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Project no.: 619209

Project full title: Analysis of Massive Data STreams

Project Acronym: AMIDST

Deliverable no.: D1.1

Title of the deliverable: General methodology for requirement analysis

Contractual Date of Delivery to the CEC:	31.07.2014
Actual Date of Delivery to the CEC:	31.07.2014
Organisation name of lead contractor for this deliverable:	AAU
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Participants(s):	P01, P02, P03, P04
Work package contributing to the deliverable:	WP1
Nature:	R
Version:	0.5
Total number of pages:	27
Start date of project:	1st January 2014 Duration: 36 month

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Abstract:

The General Methodology for requirements analysis document describes the requirements engineering process developed for the AMIDST project. The process adopts a use case-based approach to requirements engineering that is tailored to the specific characteristics of the AMIDST project. These characteristics include a pre-defined project scope, stakeholders from different industries, and the development of a general software framework that can be instantiated according to the needs of the stakeholders.

Keyword list: requirements engineering process, use cases, user groups, stake holders, requirements template.

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Document history

Version	Date	Author (Unit)	Description
0.3	1/6 2014	Sigve Hovda and Andrés Masegosa	First draft finished
0.5	4/7 2014	Sigve Hovda and Thomas D. Nielsen	First version of the document to be send around to the PSRG
1.0			

1 Executive summary

The General methodology for requirement analysis document describes the requirements engineering (RE) process that has been adopted in the AMIDST project.

There is a general lack of formal and agreed upon methods for conducting requirements engineering for smaller software projects like AMIDST. As a results, the AMIDST RE process is based on selected methodological approaches from existing general RE processes, which have subsequently been tailored to the specific characteristics of the AMIDST project.

The AMIDST RE process specifically addresses the need for a joint elicitation of requirements from use case providers coming from different industries that are geographically dislocated. This is partly achieved by the development of a template supporting a unified formal framework for requirements elicitation. This framework also provides transparency in the overall requirement engineering process and helps prioritize requirements and resolve potential conflicts across different domains.

The AMIDST requirements engineering process targets the use case providers requirements concerning the functionality of the AMIDST framework. Non-functional requirements to the framework are not covered by the process, and are therefore not part of the present document. Requirements of this type are, however, defined in the Description of Work document. This e.g. includes the requirement that the software should live beyond the project as well as provide support and encourage an open source strategy.

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2 Introduction

As projects differ in various ways, there is no common way to conduct the requirement engineering RE process [1]. It is therefore a reasonable strategy to search the literature for a RE process that is closely related to the project at hand.

In the AMIDST project, a first observation is that the project is very small in terms of man months assigned to development. Despite the fact that the field of requirement engineering RE has existed since the seventies, to our knowledge only two surveys have been conducted on RE for very small software projects with less than 10 developers; [2] and [3]. Based on these two studies, it is clear that RE processes in very small companies are more ad-hoc and that there seem to be little agreement on how to conduct the RE process in practice.

A second observation is that there exist a description of work that is agreed on before the RE process is started and that there exist an explicit date when the RE process should be finished. In practice, this limits the project from following a strict Agile approach [4]. In the Agile approach, a product owner is continuously renegotiating the requirements and the RE process is seen as a continuous process throughout the whole project. Paper [5] outlines how to incorporate requirement gathering in small Agile projects.

A third observation is that there is huge widespread of stakeholders in the AMIDST project and that the software is required to interface with three different softwares from three different companies. These are challenges that are usually associated with larger software projects. This motivates looking into the more general literature on RE processes, rather than the literature on very small projects.

Based on these three observations, we realized that finding a ready-to-use strategy for the AMIDST project would be very difficult. We therefore decided to take this one step further and identify more characteristics to the AMIDST project and motivate our choices related to the RE process based on these characteristics.

The report is outlined as follows. In section 3, the basic principles of requirement engineering are briefly outlined. Section 4 starts by describing the main characteristics of the AMIDST project, before the RE process is outlined. In section 5, we have described the realization of the process so far, before the report is concluded in section 6.

3 Basic principles in requirement engineering

The requirements engineering process typically ends up with a document containing a list of requirements for the system to be developed. This could, for instance, include what a software component must do or comply with. To date there is no common and agreed-upon definition of RE. Some definitions focus on the elicitation of requirements and therefore the interaction with the user, while others focus on the documentation or the specification. A definition that takes both foci into account is the IEEE standard [6],

which defines requirements analysis as

1. *The process of studying user needs to arrive at a definition of system, hardware or software requirements.*
2. *The process of studying and refining system, hardware or software requirements.*

In the context of understanding the RE process, a possible definition of a requirement is given in the IEEE standard [6]:

1. *A condition or capability needed by a user to solve a problem or achieve an objective.*
2. *A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification or other formally imposed document.*
3. *A documented representation of a condition or capability as in 1 or 2.*

This definition has a clear focus on the user, the system/system component and also which contract, standard or specification is needed to be met. Notice, that the requirement is related to *what* a system can do and not *how* it is done. We will adopt the same perspective in the present document.

3.1 Activities involved in requirement engineering

The activities involved in RE vary widely, depending on the type of system being developed and the specific practices of the organization(s) involved [7]. These may include:

- Requirements elicitation
- Requirements analysis and negotiation; checking requirements and resolving stakeholders conflicts
- Requirements specification; documenting the requirements in a requirements document
- Requirements validation; checking that the documented requirements are consistent and meet stakeholders needs
- Requirements management; managing changes to the requirements as the system is developed and put into use

These activities are sometimes presented as chronological stages although, in practice, there are considerable interleaving between them.

