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The NFC tag structure in AmI Environment

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***Abstract*— The Near Field Communications (NFC) enabled mobile phones are excellent devices to obtain services whit minimal effort: touching interaction. We propose the implementation of an Ambient Intelligence Environment with the single use of NFC technology (AmIE-NFC), which was developed in an environment with already existing computer infrastructure. In this environment, services from devices are controlled or requested simply by touching. We put a tag-NFC on each element or device. This work explains the tag-NFC structure to implement an AmIE-NFC and information flow when a user requests a service.**

Keywords- NFC, Touching Interaction, Ambient Intelligence, Location-based Services

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I. INTRODUCTION

Ambient Intelligence (AmI) paradigm is a evolution of Mark Weiser vision of ubiquitous computing [1] and Ambient intelligent environment (AmIE) is where "humans will be surrounded by intelligent interfaces supported by computing and networking technology that is embedded in everyday objects, which should be aware of the specific characteristics of the human and there should also be unobtrusive - interaction" [2]. The origin of the AmI concept lies in the conjunction of Ubiquitous Computing, Ubiquitous Communications and Intelligent User Friendly Interfaces [3].

An AmI environment must be context awareness and sensor technology is the key for this. The new Near Field Communications (NFC) technology overcomes the problems of RFID technology use: an NFC initiator device can move to any place, the localization will be on a point because of the need to bring the target and the initiator very close together, and the initiator/objective can use the memory device. And although there are other problems (e.g. the antenna range), we considered this a sufficiently good option to explore its use in an AmI environment.

In our previous work, we used RFID to identify the users as implicit inputs in the system and offer them services as implicit outputs. The particular contexts studied here are the classroom, the research laboratory and the lecturer's office [4]. We used an RFID-Infrared sensor combination to perceive users' locations and movements in front of a projector, commence a presentation automatically and control it with a hand movement [5]. In another phase of our research work, we used an RFID-NFC combination [6] to implicitly capture the user's presence in the working area of intelligent environment, offer implicit services, and request and accept certain services using touching interaction through an NFC-enabled cell phone. The advantage of RFID and NFC technologies is that the communication channel between the antenna and receiver begins automatically when the tags are detected. Unfortunately, the cost of disseminating the RFID technology is an obstacle for its widespread use.

This work explain the NFC tag structure to obtain maximum advantage from its memory is studied. Then, we show a scenario where an NFC-enabled cell phone is used to obtain services very easily In our proposed AmI-NFC environment, we will use touching interaction to enter the environment, request and accept services, and place context information in the AmI-NFC environment management system.

II. RELATED WORK

In [7] NFC enabled cell phone was used as a user interface element so as to enable home-dwelling elderly people to choose their meals to be delivered be means of a home care service. They using a NFC tag stand with three tag where user can select one of two options of meal and third if user don't need meal. The application is based on Nokia Field Force Solution where the tags only have an instruction to execute the application in the cell phone after information about meal can be transferred through GPRS-connection to a middleware server and onwards to the back-end system.

The Mobile Sales Assistant [8] uses a NFC enabled cell phone to helps retailers and customer to check availability of articles at the point of sales. When a customer need information about an article she is interested in touch the NFC touch the NFC enabled label of the wanted articled, information about availability is taken from the ERP system and directly shown on the cell phone The tag over items have saved the electronic product code (EPC), the connection between the cell phone and the Web server (connected to the ERP) is made over GPRS.

In REACHEeS [9] using a cell phone equipped with NFC compliant RFID reader as a remote control for all kind of the multimedia content shown on an external display. In this framework each tag contains sufficient information, and

may contain some extra parameters associated to that event, to start a one service. The communication between user interface gateway and the cell phone is implemented by means of HTTP request and responses. Data bearer for the communication channel is GPRS/EGPRS.

In the previous approaches the memory tag completely it is not used (only for a service) and the use of the GPRS as data bearer can be expensive.

