Proximate interactions of wireless appliances

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Abstract:

Development and progress of appliances enable to envision the design of new application classes that exploit direct communication with a limited range. Mobile users will be able to exchange information *dynamically* and *spontaneously* when they are physically close together. The purpose of this position paper is to discuss about some research problems related to these new usage scenarios.

1. Introduction

Two directions may be envisioned for wireless appliances. On the one hand they will allow internet accesses anywhere at anytime. On the other hand it could interested to investigate how to use them in order to access to an information system set up from the nearby user just for the current situation.

To illustrate our idea, let's consider the following example : people are attending to a conference. Several sessions can occur simultaneously. Attendees are moving freely from one session to an other, depending on the subject and their interests. We assume that each participant has it own wireless appliance (w-PDA in the following) with some facilities to exchange information with others in a limited range. Each w-PDA manages information, such as the owner's identity, their domain of interests, a copy of its slides, bibliographic references and URLs … In such a conference context, each physical encounter between two people may be a nice opportunity to exchange information between their w-PDA. Due to users mobility, this information exchange can take place only during a limited duration which can not be statically known. In fact, we can consider that when some w-PDA's are close together to be able to communicate, a *spontaneous an information system* exist between these w-PDA's.

Roughly, the concept of **S**pontaneous **I**nformation **S**ystem (**SIS**) which can be defined as follows : a SIS is composed of mobile users equipped w-PDA. An SIS takes place as soon as, at least, two w-PDA's are close together (communication range of the wireless interface). Then these w-PDA's can exchange implicitly or explicitly some information. A SIS changes (and even disappears) as soon as w-PDA move away one from each other. [BANA-98, BANA-99]. In such a context our purpose is not to provide mechanisms to mask possible disconnection during a time period, because two w-PDA's which are cooperating at time t might not at all be able to cooperate at time t' due their movement. In other words, *the physical mobility of entities belongs to the « semantics » of considered applications.*

Then, we claim that the main challenge to solve in that context is to use in the most effective way the limited communication period between w-PDA's of a SIS, assuming that this period cannot be determine *a priori*. It depends of a lot of parameters such that speed of the entities, communication range, communication reliability, ...

The rest of the paper is organized as follows. Section 2 presents the two challenges that we have identified for the SIS system architecture. Section 3 discusses about the related works. Finally, we give the status of this study.

2. Design Issues for the Software Environment

Given a w-PDAi , the SIS(w-PDAi, t) can be seen as the set of information available from the neighbor w-PDAj, at the time t, through a direct (one hop) communication. It is important to note that an SIS(w-PDAi, t) is only defined from w-PDAi local point of view, meaning that each w-PDA has its own SIS. This model raises two important problems:

- To determine the set of visible information space that w-PDAi can access from the SIS(w-PDAi, t), in spite of the strong dynamicity of this set. Due to the communication time limited by physical mobility, it is important to determine the most relevant information that are likely interesting for the peer w-PDA.
- Once the set of information is determined we have to provide optimized protocols in order to get the maximum benefit from the available communication time which depends on users mobility.

2.1. More about the construction of the visible information space

Precisely, SIS is a progressive information integration scheme: information are added or deleted at any time according to w-PDA's movement. Information available from the SIS is distributed over the participating w-PDA at time t. We called all these information *the visible information space* of the SIS, and our objective here is to provide a mechanism to build it. This space must reflect dynamically at any time the set of information that are present in the SIS (see figure 1).

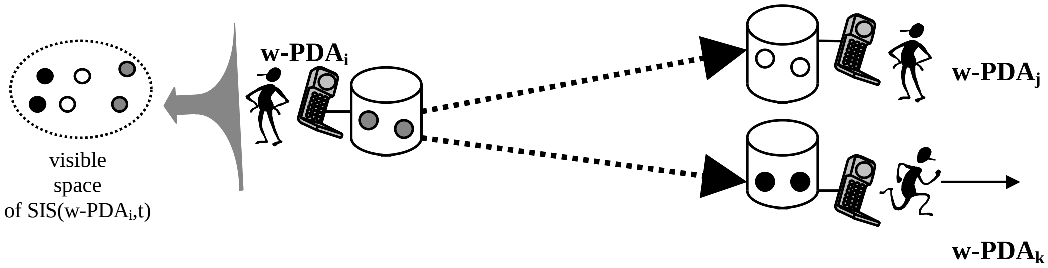

Figure 1 : information discovery mechanism in a SIS

Due to the limited communication time available during an "encounter", it is important quickly reach the most relevant information. An idea we are currently investigating is to structure the information space such that it can be explored progressively by keyword matching, eventually leading to a user profile characterization.

Of course the visible space construction raises security issues that will have to be addressed. Indeed access to information present in the appliances must be restricted by access rights. In certain cases the anonymity of the information owner's must be guaranteed, for example during an encounter between people who have never met before and who don't want to know each other. In other cases the confidentiality of information to be transferred must be guaranteed.

As an example, reconsider the business card exchange scenario : we are interested in getting the business card of some nearby attendees in a meeting, as we would like to be notified when someone interests seem to match ours. In these interactions, it is both the physical situation and the semantic of the information which make relevant the exchange of information. The information discovery mechanism for SIS appears to be a specialized approach, with the advantage of enabling fine context-awareness to application.

