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Tuomo Tuikka & Minna Isomursu (eds.)

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Abstract

NFC – Near Field Communication – is a very short range wireless communication technology that supports the use of mobile handsets by touch-based interaction. This is an intuitive and user-friendly way of establishing connections and exchanging information between mobile handsets and other devices by just setting them side by side. The SmartTouch project (ITEA No 05024) has been the largest effort on piloting NFC technology in the European Union. The project started in 2006 and extended to the end of year 2008, examining in the role of NFC in City Life, Home, Wellness and Health, and its Technological Building Blocks, Security and Privacy, and Business Building Blocks. The extraordinary combination of partners in SmartTouch, including technology and service producers, researchers, and organizations setting up first pilots, has been pushing the NFC technology forward on many fronts. This book collects those developments by starting with NFC and its basics and continuing through genuine pilot cases towards an understanding of NFC enabled business areas. This book is a valuable source of information for those who want to study NFC as a technology for their business, as a technology primer, or learning from others experiences of NFC use.

Preface

What does the future of mobile world look like to you? Cast your mind forward a decade or two and ask yourself: How will people use their mobile devices? What technology and innovations will distinguish the forerunners and early adopters from the old guard? What will researchers and innovators in organisations be doing that would surprise us today? In other words, can you imagine changes in mobile technology and in the way it is used?

Don't be dispirited if the answer is "no". Considering how the mobile technology has developed over the past few decades, it is hardly surprising that most people have a hard time imagining what new the future can bring. Yet over time, every great invention travels a road, step-by-step, that leads from birth to maturity. And most of the time this requires contribution and participation from number of individuals and organisations.

This is also the case with the NFC (Near Field Communication) technology and its adoption to mobile devices. In fact, the roots of the NFC are in the RFID (Radio Frequency IDentification Technology) technology, which was developed early 1940s. Knowledge compounded, and few decades later the whole clusters of the organisations were and are defining and planning what is possible with the NFC, what else is needed and especially how to make business out of it. At the beginning there were number of technical challenges that bedevilled inventors and slowed down the progress. An important milestone here is the foundation of the NFC Forum in 2004. The aim was to develop specifications and standards, ensuring interoperability among devices and services and educating the market about the NFC. Today, NFC Forum has over 150 members, working together to promote the use of NFC technology.

In 2002 first NFC concept phones were designed and developed and soon after that, at the end of 2004 the first commercial NFC enabled mobile phone (Nokia 3220 with NFC shell) and first NFC-payment concept were launched in

CARTES tradeshow. It can be argued that this was the real starting point for the NFC piloting and trial phase, which today continues. The first NFC-based ticketing application trial started early 2005 in the city of Hanau, Germany and was soon followed by the pilot where NFC enabled phones were used as a part of a loyalty program at retail outlets and attractions. Those “intrepid pioneers” from several organisations went through a sequence of trials and errors and thus prepared the way for the other NFC pilots, demonstrations, and field-tests.

Of course, this begs the questions of what was the real motivation behind the NFC adoption to the mobile devices. Indeed, many argue that the reason was purely the aim to improve end-users’ experience. The idea of intuitive, easy-to-use, touch based user-interface was raised in some organisations late 1990s (or possibly even earlier) and the research community published papers on psychical browsing concept already in 2001. Today many people justify NFC adoption also with the economical reasons. It has been argued that with the NFC, organisations can e.g. minimise cash handling costs, increase automation and reduce the use of the smartcards. In other words, NFC would bring clear business benefits and cost-savings. In addition, NFC enables totally new services and products, which without the intuitive user interface would not be possible to implement.

Through the different pilots NFC was soon spread out to various businesses and awareness increased. An important milestone here is the first NFC-competition in April 2007 (Figure 1). During this competition it become evident that besides of the ticketing and payment applications NFC would bring usability and business benefits to the other sectors as well. Especially personalised healthcare and wellness systems and business solutions were well represented in the competition. The competition was successfully organised again in 2008 and is now one of the NFC-forum’s yearly events.

We have witnessed over the past years how the NFC technology has rapidly evolved. Technology has become mature, main standards have been established and numbers of pilots and solutions in all regions have been done or are running. However, we are still waiting the real commercial deployment of the NFC. Evidently, NFC technology changes business ecosystems and requires new

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[1] Ailisto, H., Plomp, J., Pohjanheimo, L., Strömmer, E. 2003. A physical selection paradigm for ubiquitous computing. Ambient Intelligence. Lecture Notes in Computer Science, Vol. 2875. Aarts, Emile et al. (Eds.). Springer-Verlag. 1st European Symposium on Ambient Intelligence (EUSAI 2003). Veldhoven, NL, 3–4 Nov. 2003. Pp. 372–383.

co-operation models and value networks. And in fact, the unclear business and co-operation models are the main brakes for NFC penetration today.

Figure 1. Winners of the first NFC competition in 2007.

So what is the role of the SmartTouch project in this picture and how the project started? For me it would be easy to describe the moment when the idea of the project was first times expressed late 2004. Also, it would be easy to point some people who enthusiastically investigated, push forward and told about NFC to anyone who had time to listen. Furthermore, I could, with no trouble, name the people who participated to the first ITEA project preparation meeting and SmartTouch sessions in February 2005. However, I think it is pointless to name any individuals in this context. For me it is more important to say that the organisations and individuals of the SmartTouch project have been involved and contributed in every NFC development step described above and many others. SmartTouch has been an impressive consortium, truly an outstanding example of the European level co-operation. And the results have been remarkable. Indeed, we have worked well together towards the original vision of the project (Figure 2):

"The vision of the SmartTouch project is a mobile world, where we all be surrounded by all kinds of smart objects. We believe that in the near future, more and more people will want to communicate with each other, access entertainment, pay for the shopping, travel, seek products and services to buy, access applications and browse for information just by touching the smart object."

Figure 2. SmartTouch vision.

Today, the SmartTouch vision is closer to reality. Several market studies estimate that the global market for NFC solutions will experience significant growth in the next few years and many SmartTouch organisations will benefit the development. Yet before we break out the champagne, we should ask ourselves whether we are truly satisfied with the status quo. I don't think so. The fact is that despite the SmartTouch and NFC-community indisputable accomplishment to date, there is still lot to do. And I think we always should long for something better.

Oulu, Finland, August 2009
Tua Huomo
SmartTouch Project Leader 2005 – June 2007

Contents

List of symbols

2D	Two-dimensional
ACK	Acknowledgment message
AFC	Automatic Fare Collection
API	Application Program Interface
ASK	Amplitude Shift Keying modulation scheme
B2B	Business to Business application
B2C	Business to Consumer application
BPSK	Binary phase-shift keying modulation scheme
CCS	Content Correlation Service
CCTV	Closed-Circuit Television
CLF	Contactless front-end
SCF	Critical Success Factors
DIY	Do-It-Yourself
ECMA	Ecma International
EMV	Euro MasterCard Visa
EPOS	Electronic Point Of Sales
ETSI	European Telecommunications Standards Institute

ETSI/3GPP	3rd Generation Partnership Project
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSMA	GSM Association
HCI	Host Controller Interface
HCP	Host Control Protocol
HD	High Definition
HDLC	ISO/IEC 12239 communication standard
HW	Hardware
ICT	Information and Communication Technologies
IEC	International Electrotechnical Commission
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPTV	Television over IP
IR	Infrared
IrDA	Infrared Data Association
ISO	International Organization for Standardization
IWT	Institute for the promotion of Innovation by Science and Technology in Flanders
J2ME	Java Platform, Micro Edition
J2SE	Java 2 Platform, Standard Edition
JIS X	Specification of implementation for integrated circuit(s) cards (JIS X 6319)
LLCP	Logical Link Control Protocol

MAC	Medium Access Controller
MIDlet	Java application framework typically for mobile phones
MNO	Mobile Network Operator
MTU	Maximum Transmission Unit sent by a protocol
MVS	Media Vault Service
NACK	Non-Acknowledgement message
NDEF	NFC Data Exchange Format
NFC	Near Field Communication
NFCIP	Near Field Communication Interface Protocol
NFI	Near-Field Interface
NRS	NFC Reader Service
NRZ-L	Non-Return to Zero-L binary code
OAMK	Oulu University of Applied Sciences
OBEX	OBject EXchange, communication protocol for binary objects exchange
OSDE	Open Service Delivery Environment
OTA	Over The Air
P2P	Peer to peer
PC	Personal Computer
PCD	Proximity Coupling Device (or reader)
PDA	Personal Digital Assistant
PICC	Proximity Integrated Circuit Card
PIN	Personal Identification Number
PLC	Power Line Communication

POS	Point Of Sales
PTO	Public Transport Operator
RCS	Reader Correlation Service
RF	Radio Frequency
RFID	Radio Frequency Identification
RGB	Red-Green-Blue
RMV	Regional Public Transport Authorities in the State of Hess/Germany
ROI	Return of Investment
RTD	Record Type Definition
SAR	Segmentation and Reassembly
SCP	ESTI's Smart Card Platform
SDIO	Secure Digital Input Output
SEP	Seeing Eye Phone
SEPA	Single Euro Payment Area
SIM	Subscriber Identity Module -card
SME	Small and Medium Enterprise
SMS	Short Message Service
SOHO	Small Office Home Office
SSL	Secure Sockets Layer
SW	Software
SWP	Single Wire Protocol
TAM	Total Available Market
TCP/IP	Internet Protocol Suite

TES	French Secure Electronic Transaction cluster in Lower Normandy
TKL	Tampere Public Transportation Company
TMC	Tangible Media Core
TSM	Trusted Service Manager
TV	Television
UART	Universal Asynchronous Receiver Transmitter
UHF	Ultra High Frequency
UICC	Universal Integrated Circuit Card
UPnP	Universal Plug and Play Protocol
URI	Universal Resource Identifier
URL	Universal Resource Locator
USB	Universal Serial Bus
VDV	VDV Core Application, German Standard for Electronic Ticketing
VIKSU	Viksu the Academy of Finland Annual Science Competition for Senior Secondary Students
VSDC	Visa Smart Debit/Credit (chip card)
WAP	Wireless Application Protocol
WLAN	Wireless LAN
XML	Extensible Markup Language

1. Vision

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Natural interaction between humans and technology is one of the key challenges for the efficient use of Information and Communication Technologies (ICT). Furthermore, the way we implement this interaction has a significant impact on how users experience not only the interaction and interaction methods and technology but the whole process and task and even the companies or organisations related to the task or service. Thus, it is meaningful to study and develop methods which will lead to more efficient and natural human technology interaction. The notion of natural interaction is very much inline with the ideas of ubiquitous computing (Weiser 1991). Often related concepts of pervasive computing and ambient intelligence are used almost interchangeably with ubiquitous computing. For example Aarts and Marazano (2003) states that the vision of ambient intelligence involves the idea of accessing services and devices embedded in our everyday environment in a natural way. Relying on resources embedded ubiquitously in the environment, for example using local displays, pads and boards, and input devices (such as whiteboards) has been suggested and demonstrated (Streitz et al. 2001). In this vision, the technology is embedded in the environment, not so much carried by the user. However, the proliferation of portable devices with increasing capabilities has evoked the question of their potential, especially when combined with the concept of a “tagged environment” (Rekimoto et al. 2003).

One way to provide natural interaction between the user and technology is the concept of physical browsing, i.e. to implement interaction methods by which the user can achieve her or his goals, such as acquiring information, transferring data, performing financial transactions or initiating actions, just by pointing or touching. The concept of physical browsing based interaction can be best applied to situations where the user's goals are tied to a location – where she or he currently is – and can benefit from the use of ICT. Thus, physical browsing can be seen to "bridge the gap between physical and digital worlds" (Ailisto et al. 2006). Examples of such situations are finding information related to current place, e.g. timetables at *this* bus stop, finding information about *this* product or doing electronic payment of purchases in *this* shop. Physical browsing is less suited for, e.g., mobile web surfing or other activities not tied to a certain location.

The concept of using intuitive means of touching or pointing as a way of interfacing between a human and digital resources has been present in research at least since the 1990s (Ullmer et al. 1998, Want et al. 1998). *In the physical browsing concept as defined here the personal device or ensemble of personal devices used for interacting with the environment through physical browsing has capabilities for user interfacing, such as display, sound and keypad; read and write memory; processing power and communication capabilities other than those needed for physical browsing.* An example of such a personal device is a mobile phone with the ability to read (and write) RFID tags with an incorporated RFID reader-writer.

Several methods for implementing the concept of physical browsing have been developed (see, for example, Want et al. 1998, Ailisto et al. 2003). From the user perspective, these can be divided into "point me", "touch me" and "scan me" paradigms. The point me paradigm is most naturally implemented with optical means, since the direction of optical pointing, either an active "ray" or a passive camera, can be directed easier and more intuitively than radio frequency (RF) or magnetic techniques, which lend themselves more naturally to touch me and scan me paradigms. VTT has implemented all of these methods in earlier projects with infrared (IrDA), laser pointing, camera and RFID technologies (Ailisto et al. 2006). One of the camera-based methods has led to commercial activity (Bäckström et al. 2006). Related work in the field of pervasive or ubiquitous computing has been reported for example in studies by Kindberg et al. (2000) who presented and demonstrated the idea of infrastructure to support "web presence" in the real world. The main idea is connecting physical objects with corresponding web sites. Infrared (IR) beacons, electronic tags or barcodes are suggested for creating the connection. SpotCode is a visual code which enables a camera phone to be used as an innovative user interface (Toye et al. 2004). The Quick Response code is a commercial implementation of similar technology with widespread use in Japan. Different paradigms and their implementations and properties are compared in Table 1.

