Near Field Communication Technology: Contactless Applications in Mobile Environment

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Abstract: StoLPaN, a pan-European consortium of companies, universities and user groups co-funded by the European Commission (EU), Information Society Technologies (IST) Programme aims to define open commercial and technical frameworks for the remote management of NFC-enabled (NFC: Near Field Communication) services on mobile devices. These frameworks will facilitate the deployment of NFC-enabled mobile applications across a wide range of vertical markets, regardless of the phone type and the nature of the services required. This paper introduces the application opportunities of the NFC technology, the business aspects of the NFC based service development and the technical infrastructure implementing the core of the NFC-enabled services.

Keywords: mobile communication, Near Field Communication (NFC), RFID, OTA, software engineering

1 Introduction

The combination of the world's most popular mobile device, the cell phone, with the novel wireless technology NFC (Near Field Communication [1]) makes possible variety of business opportunities. Payment, ticketing, access control, content distribution, smart advertising, peer-to-peer data/money transfer – the potential is virtually limitless.

'Store Logistics and Payment with NFC' (StoLPaN) project, aims to establish a secure, interoperable operating environment for third party NFC-enabled applications. To achieve this, the project helps to define open commercial and technical frameworks for NFC-enabled services on mobile devices.

These frameworks will allow the different industries involved in the mobile services arena to build their applications on a reliable, common platform, regardless of either phone type or services required. It's an approach that also promotes the deployment of NFC-enabled mobile applications in many diverse markets [2] [3].

A StoLPaN Consortium

The StoLPaN consortium was founded by several leading companies, universities and user groups from across Europe. A non-profit member of the NFC Forum, the consortium is co-funded by the European Commission's Information Society Technology (IST) program.

2 NFC Technology

One of the most important building blocks the StoLPaN architecture relies on is the NFC 13.56 MHz radio frequency communication technology. This new technology jointly developed by Philips and Sony is named 'near field', because the communication distance is limited to less than 10 centimeters. This technology is widely used for communication with Radio Frequency IDentification (RFID) tags [4] and external smart cards, and it can be accessed from Java applications using the Contactless Communication API [5]. The technology is compatible with existing contactless infrastructure, and the mobile device that has NFC interface can emulate smart cards (ISO 14443), can act as a reader terminal and can even realize pear-to-pear (P2P) communication. These features allow the NFC enabled mobile handset e.g. to connect to a web page by scanning an RFID tag, can be used in payment transactions as a payment card but also as virtual payment terminal, or can even facilitate instantaneous coupling of Bluetooth or WiFi enabled devices [6] [7].

This versatility of the technology enables it to support a wide variety of contactless functions and services.

NFC and smart card standards are acknowledged by ISO/IEC (International Organization for Standardization / International Electro-technical Commission), ETSI (European Telecommunications Standards Institute), and ECMA (European association for standardizing information and communication systems).

3 Application Fields of NFC Technology

It is impossible to give a complete picture of NFC applications as NFC is just an interface. However it is possible to group the various applications into three main categories:

- Contactless Token,
- Ticketing / Micro Payment,
- Device Pairing.

These shall be viewed as typical use cases.

B Contactless Token

This covers all applications, which use NFC to retrieve data from a passive token. The passive token could be a contactless Smart Card, an RFID label, or a key fob. Also, the token could be physically included into the reader device without an electric connection.

The only interface of the token, in this case, the contactless interface. This means that the NFC channel cannot act as a communication link between the reader device and the mobile device. We have to also consider that the token most of the applications has rather limited computing power, so it cannot run any complex protocols.

If we use our mobile NFC device as a Contactless Token then we will store some data on the device. This data can then conveniently be read by an active NFC device. Examples of such data would be a URL stored in a tag of a consumer product or the user guide of such a product. The user could then read the tag and get automatically linked to the support web page of that product. A different example would be to store the configuration data needed to access a WiFi network. New users could then easily configure their laptops to be connected to the network.

