A methodology for eliciting requirements in context-aware systems

Dear developers,

We have been developing a requirements elicitation methodology specific to context-awareness (R4C-AS) which involves the identification of "situations of interest" through the needs and preferences of users. We would be very grateful if you could take the time to complete this exercise and questionnaire, which we have tried to keep brief. By doing this, you will significantly help us to assess this methodology.

In Section 1 we will shortly highlight the essentials of the methodology, illustrating it with the POSEIDON Navigation Application case studio. The aim is to get you familiarized with how the methodology is used for identifying the different stakeholder goals, needs and preferences. Then, Section 2 explains how to elicit requirements for the context-awareness part of the navigation application. During this section, we will explain the methodology step by step, asking you to complete an exercise in each of the steps. The methodology is divided in three steps. It will make you think about the situations of interest related to the POSEIDON Navigation Application.

Finally, we will ask you a couple of questions about your experience using the proposed methodology.

Thank you in advance for participating.

1 Introducing the first stages of the methodology

The first aim of the methodology is to identify the stakeholder goals, preferences, needs and activities. The initial stages of the methodology can be described as a form of workout model, illustrated by Figure 1, whereby we introduced six core requirements gathering categories against which dedicated requirements elicitation activities proceed. They are not meant to be mutually exclusive or follow a synchronous process flow. Rather, they can take place concurrently/iteratively and are covered by two further activities that play a vital role: "operational support" and "harmonisation". The first one is intended to determine technical support requirements for all aspects of the operational load: Delivery/set-up, customization training, system monitoring, review and potential upgrade requirements. The second one involves managing the overall requirements process and requirements specifications (including future review), particularly with the reference to a multi disciplinary team that may or may not be distributed across different centres. In order to illustrate the explanations, we will follow the example of the POSEIDON Navigation application. The reader has to understand that the activities described in this section are meant to be iterative, and do not follow a linear process. They all influence each other in an iterative manner. Please take a few minutes to have a look at Figure 1.
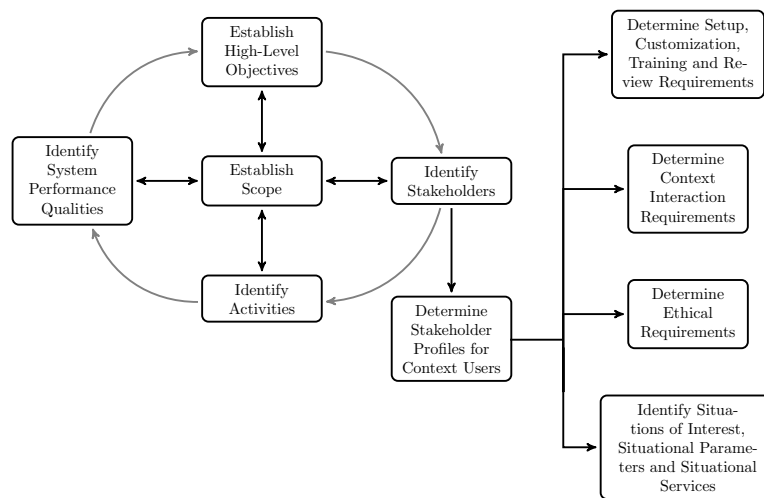

Figure 1: Simplified figure describing the main stages of the methodology.

1.1 Establish Scope and High-Level Objectives

These activities essentially refer to the initial stages of the requirements gathering phase during which "blue skies" thinking will be encouraged. The aim is to specify the main objectives of the project so that all parties understand them. When it comes to establish the scope, the purpose is to determine the system boundaries. The developers decide what the system can and cannot do, specifying what is inside it and immediately external to it. As shown in Figure 1, establishing the scope is an activity affected by the main iterative circle. Table 1 shows an example of the scope and the high-level objectives for the Navigation Application example.

Scope	High Level Objectives
Mobile Application	Foster the independence of people with Down's Syndrome when displacing outdoors
Based on a maps	
With tailored notifications to guide users depending on the context	

Table 1: Scope and High-Level objectives in the example of the Navigation Application

1.2 Identify Stakeholders & Profiles

The following step is to identify the stakeholders of the project. Table 2 illustrates the stakeholders involved in the Navigation Application.

