded and the work packages get notified about relevant changes. Essentially the work package leader of work package 1 can be notified at any time during the TIMMO-2-USE project in order to inform other work package leaders about changes.

5 Requirements

An important work product of the work package 1 is the specification of requirements for the TIMMO-2-USE project. For this purpose, requirements from every partner were gathered and recorded, in the first place. In subsequent telephone conferences and face-to-face meetings, the requirements were reviewed, discussed, and revised when necessary. These meetings have been conducted in order to gain a common understanding about the requirements between the partners and to ensure a common view on the objectives of the TIMMO-2-USE project.

Furthermore it was agreed that the identified requirements are considered as a “wish-list” and not all accepted requirements have to be satisfied at the end of the project. The partners shared the understanding that the requirements will be reviewed at the beginning of the various work packages – mainly work package 2 “Language” through 5 “Validation”. During the beginning of these work packages the requirements are prioritized and work tasks are defined accordingly to work on satisfying these requirements. It is also expected that work packages may refuse some requirements due to whatsoever reason, like the fact that the amount of time available is not sufficient for resolving a given requirement.

Status of Requirements

During the various reviews of the requirements the reviewers decided on the status of the requirement. Initially, the status of a requirement was set to “proposed” in order to indicate that the requirement has been newly created and awaits its review. After such a review the status of the requirement is changed such that it is in one of the following states:

- Approved. This status indicates that the requirement has been approved and is considered as an important input for the work to be conducted in the corresponding work package(s).
- Rejected. This status indicates that the requirement has been rejected and is not considered as an important input for the work to be conducted in the work packages.

- Implemented. This status indicates that the requirement has been reviewed and has been already implemented by the TIMMO project. Indeed, requirements in this state are still considered as an important input but the need not to be considered in the work to be conducted in the corresponding work package(s).

Assignment of Requirements

During the review of the requirements, the requirements were assigned to a work package most suited for working out a solution that satisfies this requirement. But sometimes requirements were stated in such a way that it was not obvious which work package should deal with this requirement. Rather it was necessary to derive further requirements each suited for a specific work package. Commonly this happened when requirements were related to methodology (work package 4), but require language support (work package 2).

Requirements and Use Cases

When requirements were reviewed, they were also associated with the use case they evolved from. For this purpose a relationship matrix has been created to present these dependencies. Figure 3 shows an excerpt of this relationship matrix. The idea behind this approach is to ensure that requirements and use cases are consistently matching.

