

Context Aware Applications on Mobile Environments - Engaged by the use of NFC

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Abstract. Nowadays the improvement of the hardware of mobile devices, whether it be in processing capacity or the diversity of sensors they possess, make them the ideal platform to develop context aware applications. By obtaining information from the user and the context where he or she is, applications which adapt their performance to the current context and user preferences can be created. User interaction is often necessary where the user modifies the application to establish some parameters or configure the beginning of a new task. This paper introduces the present fields of action of the NFC (Near Field Communication) technology. In the end, the advantages of using NFC are presented and how they help context aware applications allowing the creation of faster and more natural interactions with the system as a result of establishing a new context controlled by the user by only approaching the device to a NFC tag.

Keywords. Mobile, Context Aware, NFC

1. Introduction

A mobile device, such as a cell phone, is present in almost every activity that a person realizes along the day. Due to the fact that a person's attention isn't focused in the device permanently, the application should have little but representative information. On the other hand, applications should take into account the context. "Context is any information that can be used to characterize the situation of entities (i.e. whether a person, place or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves" (Dey, 2001). If there is a meeting scheduled in the appointment book, the cell phone should be in vibration mode, as well as if the person is giving a speech in a conference. In exchange, if the user is travelling on a public transport and there is too much noise around, the mobile phone should vibrate and ring at the same time. Being aware of the

working hours, having scheduled meetings and important appointments in the calendar, these configurations can be automatically carried out. The characteristics of context aware applications and the sensors of mobile devices, which can contribute giving information to these applications, are presented below.

2. Context Aware Applications

There are many definitions about context aware applications, so only three of them (that are considered as the most representative) have been chosen. A context aware application:

- Possesses the ability to automatically adapt its performance as a result of knowing the use of context. (Abowd, 1999)
- “...the context is used to provide information and services to the user, where the relevance depends on the task that he or she is doing” (Dey, 2001).
- “Automatically provide information and/or take actions according to the user’s present context as detected by sensors” (Brown, 1999)

In summary, context aware applications obtain information from the user and the context where he or she is located at the time of using this application, and can foresee a future context by information provided by the user to the system. For example, the context aware application “google now”, check the events in the user’s appointment book and if the present user’s location is different from the place of the next appointment, the application shows the destination in a map and calculates the time of the trip taking into account the traffic information along the suggested route.

In the Figure 1 and 2 there are screenshots of Google Now in a mobile device. The Figure 1 shows “It is time to go...”, due to the fact that the destination is scheduled, the system calculates and alerts the departure time.



Fig. 1. Google Now alert to begin a trip in time.

In the Figure 2, the user can visualize the arriving time to the next destination and this location in a map.

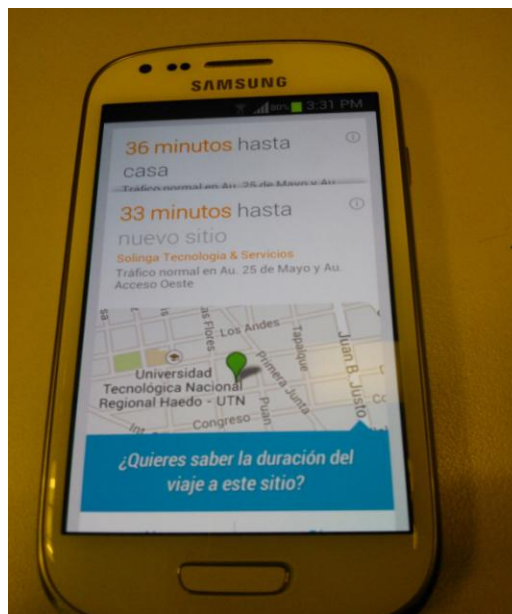


Fig. 2. Calculation of the route and automatic query of the traffic – Google Now

To make these applications successful, the user must feed the system with relevant information. In the example of the appointment book, user must indicate the location of the next reunion. On the other hand, the application needs to take information from the context by different sensors, for example getting the present location by the GPS and wifi networks.