Table 1. Comparison of potential commercial technologies for physical selection (Bluetooth included as a reference) (Adapted from Ailisto et al. 2006).

	Visual code	**IrDA**	**RFID, e.g. NFC inductive**	**RFID, UHF**	**Bluetooth**
Selection concept	PointMe (TouchMe)	PointMe	TouchMe	ScanMe (TouchMe) (PointMe **)	(ScanMe)
Data transfer type	unidirectional	bidirectional	unidirectional and bidirectional	unidirectional (bidirectional*)	bidirectional
Data rate	medium	high	medium	low-medium	high
Latency	short	medium	short	short	long
Typical operating range	short-long	medium (long)	short (medium*)	medium-long	long
Data storage type	fixed	dynamic	fixed (dynamic)	fixed (dynamic*)	dynamic
Data storage capacity	limited	not limited	limited (not limited*)	limited (not limited*)	not limited
Data processing	none	yes	limited (not limited*)	limited (not limited*)	yes
Unit costs	very low	medium	low	low	medium-high
Power consumption	no	medium	no (low*)	no (low*)	medium-high
Interference hazard	no	medium	low-medium	medium-high	medium-high
Support in PDAs or mobile phones	common (camera phones)	yes	limited	no (emerging)	common

* with battery powered tags.
** when combined with e.g. light and photosensitive sensor

Comparison of different technologies for physical browsing show that visual codes are superior, when the cost of individual code ("tag") is the most important criteria for decision. Inductive RFID technology, such as NFC, is suitable when bidirectional information exchange or more memory capacity is needed. Furthermore, RFID tags can be interfaced to other digital systems, such as Point of Sale (POS) terminals, or sensors, which is not the case with visual codes. IrDA based tags are more expensive than the visual and RFID tags. Also, they have not found commercial drive in a way that RFID and visual code based technologies have. It seems evident that both visual codes at the low end of the application spectrum and the RFID tags in the more demanding applications can find their place in the market.

A number of major companies, including Nokia, Philips and Sony, formed an alliance in 2004 to advance the use of RFID technology in consumer applications. The alliance, the Near Field Communication forum (NFC), was later joined by others such as Visa, MasterCard, Samsung, Microsoft and Motorola. The applications targeted are contactless payment, ticketing, easy information access, and peer-to-peer communication. The NFC concept is based on integrating existing RFID technology, especially ISO 14443-based Mifare (Philips) and Felica (Sony), to portable consumer devices, such as mobile phones. Due to the strong support it receives from companies, the NFC concept is forecasted[2] to achieve significant penetration in mobile phones, excluding the ultra-low-cost models, in 2012, i.e. 200 million NFC compatible mobile phones sold that year.

We can envisage following application categories for physical browsing, and thus, for NFC technology.

- Information retrieval. The information retrieval may be location and situation independent, such as getting product information by reading e.g. a web address from a NFC in a Smart Poster or it can be location or item specific, such as finding the time tables or next arrivals information on a specific bus stop.
- Value transactions. This application category consists of two main types: ticketing and payment. Ticketing refers to applications such as mass transit, sport events, concerts and movies, where the value is usually prepaid and usable only for limited and a priori known services. From user perspective this usually means a shift from a dedicated smart card, such as bus card, to emulation of that card inside the user's mobile phone. Payments are more general and can be seen substituting both cash based and debit card based (small) payments in cafeterias,

[2] ABI Research reports 2007.

kiosks, and shops. Mobile payment and ticketing is seen as the potential “killer application” for NFC technology. Some researchers see potential for great changes in the payment infrastructure in developing countries, where the users can skip the debit and credit card phase as well as bank transfers and substitute cash directly with NFC and mobile phone based money transactions.

- Initiating action. Many digital and physical operations can be initiated and even controlled using physical browsing paradigm. Simple examples include initiating a phone call by touching a business card or a person’s photo – both equipped with a computer readable tag, or ordering a taxi to certain place by touching a special service tag. The uploading of photos from a camera to a home server can be initiated easily by touching the home PC with the camera, if both are NFC equipped. This is also an example of peer-to-peer application, where no commercial partner is, at least directly, involved.
- Creating social networks. We can envisage using NFC technology for establishing a digital link between persons who have established similar link in real world, for example people meeting in a business meeting or in a disco. Generation of digital links in the real world (by touching) is something between traditional means of networking (face to face) and web based networking, such as Facebook or LinkedIn.

All of the mentioned application categories rely on the intuitiveness of NFC based user interface paradigm. The use must be natural, easy and effective, when compared to other means for achieving the user’s goals. For example, payment should be easier and faster than payment with a debit card or cash. Furthermore, the user must be able to feel secured that his money and privacy are not jeopardized.

In some application cases the location information available in NFC based actions (each tag is always in a certain physical location and it is possible to identify each tag uniquely) can be of great value to the user or the service provider. Simple example is getting the relevant time table or arrival data to a mobile device by touching a tag at your bus stop, eliminating the need for cumbersome keying of the name or number of the bus stop.

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2. SmartTouch project

Author: Tuomo Tuikka, VTT Technical Research Centre of Finland

SmartTouch (http://www.smarttouch.org) has been a project with 22 partners from 8 European countries under the Eureka, Information Technology for European Advancement i.e. ITEA2 collaboration framework focusing on Near Field Communication (NFC) technology. The partners have included a combination of large industrial organizations and small and medium sized enterprises, research and public organizations. The composition of various actors, device manufacturers, teleoperators, research institutes, bank, and a city to name a few domains, created a fruitful interaction for new NFC based services to emerge. Figure 3 depicts the geographical distribution of SmartTouch consortium with a map and the company logos.

Altogether, SmartTouch partners have contributed a total of 215 person years, which makes the project the biggest effort in the European Union on NFC technology and services. The total budget was close to 30 M€. SmartTouch project was coordinated by VTT Technical Research Centre of Finland.

Figure 3. SmartTouch Consortium. Finland: Nordea, City of Oulu, VTT, Top Tunniste, Idesco, Fara, Nokia, TeliaSonera. Germany: RMV. Belgium: Alcatel-Lucent, KUL. The Netherlands: Philips. UK: Innovision. France: Gemalto, ENSICAEN. Spain: Telefonica, Robotiker, Fagor, Visual Tools, Telvent, Ikerlan. Israel: MedicTouch.

2.1 Thematic areas

This book gives an account of many partners who have been working within their very own business areas to seek solutions that will enhance the business based on NFC in the future. Retrospectively, SmartTouch has produced solutions in all of the thematic areas it has been covering. These thematic areas and application domains addressed in this book are:

- Home thematic area. Services to support activities by people in their private home environment in order to exchange information inside and outside the home.
- Human System Interaction application domain. Studies of interaction between human beings and the appliances and systems that support the services.
- Software and Service Creation application domain. Deals with the activities that may be required to facilitate the people engaged in designing, implementing, verifying, maintaining and modifying software-intensive products, systems or services.
- Nomadic application domain. Activities that may be required by nomadic people away from their home or workplace and on the move to exchange information and perform corresponding tasks.

These themes were originally selected with the assumption that personal services are becoming an essential part of life and will continue growing in significance. ‘Personal Services’ concept is supported mainly by ambient embedded personal devices building unified personal environments, allowing natural interaction between humans and its ambient (home, car, body, etc) with mobile and nomadic attributes.

It is assumed, however, that people want and need to communicate more and more with each other, access to entertainment or care services, browse information, manage their businesses, seek products and services to buy, conduct financial transactions, and share, store and display information of all kinds. As far as the service deployment is concerned, the interaction between the user and the system and service has a major impact on the acceptance of the systems. User interfaces are then challenged to meet requirements of intuitive, almost self set-up, immediate, and easy access to services, secure digital rights management, secure payment facilities and intuitive technology to make most out of today’s consumer devices and services at home and on-the-move.

One of the main visions of establishing a SmartTouch project is that, in the future, users can all access content and services by touching smart objects and connecting devices just by holding them next to each other. In other words, get some value by browsing through smart objects around. This idea of smart touch is visioned in the project ***SmartTouch*** (Figure 4).

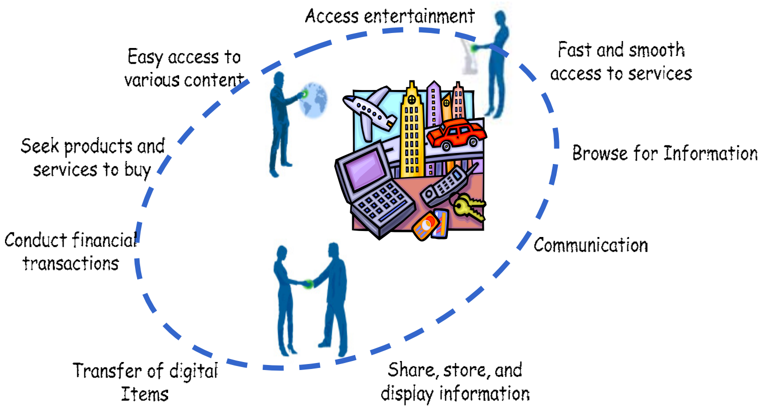

Figure 4. Browsing Through Smart Objects Around You – vision of *SmartTouch* project.

These thematic areas were crystallized into objectives. In general, Smart Touch project objective has been to conceive, design, construct, and trial a full service platform and develop the main concepts for the corresponding business chains:

1. Design, build and implement of ***SmartTouch*** system
2. Identify and define applications for ***SmartTouch*** environment and implement ***SmartTouch*** products / service concepts with real content and case environment
3. Conceive ***SmartTouch*** business concepts
4. Create ***SmartTouch*** building blocks for markets by investigating standardization needs and supporting for standardization.

2.2 Broad range of activities

SmartTouch consortium has been working, during the three consecutive years of 2006–2008, on new and innovative solutions and services based on the NFC technology. SmartTouch undertook a broad cycle of activities in an effort to understand and find business areas for such an NFC approach. Technical partners tackled the necessary protocols, enablers, applications, security and privacy through pilot applications in the home, city life and wellness areas. At the same time, other players were seeing what kind of business areas there would be for the future mobile services. To identify real-life applications of NFC technology and gain a greater understanding of the user experience, SmartTouch carried out 33 pilots and 44 technology demonstrations. Delivering demonstrations for user testing and systems for pilot use was found to be highly effective way to probe possibilities for successful approaches. Acceptance of NFC in use was considered important for its success.

As well as creating new and innovative applications, SmartTouch worked on technology enablers to make application development possible and provide a basis for secure NFC services in the future. Thus, SmartTouch provided the opportunity to create applications for mobile phones, such as working on the basic standard solution for SIM-based payment, and the building service solutions on top of these technologies.

Currently, the whole industry is looking at the development of payment and ticketing applications to open the way for use of NFC technology. SmartTouch piloted vertical applications such as payment in France and ticketing in Frankfurt; smaller tests were carried out in Finland and in Spain. Horizontal industrial sectors tackled included home consumer electronics, business-to-business manufacturing, and telecommunication services.

The Frankfurt ticketing pilot involved equipping 750 Rhein-Main-Vehrkehrsverbund (RMV) public transport network stops with radio tags. NFC-enabled mobile phones are used to make secure ticket purchases simply by touching one of the tags at a stop. The phone user can also receive real-time information on transport schedules. Anyone can use the system to buy single trip and daily passes. And NFC-based mobile tickets are also available for the entire RMV area.

The main breakthroughs in SmartTouch were in the technology to make the NFC possible, providing mobile handsets with relevant toolsets, protocol-level achievements in standards, making payment possible and methods for security in the production of NFC enabled subscriber-identity module (SIM) cards. In addition, these elements were used in the creation of vertical applications, ticketing devices, locking devices and domestic electronic devices.

The results of this ITEA project will make to major difference: from a consumer perspective, the idea is to provide a natural and easy user interface for service discovery and use. The pilot projects provided a perspective on value chains where new employment and businesses identified include content provider, media and back-end systems.

European citizens will therefore benefit, as the aim is to provide devices that are easier to use. Moreover, at some point in future, many of the things we carry in our wallets today will in the future be contained in the mobile device – even our house keys.

Industry in Europe will also benefit:

- Firstly, European players in a range of industries – including communications, banking and local government – have gained knowledge about the technology and have already been able to develop new products and services accordingly.
- Secondly, European industry has improved its competitive position, with project partners actively paving the way for global exploitation of NFC.

2.3 Exploitation

NFC technology brings the touch paradigm to mobile services, in addition to other dimensions, thus allowing services such as mobile payment or ticketing by simply touching a reader with a mobile phone. As experienced in SmartTouch and as shown in this book, the possibilities are endless, including offering new ways of interacting with home consumer electronics and offering help for people with disabilities and elderly.

A pilot in the city of Oulu in Finland offered a meal service for elderly people. A touch-based user interface was embedded into a meal menu, which was used by the elderly home-care clients to order their meal for the following day. The application also allows monitoring of the meal delivery process in real time, increasing traceability and cutting down manual work.

The project is now finished, and in its exploitation phase. More than 22 products have already resulted. These include NFC cards for PCs enabling Internet connections, ticket validators and readers, handset applications and smart-card systems.

An interesting exploitation has been the ‘touchatag’ spin-off from Alcatel-Lucent. This offers a contactless radio-frequency identification (RFID) tag that automatically launches services. For example, a tag on a painting in a gallery could provide a mobile phone user with information about the painter. Or a cleaning service could register completion of work in a room on a tag in the room.

SmartTouch members have been also active in standardisation work in the NFC Forum and the Mobey Forum, which encourages the use of mobile technology in financial services, as well as in the GSMA mobile communications industry organisation. Examples include the single wire protocol, contributions to security aspects of NFC, and suggestions for work items in context data representation.