Anyone who has a direct or indirect influence on the process or the system to be developed is identified as a stakeholder. Stakeholders include end-users that will interact with the system, the developers that will maintain the system, management, domain experts, union representatives, etc.. A challenge in the RE process is therefore to keep a smooth communication between the different stakeholders. The use-case driven approach to RE focuses on simplifying the communication between the end-users and the developers to improve the overall communication.

3.2 Use-case driven requirement engineering

It can often be a challenge for the software industry to accurately communicate expectations about functionality to the future users of a software system. Moreover, this communication can be further hampered by the users not being able to accurately express what functionality they want. To improve on this communication, a use-case driven approach to requirements engineering was developed in the nineties [1, 8, 9]. A use-case focuses only on the interaction between a user and the system to be developed, and forms the basis for the requirements engineering where each requirement is associated with a use-case. This means that when specifying the use cases and requirements, the user is requested to only focus on what he/she wants. This is an advantage, compared to the traditional requirements engineering approach, where requirements are listed in relation to components or subcomponents in the software; an approach that often entails a degree of complexity that the user finds difficult to understand.

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A use-case consist of a list of steps, typically defining interactions between an actor and a system component, with the aim of achieving a specific goal; the actor can be either a human or an external system. An overview on how to write effective use-cases is given in [9], where several templates are presented. Common for these templates is that the users are asked to describe the use-cases in natural language and addressing the following questions:

1. Who are the actors involved in the use-case? An actor is either a person or an entity that interacts with the software.
2. What is the main event that initiates the use-case? This could, e.g., be an external business event or a system event that causes the use-case to begin. It could also be the initial step in a normal work flow.
3. What are the main user actions and system responses that will take place during the normal execution of the use-case?.
4. How can we evaluate the success of the use-case?

This dialog/question sequence will ultimately lead to accomplishing the goal that is implied by the use-case name and description.

Since different users may have different requirements to the functionality of the system, it is also common to define user groups that are expected to have similar types of interactions with the system. The users within a user group typically have the same profile and role within their organization and their set of competences are expected to be similar. This allows use cases and their associated requirements to be defined in relation to particular user groups.

In order to provide further insight into the use-case driven approach, it is useful to distinguish between functional and nonfunctional requirements. Functional requirements are those requirements that are directly related to the interaction between the user and the system. The nonfunctional requirements are hidden for the user and are more indirectly related to the overall success of the system. Nonfunctional requirements can, for instance, include scalability, trace-ability and test-ability. When use-cases are provided and functional requirements are identified, it is the requirement engineers responsibility to identify, document and communicate these nonfunctional requirements. The use-case driven approach to requirement engineering thus focuses on eliciting the functional requirements in collaboration with the users. This process supports and improves the communication between the users and the developers, because the focus is on what the users want and less on how the requested functionality can actually be achieved.

4 The AMIDST requirements engineering process

This section contains a description of the AMIDST RE process. We first describe the main characteristics of the AMIDST project that has influenced and shaped the requirements engineering process. Based on these characteristics we present the AMIDST RE process, which is based on the RE processes described in Section 3.2, but tailored to the specific characteristics of AMIDST. Since the focus of the requirements engineering process is on the functionality and documentation of the software products being developed, we will, e.g., not cover process-related requirements or non-functional requirements, c.f. Section 3.2. Non-functional requirements pertaining, e.g., to the open source strategy or the lifespan of the AMIDST software project are defined by the DoW framework.

4.1 Characteristics of the AMIDST project

In this section we identify and describe the key characteristics of the AMIDST project that directly influence the requirements engineering process.

Characteristics one: Pre-specified scope of the project

The AMIDST project is funded by the European Union's Seventh Framework Programme for research, technological development, and demonstration. The overall scope and main developments in the project are therefore defined from the beginning of the

project period and documented in the Description of Work. This will henceforth be referred to as the DoW framework. More detailed requirements pertaining to the functionality and documentation of the developed software should thus fit within the DoW framework, and their necessity in relation to AMIDST should be justified and demonstrated.

Characteristics two: Partners at different geographical locations

The AMIDST consortium consists of 7 partners/stakeholders, 4 industrial and 3 universities, which are situated in 4 different countries. This diverse consortium composition has at least a two-fold impact on the requirements engineering process.

First of all, although AMIDST targets the industrial stakeholders' common need for processing massive data streams, the more intrinsic aspects of the three industrial domains differ significantly. This, in turn, means that the partners will have different (possibly conflicting) requirements for the system being developed. To ensure that the requirements are comparable across domains and abide to the DoW, a unified formal framework for eliciting system requirements is needed. Such a framework may also provide transparency in the overall requirement engineering process and help prioritize requirements across different domains and thereby help resolve potential conflicts.

Secondly, with the project partners located in different countries, there is a need for a controlled and stringent requirements process in order to limit travel expenditures. This approach is supported by a unified formal requirements engineering framework. Consultancy and discussions in relation to the requirements will primarily be achieved through telecommunication conferences and by physical meetings only secondarily.