C Ticketing / Micro Payment

In this example application, the NFC interface is used to transfer some valuable information. The ticket or the micro payment data is stored in a secure device. This could be a contactless Smart Card, but could as well be a mobile phone. When the user wants to perform a payment or use the stored ticket, the user presents the device to a reader, which checks the received information and processes the payment or accepts/rejects the ticket.

In this application example the user device must be able to perform a certain protocol with the reader. A simple read operation will not be sufficient in most of the cases. Also, the user device is likely to have a second interface which is used to load money or to buy tickets. This second interface can for example be linked

to the mobile phone CPU. The ticket data could then be loaded into the mobile phone via the cellular network.

Sometimes the term ’Secure NFC’ is used for these applications. However, this does not mean at all that the NFC link is somehow secured. In fact the name is rather misleading. The name just denotes a configuration using an NFC hardware chip in combination with a Smart Card chip. It should be called ’Secure Smart Card and NFC’, but unfortunately the shorter name is used quite often.

D Device Pairing

In this application the two devices communicating would belong to the same group of devices. An example could be a laptop and a digital camera. The user wants to establish a Bluetooth connection between the two devices to exchange image data. The Bluetooth link is established by bringing the two devices close together and running a given protocol over NFC between the two devices. This makes it obvious for the user which two devices get actually linked and takes away the burden of navigating through menus and selecting the right devices from lists of possible communication partners.

It should be noted that the NFC connection itself in this example is only used to establish the Bluetooth link. Image data is not transferred over NFC because NFC’s bandwidth is simply too small for transferring big amounts of data.

E NFC Trials

There are number of trials all around the world [10] dealing with NFC enabled devises and services. Here are some typical examples for NFC applications classified according to the field of the service:

Urban life:

- Smart posters, which give users up-to-date, incremental content when touched.
- Replacement of contactless credit cards with mobile phones.
- Parking-facility management and parking-fee payment.
- Aid for the visually impaired (for example, through voice clips).

Personal wellness and health care:

- Personal training (for example, a mobile phone application that can collect information on the consumer's training and that can modify and even create training programs).
- Medication reminders.
- Identification of medication and blood samples.
- Health monitoring.

Enterprise:

- Time and attendance applications for field employees.
- Electronic product codes on NFC tags for retail.
- Workflow management and reporting for home health-care workers.
- Access control.
- Guiding of consumers in retail.

4 Challenges of the Implementation of NFC-based Services

F Technology Aspect

NFC-based solutions collaborating with existing contactless and smart card standards have still deficiencies. Many problems can be derived from technical and technological barriers:

1) NFC combined with mobile communication has great perspective. Nevertheless mobile NFC applications are handset specific. This restriction requires from the service providers – mobile operators – to develop, test and maintain a unique application for each NFC enabled device. To make the issue even more difficult it is possible that also network specific issues are adding to the complexity and variety of applications. In order to make the NFC technology more handset independent a neutral technology platform needs to be used that can hide specifics of the various mobile devices.

2) The recently elaborated operating models are supporting single application business models. It means that on the chip, that stores the business application, there is only one application running, although technologically it would be possible to host multiple – 6-10 – applications, service profiles simultaneously. There are multiple reasons of this situation.

Although the technology itself warrants the separation of various applications on the same chip with very high security, with minimal risk of corruption, or infringing one another still certain security specifications just prohibit this coexistence. The management of multiple applications on the same chip is also an unsolved issue.

3) The mobile NFC technology allows over the air (OTA) access to the applications, which could facilitate remote download, management, update-recharge and deletion of the service profiles and content, but more than that, it also provides the support of the phone's resources. OTA technology provides the

transmission and reception of application-related information in a wireless communications system. However there are different technical OTA solutions that are not interoperable with each other. The OTA service provisioning is a great benefit of the mobile NFC technology. To be able to download an application remotely to a handset, and to be able to recharge its content, or renew the application itself allows great savings for the service providers and important usability improvements for the customers. However the technology diversity comes into the picture again and deteriorates the overall scenario.