3. NFC Technology and Reference Application Scenarios

Author: Tuomo Tuikka, VTT Technical Research Centre of Finland

This chapter explains briefly the basics of NFC technology, its background organisation, and locates NFC into a larger framework on technologies. Next, some of the mainstream applications are addressed to give reference on what has been developed in SmartTouch that makes it a unique project. Finally, a short market wrap is made.

3.1 NFC basics

3.1.1 NFC and NFC Forum

Near Field Communication (NFC) is short-range wireless connectivity technology that evolved from a combination of existing contact-less identification and interconnection technologies. Products with built-in NFC will simplify the way consumer devices interact with one another, helping people speed connections, receive and share information and make secure payments[3].

NFC is both a “read” and “write” technology. Communication between two NFC-compatible devices occurs when they are brought within four centimetres of one another: a simple wave or touch can establish an NFC connection. The underlying layers of NFC technology follow universally implemented ISO, ECMA, and ETSI standards. Because the transmission range is short, NFC-enabled transactions are inherently secure.

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[3] Source NFC Forum: http://www.nfc-forum.org.

NFC can be used with a variety of devices, from mobile phones that enable payment or transfer information to digital cameras that send their photos to a TV set with just a touch. Figure 5 illustrates exemplary application areas, ticketing, payment, smart poster, etc.

Figure 5. NFC opportunities [Picture source: NFC Forum].

In order to make NFC happen, NFC Forum – an alliance on specifying the NFC standards, was established. The start of this organization dates back to 2004 when a number of major companies, including Nokia, Philips and Sony, formed an alliance to advance the use of RFID technology in consumer applications. The NFC Forum was later joined by others such as Visa, MasterCard, Samsung, Microsoft and Motorola. In 2008 NFC Forum has close to 150 members.[4]

3.1.2 NFC in relation to other technologies

The NFC concept is based on integrating existing RFID technology, especially ISO 14443 based Mifare (Philips) and FeliCa (Sony), to portable consumer devices, such as mobile phones. As a technology NFC has its own position in

4 More information can be found at http://www.nfc-forum.org.

contrast to other technologies. Figure 6 illustrates how NFC positions to close proximity, and lower data rates.

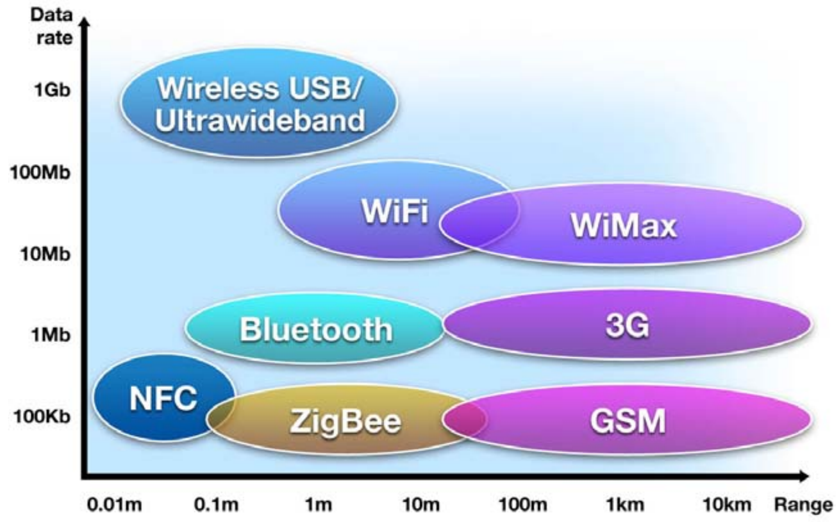

Figure 6. NFC and other technologies [Picture source: NFC Forum].

The legacy of earlier standards gives NFC compatibility benefits with existing RFID applications, such as access control or public transport ticketing – it is often possible to operate with old infrastructure, even if the RFID card or reader is replaced with an NFC-enabled mobile phone, for example. This is possible because of NFC's capability to emulate both RFID readers ("reader/writer mode") and RFID tags ("card emulation mode"). NFC hardware can include a secure element for improved security in critical applications such as payments. For example, a credit card could be integrated into a mobile phone and used by contactless credit card readers over NFC.

In addition to the reader/writer and card emulation modes, there is an NFC-specific NFCIP-1 mode ("peer-to-peer mode"), defined in the ECMA-340 standard. This mode is intended for peer-to-peer data communication between devices. In this mode, NFC is comparable to other short-range communication technologies such as Bluetooth, Wibree and IrDA, although the physical data transfer mechanism is different. In this respect, NFC can be seen as a rival of these technologies, even though it can also complement them. NFC can open a connection between two devices that are brought close to each other, and the actual communication will then occur by Bluetooth or WLAN.

NFCIP-2 (specified in ECMA-352) defines how to automatically select the correct operation mode when starting communications.

In peer-to-peer mode, the participant that starts the communication is called the initiator and the other participant the target. The peer-to-peer mode is divided into two variants: active mode and passive mode. In active mode, both participants generate their own carrier while transmitting data. In passive mode, only the initiator generates a carrier during communications, and the target device uses load modulation when communicating back to the initiator, in a way similar to passive RFID tag behaviour. This makes it possible to save power in the target device, which is a useful feature if the target device has a very restricted energy source, such as a small battery. Fundamentally it is possible to make a target device – such as a battery assisted (semipassive) sensor readable over NFC – last for several years, even if operated from a small lithium coin-cell battery. Batteryless (passive) sensors that are powered by the RF field of an active NFC device are also feasible.

In peer-to-peer mode, NFC communication offers following advantages over Bluetooth:

- NFC enables easy-to-use touch-based communication and interaction between two devices.
- Communication set-up latency with NFC is typically some hundreds of milliseconds, whereas with Bluetooth that is typically several seconds.
- NFC enables longer lifetime of the battery, since the power consumption of an NFC node in passive mode can be negligible and the passive NFC node can be activated by an active NFC device (e.g. a mobile phone).
- Pure NFC communication enables lower price, since NFC is technically less complex than Bluetooth.
- Due to its shorter range and near field coupling, NFC is more immune to eavesdropping and intentional or unintentional interferences.

The main limitation of NFC compared to Bluetooth is the very short communication range, which, depending on the application, can bring along following disadvantages:

- NFC doesn’t suit to portable devices that require online connectivity to another portable device or to a fixed access point.

- Lower bit rate together with the short communication range can make the touch-based transfer of longer data blocks unpleasant.
- The placement of the antenna is more critical. The place of the antenna has to be indicated to the user.

These disadvantages can be partly overcome by combining NFC with Bluetooth or WLAN, which on the other hand will mean that some of the advantages such as the lower price of pure NFC implementation are lost.

3.1.3 NFC mandated tag types[5]

Initiation of service requires two devices to communicate using NFC; one device is an NFC reader/writer and the other a passive NFC tag.

In June 2006, the NFC Forum introduced standardized technology architecture, initial specifications and tag formats for NFC-compliant devices. These include Data Exchange Format (NDEF), and three initial Record Type Definition (RTD) specifications for smart poster, text and Internet resource reading applications.

In addition, the NFC Forum announced the initial set of four tag formats that all NFC Forum-compliant devices must support. These are based on ISO 14443 Types A and B (the international standards for contactless smartcards) and FeliCa (conformant with the ISO 18092, passive communication mode, standard). Already more than one billion tags of this kind have been deployed globally, albeit for non-NFC applications like mass transit and access control.

The NFC Forum chose the initial tag formats to cater for the broadest possible range of applications and device capabilities:

- Type 1 is based on ISO 14443 A. (available from Innovision Research & Technology (Topaz™)). It has a 96-byte memory capacity, which makes it a very cost-efficient tag for a wide range of NFC applications.
- Type 2 is also based on ISO 14443 A (MIFARE UltraLight, available by Philips). It has half the memory capacity of Type 1 tags.

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5 Source: Innovision white paper on NFC in NFC Forum. Innovision from U.K. was one of SmartTouch partners.

- Type 3 is based on FeliCa (available by Sony). It has a larger memory (currently 2kbyte) and operates at a higher data rate (212kbit/s), which means it is suitable for more complex applications.
- Type 4 is fully compatible with ISO 14443A/B and is available from a number of manufacturers, including Philips (typical product example is MIFARE DESFire). It offers large memory-addressing capability with read speeds of between 106kbit/s and 424kbit/s – making it suitable for multiple applications.

It is worth noting that Type 1 and 2 tags and Type 3 and 4 tags are two very different groups, with very different memory capacities. There is very little overlap in the types of applications they are likely to be used for.

3.2 Reference Applications

This chapter briefly presents three reference application scenarios used when designing the generic use case of NFC. These are well known examples in the industry: mobile payment and ticketing, and Smart Poster. During the three years of its existence SmartTouch project has widely expanded use cases of NFC from these scenarios, as can be seen from the pilots in the book.

3.2.1 Mobile Payment and Ticketing

Payment and ticketing have been considered as ‘killer applications’ of NFC. One of the main advantages of NFC it can simulate a smart card. The NFC is built as such that it is backward compatible with the contactless card standards. Mobile payment as a concept is defined as the use of a mobile device to perform a payment transaction in which money or funds are transferred from one party (payer) to another party (receiver) via an intermediary, such as a financial institution, or directly without an intermediary.

Near Field Communication (NFC) brings a new twist for the mobile payment as it can embed the functions that we have gotten used with different contact-less cards like credit cards, public transportation tickets and alike. Combination of mobile devices and NFC opens up new possibilities for mobile payment, which as a whole has encountered different problems and its volume has been small.

As a new technology that needs an infrastructure to work, the process of adaptation has been slow when compared to other technologies integrated to mobile devices, for example camera. Secure payment and ticketing function needs different kind of architecture than straight NFC-function with reader and tag. Some kind of secure chip must be included into the architecture for the secure place for persistent data.

There are two different solutions for this secure chip implementation. In current Nokia solution there is a separate chip for this. It is a semi-open device specific chip that is controlled by *device manufacturer*. Another solution is to use SIM-card as a secure chip. It seems convenient that SIM-card is used, because it is there already. Use of SIM-cards would make *operators* a major part of the NFC-scheme.

3.2.2 Smart Poster

Smart Poster Technical Concept has been developed by the NFC Forum. It defines how phone number, SMS or URL can be stored in a NFC tag or transport them between devices. This way information and actions can be attached in a Smart Poster. Basically this allows transforming any physical object to a smart object by attaching an NFC tag in it. This means that the object can store additional information about itself.

The Smart Poster makes possible to initiate a phone call, send SMS or go to URL by reading a NFC tag with a NFC phone. The Smart Poster can contain actions, which trigger an application in the NFC phone. The technical solution makes also possible to edit or save the information (phone number, SMS, URL) read from the NFC tag.

First functionality for a smart movie poster would be ticket purchase. Touching the “buy tickets” tag would open web browser and the URL in tag leads the user to reserve and purchase the seats for the movie. When the transaction is completed, the back end system sends the ticket as an SMS to the phone.

User may ask for more information about the movie before buying the ticket by touching “more info” tag. What happens depends the functionality programmed into the tag. For instance, a mini-trailer could be loaded from the tag and then shown. The trailer could also be downloaded via URL. The tag can lead user to the film’s home page or to Internet Movie Database (http://www.imdb.com). Only one action per tag is allowed, however.

“Download soundtrack” tag has an URL which leads to an online music store. The movie poster could have an ad for a nearby restaurant offering discount. Touching the ad would save the discount offer as an SMS message in the phone’s message inbox. Yet another tag in the ad could be used to reserve a table in a restaurant. Touching the tag would open an SMS template with some predefined text and user would type name and time and then send the message for reservation.

The movie poster could also have a tag which opens web page having directions to the movie theatre. Smart Poster example is depicted in Figure 7 as it was designed by VTT to demonstrate services initiated from a poster.

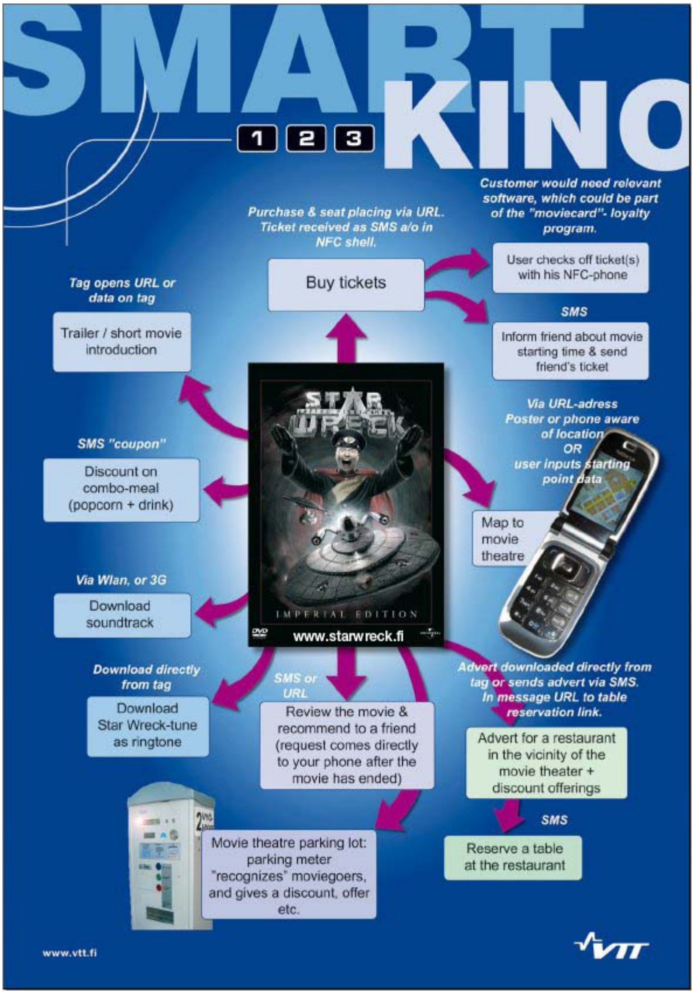


Figure 7. Smart Poster example.