Characteristics three: Transfer of domain knowledge between partners

The industrial partners of the AMIDST project come from very different domains: the automotive, energy, and finance industry. To ensure the development, refinement, and completion of the unified formal requirements framework it is necessary with regular and structured communications among the project partners during the requirements engineering process. This not only relates to the specific requirements, but also to the software and user context in which the AMIDST framework should be deployed. The latter part, in particular, is required for a proper evaluation and validation of the elicited requirements.

Characteristics four: One framework for three different domains

The AMIDST system should define a general framework that can encompass the diverse domains of the three industrial partners. Thus, the format of the unified requirements framework should be sufficiently general and flexible to allow for all relevant requirements to be elicited for the three domains. At the same time the framework should be appropriately structured and formalized enabling a controlled elicitation process (see

also Characteristic two) with the requirements specified in a consistent manner making them comparable across domains. In order to also provide a basis for a controlled and balanced system development, the requirements should be linked to relevant project phases, work packages, and tasks. This, in particular, will provide the work package leaders with a clear overview of the requirements that are relevant for the activities in a specific work package.

Characteristics five: Potential refinement of project focus

AMIDST is a research project, where both the industrial and academic partners' understanding of the domains develop as the project unfolds. In order to support a potential refinement of the project's focus and goals, the requirements engineering process should allow for an internal (re)prioritization of the requirements that is transparent across application domains.

4.2 Project phases and AMIDST requirements identification

The overall project duration will be decomposed into different phases, each having distinct requirements. According to [10] a project's life cycle can be divided into three general phases: the design phase, operations phase, and disposal phase. The disposal phase is outside the scope of AMIDST and, thus, will not be considered in the present document. The design and operations phase, however, represent the temporal development of the project, and are initiated by the start of the project and ends with the testing of the deployed system. Each phase can furthermore be described as a collection of distinct stages in the project. The overall process is illustrated in Figure 1.

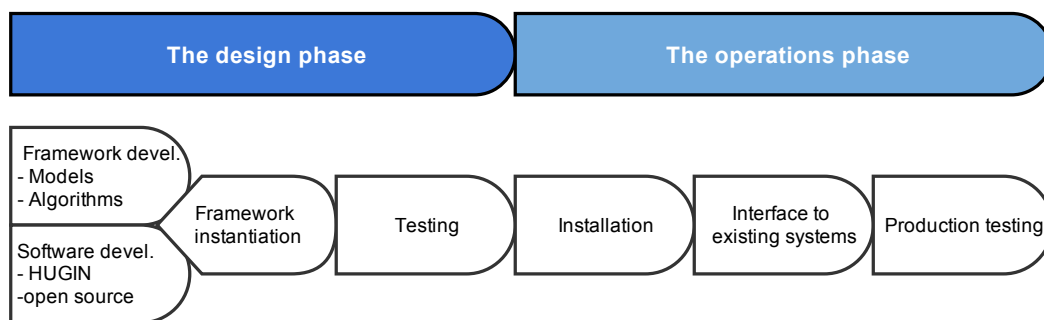


Figure 1: The figure shows the key stages in the design and operations phases. For the requirement specification, each requirement should be defined relative to one of these stages.

In the design phase general functionality requirements for the system is specified, i.e., what the system should do and support. Figure 1 details key stages inside this phase. The first stage consists of the design of the general framework (models and algorithms)

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as well as the design and development of the software tools. These stages are primarily related to Work packages 1–5. In the second stage, the general framework and software is instantiated for each specific use case. Finally, initial tests of the use case instantiated frameworks are conducted. During this phase of the project, possible design requirements could, e.g., address

- the scope of the model
- the interpretability of the learned models
- the extent and type of domain knowledge that can be integrated into the models
- prediction accuracy of the developed models
- documentation

The requirements for the operation phase concern the functionality of the deployed system. In Figure 1, we decompose this phase into three stages: installation, interface to existing systems, and production testing. The requirements for this phase could, e.g., address

- hardware constraints
- interfaces to existing software or data base systems
- inference functionality, i.e., what queries the system should be able to answer
- response time

4.2.1 Use cases and user groups in the requirements engineering process

As discussed in Section 3, a use case driven approach to requirements engineering puts emphasis on the functional requirements of the system, by focusing on the interactions between actors (this being either persons or other hardware/software modules) and the system. This focus is consistent with the general objectives of the requirement engineering process in AMIDST, and the use case-based approach to RE is therefore adopted in AMIDST. However, to obtain more well-defined requirements and establish a closer connection between the use cases and the project stages/work packages (c.f. Characteristics four), we further require that use cases should be specified as indivisible scenarios. Specifically, when defining the use cases, the industrial partners were informed that:

... a use case should ideally be indivisible. If a use case can be decomposed into multiple sub-use cases, each with a well-defined sub-objective relevant for AMIDST, then these sub-use cases should be described separately.

The requirements derived from a use case are typically specified in relation to a particular user or type of user (possibly another component of the system). In AMIDST the possible users have very diverse backgrounds, ranging from developers with an intimate knowledge of the key technologies embedded in the AMIDST framework to programmers and users working in marketing. In order to ensure that focus is on the future *users* of the system, the AMIDST requirements engineering process also adopts and identifies user groups (as described in Section 3), which will be explicitly linked to the relevant requirements.

4.3 The general AMIDST requirements engineering process

To ensure a sufficient amount of knowledge transfer between the partners (c.f. Characteristics three, Page 9), the overall requirement engineering process will be carried out in an iterative fashion that is expected to involve a high level of cooperation and interaction between the partners.

