

NFC–Capable Mobile Devices for Mobile Payment Services

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INTRODUCTION

An old saying coming from the telecom world states that nothing can be really considered as a service unless you are able to charge for it. As we move towards a service-oriented society, the necessity to pay in real time for a variety of services via different channels anywhere, anytime, in any currency increases. According to Gartner (www.gartner.com), worldwide mobile phone sales totaled 816.6 million units in 2005, a 21% increase from 2004. Due to the high penetration rates of the mobile devices, they pose an interesting candidate for the real-time payment scenarios. Several efforts have already been done (Karnouskos, 2004), but as new technology comes aboard, new capabilities are also brought along. Near Field Communication (NFC) is such a technology, which due to the industry support and its low cost (in comparison with similar ones) may become dominant in short-range communication among a variety of devices, including mobile phones. NFC is well equipped in order to facilitate mobile payments with little interference from the user side.

Mobile Payment

People today use their mobile devices to pay for a variety of mostly intangible goods such as ring tones, games, digital content, and so forth. However existing solutions are confined usually within one service provider and usually consist of local island solutions. The promising trend is to mainly use mobile devices at physical points of sale (POS) and additionally expand the payment capabilities in virtual ones. We consider as mobile payment, any payment where a mobile device is used in order to initiate, activate, and/or confirm this payment (Karnouskos, 2004). A global study by Arthur D. Little Consulting (Taga & Karlsson, 2004) estimates that m-payment transaction revenues will increase from \$3.2 billion in 2003 to \$37.1 billion in 2008 worldwide. There is evidence of the need for real-time, open, and trusted payment services that can support in a more efficient way the processes evolved in existing electronic and mobile commerce scenarios. Although in the last few years we have witnessed several standardization efforts, the rise and fall of some mobile payment services, promising technologies, ongoing trials, predictions for the future,

investments on startup companies, and so forth, there is still no solution that is open, widely accepted, and acknowledged as a clear market leader.

Several reasons exist as to why the mobile payment has not become mainstream such as user friendliness, security, cost, high learning curve for users, lack of the right business models, lack of advanced technology in devices and mobile networks, non-existent cooperation among the key players, and so on. Implementation of mobile payment services is more complex than originally thought and to provide a viable solution has been proven challenging both at the technology and business level. NFC could be one of the enablers that can lead us into effectively tackling some of the issues that have hindered other mobile payment approaches; therefore it is interesting to look at its capabilities and the context of its usage in mobile payment scenarios.

Near Field Communication

NFC is an interface technology for exchanging data between electronic devices. It represents the second generation of the proximity contactless technology, which supports peer-to-peer communication and enables access to services, anytime, anywhere, with any type of NFC-enabled stationary or mobile device. As NFC-compliant devices are brought close together, they detect each other and begin to communicate. This is done at small distances of about 10 cm (4 inches). NFC is based on RF technology at 13.56 MHz, is standardized ISO 18092, and is backwards compatible with ISO 14443. The data exchange rate can be up to 424 Kbit/sec (while 1 Mbit/sec is planned). NFC was designed with the goal to be easy and intuitive to use, in order to be successful also among the technology illiterate users.

NFC devices operate in two different modes:

1. **Reader Mode:** This mode allows the communication with other tags which effectively transforms any device to a fully capable tag reader.
2. **Card Emulation Mode:** This enables the device to behave like a tag itself which can be read by other devices in reader mode.

Standardization of NFC is done within the NFC Forum (www.nfc-forum.org), which was launched in 2004 and in

the meanwhile has more than 70 members, many of which are key players in their domains and drive the consortium to success. The Nokia 3220 mobile phone (Nokia, 2004) was the first NFC-enabled device that was brought to the market and delivered all the services envisioned by the NFC forum including service discovery, ticketing, and payment. Today other mobile phones also exist such as the Samsung SGH-X700. NFC is compatible with Sony's FeliCa card (<http://www.sony.net/Products/felica/>) and the broadly established contactless smart card infrastructure based on ISO 14443A, which is used in Philips' MIFARE technology (<http://www.semiconductors.philips.com/products/identification/mifare/>). This backwards compatibility with the existing infrastructure will ease the introduction of NFC-related services, as not everything has to be done from scratch.