There is a uniform standard for remote application download controlled by the Mobile Network Operators (MNO) as it ends in the SIM card, which is the MNO's property. For some business – these aspects will be discussed in the next bullet – and technical reasons this channel cannot always be used.

Potentially there is also another standard from OMA (Open Mobile Alliance), called SynchML which could also be used, but it still needs some further enhancement which is not part of the accepted standard yet.

The third general solution could be a simple J2ME supported HTTPs communication between the handset and a back office architecture however on this channel a dedicated midlet needs to be deployed to support this feature.

The problem with this situation is similar to that of the handset diversity and the resulting need of complex version control. The service provider or the third party providing the service delivery needs to keep track of the NFC device of each and every user to be able to support its applications. This is a very complex and costly exercise.

G Business Aspect

When defining the NFC-based services and applications, only a part of the problems are technology-related. In order to implement the services it is very important to work out the necessary and suitable business models and processes [8].

In the mobile NFC ecosystem the two major actors are the service providers and the MNOs. Among the service providers it is important to single out the card companies, who are representing a very concentrated power with a service that has great application potential in the NFC environment. Other service providers – even the large transport companies – are a more fragmented group.

These two actors are representing diverse business and marketing interest which up to this point could not be bridged. The MNO's have the benefit that they control the only generally available download facility. What is more they also have the space on their SIM cards which could also be utilized for storing third party secure applications. Controlling the download and hosting the applications as well, two services that can be charged for, would provide great benefits for the operators.

The service providers – actually at this point we should not generalize too much, as we are talking about a very diverse group – would prefer a solution where they can independently arrange for the application download, and where the application would be hosted in a neutral space in the handset. This could be a second chip, which is either embedded in the device or an SD card that can be used in various devices, or under certain operating and security conditions even a SIM card.

It is clear that MNOs should have an important position in the new value chain as most of the handsets that come to the market are still ordered and co-financed, subsidized by the mobile operators. This means that unless they find their financial and business interests there will not be enough NFC capable handsets on the market the proliferation of the services will be blocked by the lack of the necessary devices.

The wide application potential of NFC and the long value chain of the services (various service providers, partners in the service delivery, and vendors of the support technologies) results in a large number of stake holders with all their individual strategies and targets. These interests need to be harmonized otherwise either conflicting, not interoperable solutions will gain market acceptance, or the technology itself will not be able to proliferate. Introducing NFC-based services collaboration of all actors is needed.

5 Project Goals and Deliverables

StoLPaN's primary goal is to define a transparent, uniform methodology for managing multiple services, such as payment, ticketing, access and loyalty, on an NFC-enabled mobile device, irrespective of the handset type or manufacturer, and the support infrastructure used.

A common methodology will help to reduce the cost of launching new NFC applications by removing the need to develop, certify and manage multiple versions of the same application. For consumers, the implementation of a uniform platform will help create a consistent and convenient user experience across all the NFC services on their mobile handsets.

The secondary objective is to demonstrate the use of the methodology in the high street. A range of demonstration applications will be developed to show how consumers will be able to load and use their preferred payment, loyalty and ticketing applications with their NFC-enabled mobile device.

Of course, phones are only part of the equation: StoLPaN is also developing and testing the in-store support devices. NFC-based communications between the phone and a smart trolley, capable of reading the smart tags on the goods placed

in it, will allow the consumer to automatically pay for the goods as they leave the store. A loyalty application will be used to deliver targeted marketing messages to the consumer as they travel around the store.

Based on these goals, the following deliverables will be defined: a set of commercial and technical frameworks for the delivery, use, update and removal of secure NFC-enabled applications, a host application demonstrating how those rules could be implemented and a set of retail mobility services.

6 Commercial and Technical Frameworks

Working with service providers, mobile network operators and key players in the value chain, the StoLPaN consortium will identify the applications and use cases that NFC will enable.