Reference

Heikki Ailisto et al. 2007. Physical browsing with NFC technology. VTT Tiedotteita - Research Notes 2400. Espoo, 2007. 70 p.

3.3 Market development

Authors: Alain Rhelimi, Jean-Pierre Tual, Gemalto, France

3.3.1 Technology market shares

In this quick market overview, we will basically compare, from a market perspective, the three main competing technologies for smart contact-less applications. The market is currently roughly split between three major standards:

- Felica
- ISO 14443
- NFCIP-1.

3.3.1.1 Felica™ Market in Asia

The Felica™ technology (based on the Japanese standard JIS-X6319) is essentially deployed in Asia. The Figure 8 illustrates the use of this technology per country.

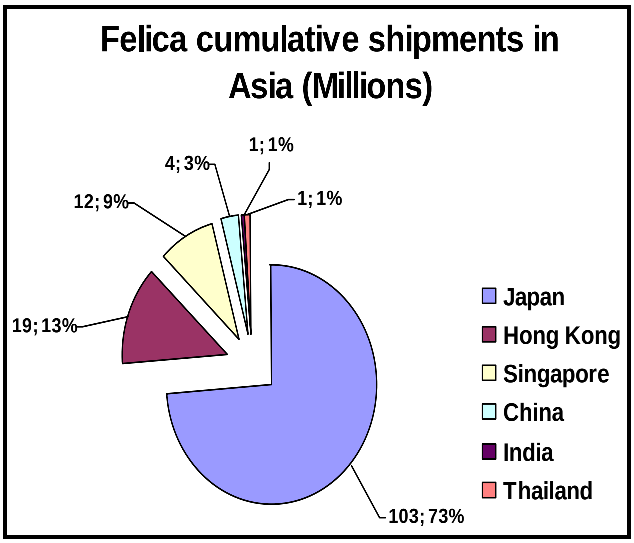


Figure 8. Felica™ cumulative shipments per country since 2001[6].

[6] Source: ABI research 2007.

Felica™ is mainly deployed in Japan. Other technologies compete in Japan as the ISO/IEC 14443 (type A and B).

3.3.1.2 ISO 14443 based technology

ISO/IEC 14443 products dominate the rest of the world (except Japan). 80 % of the applications are based on tag technology and require simple (without microprocessor) and low cost technology. The first application in volume is related to transport, ticketing and access control where low cost solutions are preferred.

The Figure 9 illustrates the IC TAM for applications related to the transport, event ticketing and access control.

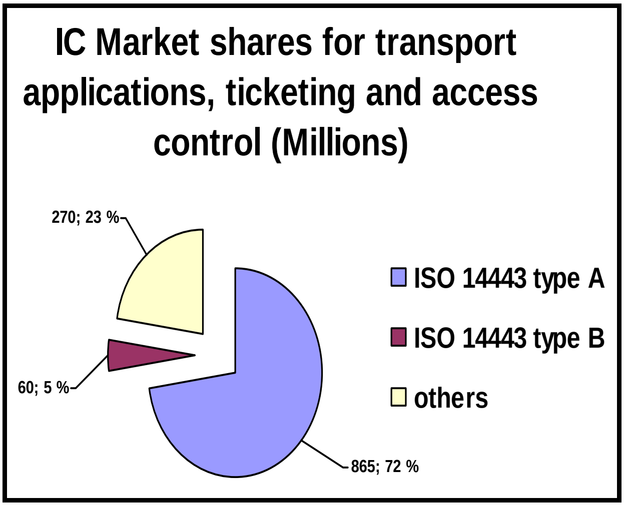


Figure 9. ISO 14443 TAM for transport applications.[7]

The ISO/IEC 14443 type B is gaining market share for government and EMV-based payment applications due to good performance and the availability of numerous silicon suppliers. The type B targets mainly microprocessor based products calling for fast transactions involving large data volumes. The Figure 10 shows the complete ISO 14443 microprocessor market in 2007.

[7] NXP; source: Cartes 2007 presentation.

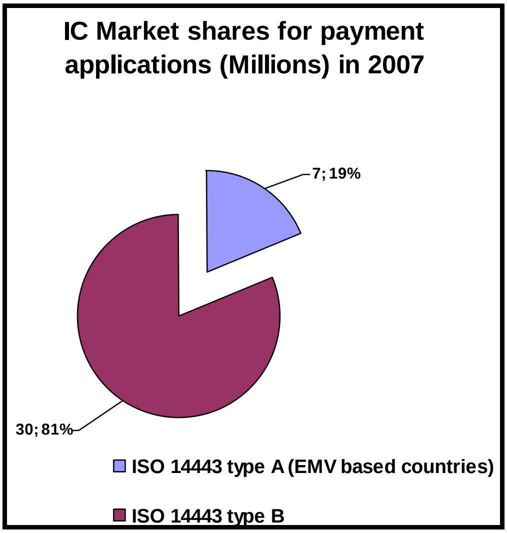


Figure 10. IC market shares for payment applications in 2007 (source: Gemalto).

3.3.1.3 NFCIP-1 technology

The NFCIP-1 technology is the combination (in passive mode) of the ISO/IEC14443 type A and of the JIS-X6319 at the physical layer. At the link layer, the NFCIP-1 reuses the ISO/IEC 14443 part 4 (T = CL) principles. Even though this standard exploits existing physical layers (ISO/ IEC14443 type A or Felica™) it is not usual for a platform to host both standards. One of the technologies is typically redundant within an installed base.

The support of Felica™ has few examples out of Asia which may not ease the deployment of this technology. The market share of the NFCIP-1 technology seems still very embryonic.

3.3.2 Conclusion

The IC market shares are an indicator to appreciate the support of a given technology but the most important criteria for assessing its future evolution of is the deployment of the related infrastructure and its capability to be upgraded. For instance, and in spite of a lower market for type-B devices, a large part of the ticketing/payment infrastructure is supporting both ISO/IEC 14443 type A and type B (except Japan).

4. Standards

Authors: Alain Rhelimi, Jean-Pierre Tual, Gemalto, France
Olli Welin, Jukka Suikkanen, TeliaSonera[8], Finland

4.1 Standardization organizations

Future NFC ecosystem is a combination of mobile handset OTA management, security domains key management, ticketing delivery & clearing, payment and micropayment functions. Security and privacy are also very important issues for all ecosystem players. Therefore NFC ecosystem technology platform and all functions should be carefully considered to able to fulfill all requirements from ecosystem partners. Here is a list of standardization bodies which all will place requirements for future NFC ecosystem architecture and its functions.

NFC (Near Field Communication) Forum, http://www.nfc-forum.org

NFC Forum is a non-profit industry association formed to advance the use of NFC short-range wireless interaction in consumer electronics, mobile devices and PCs. The NFC Forum will promote implementation and standardization of NFC technology to ensure interoperability between devices and services.

The **mission** of the Near Field Communication (NFC) Forum is to advance the use of Near Field Communication technology by developing specifications, ensuring interoperability among devices and services, and educating the market about NFC technology.

The **objectives** of the NFC Forum are to

8 TeliaSonera is a teleoperator in Sweden and Finland.

- develop standards-based Near Field Communication specifications that define a modular architecture for NFC devices
- define protocols for interoperable data exchange and device-independent service delivery
- define protocols for device discovery and device capability
- encourage technology providers to develop and deploy NFC-enabled products around a common set of specifications
- establish a certification program that ensures compliant products function according to NFC Forum specifications
- promote global use of NFC technology by educating consumers and enterprise users on the applications and benefits of NFC technology.

The NFC Forum aims to be active in areas where there is no overlap with pre-existing standardization bodies and advocacy groups.

ETSI – SmartCard Platform

ETSI's Smart Card Platform (SCP) Committee and GlobalPlatform have fully aligned the latest versions of their smart card specifications – ETSI's UMTS Integrated Circuit Card (UICC) Specifications (TS 102 225 & 226) and the GlobalPlatform Card (2.1.1) Specification.

The result of combining the ETSI SCP smart card solution with GlobalPlatform's multi-application infrastructure is that they will now provide one end-to-end solution for secure, flexible and remote smart card application life cycle and file management.

GSMA (GSM Association), http://www.gsmworld.com

The GSMA (The GSM Association) is the global trade association representing more than 700 GSM mobile phone operators across 218 countries and territories of the world. In addition, more than 200 manufacturers and suppliers support the Association's initiatives as key partners.

The primary goals of the GSMA are to ensure mobile phones and wireless services work globally and are easily accessible, enhancing their value to individual customers and national economies, while creating new business opportunities for operators and their suppliers. The Association's members serve more than 3.4 billion customers – 85 % of the world's mobile phone users.

GSMA has had several NFC projects the goal of which is to identify the Mobile Operator's role in the NFC value chain. In addition to this the projects aim to develop NFC service requirements and use cases, and a common vision between MOs. The vision will be shared with NFC application providers and service developers. The projects will also promote the development of NFC technology that supports inter-operability via standardization.

4.2 Global overview

4.2.1 ISO/IEC 1443 standards

ISO/IEC 14443 is a set of standards that are based on RFID technologies and enable contact-less transactions between a reader device and a proximity card used for identification (usually this proximity card uses the standard credit card form factor defined by ISO/IEC 7810 ID-1, but other form factors – such as tokens, key-fobs,.. – are also possible). This set of standards has been developed by the *Working Group 8* of *Subcommittee 17* in *ISO's/IEC's Joint Technical Committee 1*.

Proximity transactions as described in the ISO/IEC 14443 are based on an electromagnetic coupling between the proximity card and the Radio Frequency Identification (RFID) reader, which uses an embedded microcontroller (including its own processor and several types of memory) and a magnetic loop antenna that operates at 13.56 MHz (RFID frequency). The same principle is also used in more recent ICAO standards for machine-readable travel documents, that specify a cryptographically-signed file format and authentication protocol (based on the same coupling principle) for storing biometric features (photos of the face, fingerprints, and/or iris).

ISO/IEC 14443 consists of four parts and involves two possible types of cards, known as type A and type B. The main differences between these types concern modulation methods, coding schemes (part 2) and protocol initialization procedures (part 3). Both type A and type B cards use the same transmission protocol described in part 4. The transmission protocol specifies data block exchange and related mechanisms, including

1. data block chaining
2. waiting time extension
3. multi-activation.

ISO/IEC 14443 uses following terms for components taking part to a transaction:

- **PCD** – proximity coupling device (or reader)
- **PICC** – proximity integrated circuit card.

Both Type A and Type B cards are supposed to operate within approximately 10 cm of the reader antenna.

Part 1 [ISO/IEC 14443-1:2000(E)] defines the size and physical characteristics of the card. It also lists several environmental stresses that the card must be capable of supporting for avoiding any risk of permanent loss of functionality. A list of test stresses are described and intended to be performed at the card level to ensure such protection level. Those tests are dependent on the card and on the antenna design and hardly readily translated to the ICC level. The operating temperature range supported by Type A and Type B cards is specified ranging from 0 °C to 50 °C.

Part 2 [ISO/IEC 14443-2:2001(E)] defines the RF power and signal interface needed for completing a transaction, for both Type A and Type B. Both communication schemes are half duplex with a multiple of 106 kb/s data rate in each direction (up to 848 kb/s for Type B). Data transmitted by the card is load modulated with an 847.5 kHz sub-carrier. The card is powered by the RF field and no battery is required.

Part 3 [ISO/IEC 14443-3:2001(E)] defines the initialization and anti-collision protocols for Type A and Type B cards. This includes the definition of the anti-collision commands, responses, data frame, and timing. The initialization and anti-collision scheme is designed to permit the construction of multi-protocol readers capable of supporting both Type A and Type B cards. The general principle is that both card types wait silently in the field for a polling command. A multi-protocol reader then polls one type of cards, completes all transactions with cards of this type responding, and then polls for the other type of cards and transact with them.

Part 4 [ISO/IEC 14443-4:2001(E)] defines the high-level data transmission protocols for Type A and Type B. The protocols described in Part 4 are optional elements of the ISO/IEC 14443 standard; proximity cards may be designed with or without support for Part 4 protocols. The PICC reports to the reader if it supports the Part 4 commands in the response to the polling command (as defined in Part 3).

4.2.2 Introduction to NFC standards

NFC is based on RFID technology and uses the same electromagnetic coupling working principles as the ISO/IEC 14443 technology. The NFC standard has been issued in 2003 and is also targeting proximity-range (~10 cm) data communications, working in the same frequency band of 13.56 MHz. NFC is a super-set of the standard protocols standardized in ISO/IEC 18092, and is compatible with the ISO/IEC 14443 (proximity cards) and ISO 15693 (vicinity cards) standards, and also with the Japanese JIS X 6319 standard, corresponding to Sony's FeliCa contact-less smart card system. NFC can then be used with existing infrastructures based on the standards mentioned, eliminating the need for a dedicated one.

The NFC standard specifications, prior to be pushed to International Standardization organisations (such as ISO/IEC, ETSI/3GPP) are debated within the NFC-Forum. "The NFC Forum is a not-for-profit industry organization, whose mission is to advance the use of Near Field Communication technology by developing specifications, ensuring interoperability among devices and services, and educating the market about NFC technology. More than 150 companies, many of them leaders in their markets, have teamed up to achieve this goal. More information can be found at http://www.nfc-forum.org (mission statement from the NFC-Forum web site).

