

# How to Define the Communication Situation: Context Measures in Present Mobile Telephony

Louise Barkhuus

The IT University of Copenhagen  
Department of Design and Use of IT  
Glentevej 67, DK-2400 Copenhagen, Denmark\*\*  
barkhuus@it.edu

**Abstract.** Mobile telephony is rapidly becoming a wide spread mobile technology. The technological possibilities for context-aware features are increasing, although only few services exist in real consumer settings. In an exploratory case study of high level mobile telephone users, the context measures that are relevant to mobile telephony are studied. Starting with three measures, location, time and identity, a fourth context measure is also found, leading to the measure of social situation to be important to users as well. The study concludes that the use of mobile telephony is highly influenced by this limited set of context measures but that these are not necessarily the same as the users wish to see facilitated by technology. It also suggests that when developing context-aware features for mobile communication, supporting these four pieces of information should be prioritized.

## Keywords

Context-aware applications, Human-computer interaction.

## 1 Introduction

As mobile communication has become increasingly popular during the last decade, the request for more intelligent devices and services is apparent. From solely being used as voice communication tools, mobile phones have evolved into information and data access terminals that support numerous tasks for the busy user. Examples of such functions are the wireless internet (WAP and i-mode), calender functions, e-mail services and text messaging. Although social behavior seems to adapt to the instant, out-of-context communication that mobile phones provide, suggestions for more aware and adaptable functions are suggested by research (e.g. [5] and [11]). These functions address the social problems arising when a person is available anywhere, anytime by letting the user define his/her own context to the possible communicators.

---

\*\* Currently visiting researcher at UC Berkeley, The Department of Engineering and Computer Science, working with Assistant Adjunct Professor Anind Dey.

The technological possibilities today make context-aware services easier to implement and maintain. Intelligent features that assist the mobile device are relevant for numerous purposes, such as locating people, assessing other people's situational context and adjusting the device itself to the context. Although researchers often consider consumer products as targets for context-awareness, few features have been implemented to real-life consumer products such as cell phones and PDAs. One exception is the 'friend finder' implemented in Sweden by Telia, where mobile phone users can sign up for the service and then observe where their friends are located real-time. The friends, naturally, have to sign up as well [13].

Contextual information can be considered as the 'clues' that make up an overall situation in which the use of the mobile device takes place. Being part of the overall context, they are not the definition of context, because that is affected by the individual's interpretation as well. Many researchers of context-awareness have questioned how a contextual situation can in fact be defined. The ones who focus on the actual technologies, limit their definition to the context measures that are utilized in their applications (e.g. [2] and [?]), for example position, time and historical preferences. Others claim that a context is impossible to describe in technical terms or even in words [4]. The approach to studying context in this paper then facilitates the request for "studying the expected context-of-use carefully [...] to determine what contexts are mostly emergent, contingent, and improvisatory" [4].

What this paper propose is to trace context measures by conducting an exploratory case study, focusing on one area of mobile computing. It aims to find the context information that mobile device users rely on when communicating and using the device. As an example of mobile communication, mobile telephony is chosen, because of its wide spread among the population as well as its familiarity of use among most users. Had the study taken place just a decade ago, the users would not have been as comfortable with the type of communication as they are today.

## 2 Context-Aware Mobile Communication

Originally considered to be a subset of ubiquitous computing, context-aware computing is increasingly viewed as essential to a truly ubiquitous computing environment [6]. Context-aware computing is described as "an application's ability to detect and react to environment variables autonomously" [1]. Where context-aware computing includes a large variety of applications and systems, context-aware communication limits the scope to applications that facilitate communication, such as messaging and virtual whiteboard applications [9]. This dimension of context-awareness that includes stationary as well as mobile applications is highly researched with the purpose of making communication more fluent and efficient. From the Olivetti Active Badge system in the early nineties [14] to the context-aware mailing list system [3], the approaches to aiding communication with situational information have been numerous. However, limiting the scope to

mobile communication, the research decreases to features that rely on the user's own definition of context. Moreover the features are developed on the basis of state-of-the-art technologies and what is considered useful by the researchers themselves. Thorough user studies have yet to be made in order to clarify possible other needs and present habits of communication, especially among consumer target groups <sup>1</sup>.

## 2.1 Context as Real Life Clues

People rely on 'clues' in their everyday life in order to act according to a certain situations; they depend on personal observations in order to conclude on the situation's higher level. One example is the person who sees a coworker's car in the parking lot and uses this clue to infer that the coworker is in the office at the moment. These clues can be compared to the context measures that context-aware applications use to adapt according to the situation or environment. By tracing informational clues that people rely on in specific situations, the study of present context measures can add to the usability and success of future context-aware communication applications.