The process involves:

- Evaluating how NFC affects the existing value chain for the issuance of payment cards, event and transit tickets and other services.
- Identifying the business requirements and flow of funds within and through each key player.
- Verifying the commercial dependencies and distribution of risk between key stakeholders.

From this, it will be possible to define the business rules and technical requirements which will lay the foundation for a new NFC ecosystem. Both sets of rules and requirements will then be submitted to the relevant trade bodies, for adoption by the payment, mobile, transit and ticketing industries, and demonstrated in a host application developed by the project team.

7 Host Application

The host application will demonstrate a potential middleware implementation of the business rules and technical requirements. A multifunction, standardized StoLPaN mobile NFC host will allow the collaboration among the diversity of applications, service providers, network operators and the variety of handsets.

The host will be able to support multiple NFC services, provide access to the phone's resources and facilitates the loading, use, maintenance and deletion of third party NFC-enabled applications via:

• Common API between the third party application and the mobile device's OS, removing the need for the:

- service provider to provide a unique application for each NFC-enabled device.

- trusted third party to manage multiple versions of the same application.

• Common API between the service provider and the third party's Application Provisioning Platform, simplifying validation of adherence to their service level agreements.

• Common User Interface for applications loaded into the Secure Element or the host's JAVA storage, providing value added features to existing contactless services. It will simplify the learning curve associated with any new application whilst allowing the:

- user to select their preferences.

- service provider and/or network operator to remotely manage their application on mobile device, determine the security required to access the application on the handset and control the person-to-person distribution of the application through the GPRS or NFC interface.

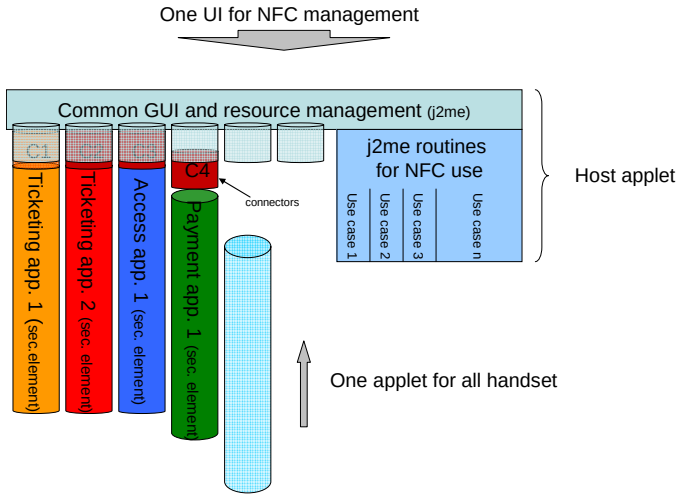

Figure 1
The host application concept

8 Retail Mobility Services

The final deliverable will be a set of retail services forming a complete smart retail environment based on item level tagging and NFC applications [9]. It will provide a user friendly shopping experience, improve economics and increase the efficiency of the retail operation.

The cornerstone of the new NFC-based retail solution is the checkout and payment process, where most benefits can be realized. To reach the targeted results StoLPaN will support connectivity to other NFC devices, such as a smart shopping cart, and also leverage the integrated security architecture.

According to the general concept, product data of smart tagged merchandize will be captured by a smart shopping cart, being connected to the back office system of the store. Here the EPC product information is turned into pricing information and is returned to the cart or the customer's handset. Customer performs payment either directly to the shopping cart or at special payment terminals anywhere in the stores. The payment information is transmitted to the back office system and also to the integrated security system of the store. After the payment customer may leave the store without any further personal interaction. When exiting, the smart tags are going to be deactivated by the security gates.