The key distinctive feature of NFC-enabled devices (as compared with ISO/IEC 14443) is that they can both read-out RFID transponders and emulate them. Furthermore, peer-to-peer communication is possible when two NFC devices are brought together. By contrast, classical RFID systems are designed with only a read-write device attached to a computer or reader. NFC was designed to enable intuitive communication with other entities and to offer an intuitive way of sharing data between electronic devices. In summary, NFC technology combines two paradigms, the communication between devices that both have active power supply and computing capabilities, and the communication between powered devices and passive tags.

NFC devices support three modes of operation: reader/writer mode, peer-to-peer mode, or card emulation mode.

- In reader/writer mode, the NFC device is capable of reading NFC Forum mandated tag types, such as in the scenario of reading an NFC Smartposter tag. The reader/writer mode relies on an RF interface compliant with the ISO 14443 (Type A) and FeliCa schemes (also known as NFC-IP1 Type F), and globally known as NFC-IP1.

- In Peer-to-Peer mode, two NFC devices can exchange data. This enables for example to share Bluetooth or WiFi link set-up parameters, and exchange data such as virtual business cards or digital photos. The RF interface for Peer-to-Peer mode is based on the ISO/IEC 18092 standard.
- In Card Emulation mode, the NFC device itself acts as an NFC tag, appearing to an external reader exactly as a traditional contact-less smart card. The RF Interface used for this mode is based on the ISO 14443. The Type B is especially used for highly secure transactions such as contact-less (Mobile) payments or Ticketing.

At application level, the three modes of operations are based on a different set of protocol stacks, as defined in figure below:

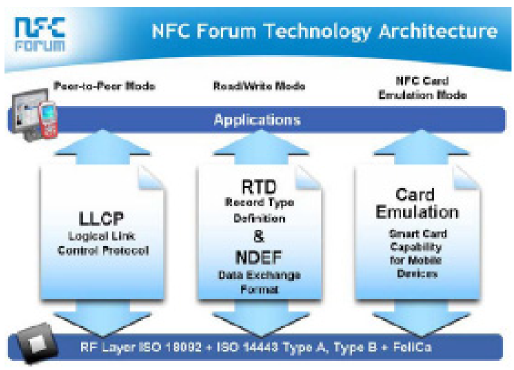


Figure 11. NFC Technology Architecture defined by NFC Forum.

4.2.3 NFC-IP Air-Interface Protocols overview

Near Field Communication Interface Protocol-1 (ISO 18092)

The Near Field Communication Interface Protocol 1 (NFCIP-1) is standardized in ECMA-340 and in ISO/IEC 18092. The standards define the modulation and bit encoding schemes and the frame architecture for the supported data rates of 106, 212, and 424 kb/s. The communication signal interface and the general protocol flow are also specified in the standard.

In NFC systems, at most two devices can communicate concurrently. They exchange data using inductive coupling and radio signals. One of the communication partners is called initiator and has an active role, whereas the passive part is called target. Both roles are always assigned, even if two battery-powered NFC devices communicate.

NFCIP-1 defines the active and passive communication modes. In active mode, both the initiator and the target generate a radio frequency field. The initiator starts the communication using the NFCIP-1 protocol. Once the initial handshake and configuration are completed, the data transfer starts. In passive mode, only the initiator generates the radio frequency field. The target is powered by inductive coupling and is able to send or receive data. This mode achieves significant power savings. Furthermore, NFCIP-1 defines the transport protocol, anti-collision methods for the active mode and target selection and initialization for the passive mode.

Near Field Communication Interface Protocol-2 (ECMA-352)

The Near Field Communication Interface Protocol 2 (NFCIP-2) is a standard specified in ECMA-352. The standard specifies a method for choosing one out of the three possible communication modes defined in ECMA-340 (i.e. NFCIP-1), ISO/IEC 14443 (e.g. Philips MIFARE) and ISO/IEC 15693 (e.g. RFID tags). As a result, NFCIP-2 provides a gateway between existing interface standards.

Devices that implement NFCIP-2 need to implement the functions *proximity coupling device* (ISO/IEC 14443), *vicinity coupling device* (ISO/IEC 15693) and the *initiator* and *target* functions defined in ECMA-340. This makes NFC devices compatible to existing commercially deployed FeliCa and MIFARE systems. However, compatibility is not achieved on the smart card emulation side for the standards ISO/IEC 14443B and ISO/IEC 15936, although read-out and editing is possible.

Another aim of the protocol is not to disturb any ongoing communication on the operating frequency of 13.56 MHz. This is achieved using carrier sense multiple access (CSMA), hence an NFCIP-2 device will not activate its radio frequency field when it detects an external radio field that exceeds a certain threshold.

Enhanced Near Field Communication

INSIDE Contactless has developed a standard called *Enhanced Near Field Communication* (eNFC) that has slightly more capabilities regarding compatibility with existing systems. In contrast to the original NFC standard, eNFC additionally supports the standards ISO/IEC 14443B and ISO/IEC 15936 (RFID tags) on the smart card emulation side. The main advantage of ISO/IEC 14443B is that it makes card emulation possible even when the mobile device's battery is empty or the device is turned off. This feature is very useful in ticketing applications. Without the feature, passengers could not present their ticket if their mobile phone is discharged.

4.3 Detailed description of the NFC Protocols

4.3.1 Coding and modulation schemes

Next figure illustrates the coding and the modulation of the PCD to the PICC of the three main technologies already deployed on the field.

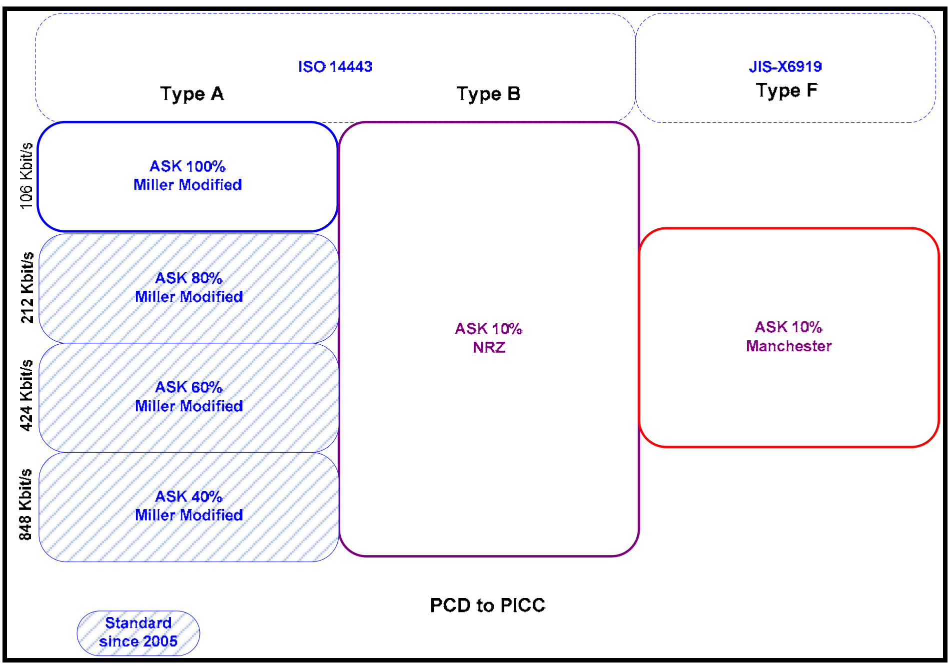


Figure 12. Coding and modulation PCD to PICC.

The type A high speed is standardized since 2005 but not integrated in the ISO 18092 (NFCIP-1). This new capability of the ISO/IEC 14443 type A is not bringing speed advantages compared with existing and deployed technologies as the ISO/IEC 14443 type B and the JIS-X6319 based products.

The Figure 13 illustrates the coding and the modulation schemes of the PICC to the PCD.

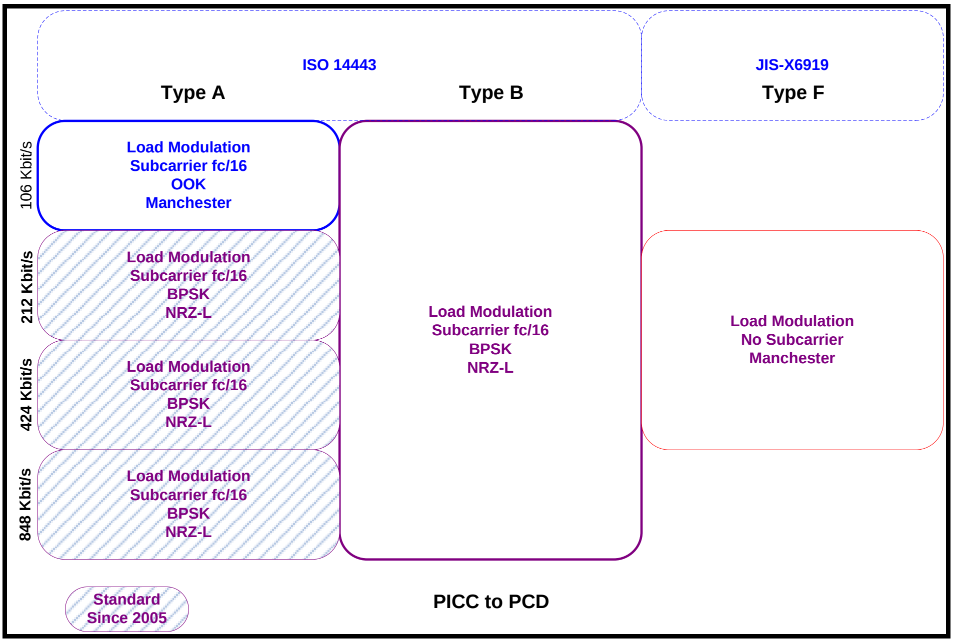


Figure 13. Coding and modulation PICC to PCD.

The NFCIP-1 is the combination of the ISO/IEC 14443-3 (type A) and the JIS-X6319. For PICC to PCD data transfers, the high speed technology (coding and modulation) for the type A is based on the type B.

The Figure 14 illustrates the combination PCD to PICC.

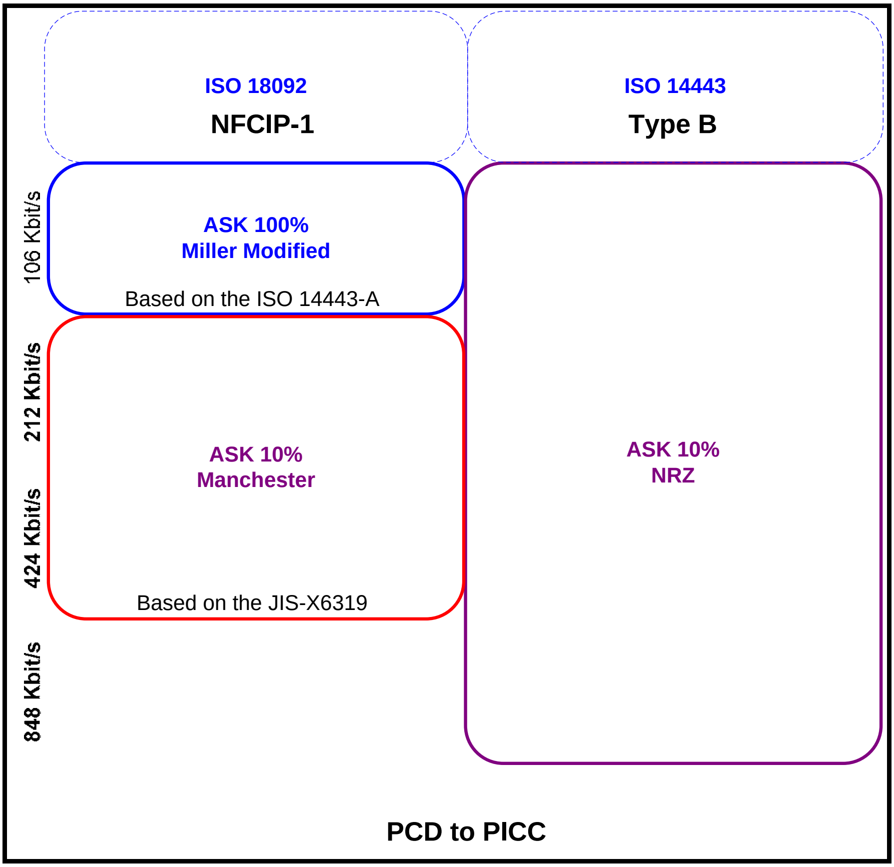


Figure 14. NFCIP-1 and ISO/IEC 14443 PCD to PICC.

The ISO/IEC 18092 does not define coding and modulation based on the ISO/IEC 14443 type A greater than 106 Kbit/s. Consequently, higher data rates in passive mode use the protocol based on the JIS-X 6319.

The Figure 15 illustrates the combination PICC to PCD.