Nowadays mobile devices and mobile phones in particular, offer the necessary hardware and information to make complete applications full of context information because of two reasons:

1. Mobile devices and mainly mobile phones are personal. Because of this, the user is able to put in them information about him/herself and his/her activities and appointments. Many times they are used as personal diaries. They might have information about:
 - Contacts: Names, telephone numbers, emails, birthdays, address.
 - Planning: Tasks and activities put in the schedule.
 - Personal preferences.
 - Access to social networks, which allows the creation of interactive applications.
2. They have several sensors to obtain context information. Among them can be mentioned:
 - GPS: to establish the current location when the user is in open spaces.
 - Accelerometer: to determine device movements, this can help to establish the user position when he or she is in enclosed spaces.
 - Compass: to exactly know where the device points at any time.
 - Gyroscope: to know the device inclination. This makes possible the development of rich interfaces which allow changing the visualization of the screen between landscape and portrait mode.
 - Proximity sensor: detects closeness and movements without touching the device. Ideal to create interfaces where the user is not able to physically handle the device.
 - Camera: to take context pictures, and with recognition software give the user information about what he or she is looking at.
 - Wireless Communication: Bluetooth, WiFi and telephone networks allow sharing information with near devices, internet access and determine the current user location thanks to the presence of a certain network.
 - NFC: NFC sensors (Near Field Communication) can respond in different ways when reading a tag close to them. This will be explained thereupon

One important characteristic about mobile devices is ubiquity. With the advancement of smart phones, they can now resolve complex problems so users carry them all the time in their daily activities.

3. NFC

Near Field Communication (NFC) is a wireless technology that enables data transfer between close devices (10 centimetres). The transmission frequency is 13,56 MHz (doesn't require license). (NFC Forum, 2013).

Two devices take action in a NFC communication:

- Active: the device generates its own electromagnetic field and uses it to establish the communication reading or transmitting data to other device.
- Passive: aren't able to generate its own electromagnetic field, so they have information that an active device can read or even modify.

The one who initialises the communication is the active device. In some cases, if two active devices want to communicate, one of them must act like a passive device so that the other can read and modify its information.

The ISO/IEC contains rules for NFC types 1, 2 and 4. By contrast, type 3 belongs to a Japanese normative called Japanese Industrial Standards (JIS), in particular JIS 6319-4 which has been denominated as well as FELICA. Table 1, made on the basis of (NFC Forum, 2013) and (Minihold, 2011), presents the characteristics of every NFC type.

Table 1. NFC Types

Type	Normative	Capacity	Velocity
1	ISO/IEC 14443A	96 Bytes Expandable to 2 kbyte	106 Kb/s
2	ISO/IEC 14443A	48 Bytes Expandable to 2 kbyte	106 Kb/s
3	JIS 6319-4 (FELICA)	1Mbyte	212 kb/s 424 kb/s
4	ISO/IEC 14443A / B	32 Kbytes	106 kb/s 212 kb/s 424 kb/s

NFC is currently integrated in: Mobile Phones; Tablets; Games Consoles (e.g. WiiU); Cameras (e.g. Sony NEX-5T). The integration of NFC to other devices is

being planned: Book readers (e.g. Sony Reader), Notebook (e.g. HP Elite Book, Dell XPS12).

Every device mentioned has active NFC tags but there are also passive tags in key-rings, cards, etc. These tags are low cost, which allow including them in different environments.

4. NFC Implementations

This section presents a review of NFC implementations in different environments:

1. Academic (Bueno-Delgado, 2012);(Borrego-Jaraba, 2013):
 - Students' assistance registration by means of NFC tags.
 - Quota payments
 - Control access system with NFC, which allows university personnel to enter some buildings only touching a NFC tag with their mobile phones.
 - NFC Library: Allows every member to borrow books, software, etc in 2 steps: (1) the user touches the NFC tag located in the back of a book and obtains its information; (2) the user touches a NFC reader of the library to finish the loan.
 - Access system to bibliographic resources for each subject. A mobile library service is provided to allow book search, showing as a result a map with its physical location. This project was called *SmartLibrary*.
 - Information related to professors can be accessed, such as: request a meeting with them and obtain the information content anywhere at any time.
2. Automobile, BMW realizes research activities to implement NFC functionalities (Rainer Steffen, 2010):
 - Bluetooth synchronization (process between the mobile phone and hands – free devices: this can be made just touching the NFC tag of the car with the mobile phone.
 - Car customization for different drivers (sound, air conditioned, screen mode, side view mirrors, seats, last destinations, etc.)
3. Payments (Broll, 2009), (Rainer Steffen, 2010):
 - Applications to purchase cinema tickets. This can be made by situating posters with different images on it (each one with a NFC tag). The poster must have the indications to buy a cinema ticket, showing the different available movies, timetables, number of people who have bought the ticket yet, etc.
 - Electronic Bill, through intelligent card systems like *Octopus Card* in Hong Kong, *Suica Card* in TOKio, *Oyster Card* in London or *Touch & Travel* in Germany.
4. Senior citizen assistance (Castro Garrido, 2010):
 - The purpose is that in case of emergency, a user can ask for help in an easy way. Touching a frame with an image on it with the mobile phone, it generates two service possibilities: a) a phone call to the emergency number, and b) the sending of a text message to two different relatives.
5. Geolocalization in internal spaces (Busra Ozdenizci, 2011):