In Figure 3, inspired by [11], an illustration of the requirement engineering process for AMIDST is given. The process contains five phases, which are discussed below.

Preparation I: This phase starts at the same time as work package one and ends when the initial template, see Appendix A, for the requirement engineering document is finished. In this template, the requirement engineering process is outlined, including definitions of use cases, user groups, and how to link requirements with the stages and WP/tasks in the development process. In order to meet characteristic three, four and five, the use case providers are asked to provide a detailed description of the system context that the AMIDST software is expected to operate in, identify user groups, describe use cases and requirements. In order to meet characteristic four, the requirements are linked to their associated work packages and tasks.

Elicitation: The distribution of the above mentioned template marks the initialization of this phase. Its aim is to get an initial high-level description of the different use cases and their requirements. This information are specified by the use case providers in collaboration with the academic partners, thus addressing characteristic one, three and four. Once the use case providers return the present document with the requested information, feedback and informal meetings are expected to clarify and refine the information provided. At the end of the elicitation phase, the aim is to have a first coherent description of the requirements for each use case provider.

Prioritization: In this phase the use case providers complete and refine the document template used in the previous phase. This template explicitly links each of the requirements to the relevant work packages and tasks in the AMIDST project, thus providing an initial consistency check with the DoW framework (see Characteristic one). Moreover, the template allows the use case providers to give a fine grained prioritization of the relevant requirements for the AMIDST framework. Specifically, the use case providers are asked to rate each requirement in terms of whether it is a must, should, or could

requirement:

Must (be) These requirements are expected by the use case providers and include properties guaranteed in the AMIDST DoW framework.

Should (performance) These requirements are expected by the use-case provider, but are not explicitly agreed upon.

Could (delighters) Optional requirements that will often be satisfying to have.

This high-level prioritization scheme is inspired by the Kano model correlating product development with customer satisfaction, see Figure 2. Within each of these categories, the use case providers should also make a more fine-grained prioritization by numerically weighting the different requirements on a scale from 0 to 100.

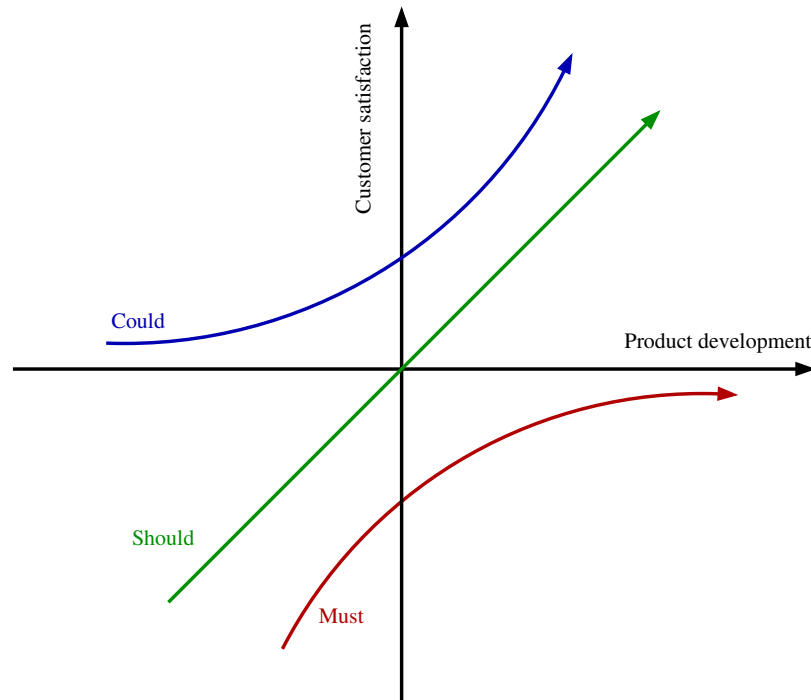


Figure 2: The Kano model.

Validation: In this phase, the requirements from all use-case providers are collected to get the *big picture*. This includes a discussion among the members of the science project review group as to the extent in which the requirements can be accommodated and whether they collectively produce any potential conflicts, either internally or in relation to the DoW framework. Revisions and negotiations of the detailed requirements are therefore expected. In this phase, it is important to ensure that Characteristic one is met.

Evaluation and Testing: In this phase, the focus is on the elicitation of the evaluation and testing procedures in the AMIDST project. This phase starts with the distribution of a new document template, where the aim is to obtain a high level description of the evaluation and testing methods that are necessary to measure the performance of the AMIDST framework. This phase is not strictly part of the requirements engineering process, but will supplement the process by providing detailed specifications of how to perform specific tests and evaluations. Documentation of this phase is out of the scope of the present document, but will be included in the initial version of the AMIDST handbook (Deliverable D1.3).