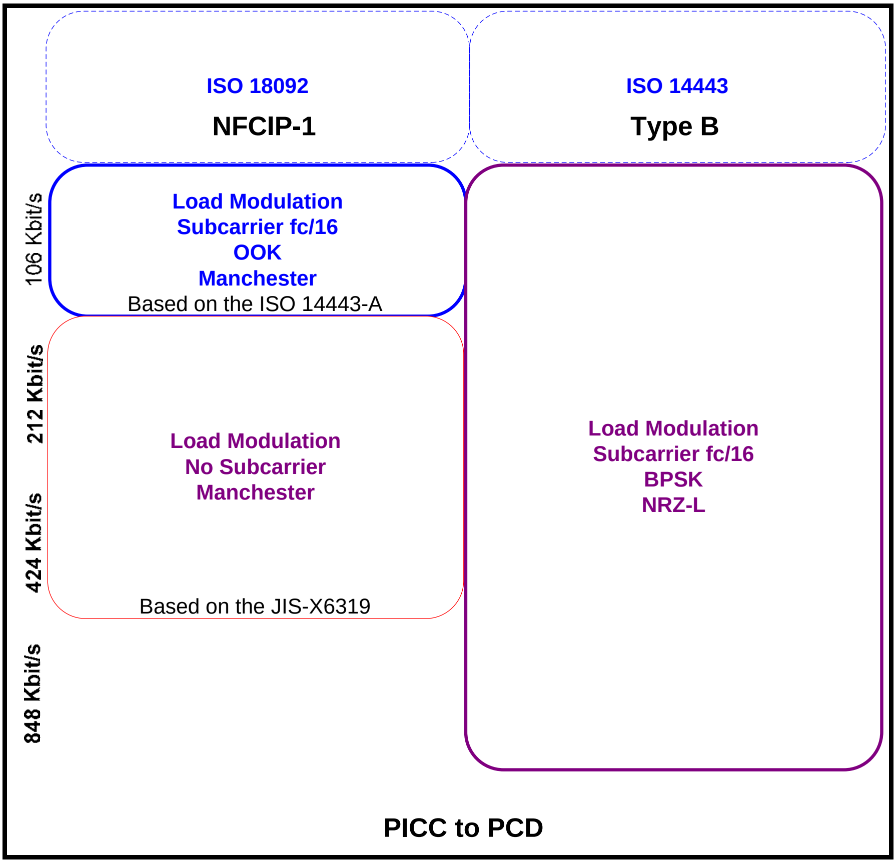


Figure 15. NFCIP-1 and ISO/IEC 14443 PICC to PCD.

4.3.2 Physical layers protocols

This section aims to compare the three RF technologies related to the ISO/IEC 18092 (NFCIP-1 type A and type F) and the ISO/IEC14443 type B and that are at the basis of the NFC technology.

4.3.2.1 ISO 14443 type A (NFCIP-1 type A)

This technology is also very popular for contact-less devices using wired logic (no microprocessor). The coding scheme from the PCD to the PICC uses the ASK 100 % and Miller modified code. The Figure 16 below illustrates the coding and the signal spectrum of the transmitted signal for a data rate at 100 Kbit/s.

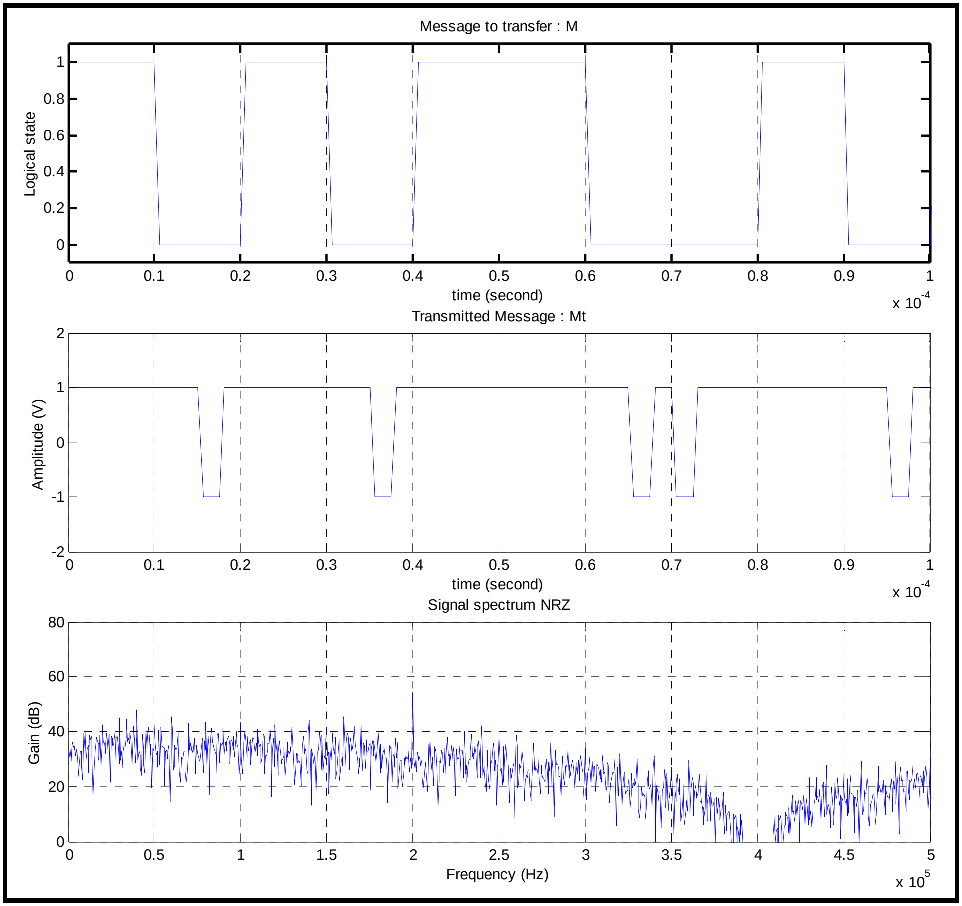


Figure 16. Miller Modified spectrum.

The signal is digital, nevertheless the signal spectrum is equivalent for a ASK 100 % modulation. The ratio between the elementary bit time and the Miller modified pulse time is about ¼ so, the bandwidth needed to convey the signal shall be about 4 times the signal data frequency.

The next figure illustrates the signal spectrum for the data transmission from the PICC (target) to the PCD (initiator).

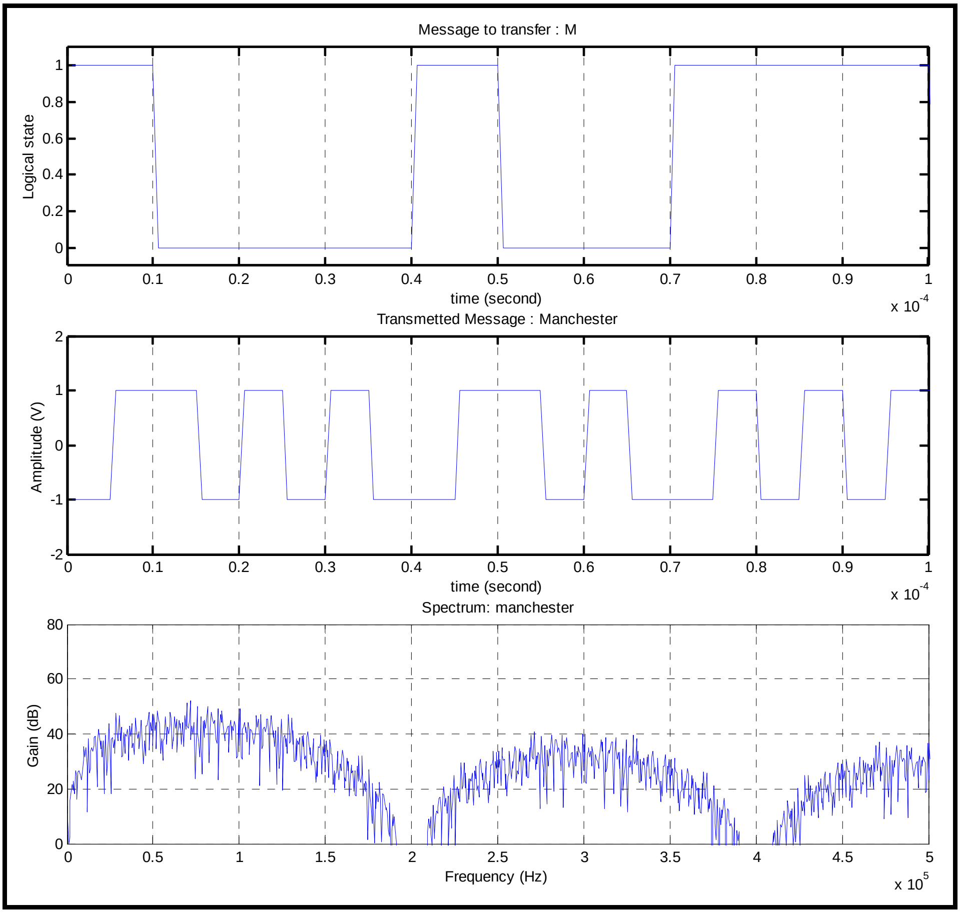


Figure 17. Signal spectrum for Manchester coding.

The Manchester coding requires a bandwidth twice the data signal frequency (data rate).

4.3.2.2 ISO 14443 type B

This technology is very popular for contact-less devices using a microprocessor for example in contact-less EMV payment transactions. The coding form the PCD to the PICC uses the ASK 10 % and NRZ-L code.

The Figure 18 below illustrates the coding and the signal spectrum of the transmitted signal for a data rate at 100 Kbit/s.

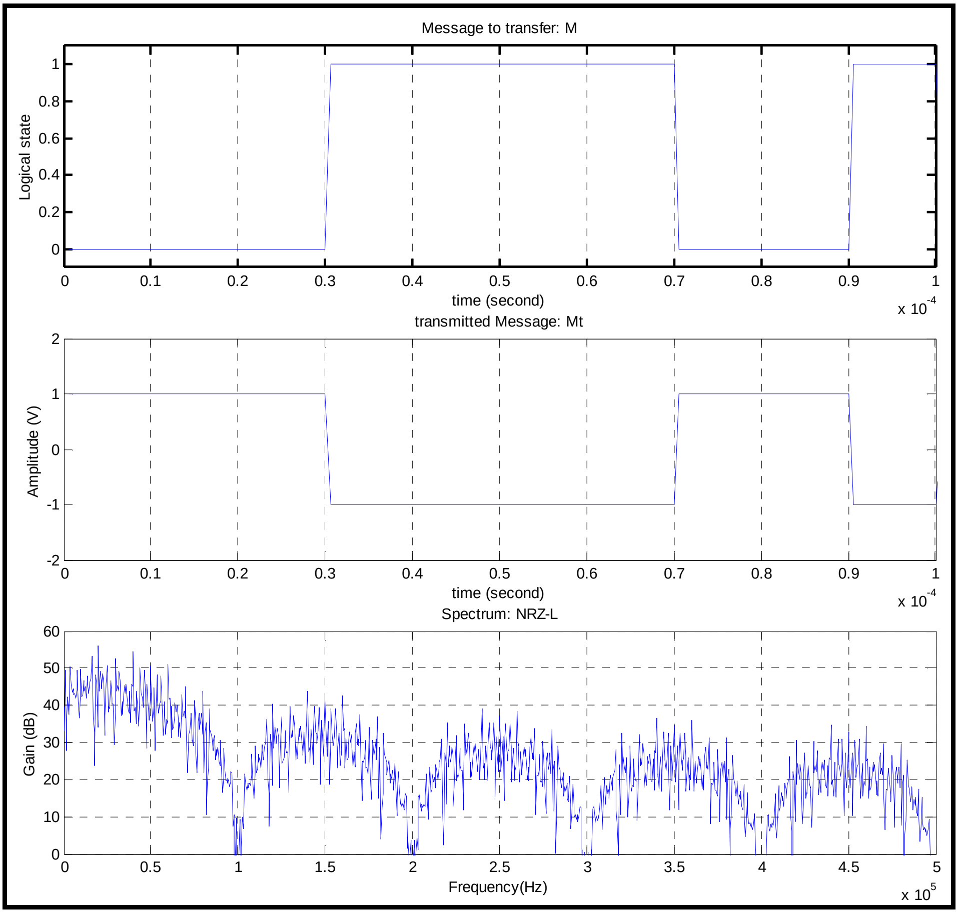


Figure 18. Signal spectrum for NRZ-L coding.

The transmission from the PICC to the PCD is using the coding BPSK NRZ-L.

The next figure illustrates the signal spectrum for the upstream data traffic.

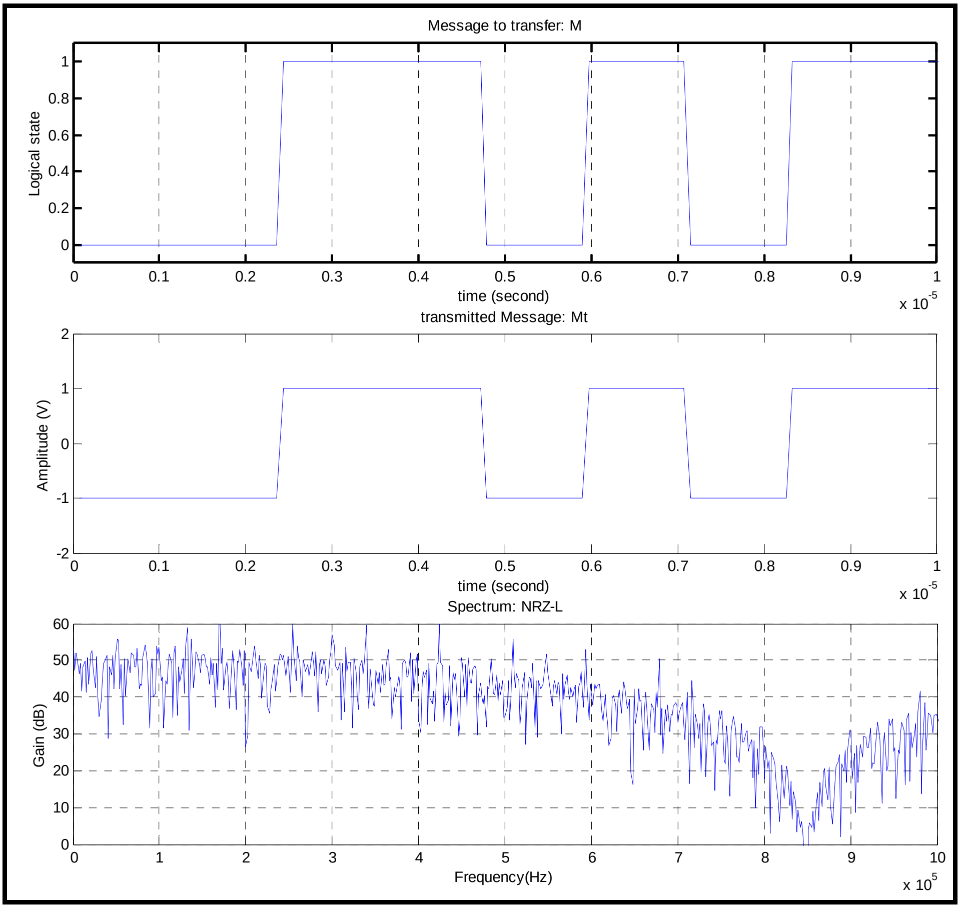


Figure 19. Signal spectrum for NRZ-L over BPSK @ 848 Kbit/s sub-carrier 848 KHz.

