

# Requirement Engineering for Mobile Information Systems

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**Abstract** Requirements Engineering for business solutions have so far primarily dealt with the elicitation, specification, validation, management and change to information systems to be accessed through PCs and workstations. As mobile solutions are applied in more and more situations, additional challenges will meet those that specify the requirements to the applications running on mobile technology. This position paper summarises some of these challenges, and points to areas for research that should receive the attention of the RE community.

## 1 Introduction

Today the PC is only one of many ways of utilising information resources. On one hand the technology is becoming more mobile and ubiquitous, and on the other hand the medium is becoming richer as in interactive TV. This will influence the usage of information resources: Outdoors, away from home or business alone with my personal information appliance, or together with others in front of large, interactive TV screens.

Mobility is perhaps the most important market and technological trend within information and communication technology (ICT). For instance, it is projected that in 2004 there will be more mobile devices than PCs connected to the Internet. With the advent of new mobile infrastructures providing higher bandwidth and constant connection to the network from virtually everywhere, the way people use information resources is predicted to be radically transformed.

## 2 Characteristics of Mobility and Mobile Information Systems

Mobility is primarily about *people* moving around, having wireless access to information and services. Secondly, mobility relates to all sort of things in the

environment (parcels, cars etc.) with the possibility to interact with other devices and in this way influence the flow of work of the people interacting with these devices.

Knowledge workers in any business area are getting increasingly mobile. Such workers will be required to act flexibly within the constraints of the business processes of the company (or companies) they are currently working for. At the same time they will often want to use the same information technology to support their private tasks as they use professionally.

The mobile user is characterised by frequent changes in context, given by:

- The *spatio-temporal context* describes aspects related to the time and space. It contains attributes like: time, location, direction, speed, shape, track, place, and the social arena.
- The *environment context* captures the entities that surround the user, e.g. things, services, temperature, light, humidity, noise, persons, and networks.
- The *personal context* describes the user state. It consists of the physiological context and the mental contexts. The physiological context may contain information like pulse, blood pressure, weight, and hair colour. The mental context may describe information like mood, expertise, anger, and stress.
- The *task context*. This context describes what the user is doing. The task context may be described with explicit goals, tasks, and actions. A user is often involved in a large number of processes is she involved in at the time
- The *social context* describes the social aspects of the user context. It may, for instance, contain information about friends, neighbours, co-workers and relatives. The role that the user plays is an important aspect of the social context. A role may describe the user's status in this role and the tasks that the user may perform in this role. A role may be played at a social arena that usually is described by a name such as "at work" and is related to a geographical area.
- The *Information context* – The part of the global and personal information space that is available

Whereas many of the workers that so far have been equipped with early (GSM-based) versions of mobile information systems have been supported in well-defined work process with a limited need for data-transfer when doing mobile work (see e.g. [3]), the situation for knowledge workers such as consultants, reporters, and researchers is less predictable. Typically they will have many concurrent tasks, and will be interested in a lot of different information there and then, much of which can not be anticipated fully beforehand. There might be a need for learning on the fly, but also for capturing interesting situations to feed back to the organisation supporting the knowledge management and learning processes for a larger part of the organisation.

Mobile information systems differ from more traditional information systems in several ways:

- So far there is only a limited convergence towards a common user interface standard for mobile information appliances
- Mobile information appliances are weak compared to traditional end-user equipment (vs. memory, bandwidth etc.)

- Small input and output devices (e.g. small screens and keyboards)
- Converging functionality from many existing platforms.
- New security aspects arises, since the boundary of the organisation using such systems are no longer defined to physical locations.
- People are supposed to be able to (and are meant to) use the system under all sorts of conditions, not only in connection to a well-defined usage (office) environment.
- They are always immediately available for use

## **2.1 Research Challenges and Practical Issues in Connection to Requirements Specification for Mobile Information Systems**

In connection to requirement specification for mobile and ubiquitous information systems, we can differentiate between two situations:

- Specification of particular applications within a more or less pre-defined organisational setting (e.g. support of mobile case processing for a building or ship inspector).
- Specification of systems that to a large extent are meant to interact with other systems in an unpredictable manner.

As will be seen below, it is the last situation that appears to bring in the majority of new aspects. On the other hand, users will like to use their work specific applications in concert and thus these kind of issues will be relevant in most major system development tasks to some extent.

Developments within mobile information system foster new user groups, asking for new services to be utilised in quite new environments. Even if our main focus here is the professional scene, today ICT is not only used in the working place, but also by children, youths, adults and elderly at school, at work, at home and at leisure. There is also an increasing political awareness that everybody has a right to take advantage of this new development. Consequently the new services offered through these new technologies, are not only tasks restricted to *work situations*, but are also *entertainment services, stimulation and new experiences, exploration, games, and interpersonal interactions*. As pointed out by Souttar [7] this situation challenges the traditional usability approaches:

- Analyses: How to collect and analyze the need for a new service - need for fun, need for mobile service, need for social enrichment etc.
- Requirement specification: The needs collected have to be transformed to requirements, which could be used for design and evaluation. How is a fun service specified, how is a social enrichment service specified?
- Evaluation: New aspects, new users and other environments call for different evaluation methods. What shall we measure and how can we use technology to make the measurements more efficient and reliable? Starner [4] focus on the aspect related to ubiquitous computing (ubicom), where the computer will be

present continuously. Therefore the design and evaluation of the information appliance has to include other aspects than just the usability of the software, but rather focus on the actual information appliance in use by a user in natural environment doing regular tasks.

