

Context Awareness in Mobile Telephony

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INTRODUCTION

Much of the research on context-aware and situated computing so far have been driven by a technology oriented approach [e.g. 2, 6, 10]. There have been a number of propositions concerning how to make creative use of various types of sensors for passively capturing different aspects of the nearby physical environment, as well as various cues from the virtual or computational environment of a user, or rather the user's computer. These approaches mainly concern new types of "raw" data input to a computer system, presumably because these inputs allows for building a new class of computer applications, ones that actively adapt to or at least take into account a user's or a computer's shifting usage context. In order for an application to make sense of the collected raw input data, it must be "cooked" [6], or abstracted in some way before it can be useful. A number of different algorithms have been proposed, often using techniques from artificial intelligence.

Following current technological and cultural trends, many people seem to be increasingly relying on a multitude of computational devices, may they be mobile, wearable or embedded in the environment. Both the devices and their users will probably have dynamically changing environmental and usage contexts over time. Most context-aware applications so far have been about human-computer interaction in some sense, rather than human-human (though possibly computer augmented or mediated) interaction. Many mobile or wearable devices have been equipped with sensor technology, with the intention to directly support the person holding or wearing the device, or others who are physically close. However, I argue that in some cases, contextual information about a person's current situation might be much more useful to someone else than that very person.

Suppose that you for some reason want to communicate with another person. How do you choose the most appropriate among the available channels for communicating a message to someone else? There are often several possibilities: face-to-face conversation, telephone, email, SMS, fax, letter via traditional mail, paper note left by oneself, message delivered verbally through a third party, to name but a few. In this paper, I will deal with telephone communication in particular, but the most of the discussion applies to some extent to other channels for interpersonal communication as well.

Finding the appropriate context of communication

There are many social conventions about when and how to initiate communication. In cases where technology disables people to follow traditional rules, other strategies have to be

developed. One interesting example of this is the organizational structures that followed the use of a non-context sensitive technology such as the telephone. A large organization might have a special routing service in order to distribute incoming calls. Important, and hence busy, persons may have a special secretary or assistant that answer the phone and choose the proper action: to let the call through, to call back later, to encourage some other form of communication such as to book a meeting etc.

In many ways, such an organization works as a more or less effective information filter due to its hierarchical structure. With the coming plethora of communication devices, many ordinary people are almost as likely to be overloaded with communication. Finding the counterpart to the secretary or assistant is therefore of some considerable interest, even to the normal user. New sensor technology combined with proper software could for instance automatically gather context information from the surroundings of a phone, and use this as a filtering mechanism [cf. 10].

An alternative to the use of adaptive context-aware devices that takes on the role of the secretary, is to address the original problem, namely that the phone call as such is placed out of context. Creating technology that decides what is important or not, is, at least most of the time, much harder than presenting the proper information to the users and letting them decide. If this burden of deciding is placed on the receiver of a message there is little done to help the communication overload, but if it is placed on the sender it can be done as a part of the activity of placing the call itself. Providing the calling party with information about the context of the person she is trying to reach, *even before she makes the call*, makes it possible for her to decide when to initiate the communication and how.

TELEPHONE TECHNOLOGIES

Current telephone technologies provide very little context information. At the network level, there is Caller ID, which allows one to see the phone number for an incoming call. Most modern mobile phones allow you to explicitly select a predefined context, e.g. "meeting", "silent", "outdoors", etc. Each context, or profile, is associated with a certain notification cues [cf. 4], such as different phone call melodies, sound levels or vibration. In addition, there is a possibility to allow certain phone numbers to override the current profile, e.g. to give an audible signal even though you are in a meeting. This is a way to filter incoming calls (using Caller ID of course). Besides their limited usefulness, these techniques are only available to the person being called, not to calling party, introducing an information asymmetry. The very existence of this asymmetry could be uncomfortable for the calling party: "Why isn't he answering? Perhaps he

saw that it was I on his Caller ID? Doesn't he want to speak with me?" [cf. 9].

Mobile and stationary phone use

Current mobile phones have inherited a lot from their stationary counterparts. The design of the user interface, the ways they ring, etc. Talking in a phone has become a well-established social act that is easily recognized and understood by others watching. However, mobile phone use differs from stationary phone use. The introduction of hands-free, almost invisible headsets for mobile phones made it harder to interpret someone else's actions, but things change quickly. Today, at least in Sweden, when encountering someone that appears to be talking to himself on the street, the first explanation that pops up is 'ah, he is probably on the phone using a headset' and not 'he is probably mad'.