Stakeholder	Description
Primary Users	People with Down's Syndrome
Secondary Users	Parents or carers of people with Down's Syndrome
Tertiary Users	Teachers or supervisors of people with Down's Syndrome
Calls Provider	Company that provides phone calls and SMS to the mobile device
Internet Provide	Company that provides internet to the mobile device
Device Manufacturer	Company that manufactures the device
Operating System Developers	Group involved in the development of the operating system of the device
Maps Library Developers	Group involved in the development of the maps libraries

Table 2: Stakeholders involved in the example of the Navigation Application

1.2.1 Identifying Stakeholder Profiles

For completing this activity there is a need to create different profiles of stakeholders in order to have a better perspective on what services can be offered by the system. The reader should bear in mind that not all the stakeholders will require context profiles. In order to identify different profiles that there might arise, there is a need to identify the requirements for a certain stakeholder by using the following four sub-activities:

1. *Set-up, customization, train, monitor the system and review its use:* It is about determining the technical support a specific profile will receive. Examples of these requirements can be: 1) When live, maintainability should be such that the time to get system restored after major failure (such as fire at a server location or database corruption due to server failure) is less than 1 day; 2) When live, technical support should be available; 3) When live, first set up time by supplier should be less than 1 hour; 4)When live, system upgrades should be achieved in less than 2 hours

2. *Interaction design issues:* The context interaction requirements for the primary and secondary users. Psychological questionnaires can be used to assess individual skills (cognitive, physical and perceptual). In addition, prototyping will be a key approach to ensure the context interactions are carried out and work as intended.

3. *Ethical requirements:* It is about determining the ethical requirements for a specific profile. This is done by using the e-FRIEND framework, which consists in the following principles:
   - Deliver help according to the needs and preferences of those who are being helped
   - Preserve the privacy of the users

- Prioritize safety of the users all times

- Adhere to the strict principle that the user is in command and the computer obeys

- Working for the social benefit of users and not developing any system that will cause harm to them

- Users exercise control over monitoring, tracking and recording activities

- Comply with relevant data protection legislation

- Building appropriate and adequate security

- Provide users to take control over the actions of the system

- Have transparency in what regards to the positive and negative ways in which a service can affect their lifes

- Equality and dignity and inclusiveness of provision

4. *Identify Situations of Interest, Situational Parameters and Situational Services:* It is related to identifying the situations in which the system can provide services, using the information about the profiles and the activities of the different stakeholders. This sub-activity is further explained in Section 2.

1.3 Identify Activities

During this stage the aim is to determine the activities that stakeholders perform in they daily lives, in order to identify how can the system assist them in those activities. The process can be supported by scenario-based methods. For example, Figure 2 illustrates the activities that are generally involved when moving from one place to another by bus.
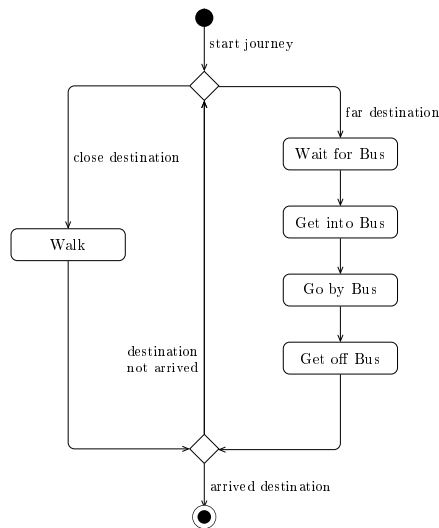

Figure 2: Main activities involved in displacements by bus.

1.4 Identifying System Performance Qualities

System Performance Qualities are related to the gathering of requirements that can be used to judge the operation of a system, describing how it has to work, rather than citing specific behaviours which describe what the system should do. This idea is similar to the classical non-functional requirements, but it explicitly considers them as quality attributes, recognizing that they could stem from functionalities of the system. The process can be supported by analysing the high-level objectives as it can be observed in Table 3.