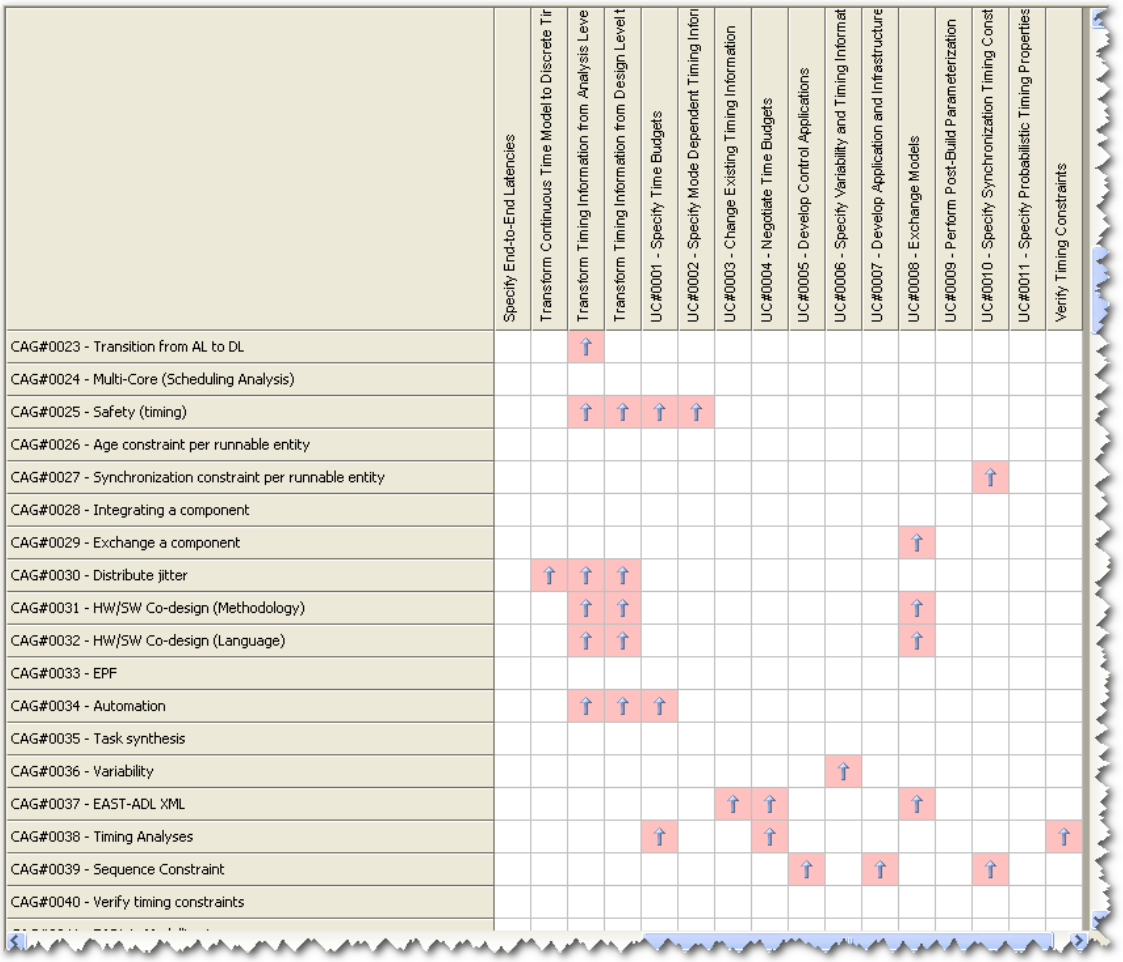

Figure 3: Relationship between requirements, which are listed in the left-most column, and the use cases, which are listed in the top row. The blue arrows in the cells of this relationship matrix indicate that a requirement is related to a use case listed in the specific column. For example, the requirement “CAG#0023 Transition from AL to DL” (second row) relates to the use case “Transform Timing Information from the Analysis to the Design Level” (fourth column from left).

Role of the software tool Enterprise Architect

At the beginning of work package 1 the SPARX Systems Enterprise Architect UML Modeling Software has been chosen for recording and capturing all requirements.

For this purpose an Enterprise Architect Project file has been set-up containing a package called “WP1 – Use Cases and Requirements”. This package is subdivided into two parts. One part is dedicated to requirements and is therefore called “Requirements” and in turn contains further packages each dedicated to one of the work packages 1 through 6 as shown in Figure 4.

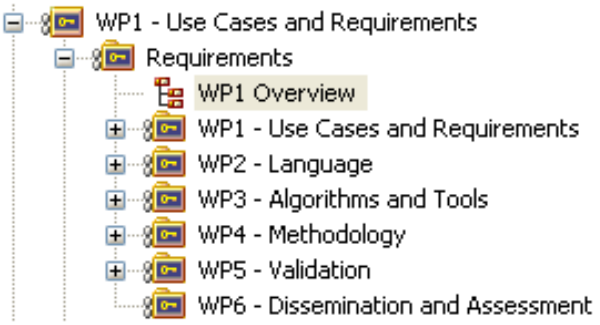

Figure 4: Structure of the Enterprise Architect Project. The package "WP1 - Use Cases and Requirements" is dedicated to the work package 1. The sub-package called "Requirements" is intended to contain all requirements obtained during the requirements elicitation.

In subsequent reviews the requirements provided by the partners were sorted into the corresponding sub-packages.

For more details on how the Enterprise Architect UML Modeling Software has been used during the course of work package 1 refer to the Getting Started Guide "Getting Started with Enterprise Architect and Requirements" [9].

Linking Requirements and Solutions

One of the most important reasons for choosing the Enterprise Architect UML Modeling Software was to be able to associate the requirements with the solutions worked out in the work packages, mainly work package 2 "Language" and possibly 4 "Methodology"[4].

It is assumed that the language is modeled using UML, as already done in the TIMMO project, and the language elements are associated with the particular requirements by a specific UML association («realization»). A relationship matrix can be created to show the relationship between requirements and their solution, in other words the elements that realize the requirements.

Requirements Document

For more details about the requirements identified refer to deliverable D1.1 [5].

6 Use Cases

An important work product of the work package 1 is the definition of relevant use cases for the TIMMO-2-USE project.