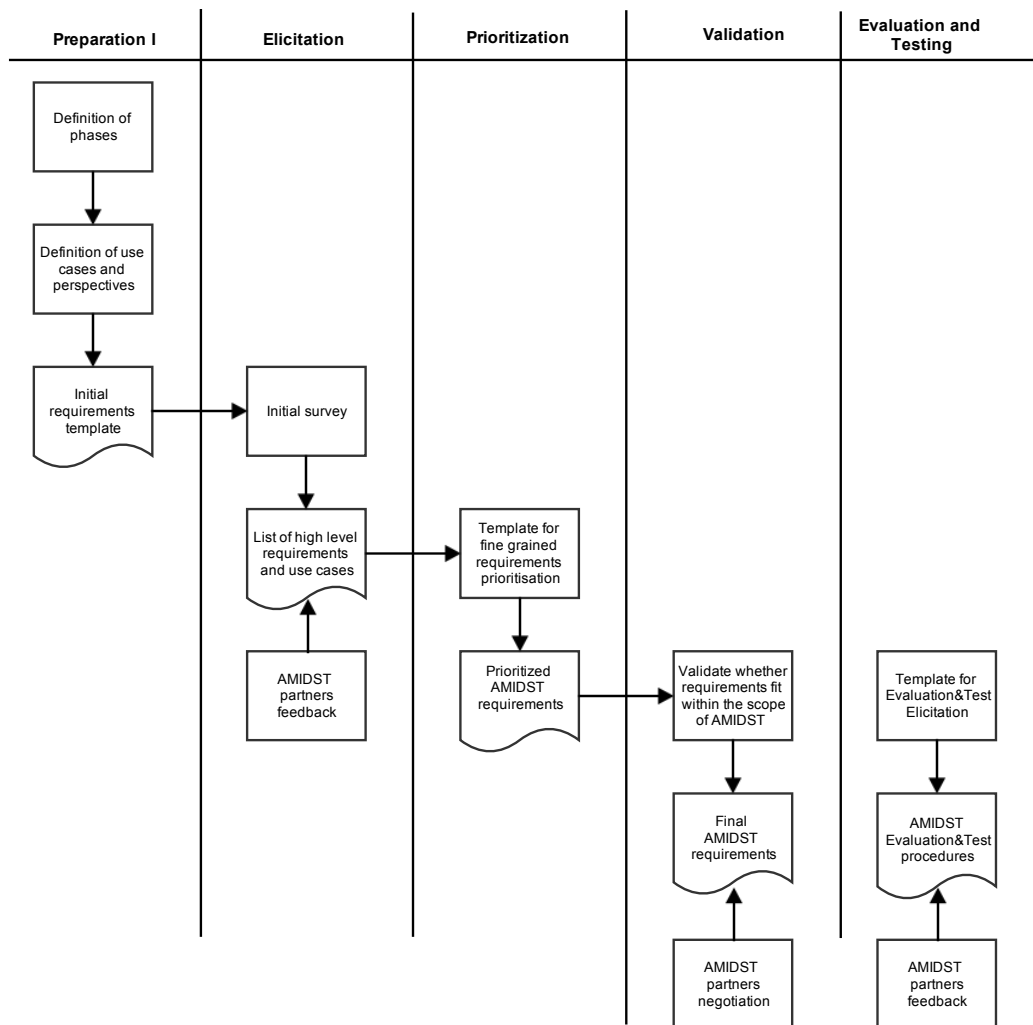


Figure 3: Description of the five phases in the requirement engineering process in AMIDST.

5 Realization of the requirements engineering process

The requirements engineering process was organized by coupling each use case provider with an academic partner; Verdande Technology was paired with NTNU, DAIMLER was paired with AAU, and CajaMar was paired with UAL. Hugin maintained a coordinating role. The particular partner associations were based on geographical as well as affinity considerations. It is important to stress that the requirements engineering process does *not* prescribe such a partner association, but it does bring distinct advantages. First of all, the academic partners can better assist the use case providers when completing the requirements template, and the ongoing internal communications and discussions (both formal and informal) provide an opportunity for early feedback on drafts of the requirements specification. Secondly, this division of work also provides an increased knowledge transfer between industrial and academic partners.

As described in Section 4 one of the design considerations for the requirements engineering process was to base the requirements specification on a formal template that would be shared by all three use case providers. In addition to the information that the use case providers are requested to fill-in, the template also provides a description of the overall requirements engineering process as well as guidelines on how to complete the template. A generic template can be found in Appendix A.

The completion of the templates were conducted as an iterative process with a close collaboration between the use case providers and the paired academic partners. In addition to the more formal deadlines marking transitions between phases in the requirements engineering process, we also introduced several short-term deadlines, where the use case providers were given feed-back on draft versions of their completed templates. Not only did this serve as an instrument to ensure a continuous progression in the requirements specification, where misunderstandings and problems could be identified and mitigated at an early stage, but it also provided an early transfer of knowledge from the industrial partners to the academic partners in the project. Part of this (otherwise tacit) knowledge were documented for the benefit of the other partners, both current and future, in the consortium, and is expected to be included in the deliverables planned for Work packages 6–8. This, e.g., includes a description of the data characteristics for the use case providers.

The specified requirements (identified by a unique label as described in Appendix A) together with their work package/task allocations and prioritizations will be summarized in tables at the work package level. These tables allow work package leaders to get a clear overview of the specific requirements that need to be taken into account in the different work packages. An example of a part of such a work package requirements table can be found in Table 1, which includes some of the presently collected requirements pertaining to Work package 2.

Req. ID.	Relevant subphase	Must/should/could	Points	Task
DAI.U5.D1	Framework devel. & instan.	Should	20	2.2
DAI.U5.D2	Framework devel. & instan.	Should	20	2.2
DAI.U5.D3	Framework devel.	Should	15	2.2
DAI.U5.D4	Framework devel.	Should	15	2.2
DAI.U5.D4	Framework instant.	Should	20	2.2
DAI.U7.D1	Framework devel.	Must	35	2.1
⋮	⋮	⋮	⋮	⋮

Table 1: The work package requirements table containing the presently collected requirements for Work package 2.