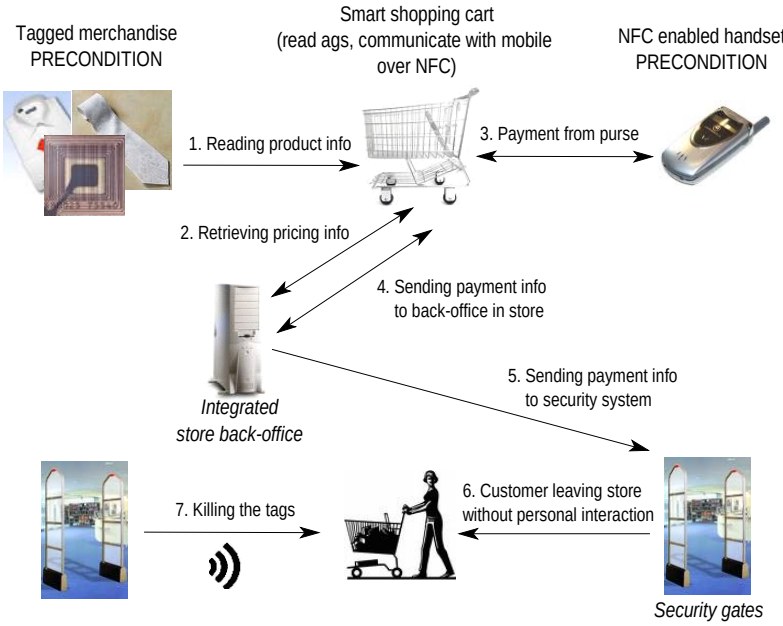

Figure 2
NFC-based payment process in retail environment

As a result of the new check-out and payment solution, crowded check-out counters can be avoided improving customer satisfaction and also increasing store capacity. With the proposed NFC-based logistics the check-out and payment transaction becomes and individual activity, eliminating the need for staying in line, and the long wait till others finish their own transactions.

NFC-enabled mobile handsets will also support functions such as loyalty applications, product authentication, capturing product information, etc. The StoLPaN retail NFC architecture will be modular, allowing smooth integration of new services and functions into existing barcode-based shopping environments.

9 Results

The StoLPaN project runs for three years. After the first twelve months of work the following results has been achieved so far:

Software Development Guidelines document has been developed and finalized standardizing the business modeling and software development artifacts.

Baseline Security Document has been developed.

Detailed analysis of retail related business processes has been done. Several scenarios have been developed how can a merchant migrate his bar code based logistic system to an NFC (or RFID) based environment. These scenarios are going to be tested in the practice. An example for the retail process description is shown in Fig. 3.

Key potential business processes (i.e. business use cases) involving NFC devices were studied and analyzed. The technical use cases derived from these business cases are identified and categorized. Based on this analytical work the core of a ‘standard’ application programming interface is defined. This interface implements those primitive functions that support the various NFC application delivered by different Application Providers. As an example for the resulted artifacts of the business use cases a sequence diagram is shown in Fig. 4.

The basic technical architecture of the NFC host system has been developed. The overview of the architecture is shown in Fig. 5.