COUPLING NFC WITH MOBILE PAYMENT SERVICES

NFC can be used as a communication protocol for mobile payment applications. In a typical scenario, the user would simply bring in-contact his mobile device with the payment point of sale (POS), and the payment transaction would occur. NFC-enabled devices (e.g., mobile phones) provide an additional security layer since they can transmit encrypted payment information to a POS in a way similar to that used with RFID-enabled credit cards. Furthermore, beyond the existence of an NFC-compliant tag capable of storing a unique ID and transmitting encrypted data at 13.56 MHz using the ISO-19082 air interface protocol, NFC devices also feature a smart card microcontroller. The last can be used as a secure storage for applications and credentials that can be used in payment applications. This allows NFC devices

to store data on multiple payment options which provides a flexible base for several business scenarios. Apart from that, the ISO-18092 standard used is also compatible with the ISO-14443A standard, which is currently used by RFID-enabled POS currently installed in several merchants.

NFC devices can technically operate in two different modes which allows NFC-enabled phones the capability to:

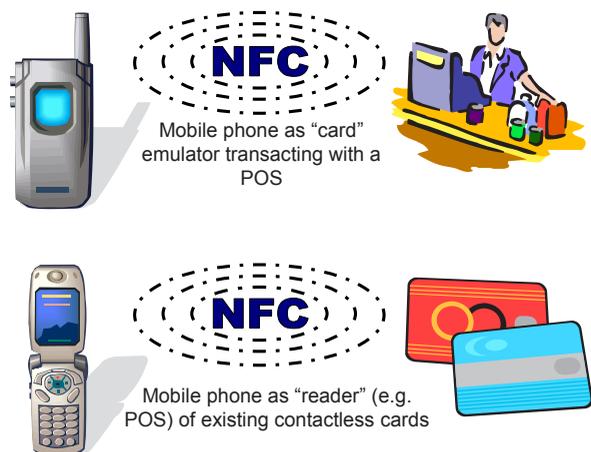
- fully replace the existing contactless smartcards (when functioning in "card emulation mode"), business and technology wise. All existing business cases that use such cards can now include NFC-enabled mobile phones, which can act as authentication tokens for any transaction.
- act as a "reader," therefore any reader/POS in the merchant side can be replaced with a mobile phone. Furthermore, the mobility advantage will make it possible to extend existing business cases.
- make possible new business cases, due to the ability of an NFC-capable device to slip into both modes. For instance in "reader" mode, information can be obtained from a smart advertisement about a concert and the video could be downloaded online from the Internet address specified by the smart tag. The user can pay online and receive the ticket on the mobile phone. Later in "card emulation mode" the user can enter the concert hall by simply waving his mobile (which now has the authentication token stored) from the respective reader.

There are numerous scenarios where NFC-enabled mobile payments can be applied such as gaming, ticketing, purchase of goods, real-time money transfer, and so forth. NFC mobile phones can fully substitute all form of cards as we know them today (credit, debit, prepaid, etc.) and flexibly enable more flexible business models and services to be built.

A number of trials using an NFC mobile phone in order to realize applications that can be hosted under the mobile payment umbrella started within 2005/2006. Most notably:

- In the city of Caen in Normandy, France, trials began in October 2005 (and initially for six months) on NFC-based mobile payments (Caen, 2005). The 200 volunteers in the trial are able to pay with their mobile phone in selected stores (retail), for parking, in tourist sights, and so on. This is the world's first large-scale trial of this emerging technology, and valuable feedback will be obtained from mobile operators, retailers, and consumers. The solution used in this trial incorporates secure, over-the-air (OTA) download of applications on a GSM network and automatically recognizes the appropriate application to launch when an NFC connection is made. The Samsung D500 mobile phone that

Figure 1. The double mode of NFC-enabled devices in payment scenarios



is used incorporates a Philips smart card chip, enabling users to make payments and use banking applications securely. The process is straightforward: to make a purchase, the customer indicates to the cashier that s/he would like to pay using the phone. The cashier prepares the register to receive payment information via NFC, and then the customer simply waves the phone in front of the terminal.