6 Conclusion, observations and reflections

This document describes the requirement engineering process pursued in AMIDST. The general process is adapted and based on previously described approaches to requirements engineering, but tailored to the specific needs and characteristics of the AMIDST project. In particular, the idiosyncratic aspects of the AMIDST project that combined distinguishes it from other software projects at the requirements engineering level, include (i) a pre-defined project scope, (ii) many different stakeholders, and (iii) the development of a sufficiently general software framework that can be instantiated for use case providers representing different industries. Central to the requirements engineering approach is the use case concept that forms the basis for the requirements specification. The actual specification is document in a generic formal template that allows for the elicited requirements to be compared and prioritized across domains.

The division of work realized in the AMIDST project was partly successful due to the natural coupling (geographical and affinity based) between the industrial partners and the academic partners. This type of work division may not be achievable in projects with a larger number of partners or where the partners are not geographical co-located. On the other hand, it should also be emphasized that this division of work is *not* as such prescribed by the proposed requirements engineering process.

FiXme: For a possible publication, we could report on our (including the use case providers') experiences with the process, but since we are not yet finish with the RE process there is not that much to report ...

References

- [1] Pohl, K.: Requirement Engineering - Fundamentals, Principles and Techniques. Springer-Verlag (2010)
- [2] Quispe, A., Marques, M., Silvestre, L., Ochoa, S.F., Robbes, R.: Requirements engineering practices in very small software enterprises: A diagnostic study. In: Proceedings of the 2010 XXIX International Conference of the Chilean Computer

- Science Society. SCCC '10, Washington, DC, USA, IEEE Computer Society (2010) 81–87
- [3] Aranda, J., Easterbrook, S., Wilson, G.: Requirements in the wild: How small companies do it. In: Proceedings of the 15th IEEE Requirements Engineering Conference. (2007) 39–48
 - [4] Dingøy, T., Dybå, T., Moe, N.B.: Agile Software Development: Current Research and Future Directions. Springer (2010)
 - [5] Kavitha, C.R., Thomas, S.M.: Requirement gathering for small projects using agile methods. IJCA Special Issue on Computational Science - New Dimensions & Perspectives (3) (2011) 122–128
 - [6] The Institute of Electrical and Eletronics Engineers: IEEE standard glossary of software engineering terminology. IEEE Standard (September 1990)
 - [7] Sommerville, I.: Software Engineering. Addison-Wesley (2011)
 - [8] Jacobson, I.: Object Oriented Software Engineering: A Use Case Driven Approach. Addison-Wesley (1992)
 - [9] Cockburn, A.: Writing Effective Use Cases. Addison-Wesley Professional (2001)
 - [10] Eigner, M.S.: Product Lifecycle Management. Springer-verlag (2009)
 - [11] Ebert, C.: Systematisches Requirement Engineering. Dpunkt Verlag (2010)

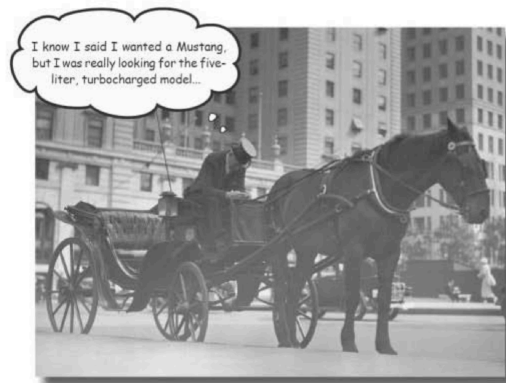
A Formal framework for requirements elicitation

Requirements analysis and evaluation procedures: *[use case provider]*

Introduction

The requirement engineering phase is a key step of the project. To develop the right system that satisfies the needs and expectations of the users, computer scientists need to have a complete understanding of the requirements. Past experiences indicate that determining the requirements can be a very hard task. Many factors contribute to that:

- Computers scientists and domain experts usually speak “different languages”, due to very different backgrounds.
- Users of the system usually do not have a clear idea about the true requirements at the beginning of the project. This is mainly because they are considering a new system that does not yet exist. As usual, there will be many new, and previously unconsidered, requirements in later phases of the project.
- Computer scientists usually have their own ideas about how the system should work and this biases their understanding of the requirements.
- Different users of the system usually have different requirements. Common misspecifications are due to this problem.
- The existence of different contexts in which the system will be used might also affect the requirements and need to be considered.