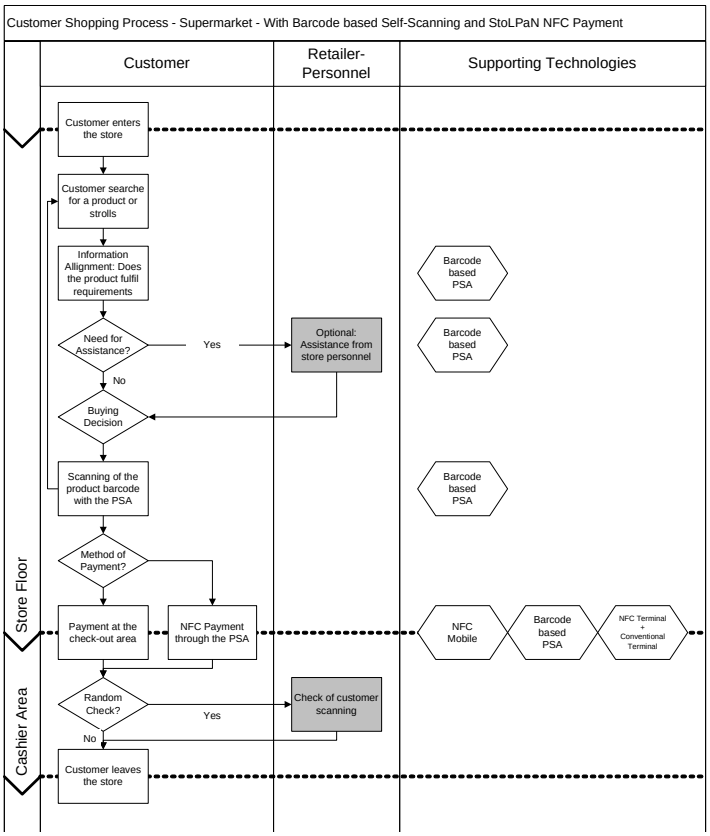

Figure 3
An example retail business process using NFC devices

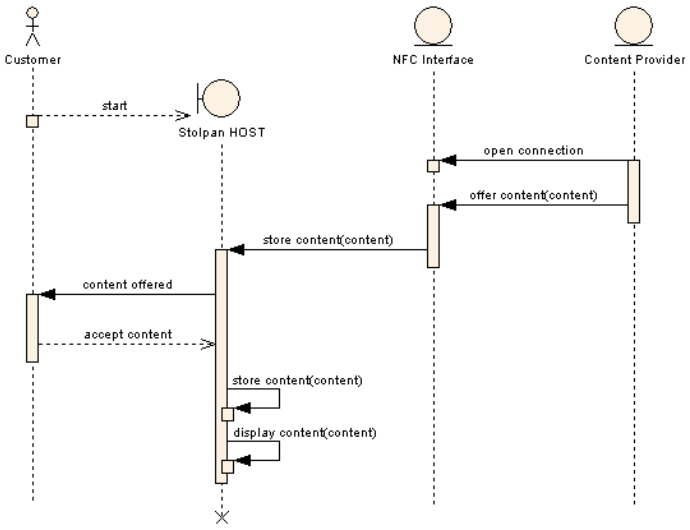

Figure 4
Sequence diagram of recharging an NFC application (an example from the business use cases analysis)

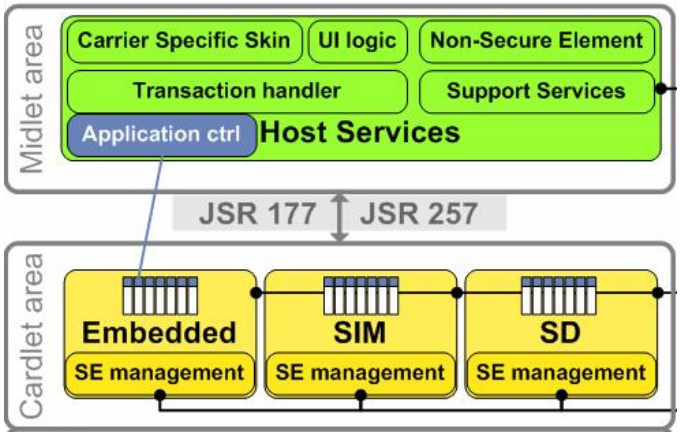

Figure 5
Architecture design of the NFC host system

Conclusion

StoLPaN project aims to research and develop a multi-application environment for the remote management of NFC-enabled services. To achieve the main goal the project has to perform various tasks:

- define a technical and commercial environment that provides a transparent technology platform and satisfactory business model for key stakeholders

• realize the concept with the development of a JAVA based mobile host application that provides a homogenous environment for the simultaneous operation of multiple NFC based service applications, by neutralizing specifics of the handset design and taking care of resource, security and communication management,

• demonstrate the StoLPaN solutions in a retail environment by porting selected contactless applications to the StoLPaN specification.

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