Although context measures are relevant for the development of context-aware applications, the notion of context is highly complex and when reviewing past literature, it shows that many researchers have attempted to define not only context itself, but also how situations can be perceived by different individuals. Examples of the latter include Greenberg, who claims that it is not possible to define a context in terms of sensor information because situations fluctuate and are unpredictable in nature [4]. The overall situation that a person is part of, is not solely made up of measurable context information, because the person's own perception of the situation is part of the context. What is possible, however, is to facilitate technology with functions that take certain aspects of the situation into account and thereby make the use more smooth and transparent for the user. Where early studies define context solely as context measures like for example location and the user's task [8], more recent research realize that sensor information is only part of the definition of a certain context [3].

The actual context measures that (at least partly) create the user's perceived situation, however, are rarely empirically explored, making most discussions either technical or theoretical. The study of present context measures is likely to provide insight into which measures are relevant to include in new technologies or applications. Moreover, it is apparent that context measures differ for different types of applications; mobile computing is highly influenced by location, where stationary applications depend more on present task. Keeping this in mind, the context information that users of mobile devices rely on can be traced as part of the relevant contribution to the context-awareness in future mobile technologies.

---

<sup>1</sup> Some studies have been made on the habits of mobile phone users, e.g. [7], however, they mostly look at social behavior in connection with the mobile communication and not at the possible need for future functions in relation to communication habits.

## 2.2 Mobile Telephony as an Example of Mobile Communication

As an example of mobile computing devices, the mobile telephone is at present time the most common mobile communication tool and therefore a good example to explore [7]. Since it is an ultra-mobile tool, meaning mobile enough to walk with at the same time as using [10], its use is likely to depend on context; opposite non-mobile technologies, such as a stationary computer placed in an office, the situation changes more rapidly with a mobile phone.

The research area of mobile telephony is presently explored in relation to use and the studies are focusing on the impact that this innovated type of communication has on the users (phones have been around for over a century, mobile phones for not even two decades). Examples of such studies include [5] and [7]. The features of mobile phones that are proposed and developed are often extra services relating to newly employed technologies. One example is the feature of WAP that enables numerous services; some intelligent services, for example messenger services, have been employed and tested, however, they are not in use among the public [12].

## 3 Case Study Design and Method

The present study is designed as an exploratory empirical study of context measures within the use of mobile phones. By interviewing high level users of mobile telephony, the users' contextual clues and habits of use are traced. The study consists of seven semi-structured qualitative interviews carried out in the participants' own environment (office, own home, school cafeteria etc.). The interview guide was first tested on two participants (a miniature pilot study) and thereafter revised to better fit the relevant context measures and to phrase the questions better. It is structured into six parts with questions regarding demographics, three measures of context, general use of their mobile phone and a presented scenario. In the end a very open question is asked, leaving the participant with the option to elaborate on subjects not discussed during the regular questions.

To limit the scope of the interviews, three context measures have been selected as prime focus. The three measures that are initially investigated are location, time <sup>2</sup> and identity of person communicated with. They are chosen because they are believed to be major players in a mobile telephony situation; by proposing these measures, the interviews become more focused than if very open questions are asked.

### 3.1 Participants

The participants were selected from one main criteria: they had to be high level users of mobile telephony. This also made a casual restriction to age, since the

<sup>2</sup> The study distinguishes between time and relative time, that being the user's actual time and the user or receiver's perceived time-frame (e.g. "do you have time to talk?").

heavy users are easier to be found in young age groups, teenagers as well as adults under 30. The age therefore ranges between 19 and 27, with an average age of 23. Their experience with mobile phones ranges from 3 years to 7 years with an average of 5.8 years and most of the participants were using their third phone at the time of their interview.

The participants' occupation vary from unemployment and university student to professional consultant and military service. Their educational level range likewise from ten years of education<sup>3</sup> to a Masters Degree in information technology. Although the variety in background is quite strong, these differences are not considered in the study, since the emphasis is on the use of the mobile phone in general and such consideration would have required a higher number of participants.

Participant	Age and gender	Occupation	Had a mobile phone for
p1	21, female	Service assistant at convenience store	7 years
p2	21, female	Retail assistant at music store	3 years
p3	25, male	2nd year graduate student	7 years
p4	26, female	2nd year graduate student	6 1/2 years
p5	21, male	Military service	6 years
p6	27, female	Freelance consultant	7 years
p7	19, male	Unemployed	4 years

Table 1: Participant description.

