Group awareness in Bluetooth

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Abstract

Bluetooth-technology enables objects to communicate with each other, humans to communicate with each other, and humans to communicate with objects. This paper discusses some possible ways to develop context awareness to enhance the Bluetooth-devices ability to "guess" the groups that Bluetooth (end) user is seeing and using at each moment.

Keywords

Usability, task, context awareness, wireless networks, communication

1. Introduction

Bluetooth-technology [15] enables objects to communicate with each other, humans to communicate with each other, and humans to communicate with objects. *Context awareness* is crucial to users when interpreting the visibility of objects, services and other users [7]. Awareness of the factors that define a group of items and users and tasks associated to the group helps to implement and manage services and hardware. Let us first have a look at some of the key concepts used in this paper.

1.1. Context awareness

Context is defined by Dey & Abowd [7] as "any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant between the user and the application, including the user and application themselves". Context awareness is, then, defined as system's ability to "use context to provide relevant information and/or services to the user, where relevancy depends on the user's task" [7].

Context awareness issues have a often been dealt withunder varying headlines, not as a separate field. For example, Chalmers and Sloman [6] define context awareness as part of Quality of Service (QoS) in mobile computing. Also, context awareness is often seen as a sub category of ubiquitous computing [1].

1.2. Group Awareness in desktop computing

Sohlenkamp [18] defines Group Awareness in context of computer supported collaborative work (CSCW) as communication-collaboratorion-awareness -continuum. Awareness for example gives an end user the ability to see what another end user is doing, or has done recently, while communicative application only gives the possiblity to deliver messages [18]. Sohlenkamp

also presents a concurrent paradigm to predominant Windows Icons Metaphors Paradigm (WIMP; typical deskop-computer interface based on windows and icons), but also in that model work is presumed to take place on a desktop computer (or on a similarsystem such as, for example video conferencing) [18]. Problems in existing paradigms are presented more thorougly in another paper appearing in this conference [9].

1.3. Grouping

Visual grouping is a fundamental human cognitive process affecting also group awareness. The cognitive aspects of visual grouping are called "Gestalt laws". According to Gestalt laws, groups are perceived, for example, on basis of perceived similarity, location, distance and connection. [12].

1.4. User, end user

Bluetooth profiles specification [4] uses terms "user", "user interface" and "end user" in a somewhat mixed sense, not making a proper differentiation of meaning among them. In this paper, the term "user" refers to a bluetooth application, or to the programmer of the application, but not to the end user. "End user" refers to the intended user of the services or devices. "User interface" refers to end- user-level user interface. User interface does not refer to maintenance or user-level view to the system's status.

1.5. Task, goal, usability

End user of the service has some goals when using a Bluetooth service or device. Usability of the service increases, when the amount of tasks needed to reach goal lowers, and the tasks are more closely connected to the goals in the terms of the end user [8]. He or she perceives the use to be easy and pleasant.

Tasks and goals are affected by user's mental model of the service. Mental models are mental dynamic structures, schemas containing knowledge about the system at hand. Humans always build mental models of systems they use [16], [19].

1.6. Organization of the paper

The rest of this paper is organized as follows: First, we will have a look at the basic structure of a group built up using Bluetooth technology, along with pointing out the basic requirements it poses for the grouping to be understandable and manageable. Then, we will show how the existing Bluetooth specification tries to deal with these requirements, and discuss these each in turn. Finally, we will present our conclusions, together with some suggestions for further work.

2. TOWARDS GROUP AWARENESS

The great promise of Bluetooth is to get rid of cables between devices [15]. It also holds the potential to enable self-organizing wireless networks to be a reality. This is why Bluetooth has the potential to become a widely used and adapted technology [17]. There is likely to be time phases when the services are sparse, but many traditions of showing (or hiding) resources available are also being developed at the same time, so these technical problems are not discussed here. There is, however, one prominent usability problem at hand that we must deal with: At present, *cables* and the *physical nearness* of the devices forced by these cables connecting them to each other, help the user to perceive these devices as belonging to the same group. This can be described as a rather strong connection, even in terms of group-awareness by Gestalt laws (law of grouping, law of connectivity) and by convention.

However, with the introduction of Bluetooth wireless technology, these visual and physical signs of connections among and grouping of the devices will disappear. The end user is left with no clues as to which device is connected with which, and when. How, then, will the user be able

to know and fully understand the make-up of the dynamic group structure at each time? And, further, what mental model will the end user use as the analogue for this understanding of the Bluetooth group structure?

One much-used analogy in wireless communication is the usage of cell-phones [19], since they are wireless. Cell phones, however, come with certain characteristics (size, shape, weight, layout of keys and displays) that make them *personal* (for the user) and show some *group-identity* with other cell phones [12]. This similarity enables transfer of mental models - items similar to cell phones are expected to behave like cell phones [19]. Bluetooth is intended to connect both personal and public devices and services. Cell-phones are used to point-to-point personal communication, while Bluetooth's fundamental unit is "piconet" of two to eight devices [3], so there are significant differences between the two device and communication concepts underneath.