[4] At the point of writing the D1 no decision was taken regarding modeling the methodology. This decision is taken in the course of work package 4 "Methodology".

Status of Use Cases

During the various reviews of the use cases the reviewers decided on the status of the use cases. Initially, the status of a use case was set to “proposed” in order to indicate that the use case has been newly created and awaits its review. After such a review the status of the use case is changed such that it is in one of the following states:

- Approved. This status indicates that the use case has been approved and is considered as an important input for the work to be conducted in the corresponding work package(s).
- Rejected. This status indicates that the use case has been rejected and is not considered as an important input for the work to be conducted in the work packages.
- Implemented. This status indicates that the use case has been reviewed and has been already implemented by the TIMMO project. Indeed, use cases in this state are still considered as an important input but the need not to be considered in the work to be conducted in the corresponding work package(s).

Description of Use Cases

In order to ensure a consistent description of the use cases a template was provided. The template consists of the following sections:

- Use Case Title/Name. An active-verb goal phrase that names the goal of the actor respectively the purpose of the use case.
- Objective/Goal. Describes the objective of the use case.
- Description. Provides more details on the use case in order to convey the rationale of the use case.
- Actors. Lists the actors who are involved in the use case.
- Stakeholders. Lists the stakeholders who have an interest in this use case, but are not necessarily directly involved.

Main Use Cases and Specific Use Cases

Two classes of use cases have been introduced in the TIMMO-2-USE project. As already mentioned in chapter “Approach” these are the Main and Specific Use Cases and both have different scopes. The Specific Use Cases consider a very specific aspect in the specific phases of a development process; whereas the Main Use Cases have a larger scope and consider one or more aspects across an entire development process.

The Main Use Cases also serve the purpose of a) providing a context for validating the results of various work packages and b) providing a guideline for various work packages to ensure consistent results that later fit together.

On the other hand, the Specific Use Cases focus on specific aspects in the development process respectively at specific phases/steps in the development process. They therefore complement the Main Use Cases such that a [more] “complete” picture with regard to timing

information can be developed. Furthermore, Specific Use Cases occur in the Main Use Cases frequently and/or are repeated in several steps of the development process.

Indeed, some of the Specific Use Cases have the entire development process in mind, but are limiting their view (scope) to a specific application respectively type of application (reactive, control).

Relationship between Main Use Cases and Specific Use Cases

When the Main and Specific Use Cases were reviewed they also have been associated to each other to get an idea on which specific use case “supports” one or more Main Use Cases – and of course to justify the existence of a specific use case.

For this purpose a relationship matrix has been created to present these dependencies. Figure 2 shows an excerpt of this relationship matrix. The idea behind this approach is to ensure that each specific use case is related to at least one main use case.

Role of the software tool Enterprise Architect

At the beginning of work package 1 the SPARX Systems Enterprise Architect UML Modeling Software has been chosen for recording and capturing all use cases.

For this purpose an Enterprise Architect Project file has been set up containing a package called “WP1 – Use Cases and Requirements”. This package is subdivided into two parts. One part is dedicated to use cases and is therefore called “Use Cases”; and in turn contains further packages each dedicated to Main Use Cases and Specific Use Cases as shown in Figure 5.