### 3.2 Collected Data

The data was collected as a digital audio recording and transcribed shortly after. The transcription was done in several ways, a word-by-word transcription and a comprised version describing the essence of each answer. This way, comparing the different answers is easier. Finally, groups of context measures were suggested and the parts of the interviews that related to a certain measure (sometimes more at the same time), were grouped together in order to compare to which degree the measures were noted by the participants.

### 3.3 Analysis of the Study

The data of the study was analyzed according to guidelines provided by Yin [15]. Because it is exploratory in nature and the limited number of participants, none of the answers were quantitatively measured; the interviewees' expressions regarding the use and context were merely compared and analyzed for contextual

<sup>3</sup> In Denmark, high school is not obligatory and the earliest possible to leave school is after nine years.

measures. The transcriptions were analyzed for general patterns of the use of mobile telephones, in order to trace the situational context where the communication takes place.

Since the study is limited to a small number of participants and is qualitative in nature, no findings can be said to suffice as *proof* of factors of the particular use. The analysis of data simply provides indication of specific context measures in the use of mobile telephony. The findings, however, also give an insight into the social structures of mobility in an extremely mobile telephony satiated environment. The study therefore also relates to overall social and communicative practices of today's mobile device users.

Even though the questions of the study was not limited to person-to-person communication, the fact that mobile phones at present state are mainly used for this kind of communication, limits the results from for example information retrieval, which is more common in for example Japan. Context measures in relation to information search and other tasks that are not in play at present state are therefore not studied.

## 4 Overall Findings

It is immediately evident that most of the mobile telephony is influenced highly by the situation, an observation that has been made in other studies as well [11]. Several measures and pieces of context information of both communicators are found to matter to the general use. The findings support the notion that people rely on clues in their decision of how to communicate through their mobile phone and that these clues are highly individual and complex. The overall findings have been divided into three separate but related conclusions.

### 4.1 Mobile telephony is highly dependent on situational context measures

All participants phrase, at one point or another, that their actions in many cases depend on the situation. This non-ambiguous reply supports the hypothesis that users are constantly aware of their own situation, as well as the situation of the person they are communicating with, and act accordingly. One example of dependent use is a participant who, without hesitation, says that he greets virtually every caller differently except of course when the display shows no number or caller [participant 7, question 3b]. Almost half of the participants have defined different ring tones for different people. That way they know if they should "run to the phone or can just relax" [participant 5, question 3c].

This dependency is sometimes even made into a 'necessity' for the participants; several of them actually call their friends *just* to infer of the friends' situation, for example where they are and what they are doing. The three participants who do this all state that it would be efficient with technology facilitated features that could give this kind of information. "I often meet with my friends Saturday afternoon, but it is always a casual thing, so I call them up to

ask where they are; if they are at a cafe or something. Then I decide if I am close enough to go. If I knew where they were, I would just make plans to be in the neighborhood” [Participant 6, question 6a]. Besides indicating an addiction of knowing ones friends’ whereabouts, this also suggests that technology facilitated communication (as opposed to face-to-face communication) is increasingly being used to facilitate social relations in ways that were previously impossible. However, it is likely that the same social relations existed before, they were just maintained in a different matter. In a sense the mobile phone takes social relations *back* in time towards more random and improvised social relations just as it must have worked before the phone was invented. Unscheduled social gatherings were common when it was impossible to arrange for visits beforehand, just like it is now is possible to make arrangements within minutes. This social attribute is relevant but not the center of this study, the tendency could therefore very well be subject of future research within social habits of mobile communication.

#### 4.2 The situation consists of a fairly limited number of context measures

As most of the participants express that their behavior depends on the overall situation, certain major clues are used to define this situation. There are surprisingly few concrete measures that they claim to infer about and consider; often the participants will not be able to put the situational clues into categories but just say that ‘it depends on the situation’. Besides the three measures initially studied, one extra measure was found. The overall situation is made from four major context measures, listed here according to the participants’ perceived importance:

- Location of both communicators
- Relative time of the receiver of the call
- Identity of the other person
- Social situation of both communicators

**Location of both communicators** All participants mentions either in initial questioning or later in the interview that they ask for the other persons location, no matter if they are the caller or the receiver. This is not a surprise as mobility is the most vivid characteristic of mobile telephony. Most of the participants also admit that they changed their communication habit according to where the other person is. One participant gives the example that if the other person is on the bus, she will not ask very private questions [participant 2, question 6a].

