

# NFC APPROACH: TOWARDS A SIMPLE INTERACTION

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## ABSTRACT

Nowadays, there are devices with great computing capabilities and these in different places around us. This technology opens us new possibilities and allows us the simple and easy interaction between user and computer. We propose in this work an approach to make it easier to handle information in the educational context; we have adapted Near Field Communication (NFC) technology which provides a simple input to the system to come from the own context like of the environment. For this, it is necessary only the user bring his/her mobile phone, equipped with a radiofrequency reader, and near it to tag obtaining services like localization, access, presence and, the most important for us, the visualization of information.

## KEYWORDS

Ambient Intelligence, Ubiquitous Computing, Everyday Computing, Mobile Technologies, RFID, NFC.

## 1. INTRODUCTION

There are many researchers who propose to develop ambient intelligence and to do our activities of simple form. To change our daily life supported by small devices with specific functionalities situated in the environment placed around us. For this, it is necessary that the system has sensorial inputs which will give a context awareness that senses the users' presence.

At present, the main input to the computer is given in an explicit form. If we want to automate our everyday life (Everyday Computing), we would have to give to the user a simple interaction; an easy and natural type of interaction arises. Schmidt (Schmidt 2002) defines the concept of implicit interaction. He argues that this kind of interaction allow the transparent use of the computer systems, enabling the user to concentrate on the task not on the tool. The interaction between the user and the system is provided by the physical environment itself. The system must have the capability to anticipate the actions of the user by getting the appropriate contextual information. Following in the same line, this author proposes the concept of "embedded interaction" (Schmidt et al. 2005). This concept proposes embedding technology in devices of daily use and in a conceptual level, embedding interaction in the activity and tasks of our everyday life.

To achieve these goals, technologies need to be adapted. These do not have to be new, but their functionalities certainly do, offering us as implicit inputs to the system without the user's participation. For that, we have considered the RFID (Radio Frequency IDentification) technology is a good candidate, with it; the user may interact with the environment in the way that Schmidt proposes. The inflexible placement of devices, the small amount of information that can be stored in tags and, finally, the cost, are important aspects that limit this method. Due to this, we present another possibility in this work: NFC (Near Field Communication) technology. This combines an RFID reader with a mobile phone as well as other capabilities: storage, communication, and the identification process. Both technologies (RFID & NFC) have been put in practice in modeling educational experiences (Hervás et al. 2006) (Nava et al. 2007) and specifically in the traditional classroom (Bravo et al. 2005). In the next section we present the technologies, subsequently, we show the context where the technologies are used. In another section we mentioned how could obtain awareness from of own environment. Finally, we talk about the conclusions we have drawn.

## **2. TECHNOLOGIES FOR THE IDENTIFICATION**

This type of technology that has sensory capabilities provides to us a wealth of services. There are benefits that we find coming from the simple act of identifying users. This process in intelligent environments are varied: localization within a context, visualization of specialized information, access to particular zones or places of a certain type of people and their presence in those areas, etc., those are some examples that we have seen.

Some authors have made experiments to carry out identification within an organization. The experiment of Beigl and Gellersen “Mediacups” proposes identification by small devices embedded in objects of daily use (Beigl et al. 2001). Other authors have undertaken a search for mechanisms to carry out identification and tracking. Want and Hopper (Want et al. 1992) use a small infrared device which emits signals that are caught by various receivers located in different parts of a building. We have focused on two technologies that are described in the following section.

### **2.1 RFID**

Although it seems recent, this technology came into World War II to identify objects. In the 60’s it began to be used commercially.

RFID technology consists basically of three elements:

- Readers or transceivers. These devices are in charge of mediating the flow of information between the computer and the tags.
- Antennas. They are responsible for sending and receiving the electromagnetic wave.
- Tags or transponders. Important elements consisting of a microchip that stores data, along with a microantenna.