Using Bluetooth means forming groups among devices that do not traditionally communicate with each other, at least not directly, and which may not belong to the same category of object groups in the user's mind, thus bringing forth a variety of expectations as to how the system will operate. Also, let us further stress that since these Bluetooth group connections are no longer visible to the end user, understanding the make-up of a Bluetooth group is not an easy task. Even though the Bluetooth specification describes scenarios where items and services work as a group (pic 1 in [4] P70), there is no clear way for the user or end-user to know

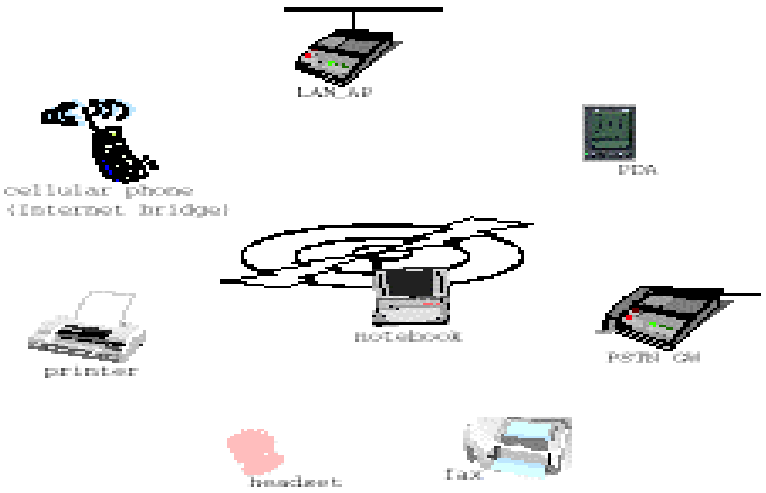
- which services are to be shown
- which services are to be used

as a group.

While bluetooth-devices come in several size and shape, the possibilities to show grouping visually to the end user(s) are somewhat limited - even the names of devices may be much too long to be easily shown, as also noted in [4 p26]. The usage of a variety of different displays also creates a problem since interaction styles designed for mainframe desktop computers are not always suitable to small one-bit color depth cell phone displays [10]. [9]

2.1. Service discovery profile

Service Discovery profile enables end user to find new Bluetooth capable services [3 p72]. Services may be known (trusted) or unknown (untrusted). Terms "trusted" or "not trusted" are used to



Pic 1, Bluetooth service scenario [2]

indicate the level of trust that the services have towards one another [3]. This concept of trust is somewhat different from the end-user's trust towards the device(s) or towards the perceived environment [14]. The feeling of trust forms the basis for feeling secure, and feeling secure forms the basis for the willingness to use any service. Naturally, all end users want to have security, but security issues are not part of the goals for end users, but could rather be described as means-to-an-end: ability to trust a service is crucial for (end) user's willingness to use the service again [11]. Thus, trust is an important factor in end user's willingness and ability to use the service(s), so it should be dealt with, and the feeling of trust towards the service should be enhanced.

To enhance trust towards - and, further, the usage of - any service, we have to be able to communicate the security of the use to the end user somehow. According to Jacob Nielsen [13], trustworthiness can be communicated through the design in the Web through the following ingredients:

- design quality (professional appearance)
- up-front disclosure (all relevant information is given at once)
- comprehensive, correct, and current content
- connected to the rest of the Web with links

Some of these ingredients are relevant for the bluetooth-devices at hand as well. However, if the visualization of these things is difficult in a graphical environment such as Web already, it is much likely to be so in the not-so-graphical environment of the bluetooth-devices. Also, the list created by Nielsen is very general and does not provide us with hints on how to create design that would be able to answer all these demands, and, further, to be able to communicate that this is so to the end user in a trustworthy way. For example, what does "design quality" or "professional appearance" actually mean? How can the end user be sure that he or she has been provided with all the relevant information? How can he or she judge that the information given really is comprehensive, correct, and current? And, in a Bluetooth-environment, how does he or she perceive how and with what or whom the device is connected with? Clearly, at present we have more questions than we can provide answers for.

One scenario of a problematic situation will enlighten the problems we have to be able to deal with. While easy connection of devices, for example, in "conference call" or while sharing meeting minutes between users (or their Personal Digital Assistants, PDAs) is desirable and enhances their usability, easy eavesdropping on phone-call or peeking another user's files is not desirable, and the end user must be able to prevent it (and know that this is so). However, this may become an elaborate job: One can imagine the unnecessary work of accepting / cancelling all bluetooth-filetransfer requests that migh bounce around, in a meeting on year 2005. Bluetooth specification offers some tools to solve the problems of task flow / security:

- Bluetooth devices have unique identification number
- One bluetooth device may offer several services, that may be governed independently.