- In Atlanta's Philips Arena in the United States, season ticketholders had the chance in December 2005 to pay for purchases at concession stands and access mobile content via their Nokia 3220 phones (Philips, 2005).
- In the same spirit, Royal Philips Electronics and Telefonica Moviles España have demonstrated NFC technology at the 3GSM World Congress (www.3gsmworldcongress.com) in Barcelona, by providing 200 selected attendees with NFC-enabled Samsung SGH-X700 mobile phones to be used in a variety of transactions during the event, including secure mobile payment (Philips, 2006). Each phone comes equipped with e-money that can be spent at a specially equipped kiosk at the Philips booth. By using the touch-screen kiosk, users select and pay for their choice of CDs, DVDs, and books using the NFC-enabled phone. After the transaction, the money is deducted from the purse and a message pops up on the phone screen indicating the balance account.
- In Hanau, Germany, the trial "NFC Handy Ticketing" was initiated in April 2005. It enables 200 people who are equipped with the Nokia 3220 mobile phone to use it as an electronic ticket. The customers interact with the electronic legacy ticketing machines that were established in 2002 for RFID contactless tickets, and the data are stored in the mobile phone. The last five trips can be seen anytime, while the NFC function can also be deactivated on demand. The charging is done via the post-payment method, at the end of the month. Controlling the passenger's ticket form is easy, since the controller now equipped with a similar mobile phone simply queries the last ticket data from the passenger's phone (RMV, 2005).

FUTURE TRENDS

The future for NFC looks promising. However there are still several challenges to be mastered before the NFC finds its way into modern application scenarios. NFC brings the promise of gluing the virtual and the real world, and give rise to new innovative services. Coupling it with the mobile phone and a secure environment such as the SIM (Subscriber Identity Module) card, new business cases will emerge which will integrate more mobile phones into our life, eventually even possibly replacing all other tokens that we use today for

authentication and payment. Mobile phones could emerge as a global platform and be the common denominator via which service providers will be able to charge for their products in a massive way. However in order for this to be done, new business models need to be developed and new strong partnerships need to be formed. Standardization ensuring interoperability at all levels is crucial when we consider the heterogeneity in hardware and software available in the mobile world. The NFC Forum was founded exactly for this reason and has a promising future.

By coupling NFC with mobile phones and especially the SIM card, network operators (the owners of the SIM) come into an advantageous position. Furthermore, more dynamic and better management of the authentication token can be done since now these tokens can be installed, updated, or revoked via OTA interface. Additionally, if this is coupled with mobile presence information, new security models and risk management mechanisms could emerge. For instance the credit card (stored as authentication token in the mobile phone) could be valid within a geographical area set by its owner. Even more interesting might be cooperative scenarios among such smart tags and context-based services.

NFC can also be used for initial communication, which can eventually result in configuration and further usage of other communication protocols or technologies. Therefore, NFC could be used as a means to initiate mobile payments that can be finalized, such as via instant messaging (Karnouskos, Arimura, Yokoyama, & Csik, 2005). For instance in a taxi-payment scenario, the taxi driver simply touches the taximeter, which registers the amount to be paid in the payment application and provides to the customer all the necessary information (e.g., IM credentials, fare, etc.) for the transaction to continue via an instant messaging platform.

As mentioned NFC-devices can function as "readers" or "card-emulators." However in the middle term, "peer-to-peer" functionality is expected to be added. In that way the reading and/or writing mode would be possible which practically empowers the realization of direct data exchanges (and not via a server) between mobile phones; therefore applications such as file exchange, business cards, and so on would become a reality. For the mobile payment domain, this simply means that payment tokens can flow anonymously from one mobile phone to another. Therefore this form of e-cash (e.g., e-coins), which can be moved among devices via local interaction (no centralized server communication infrastructure needed), has the potential to eventually substitute cash as we know it today.