III. NFC TECHNOLOGY

In 2002, given the increasing number of new devices appearing in the market and their need to interconnect with one another, Sony and Philips developed the Near Field Communications (NFC) technology. NFC is a short-range wireless connectivity technology that combines radiofrequency identification (RFID) technology and interconnection technologies, using magnetic field induction to enable communication between electronic devices in close proximity. The NFC forum was formed in 2004, "to advance the use of NFC technology by developing specifications, ensuring interoperability among devices and services, and educating the market; and promote the use in consumer electronics, mobile devices, and PCs " [10]. In May of 2008 the forum had 149 members.

NFC operates in the unlicensed high frequency band of 13.56 MHz, with a bandwidth of almost 2 MHz, supporting data transmission speeds of 106, 212, and up to 424 kbits/s within a range of 10 cm on average (since the transmission range is so short, NFC-enabled transactions are inherently secure). The system is compatible with ISO 14443, but incompatible with the EPC global standards [11]. The first NFC specifications were published by ECMA International in the open standard 340 "NFC Interface and Protocol". One year later, they were adopted by ISO/IEC with number 18092.

NFC communication is established between two devices; namely the initiator and the target. What is generally known as the initiator, as implied by the name, initiates and controls the information exchange. This element is called reader in RFID terminology. On the other hand, the target is the device that responds to the initiator's request. The target is called a tag in RFID terms. The initiator and target used in our environment proposal are shown in Figure 1.

Nowadays, we live surrounded with an enormous amount of devices and their multiple functions, thus generating a need to interconnect with one another. The Near Field Communications (NFC) technology was developed to meet this need. NFC is a short-range wireless connectivity technology that combines RFID and interconnection technologies. It works on a high frequency band of up to 13.56 MHz, with a data transmission speed of 424 kbits/s and a range of 10 cm. Although the NFC protocol can be installed in any electronic device, our interest will focus on NFC-enabled cell phones (NFC cell).

During the design process, Philips and Sony decided that NFC would be compatible with ISO 14443, but incompatible with the EPC global standards [11]. The first NFC specifications were published by ECMA International in open standard 340 "NFC Interface and Protocol"; one year later, they were adopted by ISO/IEC with number 18092. Any communication or link in the NFC technology must be made between two devices: the Initiator, which, as its name suggests, initiates and controls the information exchange (similar to a reader in RFID); and the Target, which is the device that responds to the initiator's request (called tag in RFID). In other words, the NFC tag can only work like a target and, any other NFC-enabled electronic devices can work like the initiator or target (e.g. NFC-enabled cell phone). The NFC tag can be read by the NFC cell or NFC reader (figs. 1.a and 1.b). The NFC cell can communicate

with the reader-NFC or other NFC cell (figs. 1.c and 1.d).

Figure 1. NFC technology devices: Initiator (mobile phone) and target (tag)

A. *NFC-tag Types*

The NFC Forum mandates four tag types to be operable with NFC devices [10]. Types 1 and 2 are based on ISO 14443-A, the international standard for contactless smartcards that supports MIFARE. This standard has 96 bytes availability in memory, expandable to 2 Kbytes, which can be read and re-written, although users can configure it to become read-only. Data transmission speed is 106 kbits/s.

Type 3 is based on the Japanese Industrial Standard (JIS) X 6319-4, also known as FeliCa. Its memory limit is 1 MByte and its speed may be either 212 kbit/s or 424 kbit/s. This memory can be pre-configured to be either read and re-writable, or read-only.

Finally, type 4 is based on ISO14443A and B. Its memory availability is variable, up to 32 KBytes per service while data transmission speeds reach up to 424 kbit/s. This type of memory can be pre-configured to be either read and re-writable, or read-only.

The NFC forum has defined a common data format called NFC Data Exchange Format (NDEF) specification, which contains technical specifications for Record Type Definitions (RTDs) and three specific RTDs: TEXT, URI, and Smart Poster. NDEF is based on MIME and is, therefore, very similar in concept.