Stakeholder	Goals	Sub-Goals	Requirements
Primary User (PU)	Increase their independence from SUs when moving from one place to another (outdoors)	Guide the PUs through reminders of what they need to do next	Receive instructions that are able to understand, taking into account possible visual and auditive insensitivities
Secondary User (PU)	Reduce the attention that PU require on them when they are moving from one place to another (outdoors)	Show the SU that the PU is safe	The system enables the communication between PU and SU any time.
		Show the SU that the PU is doing what s/he is meant to do.	The SU can know where the PU is.
			The SU can know when a PU has finished a task.

Table 3: An example of how to identify system performance qualities by using the high level objectives of the stakeholders.

2 Identifying situations of interest, situational parameters and situational services

In this subsection we will be using the following concepts:

- Situation of Interest (SoI): Circumstance in which the system can potentially offer a situational service.

- Situational Service: A system functionality that is triggered in a certain circumstance and is directly or indirectly related to the preferences and needs of the stakeholders in that specific circumstance.

- Situational Parameter: Is a measurable factor forming one of a set that can identify a certain situation of interest.

During the previous stages of the methodology, the aim is to identify the stakeholder activities, goals and needs. This information eases the identification of Situations of Interest (SoI). The first step is to analyse the previously identified activities of the stakeholders in order to discover different SoI. The process can also be complemented by scenario based techniques. The SoI do not have to be relevant to all the stakeholders. They might be relevant only for one of them or even to a single stakeholder profile. The concept of SoI, enables a deeper analysis on: 1) how the situation is going to be detected (Figure 3-a) and 2) what actions can the system take in those situations (Figure 3-b).
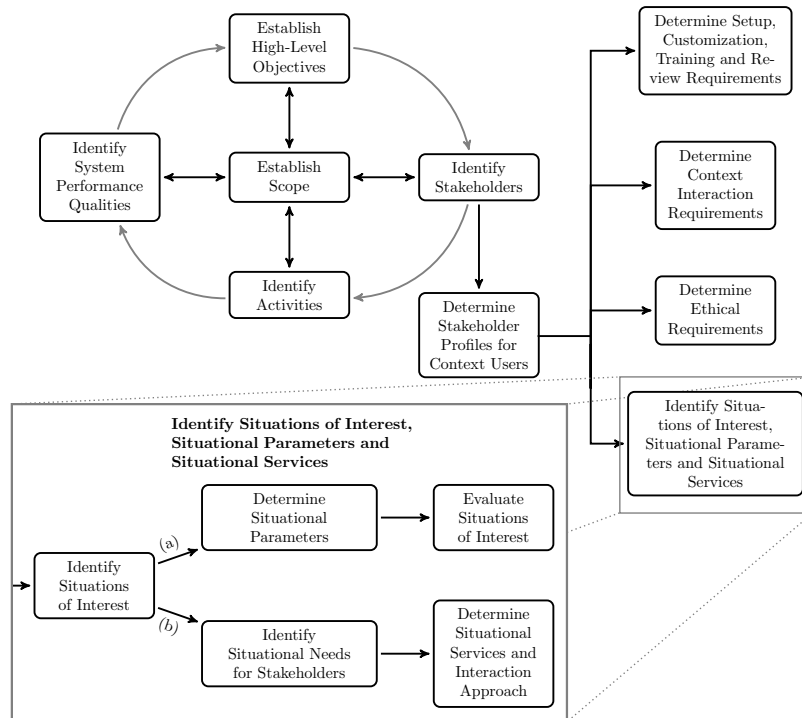

Figure 3: Simplified figure describing the main stages of the methodology.

2.1 Identifying Situations of Interest

The first step inside the extension is to use the knowledge obtained in previous stages for identifying Situations of Interest (SoI). During this stage scenario based techniques can be used. We will illustrate the example by using the activities identified in Figure 2 from Section 1.3 about displacements by bus. Table 4 resumes the situations of interest in that example.