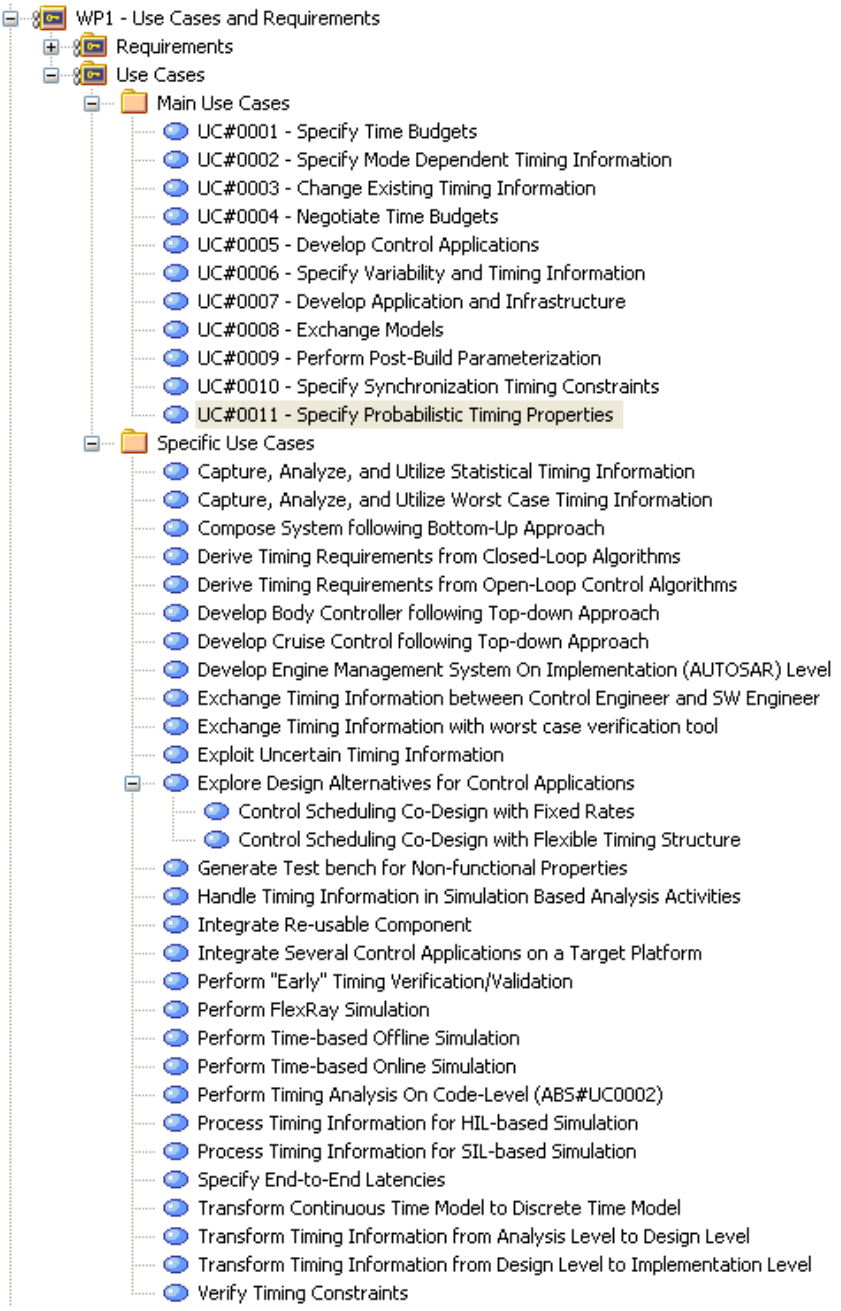

Figure 5: Structure of the package “WP1 - Use Cases and Requirements” dedicated to the work package 1. The sub-package called “Use Cases” is intended to contain all use cases obtained during the course of the work package 1.

Use Cases Document

For more details about the use cases refer to deliverable D1.2 [6].

7 State-of-the-Art Analysis

A state-of-the-art survey/analysis has been performed in the context of work package 1. The purpose of the state-of-the-art survey/analysis is to identify existing models, languages, and tools

available to solve problems arising in the domain of modeling timing requirements, constraints, and properties at various levels of abstraction and in different steps of the design process of automotive software-intensive embedded systems.

For more details about the state-of-the-art survey/analysis refer to deliverable D1.3 [7].

8 References

[1] Full Project Proposal Annex TIMMO-2-USE, TIMing MOdel - TOols, algorithms, languages, methodology, USE cases, Daniel Karlsson, Birgit Plaßmann, 2010-11-09, Version 3.0, TIMMO-2-USE Consortium.

[2] Specification of Timing Extensions 4.0.1, 2009-11-20, AUTOSAR Development Cooperation.

[3] EAST-ADL Domain Model Specification Deliverable D 4.1.1, 2010-06-30, ATESST2 Consortium.

[4] EAST-ADL Profile Specification, Internal Deliverable 4.1.1, 2010-06-30, ATESST2 Consortium.

[5] TIMMO-2-USE D1.1 Requirements, <*date*>, TIMMO-2-USE Consortium.

[6] TIMMO-2-USE D1.2 Use Cases, <*date*>, TIMMO-2-USE Consortium.

[7] TIMMO-2-USE D1.3 State-of-the-Art Analysis Report, <*date*>, TIMMO-2-USE Consortium.

[8] TIMMO-2-USE Models, Enterprise Architect Project file, <*date*>, TIMMO-2-USE Consortium.

[9] Getting Started with Enterprise Architect and Requirements, Version 0.12, 2011-02-07, TIMMO-2-USE Consortium.