D. Pilone, R. Miles “Head First Software Development”. O’Reilly.

[Mustang is either a famous sport car brand or a free-roaming horse]

The requirements engineering process in AMIDST

The overall requirement engineering process will be carried out in an iterative fashion that is expected to involve a high level of cooperation and interaction between the partners. During this process the document for the requirements analysis will be gradually refined and expanded. Below is a description and an illustration of the expected requirements engineering process within AMIDST. The overall process is divided into the following phases:

1. **Preparation I.** This phase started with Work package 1 and the collection of data characteristics.
 2. **Elicitation.** The distribution of the present document/template marks the initialization of this phase. Its aim is to get an initial high-level description of the different use cases and their requirements. This information should be specified by the use case providers (in this case Daimler). Please, consider that the use-cases and requirements (*which should be within the scope of AMIDST*) are the ones that will be addressed in the project. Once the use case providers return the present document with the requested information, we expect to provide feedback on the submitted information in order to refine the information in collaboration with the use case provider. At the end of the elicitation phase, we aim to have a first coherent description of the requirements for each use case provider.
 3. **Prioritization.** In this phase the use case providers should complete an extended version of the document template used in the previous phase. This template will firstly be used to link each of the requirements to the relevant work packages and tasks in the AMIDST project. Moreover, the template will also allow the use case providers to provide a more fine grained prioritization of the relevant requirements for the AMIDST framework.
 4. **Validation.** In the last phase we will collect the requirements of the three use-case providers to get the “big picture”. We will then discuss to what extent the requirements can be accommodated within the project. Revisions and negotiations of the detailed requirements may therefore be necessary.
 5. **Evaluation and Testing.** In this phase, focus will be on the elicitation of the evaluation and testing procedures that are going to be used in the AMIDST project. This phase starts with the distribution of a new document template. Its aim is to obtain a high level description of the evaluation and testing methods that will be used to measure the performance of the AMIDST framework in relation to the use cases elicited in the previous phases.
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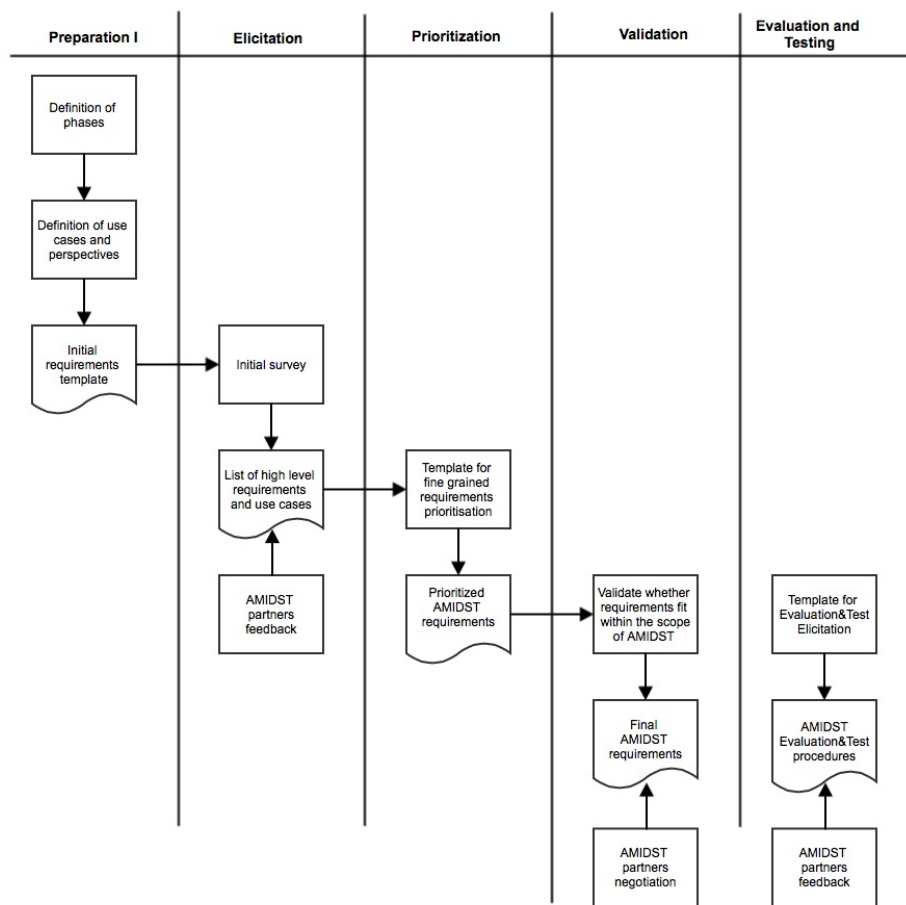


Figure 1: Requirements engineering process within AMIDST.

It is important to emphasize again that the requirement for the use case providers obviously need to be aligned with the AMIDST objectives. Hence, when specifying the requirements it is important to also justify and demonstrate their necessity in relation to AMIDST.

[Use case provider]: System context

Please describe the context for the AMIDST framework for this application domain. In particular, describe relevant aspects of existing systems that can influence the requirements for the AMIDST framework and its future impact.

User groups

At this point we will try to identify the different user groups *within your organizations* that will use the developments of the ADMIST project. The potential user groups in the AMIDST project are very diverse, ranging from active AMIDST partners with intimate knowledge of the AMIDST framework to users in the organizations not directly involved in the AMIDST project.

The issue here is to identify those user groups that may have different requirements and needs for the system. It is therefore important to identify and characterize these different user groups, because each requirement may be targeted to a specific user group.

As inspiration, for *[Use case provider]* we could tentatively envision (at least) three user groups:

- **User Group 1:** *[Insert example of hypothetical user group]*
- **User Group 2:** *[Insert example of hypothetical user group]*
- **User Group 3:** *[Insert example of hypothetical user group]*

Please, include the information for each user group in a table as the one provided below:

User Group 1: *[Name of user group]*

User Group 2: *[Name of user group]*

User Group 3: [Name of user group]**AMIDST use cases**

The requirements for AMIDST are intrinsically related to the usage of the AMIDST framework. To simplify the requirements engineering process and provide a context for the individual requirements, we need to characterize the general use cases that both the AMIDST framework and the deployed system should address. In order to support this process it is important that the use cases are within the scope of the AMIDST project and does e.g. not focus on possible future unplanned extensions and integrations of the AMIDST framework.