Security and privacy concerns will have to be fully tackled before NFC-based mobile payment services become mainstream. However, contrary to the traditional payment instruments such as credit cards, mobile devices allow more efficient risk management solutions to be deployed since now, depending on the transaction, password-code or biometric characteristics could be required for high-volume

transactions. Furthermore the mobile device can be turned on/off, and the relatively short operational range of NFC at approximately 10 cm constrains (but does not eliminate) possible remote attacks. The security required will be tailored to each service, depending on the risk management and the service's respective business model.

Currently NFC supports ISO 14443A, but ISO 14443B does not. This limits the scenarios where NFC could be used. Mobile phones depend heavily on their batteries. However there are several scenarios where we can use the mobile phone as a simple token and this should not be dependant on its battery status. In other words, in order to cover all possible payment scenarios, we need a technology that does not require that the phone is switched on or its battery charged. ISO 14443B supports such scenarios, but 14443A does not. The extension of the NFC standard to include this capability could expand the use-cases that NFC could play a critical role.

NFC is expected to be complementary to existing protocols (e.g., IrDA, Bluetooth, etc.). Its low cost (around 20¢) is still significantly less, for example, compared to Bluetooth at \$5 per item. Due to cost efficiency, as well as the compatibility with existing RFID infrastructure and the large base of smart cards, NFC creates the potential to deliver services effectively anytime, anywhere, and in a variety of channels. Effectively NFC could act as an abstraction layer that would ease the initial communication among devices and bring the vision of easy ubiquitous access to services one step closer to reality. In a service infrastructure, where tangible and intangible goods are offered and can be immediately charged for, mobile payment is expected to be highly integrated and flourish.

CONCLUSION

NFC technology is carefully taking its first steps. Standardization activities have been carefully carried out, and ongoing work within the NFC Forum looks promising. Although there are some prototype mobile phones out there, NFC technology is expected to be integrated in most mobile phones of the near future. "By 2010, we expect that over 50 percent of all mobile handsets will incorporate near field communication chips to enable short-range, easy and secure transactions," points out Erik Michielsen, director at the market analyst firm, ABI Research (www.abiresearch.com). If this will hold true, then mobile payment via NFC has the potential to reach the critical mass rapidly and emerge as an integral part of our future everyday transactions. The first commercial platforms such as the one offered by MobileLime (www.mobilelime.com) are already underway. NFC has learned from previous efforts on new protocol introduction such as Bluetooth, which looked promising but was complex and low on execution. NFC is compatible with existing infrastructure (i.e., Felica

and MIFARE) which may give it a significant advantage. Also its nature—such as the short-distance communication and user-friendliness—has an initial positive effect on security and privacy issues, which in any case need to be further investigated. Finally it is pointed out that NFC, amalgamated with mobile payment services, could realize a universal "touch-and-pay" approach anywhere, anytime, in any currency, which in its turn may form the core of more sophisticated business cases. From the market point of view, commercial rollouts could be realized as early as in 2007.

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KEY TERMS

Mobile Commerce (M-Commerce): Electronic commerce transactions realized via mobile devices (e.g., mobile

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phones, PDAs, etc). The term “m-commerce” was coined in the late 1990s during the dot.com boom.

Mobile Device: Any device that can be easily carried around and communicate via mobile/wireless technology. The terms *mobile phone* and *mobile device* are interchangeable in the context of this article.

Mobile Payment: Any payment where a mobile device is used in order to initiate, activate, and/or confirm that this payment can be considered as a mobile payment.

Mobile Ticketing: The realization of a service where virtual tickets are purchased and validated with the help of mobile devices and their authentication capabilities.

Near Field Communication (NFC): A short-range communication technology that can also be used in mobile payment scenarios.

Point of Sale (POS): A location where a transaction occurs. This may be a real POS (e.g., a checkout counter) or a virtual POS (e.g., an e-shop on the Internet).

Subscriber Identity Module (SIM): A smart card that securely stores the key identifying a mobile phone service subscriber, as well as subscription information, preferences, and text messages.

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