The ISO/IEC14443 type B takes benefits of the NRZ-L to convey the data in both directions (PCD to PICC and PICC to PCD) in using a minimal bandwidth.

4.3.2.3 JIS X 6319 (NFCIP-1 type F)

The JIS-X6319 used the Manchester coding for both transfer directions. The signal spectrum is illustrated in the Figure 17 Signal spectrum for Manchester coding.

The bandwidth needed to carry the data is the double of the data frequency. That makes this technology half way between the ISO/IEC 14443 type A and type B.

This technology is standardized for 212 Kbit/s and 424 Kbit/s only.

4.3.2.4 Summary

The Table 2 illustrates the summary of the different bandwidth related to data frequency and the technology.

Table 2. Ratio Bandwidth/Data rate vs RF technology summary.

Physical layers	**PCD to PICC BW/Data frequency**	**PICC to PCD BW/Data frequency**
ISO/IEC 18092 type F	2	2
ISO/IEC 18092 type A	4	2
ISO 14443 type B	1	1

4.3.3 Detailed description of some upper level protocols

The aim of this section is to give a description of the upper layer protocols that are involved in the various NFC modes. This can broadly depicted by the following figure, as presented by the NFC-Forum:

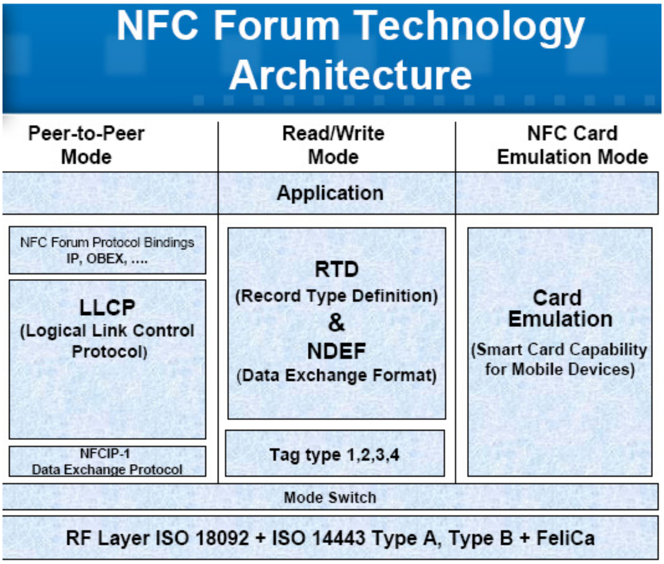


Figure 20. NFC Technology Architecture specified by NFC Forum.

On the Card emulation mode side, and taking in account the work done in SmartTouch, we will describe in this Book the protocol stack implemented in the mobile area and now standardized by the ETSI/3GPP organizations and known as the SWP (Single-Wire Protocol **ETSI TS 102. 613**) and HCI (Host Controller Interface **ETSI TS 602 622**) protocols.

4.3.3.1 Read/write mode

This section presents the protocols that are currently standardized by the NFC Forum and that enable to use the NFC technology in Read/Write mode, e.g. for reading information tags from a personal device. These specifications can be downloaded from the NFC Forum site.

The four specifications now available are:

- NFC Data Exchange Format (NDEF) Technical Specification. NDEF describes a common data exchange format for NFC Forum- compliant devices and NFC Forum-compliant tags. It also contains the rules for constructing a valid NDEF message as an ordered and unbroken collection of NDEF records. Further, it defines the mechanism for specifying the types of application data encapsulated in NDEF records.

There are currently four types of tags supported by the NDEF specification, according to the following Table 3.

Table 3. Tag type specification, source NFC Forum.

	Type 1	Type 2	Type 3	Type 4
RF Interface	ISO 14443 A-2	ISO 14443 A-2	FeliCa (ISO 18092, passive communication mode at 212 kbits/sec)	ISO 14443-2
Initialization	ISO 14443 A-3	ISO 14443 A-3	FeliCa (ISO 18092, passive communication mode at 212 kbits/sec)	ISO 14443-3
Speed	106 kbits/sec	106 kbits/sec	212 kbits/sec	106-424 kbits/sec
Protocol	Specific Command set	Specific Command Set	FeliCa protocol	ISO 14443-4 ISO 7816-4 commands
Memory Size	Up to 1 KB	Up to 2 KB	Up to 1 MB	Up to 64KB
Cost (memory dependent)	Low	Low	Moderate	Moderate
Use cases	Tags with small memory for single application		Flexible tags with larger memory offering multi-application capabilities	

- NFC Record Type Definition (RTD) Technical Specification. To help ensure interoperability of NFC technology in a broad variety of devices, the RTD provides guidelines for specifying well-known record types for inclusion in NDEF messages exchanged between NFC Forum-compliant devices, and between NFC Forum- compliant devices and tags.
- Smart Poster Record Type Definition (RTD). The Smart Poster RTD defines a record type to put URLs, SMSs or phone numbers on an NFC tag, or to transport them between devices. The Smart Poster RTD provides the wrapper necessary to fulfil the Smart Poster use case defined by the NFC Forum, in which information about an object, event, etc., is attached to a physical object.
- Text Record Type Description (Text RTD). The Text RTD defines a record format for plain text data, which can be used for free- form text descriptions of other objects on a tag. The Text RTD is a general purpose text field to add metadata to things such as URLs, and it can be used where there is not much space. The Text RTD will also work well for non-Western languages, as it includes language information for localization purposes.

- The URI Service RTD describes a record to be used with the NDEF to retrieve a URI stored in an NFC Forum-compliant tag or to transport a URI from one NFC device to another. The URI RTD also provides a way to store URIs inside other NFC elements, such as on Smart Posters.

4.3.3.2 Peer to Peer mode

After some intensive debate at the NFC-Forum, the following protocol has finally been accepted for becoming the P2P supporting standard. This protocol, named LLCP, is entirely supposed to be implemented in the Mobile Handset, while some other open interfaces (e.g. for interfacing with smart-cards) have currently been proposed at the ETSI.

The LLCP protocol layer is relying on two sub-layers:

- the MAC layer
- the Link layer header.

The global LLCP efficiency is depending on the combined efficiency of these layers as together with the LLCP efficiency itself and of the latency between frames.

The Figure 21 below illustrates these three segments related to the link layer, the LLCP layer and the application layer.

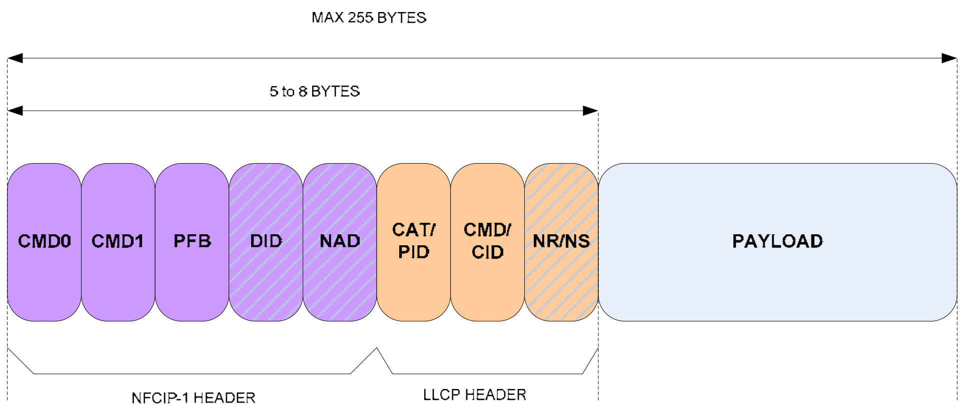


Figure 21. ECMA and LLCP headers.

The LLCP header is conveyed over the NFCIP_1 for the first LLCP fragment only if the payload is greater than 249 bytes (see SAR-Segmentation and Reassembly- level I).

The NFCIP-1 reference frame in the present document does not consider the support of the NAD and DID. The Figure 22 below illustrates the reference frame for a payload size less than 249 bytes.

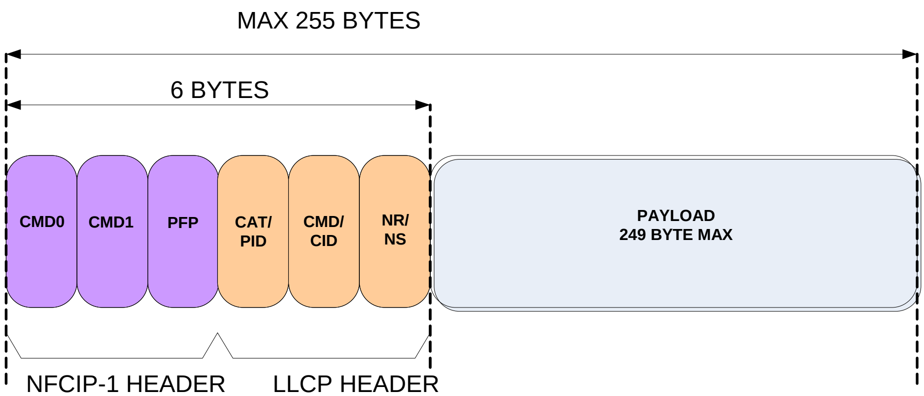


Figure 22. LLCP Reference frame.

If the SAR level I is not applied then the raw efficiency is 92,91 % (249 bytes payload over 268 byte raw frame).

4.3.3.3 NFCIP-1 features

The NFCIP-1 protocol exposes almost the same basic features as the ISO14443-4:

- Data flow control: this is based on the Go & Wait principle usual for half duplex protocols. The initiator may slow down the data traffic by just temporarily stopping the data transmission. The target may send a supervision frame for a timeout extension.
- Error handling: two supervision frames are defined to accept (ACK frame) or reject (NACK frame) a received information frame.
- Ordered data: The Information is delivered within the NFCIP-1 protocol to provide an ordered data flow. The PNI (2 bits) field in the PFB control field allows the checking of the frame sequences.
- Segmentation & Re-Assembly: the NFCIP-1 provides a SAR capability thanks the bit MI in the PFB control field.

In summary, the NFCIP-1 provides a Link Layer which is reliable (error free), ordered and having a data flow control. Optionally the NFCIP-1 may offer a logical data multiplexing thanks the NAD field. So we may define up to 256 independent logical channels (16 destination nodes and 16 source nodes).

Table 4. NFCIP-1 Features.

Features	**Available**	**Involved field**
Error recovery	Yes	Supervision frame ACK/NACK in the PFB field
Data flow control	Yes	Go & Wait principle: Time-out extension for the target, delayed DEP_REQ sending for the initiator
Ordered frames	Yes	PNI bits in the PFB field
Multi-channel	Yes	NAD field.
Data flow per channel	No	(To be checked)

4.3.4 SAR level I

As soon the message to be conveyed has a size greater than the maximum NFCIP-1 payload, SAR is mandatory. The role of the SAR is to segment, at the sender level, the message to be conveyed in frames having a payload smaller or equal to the maximum NFCIP-1 payload. At the receiver level, the counterpart is able to reassembly the message segments in order to get the original message sent by the sender. The SAR level I is the first one from the bottom of the P2P protocol stack.

We assume, in the numerical example, a latency range between 300µs to 1ms. This latency range is tight and could be reviewed according to investigation with the NFC controller makers.

The Figure 23 illustrates the SAR level I.

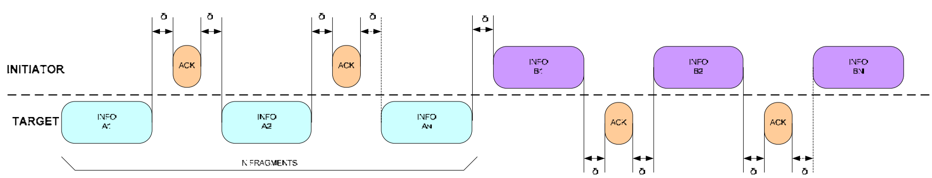


Figure 23. SAR level I.

The target sends an Information message having N segments: A1, A2,..,AN. The initiator sends an Information message having N segments: B1, B2, ,..., BN.

The maximal effective bandwidth of the channel of communication is when N is infinite:

$$\eta_{SAR1} = \frac{SINFO_{NET}}{SINFO_{RAW} + SACK + 2\delta D}$$

Equation 1. LLCP Reference frame best efficiency.

Where

- $SINFO_{NET}$: Size of the payload (bits)
- $SINFO_{RAW}$: Size of the raw NFCIP-1 frame (bits)
- SACK : Size of the NFCIP-1 ACK (Bits). It means 24 bits
- δ : System latency +internal latency of each part (in second)
- D : The data rate in bit/s.