The readers have an operation frequency and are divided generally into three basic ranks: low (125 KHz.), high (13.56 MHz.); these are the most widely-used; lastly, ultra-high frequency (UHF).

As has been mentioned, the tags are a fundamental and an important element. Here is the storage capacity of tag, which at the same time limits the interaction with the context. The tag can store just over 1 Kb of maximum information, although there are manufacturers who promise more capacity. This space on this memory size for storing the unique identifier should be made as small as possible but in any case, there is still only room for just a relatively small amount of information for the actual interaction with the environment.

RFID technology operates of the following way: the reader sends a series of waves to the tag and these are caught by the microantenna. These waves activate the microchip by means of the microantenna, with the aid of its circuit transponder; the energy is taken from the wave to transmit the unique identifier and the information contained in the tag.

This technology allows us to capture information from the environment in an implicit way, without any additional effort to the user. The services that are offered are obtained in the same way. We have employed this technology in different contexts (Bravo et al. 2006), thus supporting the users’ everyday life.

### **2.2 NFC**

NFC technology was developed by Philips and Sony in 2002 and is being propagated by Nokia, Samsung and the Philips Company itself. This technology totally changes the way of understanding traditional RFID installations. Now, the reader is mobile and the tag can be fixed or mobile. In addition, the tag will contain contextual information, solving the problem of the small amount of space that was available for the information storage in RFID.

This technology consisting of the integration of mobile telephony with identification by radiofrequency, it provides an intuitive communication between electronic devices, which is at the same time simple and secure. It works at a distance of between 5 – 10 cm. to 13.56 MHz and transfers data up to 424 Kbits/sec. (NFC Forum 2006).

NFC technology consists of two elements:

- Initiator. It is responsible, as its name indicates, to begin and to control the information exchange.
- Target. It is the responsible device to reply of the initiator's requests.

There are two forms of operation in an NFC system: active or passive. In the active form (figure 1a), both devices recognizing each other automatically, generate their own radiofrequency field to broadcast the data. In the passive form (figure 1b), only one of the devices generates the short range radiofrequency field, providing energy to a tag that was inactive, allowing it to be able to read or write data in its memory (Harold 2005). In addition, Figure 1 and 2 show the four NFC modes of operation.



Figure 1. Active and Passive forms of operation

Figure 1a shows two devices with NFC technology, a mobile phone and to its right a reader. They generate the short range radiofrequency field. In Figure 1b we can be observed devices with NFC technology, a mobile phone and to its right the electronic tags that are used with this technology. Here, the mobile phone is responsible of generating the short range radiofrequency field.

There are two characteristics which distinguish NFC technology from RFID technology are that:

- Two NFC devices are recognized each other automatically (contactless) can only work a short distance from each other (figure 2a).
- An NFC device can work as Initiator or Target (figure 2b).



Figure 2. Operation's modes in devices NFC

In Figure 2a, we can see two NFC devices that recognize each other automatically, by just bringing them close together; a similar case (figure 1a) would be that of a reader and a mobile with NFC technology, and in Figure 2b and Figure 1b, an initiator device (reader / mobile) and a target device (tag).

The change toward a mobile reader comes from to new need that is contact interaction. This process is very simple because it is only required to bring a mobile phone and to approach it the tag. Likewise, this tag could be embedded anywhere, allowing different services to be activated in the environment.

## 2.3 Exploring both technologies

In RFID technology the user only has to wear a tag and pass within the radius of the wave that is emitted by the reader; the information stored in the tag and its unique identifier are then taken and read in order to begin the necessary processes and offer services, that is, the implicit interaction exists within the context. As we said previously, certain devices need to be available with the computer system.

NFC technology does not require to be supported by a server due to the capabilities of the mobile phone, some services can be offered by itself. However, requires an explicit interaction, for it, the user just has to bring his/her mobile phone close to the tag, that is embedded in the doorframe, and the information needed for example to open the electronic lock is sent to the autonomous device via Bluetooth.