- Users which have a navigation application in their phones, can determine their current position inside a building by touching a NFC tag of the building with their mobile phone.
- 6. Intelligent Building (Yue-Shan Chang, 2009):
 - The devices are controlled by the request of the NFC phone. A NFC mobile device can act as a key to enter to a physical space and also it can control different devices of the environment to manage an intelligent space.
- 7. Information and Tourism (Enrico Rukzio, 2007):
 - Applications are being developed to satisfy: tourist guide, museum and mobile interaction with public posters. The idea is to obtain detailed information by touching certain objects with a mobile phone.

5. NFC advantages in context aware applications

Context aware applications automatically take information from the surrounding environment to adapt its functionality to the current situation. But many times this information is too large to build a particular application. The user takes part at this point by configuring the application and indicating the actual context. For example, the sound profiles changes depending on the place where the user is located: in a meeting, driving, or in an open space. These profiles can be manually or automatically changed by detecting context parameters like a wifi network by using specially designed applications e.g. *Profile Flow* (Profile Flow, 2013). In some occasions the context isn't static, so there is no way to automatically detect it, consequently, user intervention is essential in these cases. This is where NFC helps the user by quickly controlling an application when he or she approaches a mobile device to a certain tag. E.g. a teacher who enters a class, can touch a NFC tag with his/her mobile device and consequently the phone will change its sound profile to vibration mode and furthermore the device can bring the list of students in order to register the assistance. Then, when the class has finished, the teacher touches the NFC tag again and his/her profile sound go back to the original mode. When he or she is going back to his/her house, the hands – free can be activated when he/she enters the car.

These are some examples of how fast a user can control an application. In a certain way, the user indicates the current context to the phone when approaching the device to a certain tag and waits for the application to change its functionality. Besides, a certain tag could be used to modify the phone functionality in different ways according to the user's profile, e.g. the same tag situated in the class room can be used by the students to register their assistance.

NFC tags also allow adding information to physical objects and getting that information in a direct way without the need of having an internet connection, because that information can be stored in the tag. This is useful for example in museums where the users can get brief descriptions of each piece of art without using network resources. And going back to the later example of the class room, the tag could allow the students to download exercises formulations at the time they enter the class.

6. Discussion

The access to a descriptive text stored in an object could have made through a QR code (Quick Response Code). However, there are a certain number of requisites:

1. Code quality: printed in an appropriate size, etc. In some cases it might be difficult to read the code stuck to a stained glass because of light reflections.
2. The user must have a reading system installed in his/her mobile device and he/she have to aim the camera of the device to the QR code.

A NFC doesn't require user manipulation, the application reads the tag by approach, it doesn't exist any difficulty like the reading of a QR code in some places. Passive NFC tags inside cards, key-rings are low cost and the storage possibility is quite important. Referring to hardware, nowadays almost every mobile phone for sale has an integrated camera which is necessary to install a reading program in order to read QR codes. A user who has a device without camera will not be able to obtain this information. The same matter occurs with NFC. In this case, the problem is bigger because for example the same model of a mobile phone may include NFC or not depending on the country where it is bought. These situations make it difficult to develop massive applications that use NFC technology. Nonetheless the tendency is incorporating the technology in every new device.

This technology, with the help of mobile phones' existing sensors is promoting the development of new context aware applications that give useful information to users in the right moment (maps, available route, information about some object, time of a certain trip), changing the functionality of the mobile device taking into account their activities, and personalizing other objects e.g. a car (height of a seat, favorite radio station, etc.).

Regarding to security, as NFC is a short-distance communication, it doesn't present difficulties in terms of signal interception. A phone can't read a NFC tag when it's locked. This prevents that anyone can close a tag or device to a user phone for example stored in a pocket an trigger an unwanted action. And if the NFC is used for payment is important to also ask for a user password to validate the transaction.

7. Conclusions

Mobile devices offer the ideal hardware for context aware applications due to their ability to obtain environment information where they are located. They are also capable of accessing user's personal information. These types of applications make tasks easier to the user and offer helpful tools in different situations.

NFC is a technology easy to integrate in diverse devices; it is in constant progress and allows completing these applications by developing more natural interfaces for the user.

The present paper shows the different ways to use NFC with context aware applications, e.g. having a NFC tag inside the car so that the telephone configuration

can be changed or even to adapt the car to the user's needs. It may be noticed the huge NFC implementations in today's world.

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