An NDEF message contains one or more NDEF records. Each record can hold a different type of object. The first record defines the context and records the amount of the entire message.

IV. An AmIE-NFC Scenario

John arrives at the building door, where his office and other workspaces (laboratory, other members' offices, and meeting room) of his research group are located. With his cell phone he touches the tag at the side of the main door of the building and the cell phone reminds him that he has an important comment for George who is already working at his desk. For this reason John decides to go to the laboratory (where George is). At the instant John touched the tag, all the members of the research group, who are working in a computer, receive a message indicating that John has entered the building.

In a corridor John can observe (on a public display) a summary of the research group's current work, such as deadlines of the congresses in which they will participate, the last versions of the papers being written, the identity and location of each person working in the building, etc.

When John arrives at the door of the laboratory he can observe who is in inside by looking at a little display. He can also see the degree of advance of the different activities (along with notes on projects, programs, articles, etc.) that the members of the group are developing. Before entering he touches the tag of the next door. Already within the laboratory he can observe a reminder of all "notes to comment on", on a public display of the laboratory, which has been stored in his cell phone. Meanwhile, all users who have "notes to comment on" to John, can see a reminder indicating that John entered the laboratory on their computers.

While John talks to George, John places his cell phone near the tag on the display of George´s computer to show a file. After commenting on it, they decide to show it to everyone in the laboratory. To this end, John touches the public display with his cell phone.

Before John leaves the laboratory, George decides to send him a paper for checking, but, due to its large size, it does not fit in the cell phone's memory. He therefore, decides to send the file to John so that it can be checked from any computer in the AmI environment.

When John leaves the laboratory, he runs the exit service in his cell phone to warn the AmI environment that he is coming out of the laboratory. When John arrives at his office and touches the tag in the door, his cell phone shows the list of people who came to see him while he was out, as well as the messages left for him

V. AmI-NFC Environment

The two essential elements of any NFC system are the initiator and target; both will be new devices when implementing an AmI-NFC environment in a computer infrastructure environment (although could be situations in which they are not needed). This infrastructure must have LAN (with internet connection), and each area must have at least one Bluetooth server, a services server, a file server and a database server (the latter three could be in the www if AmI has internet connection). The elements in AmI-NFC environment (fig. 2) can be grouped as follow:

- NFC devices. Any NFC-enabled device: cell phone, reader and tag.
- Computer devices. Printer, display, desktop computer and laptop.
- Computer/Communications Infrastructure. LAN, internet connection and servers (services, Bluetooth, databases and files).
- Software. Specific software is installed in each NFC cell and computer in the environment (, in the servers (Bluetooth, services, and files).

When users touch a tagged device with their NFC cell, a preinstalled application is executed automatically, reading necessary information from the NFC tag and sending necessary information context to management system via Bluetooth bridge to request service. The application may obtain data from data bases and satisfy the service directly to NFC cell o service device, regarding this type of service, that are required by the AmI-NFC environment infrastructure which we call "services in the AmI area". Sometimes, the users will touch another NFC cell with their NFC cell; in this case, the service is satisfied merely with their interaction, and does not require the AmI-NFC environment infrastructure. We call these services "services in the AmI point".

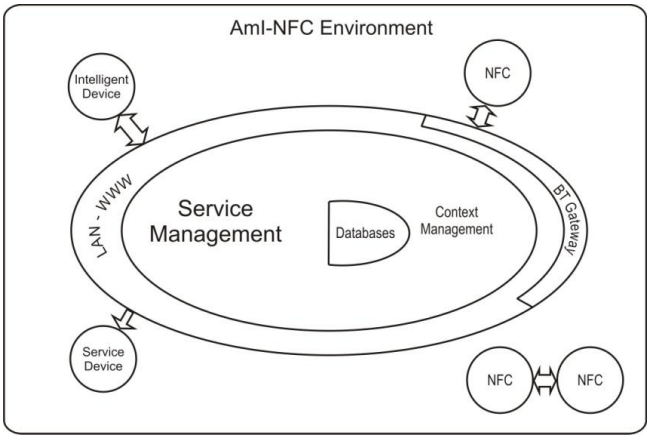

Figure 2. Element interactions in AmI-NFC Environment.