In the following table, a comparative study of both of the afore-mentioned technologies can be seen. We obtain a great variety of benefits from NFC technology with a small increase in interaction, explicit vs. implicit.

Table 1. NFC and RFID interaction

	NFC	RFID	Interaction	
			NFC	RFID
Devices	Mobile phone, tags	Computer system, readers, tags	Explicit	Implicit
Reader	Continuous movement, embedded in the mobile phone	Fixed in the environment	Explicit	Implicit
Tag	Fixed in the environment or mobile	Continuous movement	Explicit interaction	Natural interaction
Storage of data	Greater capacity, 760 bytes. Use of the memory of the mobile phone	Limited capacity, 64 bytes	-	-
Cost	Reasonable	High	-	-

## 3. SCENARIO: AN EDUCATIONAL CONTEXT SUPPORTED BY NFC TECHNOLOGY

Until recently, the context has been used in computer systems as rich source of information. The context/environment in which the interactions are developed involves an implicit understanding in many situations. Interaction between humans is reinforced by the richness of language, gestures, rules of coexistence and social interaction, something that does not happen in our interaction with the computer. In her, explicit interaction is required, along with an adaptation to the computer context. With respect to this, Dey and Abowd have defined the context 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 to the interaction between a user and an application, including the user and applications themselves”* (Dey and Abowd 1999).

If we want to obtain services, doing use of our own environment, of an easy and simple way is necessary that each one of the elements and devices that compose it are available, for it, with adhering electronic tags only, in sticker form, to the object to which we want to associate it. For example, the visualization that is an important service. Visualization is a service that is needed to express the knowledge that is required. To achieve this, the user has to be identified by e.g. when the user is giving a presentation about the subjects that he/she has investigated. This service is controlled by a computer.

Our starting-out point corresponds to groups of students who are doing Teacher-Training. The different users participating in this educative environment have to build different actions with electronic devices so that they can project and explain the presentation that they have organized, in a cooperative approach. Other practical was observed with the following group of students where, also using technology NFC, they could obtain information of a bulletin board, to take it and if they require extending it more lately. So that, these two practices can be carried out, the support of the corresponding identification technology is required.

We have mentioned different mechanisms for user identification and localization in the previous section and the identification technologies which optimize the advantages that NFC offers over RFID was described and the context of the users has to be tagged. This means getting an awareness of the acts and actions that have to be performed in any given place. The information stored in the tags depends on the place where they are found, namely on doors, notices, boards, etc. One of the most important services deriving from identification in the classroom is visualization. In the next section we present two approaches.

## **4. ACTIVITIES SUPPORTED BY NFC: EXPERIENCE & EVALUATION**

The interactions that are carried out by the users within an educative context are very rich. Sharing information by means of papers, displays, conversations, taking notes, discussions and so on are the normal forms chosen by users. Until now, these interactions have not been fully taken advantage of in this environment. For it, it is necessary to develop new interfaces to speed up the process and to help in everyday activities, and these, present a new challenge: the evaluation of the systems. This assessment is a multidisciplinary set, and due to it, there needs to be experimentation and observation of the actions and reactions that the users and computer devices share.

There are certain steps for supporting the construction of different applications have to be followed if this process is to take place, in this sense, Schmidt (Schmidt and Van Laerhoven 2001) proposes to verify the followings points in the production of these guidelines:

- Identify the contexts to study.
- Build and Assess a prototype.
- Integrate signals of processing and context abstraction.
- Build applications.

The assessment of the devices and systems was carried out in the main hall of the School of Computer Science of Castilla-La Mancha University. We set up the devices needed to make it possible to carry out the experience where the Teacher-Training took place. The devices that were involved were the computer, screen, mobile phones and tags. It is important to take note that the students have not seen the computerless scenario before.