**Relative time of the receiver of the call** Almost all the participants says that they would usually ask the person they were calling if they have time to talk. Only one claims that the people he calls will know him well enough to tell him if they were busy [participant 3]. Relative time is an essential context measure to mobile communication because the receiver of the call is available anytime,

anywhere. But where some seem to be very particular about if the receiver is busy or not, others seem to care less and expect that close acquaintances will tell them if they don't have the time to talk. Even though the number of participants is too limited to make a generalization like this, the female participants claim that they always ask if the person is busy where the male participants either does not ask or say that they only ask sometimes. One reason for this could be that girls seem to talk more about casual subjects where the guys use the mobile phone as a tool for making arrangements. One male participant even admits that he only uses the phone for making scheduled arrangements and meetings [participant 7, question 5a].

**Identity of the other person** Identity, naturally, is a big factor for the communicators. Most participants say that they adapt their greeting according to who calls (the feature of caller id is present in all the participants' mobile phones). Over half even say that they will not always answer the phone if they don't know who is calling, making identity an essential piece of context information. In return, some will also choose a certain phone to call from if they have more than one choice (a mobile phone and a home phone for example) in order to reveal or hide their identity.

**Social situation of both communicators** One context measure that arose during the interviews was the one of social situation. It was expressed as "what are you doing?" by the participants, a questions that most of them said to ask and be asked fairly often. It was also one of the measures that some of them suggested would be useful to know before initiating a phone call. One participant requested this measure as essential and admitted that she sometimes sent a text message before calling her boyfriend: "He works in such small cubicle with two desks, the person in front of him can hear everything and I don't like that. If I knew what he was doing and if the co-worker was there or not, it would be much easier. I sometimes send him a message to ask if he can talk" [participant 4, question 6a].

Other measures are also found to make up the situation, but to a lesser degree than the four described here. These measures include whom the person is together with as well as time of day.

**Voluntary sharing of information** What is striking about the results is how the participants are willing to spend much time telling or asking the other person about their context. Some of the participants give an impression that most of their conversations evolve around where the communicators are, what they are doing. Only two participants say that they use the phone for short targeted conversations such as arranging meetings and giving short messages [participant 3 and 7]. The others are willing (or curious enough) to share information of their situation in detail.

### 4.3 The context measures of mobile telephony will often adapt according to available services

Most of the participants express satisfaction with the possibilities for mobile telephony today. Several of them would like to see more technology facilitated context measures such as location detection of selected people or display of friends' social situation. Almost all are in return willing to share their own location and social situation information. The participants, however, are aware that the context measures are 'nice to have' features and not features that are necessary for mobile communication. The technology facilitated context measures that were found to be relevant to users can be divided in to three categories:

#### **Technology facilitated context measures in use:**

- Identity (display of caller)
- Time (knowledge/display of time)

#### **Possible technology facilitated context measures requested by users:**

- Location
- Social situation

#### **Impossible technology facilitated context measure:**

- Relative time

**Technology facilitated context measures in use** The participants all take it for granted that they can see who is calling before deciding to answer the call or not. There is not doubt that this context measure is highly used and two of the ones who do not set up distinct ring tones for different people, say that their phone is not equipped with this feature but that they will use the feature when they get a new phone [participant 4 and 6]. Time is another factor that is used and two participants even admit they will look at the phone while talking just to check the time. Several of the participants also claim that they use the phone as a watch, just because it is convenient. This, however, reveals a whole new function more than a context measure, but it is an interesting observation how important time is to the mobile telephone user.

#### **Possible technology facilitated context measures requested by users**

The participants do, as described before, almost all respond positive towards the function of locating selected people. Except for one, they would all like to use such service. One participant however, hesitates and says that it might take the spontaneity out of some social situations and that it would perhaps keep her from just initiating the phone call [participant 6]. Surprisingly this function is not one of utter importance, instead several of the participants specifically asks that the social situation or 'what they are doing' is displayed to the other person. One even requested some kind of messenger service that can show selected people's status such as 'busy', 'at lunch' and 'available'. This service has actually been

developed by the use of WAP but which it is not available to the public [12]. The fact that the possibility of technology facilitated location detection is not perceived as more ‘necessary’ is surprising, compared to the fact that this piece of information is the most common context measure in the overall use of mobile phones, as described in the previous sections. However, it seems as the reason for asking of the other’s location is also a means of initiating a conversation. As participant 1 state it: “Sometimes I will call up just to ask where my friend is at!” [participant 1, question 6a].

**Impossible technology facilitated context measure** Even though relative time is an important context measure for most of the participants, they realize that this is not possible to facilitate technologically. The person would either have to continuously have to update his schedule on the device or the device should calculate it on the basis of information such as time of day and the persons entered schedule which would have to be precise in order to show correct time. Even if this would work, many people do not follow their schedule to the smallest detail, leaving meetings early or late and arriving late due to delay.