A. *Services in AmI-NFC Environment*

A service is provided when users' needs are met. The proposed system manages the need from the moment that it arises, as well as the elements that are related to it. For example, the system will know when the user generates a "note to comment", it will be notified when the users who generate it and to whom it is addressed are in the same area, and it will show the "note to comment" in a nearby display if necessary.

The services in the AmI-NFC are classified based on whether or not they require the AmI-NFC environment infrastructure (table 1). The "services in the AmI point" are delivered only with the interaction of both NFC-enabled devices. The "services in the AmI area" require the use of the AmI-NFC environment infrastructure.

VI. AMI-NFC IN RESEARCH GROUP (AMIREG)

We have developed the first stage of our AmIReG (Ambient Intelligence by NFC in Research Group) system for using the NFC-enabled cell phone in order to obtain services in a building (where our laboratory and chair holder's office are located). The main objective of AmIReG is to obtain the users located and provide services with a minimum effort (one touch). In AmIReG we take advantage of the existing computer infrastructure (LANs, public displays, computer desktops) so that we only needed the NFC devices (cell phones and tags). In addition, the system requires software for the NFC cells, the users' computers, the Bluetooth and database servers, as well as that software required for the computer that controls service devices (i.e. printers and public displays).

Table 1. Services in AmI-NFC environment

Service Name	Description
Services in AmI-NFC environment **Area**	
Enter/Exit	When user touch this NFC tag, the AmI management will consider or let consider it within the AmI
Store File	Copy file to file server. The user will set up who can access to the file
Associated file	When a file is stored in the server the owner can modify the allowed users
Load File	Save file in NFC device
Show file	Show file stored (in NFC device or server) in display
Visualization	The public display in area are customize to users.
Note to Comment	The user carries out notes in NFC devices, which want to comment on with somebody next time that meet. The system detects them in the same area
Post-it NFC	User equipped with NFC-device (not tag) can leave a note in any NFC tag. To specify user or any user touch the tag
Synchronize	Process so that is equal the information of the device and the desktop computer
Services in AmI-NFC environment **Point**	
Scheduling date	The user selects an option of looking for a meeting with another people. By just putting the cell phones close to each other, the system looks for and selects a suitable meeting arrangement
Business card	Bringing cell phone near each other in order to exchange the presentation card
Serving File	Send file from NFC device to service devices

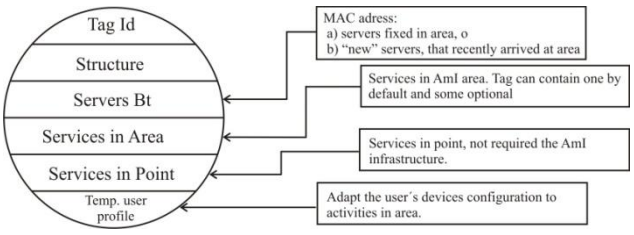

Figure 3. NFC-tag structure

In this first phase, each research group member had an NFC cell phone. At the same time, tags were placed in doors, public displays, printers, and desks. Upon arrival in the building, users must touch a tag located in the door with their NFC cells (so that the corresponding data base is updated). At this moment, a public display updates the localization and a message is sent to all computers that are executing AmIReG.