A **use case** is typically a list of steps or actions that define the interactions between an *actor* and an AMIDST framework or system in order to achieve a certain objective. The term actor should be considered in a broad sense and can e.g. refer to an actual user or a software module in DrillEdge. When specifying each use case, try to answer to the following questions:

1. Who/Which are the actors involved in the use case? An actor is an external person or entity that interacts with the AMIDST framework. If the entity is a person, please indicate which user group s/he belongs to.
2. What is the main event that initiates the use case? This could e.g. be an external business event or a system event that causes the use case to begin, or it could be the initial step in a normal work flow.
3. What are the main user actions and system responses that will take place during the normal execution of the use case?. This dialog sequence will ultimately lead to accomplishing the goal implied by the use case name and description.
4. How do you evaluate the success of a use case.

Please, consider that a use case should ideally be indivisible. If a use case can be decomposed into multiple sub-use cases, each with a well-defined sub-objective relevant for AMIDST, then these sub-use cases should be described separately.

In order to indicate the relative importance of the use-cases, please assign points (between 0 and 100) to each use case so that the sum of all assigned points is 100.

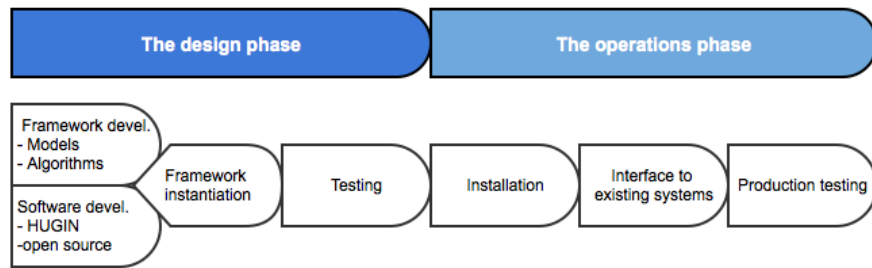
Use Case 1: [Name of use case]**N. of Points: XX****Use Case 2: [Name of use case]****N. of Points: XX****Use Case 3: [Name of use case]****N. of Points: XX**

Use-case requirements

Based on the identified use-cases and user groups, we will in this section elicit the general system requirements. The main question that we try to answer here is: what should the software be able to address in relation to the previously detailed use-cases?

In order to structure the requirements we are going to follow Kano's model¹, which is a standard methodology to determine product and service requirements. We will also ask you to specify the requirements for the system at two different stages of the development process: *design/model development* and *operations*. Please again keep in mind that all requirements should be described considering the scope of the AMIDST project.

¹ Look at http://en.wikipedia.org/wiki/Kano_model for further information about this method.



For the *design stage* we look for general functionality requirements for the system, i.e. what the system should do and support. In the above figure, we detail key steps inside this phase. The first step consists of the design of the general framework (models and algorithms) as well as the design and development of the software tools. In a second step, the general framework and software will be instantiated for each specific use case. Finally, initial tests of the use case instantiated framework will be conducted.

At this design phase, possible design requirements could e.g. address

- the scope of the model
- the interpretability of the learned models
- the extent and type of domain knowledge that can be integrated into the models
- documentation
- etc.

The requirements for the *operation phase* concern the functionality of the deployed system. In the above figure, we decompose this phase into three stages: installation, interface to existing systems, and production testing. The requirements for this phase could e.g. address

- hardware constraints
- interfaces to existing software or data base systems
- inference functionality, i.e., what queries the system should be able to answer

When specifying the requirements, try to think in each one this stages and define the requirements in relation to each of them.

Please specify each requirement concisely, using no more than one or two sentences. If you find this difficult, it might mean that the requirement should be

split into smaller entities. Moreover, please indicate which use cases and user groups that are associated to each requirement. Additionally, for each requirement, please classify it as either must, should, or could:

- **Must:** These requirements include properties guaranteed in the AMIDST description of work document.
- **Should:** These requirements could be expected by the use-case provider, but is not explicitly agreed upon.
- **Could:** Optional requirements.

When filling the tables, please consider the following points

- Each requirement should be labeled in the following way: a unique identifier containing the name of the partner (i.e. "DAI", "CAJ" or "VER") followed by an identifier of the corresponding use case (from 1 to n) and, also, by an identifier of the requirement ("D" for design requirements and "O" for operations). For example DAI.U4.O2 refers to the second requirement from Daimler for the use case 4 in the operation phase.
 - Each requirement should be linked to the work package and task in which it is involved. I.e., we should identify which part of the AMiDST project (work package and task) will address the requirement. If we do not find a clear place where the requirement can be located, this might indicate that this requirement falls out of the scope of the project.
 - With the aim of providing a fine grained prioritization, each requirement should be scored with a number between 0 (lowest priority) and 100 (highest priority) in such a way that all requirements in the same table and within the same category ("Must", "Should" or "Could") have to sum up to 100 points. For example, you should distribute 100 points among the "Should" requirements of the design phase for Use Case 1.
-

Use Case 1						
Requirements Operation Phase						
ID	Relevant Subphase	Description	Must/Should/Could	Points	Work Package	Task