## 5 Discussion and Future Research

The present study shows that the clues mobile telephony users depend on are fairly limited; the use however, is not in any way restricted by a lack of context measures, instead the user collects separate information and adapt his or her actions and behavior accordingly. What is important to note is how even though separate measures make up a great deal of the context, the overall situation is still impossible to fully explain by measurable information pieces. The users of mobile telephony are aware of this and infer to a lot of concrete measures but they still feel a lack of contextual awareness. Some chooses to ignore it, where others keep on asking for information.

Another conclusion that the study provides is that even if mobile communication technology can be facilitated to a better extent by context-awareness, people adapt easily and get by just fine with the present available services. Although the user habits depends on several context measures as well as the overall context, the communicators take the measurable information into account and then rely on instincts to conclude on the overall situation. Just as humans in general are very adaptable, the users of mobile phones are often ready to change behavior, even with small pieces of information available.

By showing that context matters to a mobile communicator, the question of how this knowledge can be used arise. Because of the number of the context measures found is fairly limited, at least when compared to the importance the users defined, one suggestion to defer from the study is to facilitate the four pieces of information in future design of context-aware features. At least two of the measures can be implemented (the measure of identity already is facilitated by caller id) into the communication tool and the features could then be tested by the user to find if they make the communication more efficient or even just

give the user a better experience. It should also be looked into how the mobile communication tools can be made more usable in a smooth and transparent manner, using the prioritized list of context measures.

The case study is by no means exhaustive within context measures and the findings have yet to be generalized to other types of mobile computing. Further research should be conducted to find if implementation of these measures are truly going to give users a better experience or if they are merely a need created out of technical possibilities. Finally the research should support further development of context-aware applications.

## 6 Acknowledgement

I would like to thank all the participants for their time they took out of their schedule to be interviewed.

## References

1. L. Barkhuus. Context information vs. sensor information: A model for categorizing context in context-aware mobile computing. In W.W. Smari and W. McQuay, editors, *Fourth International Symposium on Collaborative Technologies and Systems*, pages 127–133, San Diego, CA, 2003. The Society for Modeling and Simulation International.
2. K. Cheverst, N. Davies K., Mitchell, and A. Friday. Experiences of developing and deploying a context-aware tourist guide: The GUIDE project. In *Proceedings of MOBICOM 2000*, pages 20–31, Boston, Massachusetts, 2000. ACM Press.
3. A.K. Dey, G.D. Abowd, and D. Salber. A conceptual framework and a toolkit for supporting the rapid prototyping of context-aware applications. *Human-Computer Interaction*, 16(2–4):97–166, 2001.
4. S. Greenberg. Context as a dynamic construct. *Human-Computer Interaction*, 16(2–4):257–269, 2001.
5. P. Ljungstrand. Context awareness and mobile phones. *Personal and Ubiquitous Computing*, 5(1):58–61, 2001.
6. T.P. Moran and P. Dourish. Introduction to this special issue on context-aware computing. *Human-Computer Interaction*, 16(2–4):87–95, 2001.
7. L. Palen, M. Salzman, and E. Youngs. Discovery and integration of mobile communications in everyday life. *Personal and Ubiquitous Computing*, 5(2):109–122, 2001.
8. B. Schilit and M. Theimer. Disseminating active map information to mobile hosts. *IEEE Network*, 8(5):22–32, 1994.
9. B.N. Schilit, D.M. Hilbert, and J. Trevor. Context-aware communication. *IEEE Wireless Communications*, 9(5):46–54, October 2002.
10. A. Schmidt, M. Beigl, and H.W. Gellersen. There is more to context than location. *Computer and Graphics*, 23:893–901, 1999.
11. A. Schmidt and H.W. Gellersen. Context-aware mobile telephony. *SIGGROUP Bulletin*, 22(1):19–21, April 2001.
12. A. Schmidt, A. Takaluoma, and J. Mantyjarvi. Context-aware telephony over WAP. *Personal Technologies*, 4(4):225–229, September 2000.

13. Telia. Friendfinder, hitta dina vänner med mobilen. [www.teliamobile.se](http://www.teliamobile.se), October 2002.
14. R. Want, A. Hopper, V. Falco, and J. Gibbons. The active badge location system. *ACM Transactions on Information Systems (TOIS)*, 10(1):91–102, 1992.
15. R. K. Yin. *Case Study Research, Design and Methods*. Sage, Thousand Oaks, California, 1994.