Users can leave notes to other users in the tags found in the desks. The NFC cells can save predefined notes or, alternatively, users can write them using their NFC cells. All the printers located in the office and laboratory have a tag so that any user can print a file by deploying an NFC cell (physically stored or virtually associated, i.e. accessible file saved in server). The tags in public displays allow users to interact with the displayed information and transfer this information (see examples in Figure 4). With the use of AmIReG we find opportunities to improve the service, along with some options that we had not considered before. For instance, the SerBo (service board) is a board with several services in one place. Thus, we find places where some users need several services, and SerBo can have a tag for each service offered

VII. TAG-NFC STRUCTURE

our proposal we will take advantage of the tag-NFC being automatically read by cell-NFC, when touching. The corresponding application installed is executed automatically. The tag-NFC can be used in two situations:

- One service-one tag. If a user perceives a single service when touching the tag-NFC (e.g. the tag only opens the door).
- Several services-one tag. The tag-NFC contains several services (e.g. the tag not only opens the door, but also may contain notes for specific users or for all users who touch it, a file for the office's owner). In this case, data distribution is fundamental for optimal advantage of tag-NFC.

When a tag-NFC is associated with one service, this service is executed by default. If it contains several services, some of these are executed by default and others are based on the context (it can be a service for everyone, for a group or for someone in particular). In addition to the services, the tag-NFC must include a tag ID, a path of Bluetooth services (several if one or more are off-line) and information about the tag-NFC content. We define a structure for the tag-NFC that comprises the following elements (Figure 3):

- Tag ID. A default serial number that will be associated with the device and its location in the AmI.
- Tag Structure. This defines the fields that come next.
- Bluetooth Servers. They contain at least one MAC address of a Bluetooth server, although they will regularly be three. These servers can be permanent in an area or, in the areas where there are no computers; there will be laptops that have just arrived in the area.
- Area services. They require the infrastructure of the AmI since they are needed for consulting or modifying a database.
- Point services. They are services that do not require the infrastructure of the AmI, and are directly satisfied by other NFC devices (e.g. exchanging business cards, leaving or reading post-its).
- Temporary user profile. They adapt the user's devices configuration to activities developed in the area. When the user "leaves" the area, the devices return to their previous configuration.

Figure 4. Tags and touching interaction in

VIII. CONCLUSIONS

The use of NFC technology in the AmI environment is a step further in achieving the ideal vision of ubiquitous computing or ambient intelligence environment. Although it is not a totally proactive system, touching interaction is a somewhat explicit task that generates savings in terms of effort, compared to the traditional way of interacting with devices. Moreover, the fact that the system is embedded in a cell phone will facilitate its widespread use.

We have developed the first phase of an AmI-NFC environment at the AmI research group - AmIReG (Ambient Intelligent Research Group). This is an intelligent environment that can provide services, with minimum efforts, to a group of users who have common interests working in collaboration with each other. These users may have schedules that are frequently intertwined so that there will be a constant information flow among them. AmIReG will be able to manage a number of areas and points of service on different floors in one or more buildings. [12].

The use of AmIReG in our research group it show to use that of Bluetooth to connect the NFC-cell with the service servers it represents a saving compared with the data transferring through GPRS-connection but required computational infrastructure, and the use of the complete memory of the NFC-tag allows to offer a greater amount of services in a place. All users think the application was very simple to use and reduction in interaction effort.

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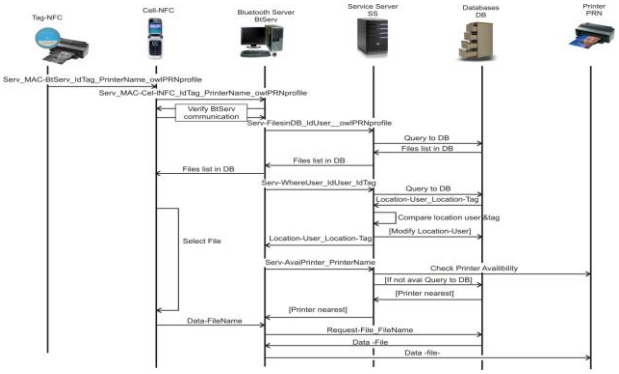

Figure 5. Information flow of print service of an associated file

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