An interesting approach in mobile computing would be to distribute the information system over the w-PDAs themselves, which are today powerful enough to support most of the services locally. But this requires from a device to able to dynamically discover the other devices in the surroundings and the services or information they may provide. Several standards address this problem: Bluetooth SDP [SDP99], the Salutation Architecture [SAL99], JINI [SUN99].

JINI seems to be a very promising one. It allows a set of independent devices to dynamically setup a federation of services, provided that they can communicate. A device which may provide services registers itself to a lookup service (this function being handled by one of the devices), describing its capabilities and specifying leases for the services (the period of time while the service is expected to be available). In addition the lookup service mediation may hides the physical proximity between JINI devices for establishing a communication. In the SIS case, our goal is to built a discovery mechanism with no centralized entity such as a lookup service. But from our point of view, the main problem for highly dynamic scenarios encountered in the SIS context, is that the discovery is de-coupled from the effective use (or transfer) of the information. And JINI assumes that once discovered, the service is here for some period of time.

Another difference is that other discovery mechanisms, like JINI, are services oriented while SIS is information oriented. JINI effectively differentiate services according to their class membership and descriptive attributes, but does not have a semantic knowledge of them, only a "syntactic" one. For example, JINI does not know the semantic of the data representing a business card. For this particular application, JINI would provide automatic discovery of the business card service, but would not help in selecting for example only the business card of nearby people working (unless each particular instance of a business card is implemented as an unique JINI service). SIS focus on the discovery and transfer of information of known semantic (text, graphics etc. specified for example as XML resources), not on services.

2.2. More about communication protocols.

Another point that seems natural to consider is to "fragility" of the link, which we characterize as its remaining "time to live", depending on the users physical mobility (ie, a "fragile" link is a one which is about to die). We try to estimate the “fragility” of the wireless connections between users, in order to prioritize the transfer which is possible due to the known semantics of the information. In that context our approach is to have an “idea” of the communication time before to perform the information process. So if a node states that an information block can not be totally transmitted considering the estimated communication time, an other block can be dynamically chosen.

In some cases, the link will die before being able to finish the on-going communication. Data degradation can be performed in cases as a "last-chance" solution to terminated initiated communication. Of course, to this end, an appropriate representation of the information has to be provided and managed. Basic information could be separated in several blocks, classified by size and priority. A well known example is for an image to have several versions coded with different resolutions and/or compression level.

To implement this estimation of the link fragility, a set of parameters characterizing user’s mobility need to be accessed at the hardware level: the quality of the transmission, the power of the received signal, a measure of the distance with the remote appliance we are connected to. Our belief is that these parameters have to be exploited thoroughly by the software environment (communication protocols), in order to produce periodically an estimation of the communication time, and so enables some anticipation before a disconnection occurs.

4. Discussion and Related Work

In this section we present briefly the related work with and we compare them with the SIS approach.

4.1. Ubiquitous Computing

An important area of related works is *ubiquitous computing*. This concept was first described by Weiser [WEI91] as an integration of the computing power into our environment by embedding computing devices everywhere. The core idea of ubiquitous computing is to assist the natural behavior of the people by allowing easy interactions with the surrounding environment and other people. Here are some of the typical application of ubiquitous computing :

- A newcomer asking his PDA to show him a map of the city and computing the best route to go to a given location.
- Using nearby devices (fax, printer, camera etc.) from a PDA.
- Exchanging or consulting personal information (business card, planning etc.) with a nearby person.

An important constraint with most ubiquitous computing world is that the focus is on the human to device interface and application exploration. The information system is external to the embedded devices, that is to say, the user's device is only used to access the information system and to determine the current location of the user. This means that a global infrastructure has to be available to support these systems, for example Parctab [SCH94] and

Shopnavi and Walknavi [NAG96]. In our approach, the applications we target do not require any surrounding infrastructure except the wireless PDAs themselves. A recent research [KOR99] presents an example of application based on ubiquitous computing and physical proximity. It mainly focus on profile-based cooperation in order to support informal communication during a physical encounter and do not address problems related to the physical mobility.

4.2. Ad Hoc Networks

An ad hoc network [JOH94] is made of mobile nodes communicating directly via wireless interfaces without relying on any fixed infrastructure. Ad hoc networks are designed to support "standard" applications, not context-aware one or those exploiting physical proximity.

According to ad hoc networks definition, the communication infrastructure of an SIS can be considered a one-hop ad hoc network. This allows applications to assume that visible information always belong to physically close nodes, which is essential for the emerging ubiquitous computing applications. Finally, solutions developed for coping with link fragility in the SIS context could be used to optimize some ad hoc routing protocols.

5. Status

The position paper reports on work that is in progress. We are currently working in two main directions. To cope with the limited communication time, we are designing an efficient way of discovering information such that most relevant one are made visible first. Such mechanism take benefit of user profiles. Second, we are investigating the problem of link fragility : we have proposed a model of the behavior of a wireless PDA taking into account for example user trajectory, wireless interface range and bandwidth etc. This model is under evaluation using the Berkeley NS simulator [BRO98]. Moreover, we are considering some new potential applications that could benefit from this new paradigm.

6. Références

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