Abowd [1] focuses on three aspects of future research in connection to the disappearing of the computer:

- *Everyday applications.* Where (1) tasks have no clear boundaries, (2) interruption will have to be expected and (3) multiple activities operate concurrently. Challenges may be to (1) design a continuously present computer interface, (2) connect events in physical and virtual worlds, (3) modify traditional HCI methods to support designing for informal, peripheral and opportunistic behaviour.
- *Evaluation of ubicomp systems.* Including (1) finding a human need (not just a possible service) and (2) evaluate the systems in contexts of natural use.
- *Social issues.* The issue of what to do with all this new personal and sensitive data ought to be taken more seriously. Much of the support for so-called location based services is based on the knowledge of a persons geographic position at the time. People will like additional control over the data that is given away. Obviously, we are already giving away a lot of information just by using mobile phones and smart cards, but we believe that the sensitivity in connection to such issues will increase. An area related to this is how to shield the user from input from all sorts of external sources when they are not wanted.

The first point above links us to trends within process and workflow technology, with a wish for supporting a user on many processes at the time (both private and business), and the simultaneous support of standard and emerging processes. Emergent workflow systems [5] represent a different approach to static and adaptive workflow systems with respect to their use of models. They target very different kinds of processes: Unique, knowledge-intensive processes where structure emerges. It can be argued that this is not specific for mobile information systems utilising GPRS and UMTS networks, but this area will be even more pronounced in such systems since future information appliances (and a multitude of services across the network) are always available (and thus more likely to be used in an emergent or ad-hoc fashion). Instead of the specification of algorithmic machines, this brings forward the need to specify interaction frameworks. Peter Wegner's interaction framework [8,9] was triggered by the realization that machines involving users in their problem solving, can solve a larger class of problems than algorithmic systems computing in isolation. The main characteristic of an *interaction machine* is that it can pose questions to human actors (users) during its computation. The problem solving process is no longer just a user providing input to the machine which then processes the request and provides an answer (output), it is a multi-step conversation between the user and the machine, each being able to take the initiative. The notion of an interaction machine is further extended to that of *multi-stream distributed interaction machines*, enabling multiple users and external systems to interact simultaneously.

Another area where modelling will be more important is the specification of the user interface. People will often need to access what is logically the same system from a multitude of platforms (PDA, PC, 'Mobile phones', TV-screens etc). A central element in this is the development of a model based specification techniques that are powerful enough to be used as a basis for the development of interfaces on the multitude of platforms needed, but still general enough to represent the commonalities at one place only [2]. One approach here is to define user-interface patterns including general usability principles as powerful building blocks. Another aspect is how to integrate the user-interface models with other parts of the requirement model, for instance the entity model, process model and goal model. On both process and user-interface modelling, the challenges can be attacked by extending existing approaches to modelling, similarly to how the use of meta-modelling techniques has found a special application for the design on mobile phone software [6], although research is needed to investigate both which techniques that should be extended and how they could be best adapted to the new problem areas.

Another aspect is the different usage conditions that the mobile user is meeting. Even when using the same device, he might have very different access to external information (e.g. via WLAN, UMTS, GPRS, GSM, or no contact with the Internet at all). One area to take into account here, is what we call graceful degradation of service, i.e. specifying what the user should be able to do at all times, or only when the conditions makes it possible? What shall happen when bandwidth is suddenly lost is another aspect to take into account? Also other aspects of dependability gets more complicated in the mobile setting. Mobile information appliances will engage dynamically in ad-hoc networks which means that at any given time, there is no central administration of the network. Such temporary clusters will have a variety of software that is supposed to work together in a predictable manner. One must expect that deliberate intrusion as well as unintended harm will occur.

Finally, many of the possible solutions for mobile information systems will be radically different from what people have grown used to at the desktop. To imagine the future has always been difficult, and established ideas in connection to the use of prototypes and scenarios will still be valid and useful. On the other hand, one should investigate even more powerful techniques, e.g. the use of hypermedia based narratives, which as it is now is mostly found in commercials for UMTS-enabled communication., which can build on early attempts of using multimedia based techniques as reported e.g. in the REFSQ-series.

### **3 Conclusion**

The large-scale application of mobile and ubiquitous systems are in its infancy, and it is not surprising that limited work have been done so far for requirements engineering in connection to the development of such systems. On the other hand, with the upcoming 3G (UMTS)-infrastructure providing higher bandwidth and constant connection to the network from virtually everywhere, the number of applications in this area is predicted to explode. With this in mind, it would be beneficial if the RE-community could be at the forefront on this development. Obviously one is not

starting this work from scratch, it is possible to build on existing work within the requirements engineering field, specifically on techniques for modelling of functional and non-functional requirements, usability requirements, RE for COTS-systems, RE for web-applications, and use of multimedia in Requirements Specification.

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