At this stage, the application's group awareness must be built to be application dependent. For example, PDA-bluetooth connection must be able to learn to know which devices (other end users) in which situations (presence of other Bluetooth devices) it may give access to upload files (minutes), upload/download data from some files (finding a time for meeting), sharing data (collaboration), etc. Instead, a server in a meeting room that works as an accesspoint and server to bluetooth PDAs must provide some contextual data (location if semantics are known), to be able to handle granting of access.

Different devices begin with different levels of group awareness [Fig 2]. In use-scenarios that widen the use of known artefacts, like home piconet of one telephone-socket and three headsets instead of an old-fashioned one fixed telephone line with one end device, the user's mental model of how telephones work and the shapes of the devices define the grouping. In totally new services enabled by bluetooth, the end user's mental models may be at start quite different from each other (and much different from the developer's models), since users may take their models for the novel device from various sources.

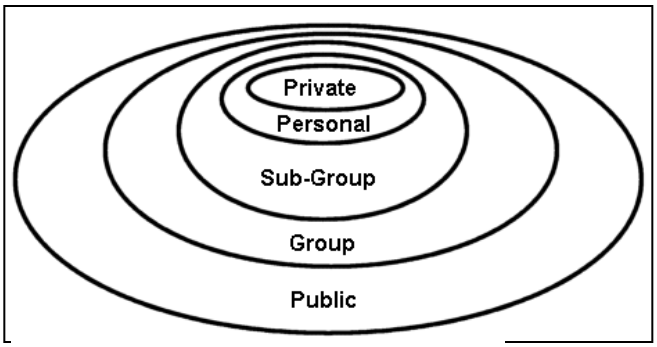


Fig 2, an example of group levels

By Gestalt law, bigger, heavier-looking and darker objects are identified as more important or "leader" objects. What this means for understanding a Bluetooth group is that a device perceived to be most prominent may be falsely assumed to be the piconet master. However, since the Bluetooth group is self-organized each time it is built, the Bluetooth piconet master is not known to the end user. This may lead to serious errors, where the end user may cut the connection in the whole piconet by accident or by working habit (turning cell-phone off etc). This results in a new piconet set-up that may take up to 2.5 seconds to be built up [4]. It would be helpful to the end-user to maintain piconets, if the better supported computing machines (mainframe computers in working places, servers, etc with steady power input and big screen for possible administrative tasks) were more "eager" to take or accept the piconet-master role.

2.2. Naming conventions

There are naming rules for certain groups of devices and services [4], app VII. These rules [4 p1013] may lead to conventions (for example Major_service_class.Major_device_class.Minor_device_class.Device_name), that do not give real benefit to the end user. From an end user's perspective a name such as Miscallenous.Computer.Any_Inteli86_Compatible is not too informative, so such names should be avoided.

While semantical [2] and ontological problems [5] make it hard for people to give their devices commonly understood names, a proper naming convention for services and devices should be built. This would help the end users to build a consistent mental model of the services, as well as help them to make informed selections in ambiguous situations [16]. However, defining the conventions falls out of the scope of this paper.

2.3. Group management

Bluetooth Telephony Control (BTC) [3 pp.435-] describes group management in bluetooth. (Note: "Phone" connection may be used for both voice and data transmission on Bluetooth)

Conventions in telephony are strongly point-to-point connections. Instead, in bluetooth the BTC refers to a method of automatically bringing one device and all its services available to other devices in the group [3 p.451]. While this offers good efficiency (end user is not interrupted by joining requests continuously flowing in), there is the problem for end user to be able to know what kind of devices and services are in his or her disposal (or threat) at any given time.

Taking care of the BTC procedures seems to be left on the responsibility of the service or device

developer, because there seems to be no established convention on how BTC is showed to the end user. The features should propably be used only when the group awareness is built by other means.

3. CONCLUSIONS AND FURTHER WORK

The Bluetooth specification does not (yet) give tools for creation of group awareness to the user or end user of Bluetooth services. While Service discovery profile describes how services are searched and found and how they are echoed on the user interface level, there are open issues regarding small (20 characters in [4 p43]) displays or technically inexperienced end users (ie. 99% of potential user population).

We suggest that the term "group awareness" in context of Wireless Ad-hoc networks (for example Bluetooth) be defined as "the service's ability to use the contextual information of other users and services available to the service for better usability and trustworthiness to the end user."

In this paper, we have described some possible problems and solutions in group awareness of Bluetooth:

1) Group Management provided by BTC does not provide group awareness to the (end) user
2) Naming convention informative to end user(s) should be built
3) Group Management as defined in Bluetoot telephony does not necessarily provide for group awareness

Further work includes usability evaluation, using for example the heuristic rules by Jacob Nielsen, to the Bluetooth user interface aspects in Bluetooth Profiles [4]. Also, finding ways to create context awareness by the closure (nearness) of devices, the usual usage patterns and device and environment semantics could prove useful.

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