Stationary phones are associated with places, mobile phones are associated with persons. While the context of a place is relatively static, the contexts of most persons are not. When you call to a stationary phone, you can assume much of the context about the person you are calling from factors such as the phone's location, time of day, etc, but this does not hold true for a mobile phone to the same extent.

Since so many people use mobile phones, I tend to overhear a lot of phone conversations while being out. I have noticed that it is very common that people both ask about and describe their own contextual situation in the beginning of a mobile phone call. This might include the place or location, who else is there, what they are doing, etc. It is common to tell the other person if you are currently driving a car, if you are in a meeting, or some other important contextual information. Besides describing your own context to the other person through the phone, it also quite common to loudly repeat the other person describing his context, so that for instance people in a group get a sense of who is calling, why, etc. I have a hypothesis about phone use: that people talking in mobile phones tend to verbally ask the remote party about, and describe their situational context, to a much larger degree than the very same people using (their own) stationary phones. Thorough empirical studies are clearly needed to verify this hypothesis. However, let us assume that this is true.

Applying context information

Rahlff et al. [9] propose a model for understanding contextual feedback in human conversations. They distinguish between communicational feedback, checking whether a message has been understood, and situational feedback, which is about the (changing) environment and state of the person being called. In face-to-face conversations both these types of feedback are used, but in teleconversations such as on the phone, the contextual feedback is almost zero.

Such contextual information is primarily useful to other people than the person it concerns, in order for them to understand a situation. In a telephone conversation, however, currently all this information has to be gathered, abstracted and transmitted by humans, verbally. I believe there is a great opportunity for context-aware systems to complement this. The availability of such functionality in the telephone networks could lead to less disturbance for

busy people during inappropriate moments. It could also lead to less frustration for a person trying to make a call, for instance to a phone that is silent due to a meeting or a cinema visit. In this case, the person would probably never try to make the call at all at that time, but instead wait or use another communication method such as for instance email.

An interesting model that makes use of context in a distributed fashion was described by Herstad et al. [5]. They propose introducing a feedback loop for contextual information into a mobile communications network. The context information could be used either by the system or by the calling party to select the most appropriate communication channel. Such a model would be somewhat difficult to implement into current circuit-switched telephone networks, but with the advent of new, packet-based communication layers developing such services will be substantially easier. Voice over IP may provide much more than just a replacement of current routing and transmission technologies. The current GSM network is circuit-switched. New mobile telephony standards such as GPRS and Edge will complement this by also having a packet-based transmission model for data communication, but voice communication will still be handled by the old model. However, with the 3rd generation mobile telephony systems that are scheduled to arrive in 2003, all types of communication, both voice and data, will use the same packet-based transmission model. This will open up for many new kinds of services for mobile devices.

Automatic sensing and privacy

Some proposed communication systems, e.g. ComCenter [1], present the user with some information about another person before the communication is being initiated. The same applies to instant messaging systems such as ICQ [7], where you not only see who is online, but also if they are busy or away from their desktop. However, many such systems relies on the user to explicitly select an appropriate mode at each time, such as when in a meeting. ICQ has a very simple way of automatically sensing the context of its user: no mouse or keyboard activity for a few minutes, and it activates the 'away' mode. Other types of context information derived from various sensors would be able to describe the user's state in a much more accurate way. However, I believe that in order for people to accept such systems, there must be a 'manual override' function. In essence, one should be able to 'lie' with such a system if desired, e.g., to state that you are busy while not really being busy. There are also some serious privacy concerns here, like who controls information about you that is being distributed, abstracted, etc.

There also appears to be some commercial interest in this area. Coordinat [8], a system that is currently being commercialized, is a sort of 'mobile ICQ' system for mobile phones. The main idea is to allow for easy instant messaging to other people you know, using the phone book. However, there is one major addition: Since the GSM network tracks each phone's location, the system also displays the relative distance to your friends, and you can sort the phone book entries according to proximity. Another related system is Ericsson's iPulse [3].

SUMMARY

With the availability of digital networks that allow for distribution of contextual information, it is not necessarily the person who the context is about that benefits the most from it. Rather it could be someone else who is currently communicating with this person, or considering contacting this person for some reason and therefore must select an appropriate communication channel. I have used mobile phone calls as an example of this, where the calling party generally would be much better off if he had access to some of the aspects of the context of the person he is trying to communicate with before even choosing the communication channel and initiating for instance a phone call.

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