The information organization that the students wanted to present to their companions was done by a small computer system that we developed to that end. This program allows simple slides to be constructed by just keying in the principal text (title) and secondary text (contents). Furthermore, it is also possible to attach images and graphs. Finally, the tool generates an exit XML that represents the knowledge of the user and, for us, the information that is stored in the database. The students did not physically use the computer in the environment where the experience was conducted. It was not necessary to run a program such as Power Point to show their presentation. The use of the mouse was not necessary either; just touching the navigation tags was enough. In the following sections we explain how this works.

### **4.1 Presentation supported with NFC**

In this experience, we have focused in the educational context where the students present and show the knowledge acquired to members of other groups with the visualization service. We took the advantage of this environment to carry out an evaluation, bringing with us a mobile NFC phone. The students who participated in this experience touched the control tag that contained the instruction about their presentations which they had produced previously.

The operation is very simple; once the teacher brings his/her mobile phone close to the control tag, embedded in the screen, the class begins when touching the tag with the mobile phone (2 cm.). The data stored in the tag are read by the mobile NFC phone and the information that it is stored in the same memory of the mobile phone or in a data base, are taken automatically initiating their transference and the presentation, which has been prepared before for the class, is visualized. Other tags exist for supporting the interaction of the presentations. In order to pass slides, all that we need is to handle is the corresponding tag. The teacher has the option of changing subjects, selecting one of these, going forward or back. Another way to interact with the presentation is with the mobile phone, that is to say, through its keyboard. To do so, a program has to be downloaded and this can be done by just touching the control tag.

For this case, the mosaic is structured in 3 zones (figure 3). In the top left the teacher's syllabus, which he/she distributes for the course, is shown. On the bottom left hand side, there are the documents for supporting the subject that is being dealt with by this group. Finally the large zone, on the right, visualizes the topic that is being explained at that moment. Thus, by simply nearing this device to a tag, their presentation was activated. The actions have to satisfy two different profiles: that of teacher and that of student, respectively.

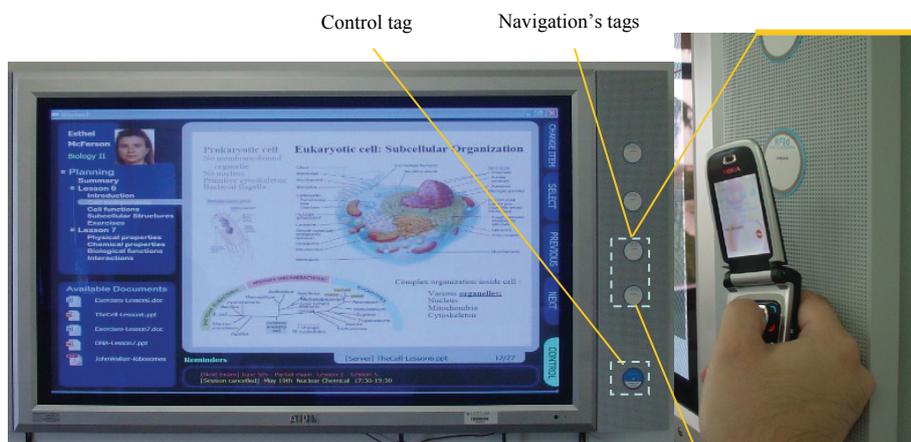


Figure 3. Structure of visualization mosaic, and tags embedded in the screen

The results that we obtained from this evaluation can be appreciated in Table 2. The great interest in, and novelty of, the technology embedded in the mobile phone found great acceptance. The success of the automatic projection of their presentation by just bringing the mobile phone near to the control tag must be underlined. The interaction with tags was satisfactory (moving slides, navigation, etc.).