Activity	Situation of interest
Waiting for bus	The user has just arrived to the bus stop
	The bus arrives to the bus stop

Table 4: Situations of Interest for the "Waiting for bus" activity from Figure 2.

2.1.1 EXERCISE A

Try to think about situations of interest for the "Going by bus" activity from Figure 2. We have left some blank space for you to complete the exercise. Draw a table similar to Table 4.

2.2 Identifying Situational Services

Once the situations of interest have been identified, the first step is to think about the needs of the stakeholders in those situations. This can be complemented by the information gathered about the stakeholders in previous stages as well as by the use of questionnaires. The next step is to determine which services or functionalities will be executed in each of the identified situations, taking into account the preferences and needs of the stakeholders (Figure 3-b). Once the service is identified there is a need also to define how the service will interact with the specific profile of users. There are two ways in which a service can be provided: A) Active, where the system changes its content autonomously; B) Passive, where the user has explicit involvement in the actions taken by the system. For example by asking permission for a service to execute, or showing a list of options. Table 5 illustrates the situational services and their interaction with the users that can be provided in some of the situations of interest identified.

Activity	Situation of interest	Situational Need	Situational Service	Interaction Type
Waiting for bus	The user has just arrived to the bus stop	Know how much time PUs have to wait	Notification showing the time remaining for the next bus	Active
	The bus arrives to the bus stop	Know if the bus is the one that the PUs need to embark	Notify the user if the bus that just arrived is the one to embark	Active

Table 5: Situational services and interaction types for the situations of interest identified in Table 4

2.2.1 EXERCISE B

Using the situations of interest identified in EXERCISE A, try to determine the situational services of the Navigation Application. We have left some blank space for you to complete the exercise. Draw a table similar to Table 5.

2.3 Identifying Situational Parameters

After the identification of the SoIs, the requirements engineers need to agree upon which parameters could make the system detect a certain SoI. First, a text based description on how the system will detect that situation will be provided. Based on this, the situational parameters will be identified which at the same time provide information about the sources of information that the system will use to identify such situation. The use of descriptions and parameters enables the participants in the project to communicate among themselves using a language that can be understood by all, without describing the inner workings of the system. The next step, as it can be observed in Figure 3-a, is to evaluate the feasibility of the system identifying the SoIs. For this purpose, there is a need to perform a preliminary evaluation of how the system is going to measure the different parameters, trying to identify their source. This evaluation has to be done for each of the SoIs identified. The idea is to perform a light analysis that can help to evaluate, until a certain extent, the feasibility of the system detecting a SoI. During this evaluation some situations of interest might be discarded if requirements engineers consider the situation not worthy to implement for different reasons. The reasons could be (among others): 1) A considerable error in the way the SoI is detected; 2) The cost of the implementation versus the value added by the system taking the actions proposed in those situations. The objective of this evaluation is not to accurately determine all the possible sources but to make engineers think about the feasibility of implementing what they are proposing. A deeper thought about the sources of each parameter will happen in further stages of the design. Rejecting to implement a SoI at requirements elicitation stage of the development can save time and money. The later the team realizes that a situation can not be implemented the higher the costs will be. Table 6 gives an example of the parameters and sources for the Navigation Application example.

Activity	Situation of interest	Identification Description	Situational Parameter	Source
Waiting for bus	The PU arrives to the bus stop	The PU Location coincides with the bus stop location	PU Location	PU Mobile Device's Coordinates
			Bus Stop Location	Bus Stop Coordinates
	The bus arrives to the bus stop	The time is approximately the time when the bus was scheduled to come	Bus Arrival Time	Bus Line Arrival Time Schedule
			Current Time	PU Mobile device's time

Table 6: Some situational parameters and their sources for the Navigation Application example

2.3.1 EXERCISE C

Using the situations of interest identified in EXERCISE A, try to determine the description on how the system is going to identify the situation, the situational parameters and their sources. We have left some blank space for you to complete the exercise. Draw a table similar to Table 6. Also write about your thoughts about the feasibility of making the system detect these situations of interest.