Table 2. Experience of the presentation supported with NFC

	<b>Interesting</b>	<b>Not Very Interesting</b>
Do you find the new technology embedded in the mobile phone interesting?	62.5 %	37.5 %
	<b>Innovative</b>	<b>Not Very Innovative</b>
How innovative did the way in which the presentation was taught seem to you?	62.5 %	37.5 %
	<b>Yes</b>	<b>No</b>
Is the interaction by touch done by means of the mobile phone appropriate?	87.5 %	12.5 %
Do you think that a broad knowledge of computer science is needed to use the system?	75 %	25 %
Do the mosaics display the information appropriately?	62.5 %	37.5 %

## 4.2 Bulletin board with NFC

This experience was similar to the previous one, as soon as, to the use of the technology it refers. There was a different change in the environment. In this occasion the students were approaching a bulletin board, and with the mobile phone, they were taking information that seem to them interesting and, thus, could take them in a very easy and simple way. The students who took part in this experience also had to touch the tag.

The operation of this experience is simple; the user must bring his/her mobile phone near the tag that is fixed next to the news displayed there (figure 4). The important of this experience is that at the same time of taking the information contained in the tag, of an easy and simple way, only a touch. With the identification of the user and a “mark” that exists in the tag, in addition to the information corresponding to the document, and the profile of the user stored in the mobile phone, an additional service (awareness) can obtain, that is to say, that to the moment to touch the tag fixed there, a matching is done to obtain an implicit service. This service initiates notifying the existence of more information related to the topic that has been examined and if it approaches a display, touching the tag of control, this one will show them the additional corresponding information to his/her user's profile.

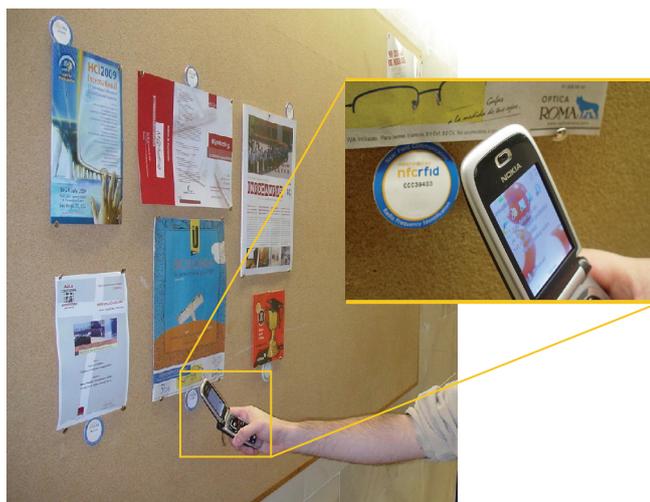


Figure 4. Bulletin board supported with NFC technology

In Table 3 it is possible to appreciate the results of this experience. The participants also thought that they found the technology embedded in the mobile phone interesting. They considered innovator the fact that just by to touch a tag, they could take the information stored in, in addition to obtaining an additional service, depending the type of preference in his/her mobile phone. The experience that they had with this technology was attractive and simple to use.

Table 3. Experience of the bulletin board supported with NFC

	<b>Innovative</b>	<b>Not Very Innovative</b>
How do you value to this experience?	75 %	25 %
What do you think about the fact of identifying your profile and implicit services are provided to you?	75 %	25 %
	<b>Interesting</b>	<b>Not Very Interesting</b>
Do you find the new technology embedded in the mobile phone interesting?	87.5 %	12.5 %
	<b>Yes</b>	<b>No</b>
Is the interaction with the mobile phone suitable for taking the information that you were interested in?	87.5 %	12.5 %
Do you think that a broad knowledge of computer science is needed to use the system?	37.5 %	62.5 %

## 5. CONCLUSIONS

New forms of interaction with technologies and devices embedded in the environment allow the users to become involved in Ambient Intelligence. In this particular case, we see how this occurs in the field of education. The ease of having devices with computer capacities, communication and storage allows users to handle information, documents, and presentations, in other words, all that is necessary in an educative context. In this work we have demonstrated how integrating RFID technology into the mobile phone as NFC allows us to make the users' daily life easier and more efficient. The use of the mobile phone is a part of the everyday life of students and other people. The students that participated in this scenario felt very much identified with this technology.

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