A real implementation may expose a MTU about 1500 bytes (IP frame size), consequently the N may reach 6. For example, let assume a MTU equals to 1509 bytes over the NFCIP-1 type F.

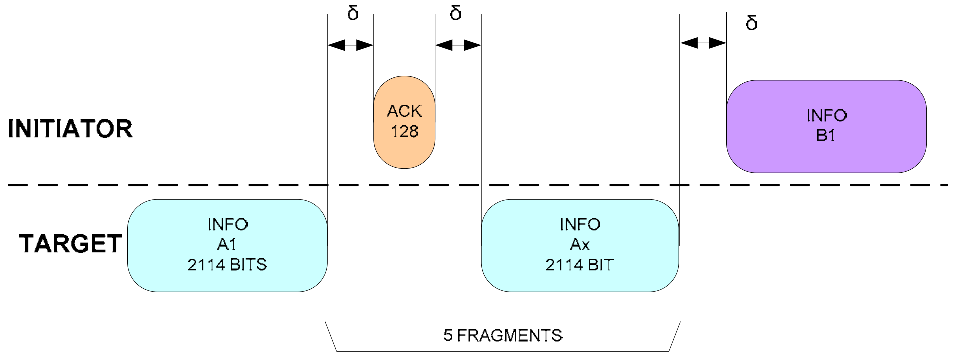


Figure 24. MTU 1506 Bytes.

The general equation for the effective efficiency of the LLCP protocol is:

$$\eta_{SAR\_llcp} = \frac{P_1 + (n-1)\times P_2}{n\times L + (n-1)\times ACK + (2\times n-1)\times \delta D}$$

$$application\,data\ \ size = P_1 + (n-1)\times P_2 + R_2$$

Equation 2. LLCP effective efficiency.

Where

P_1	: size of the payload (bits)
P_2	: size of the raw NFCIP-1 frame (bits)
ACK	: size of the NFCIP-1 ACK (Bits). It means 24 bits
δ	: system latency +internal latency of each part (in second)
D	: the data rate in bit/s
L	: size in bit of a NFCIP-1 full frame
N	: number of frame.

The limit of the LLCP effective efficiency when the payload tends to infinity is:

$$\underset{n\mapsto+\infty}{Lim}\,\eta_{SAR\_llcp} = \frac{P_2}{L\ \ + ACK + 2\times \delta D}$$

Equation 3. Effective efficiency for infinite payload.

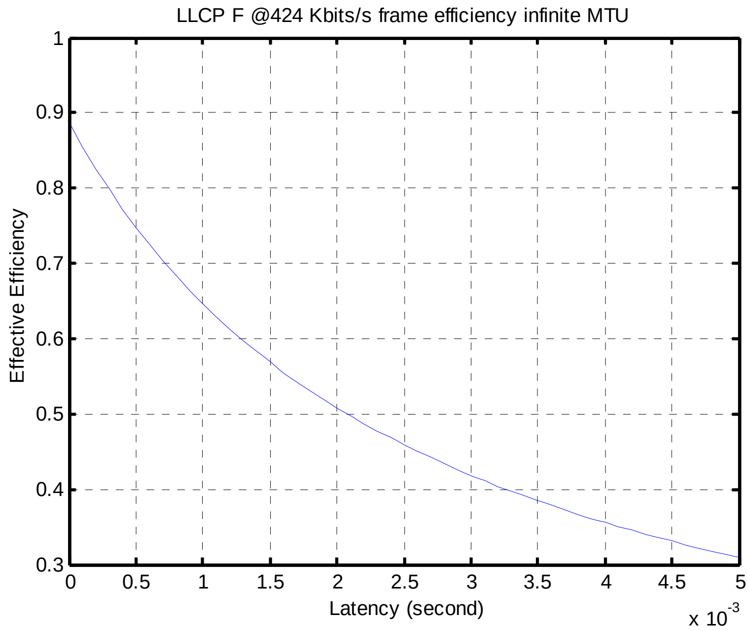


Figure 25. LLCP effective for infinite MTU.

We assume that all frames have a full payload otherwise the equation is as follow:

$$\eta_{SAR\_llcp} = \frac{P_1 + (n-1)\times P_2 + R_2}{(n-1)\times L + LR_2 + (n-1)\times ACK + (2\times n+1)\times \delta D}$$

$$application\,data\ \ size = P_1 + (n-1)\times P_2 + R_2$$

Equation 4. LLCP effective efficiency (last payload not full).

Where

P_1	: size of the payload (bits) including the LLCP header
P_2	: size of the payload (bits) excluding the LLCP header
R_2	: remaining payload (bits) excluding the LLCP header
ACK	: size of the NFCIP-1 ACK (Bits). It means 24 bits
δ	: system latency +internal latency of each part (in second)
D	: the data rate in bit/s

L : size in bit of a NFCIP-1 full frame
LR_2 : size in bit of a NFCIP-1 frame related to the remaining payload
n : number of frame.

The hereafter summarizes the numerical values for the LLCP based on the NFCIP-1 A and F (MTU = 1503).

Table 5. LLCP Protocol parameters.

Parameter	Unit	NFCIP-1 A MTU = 1503	NFCIP-1 F MTU = 1503	NFCIP-1 F MTU = 1509
P_1	bit	1984	1992	1992
P_2	bit	2008	2016	2016
ACK	bit	49	128	128
R_2	bit	0	1968	0
L	bit	2308	2144	2144
LR_2	bit	0	2096	0
N	-	6	6	6

We may easily compute the efficiency related to the latency for the NFCIP-1 type F.

$$\eta_{SAR\_ref\_F} = \frac{1509 \times 8}{6 \times 2144 + 5 \times 128 + 11\delta D}$$

$$\eta_{SAR\_ref\_F} = \frac{12072}{13504 + 11\delta D}$$

Equation 5. LLCP NFCIP-1 F effective efficiency for 1509 bytes MTU.

We may easily compute the efficiency related to the latency for the NFCIP-1 type A (MTU = 1503).

$$\eta_{SAR\_ref\_A} = \frac{1503 \times 8}{6 \times 2308 + 5 \times 49 + 11\delta D}$$

$$\eta_{SAR\_ref\_A} = \frac{12024}{14093 + 11\delta D}$$

Equation 6. LLCP efficiency for 1503 bytes MTU.

The worst case may appear when N = 2 and the last fragment payload is 8 bit.

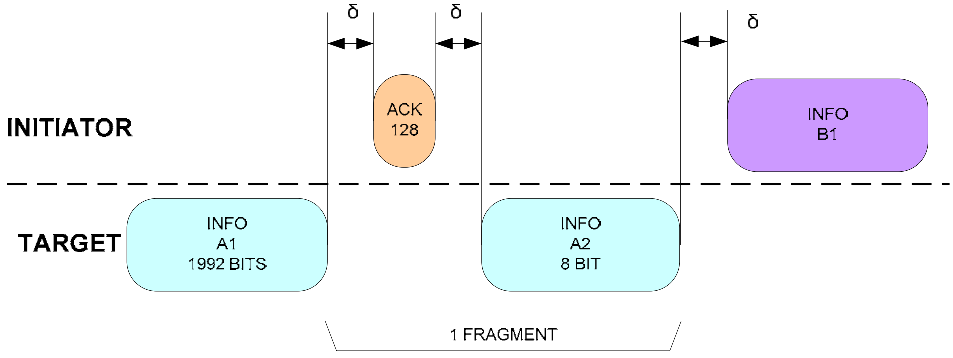


Figure 26. Reference frame worst case MTU.

$$\eta_{SAR\_worst\_C} = \frac{1992 + 8}{2144 + 136 \pm 128 + 3\delta D}$$

$$\textit{Worst case}$$

$$\eta_{SAR\_worst\_C} = \frac{2000}{2408 + 3\delta D}$$

$$\textit{Worst case}$$

Equation 7. Worst LLCP NFCIP-1 F effective efficiency.

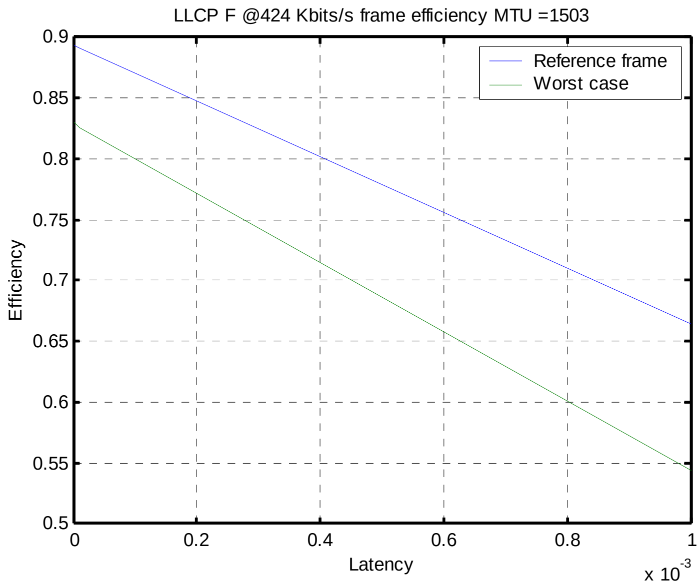


Figure 27. Reference frame efficiency.

The efficiency varies when the MTU changes. The Figure 28 illustrates the efficiency changes in function of the MTU.

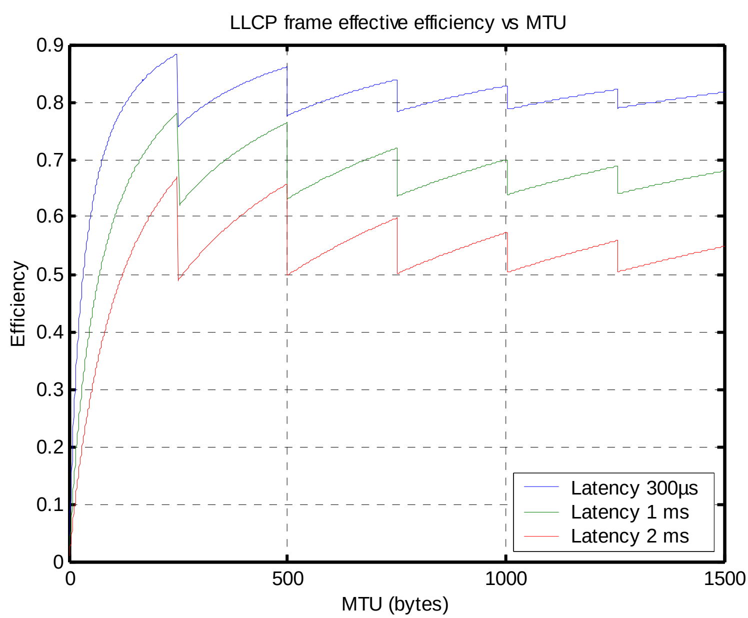


Figure 28. LLCP efficiency versus MTU size.

The Figure 29 illustrates the efficiency when the MTU tends to infinity then the efficiency tends to the reference frame best efficiency.

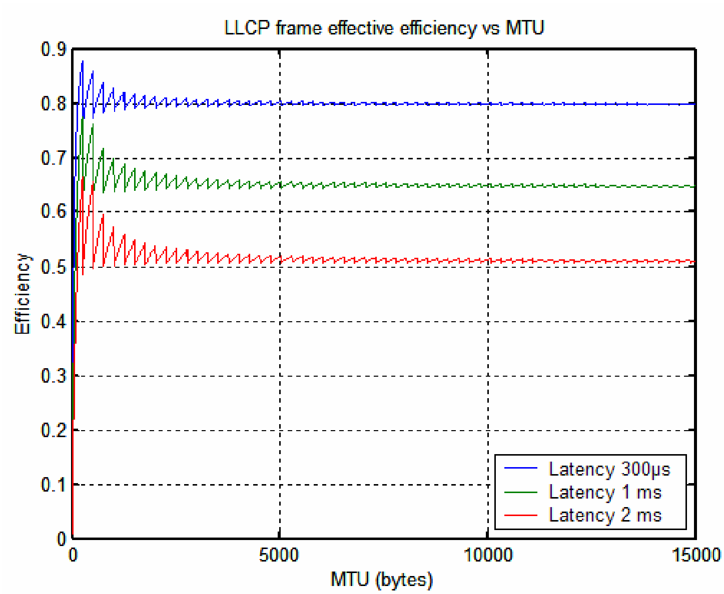


Figure 29. Reference frame efficiency for MTU tending to infinity.

4.3.5 SAR level II

The NFCIP-1 level may split the LLCP frame in several segments. Nevertheless at the LLCP level the SAR level I is totally hidden. In order to balance the data traffic between the initiator and the target, the LLCP specification defines a parameter N_{CC} which limits the number of segments at the SAR level I. Consequently, The NFCIP-1 cannot convey reassembled frames having a size larger than (N_{CC} -1) x 252 +249 bytes.

The current LLCP specification does not provide any SAR level II mechanism and this last one shall be performed in a layer higher than the LLCP layer.

Card emulation Mode (as standardized by ETSI/3GPP)

In this section, we describe two standard protocols recently adopted by the ETSI/3GPP and aiming at implementing the NFC card emulation mode in Mobile Handset terminals also provided with a SIM or UICC card. The first one, known as SWP (Single Wire protocol) is a communication interface between the SIM/ UICC and a contact-less frontend (CLF) in the terminal. This interface allows the card emulation mode independent of the power state of the terminal as well as the reader mode when the terminal is battery powered. It is to ensure interoperability between a UICC and the CLF in the terminal independently of the respective manufacturer, card issuer or operator.

The second one, known as Host Controller Interface specifies a logical interface that enables contact-less applications hosted on the UICC. It especially covers the configuration where the one host is embedded in the UICC which is connected to the host controller embedded in the CLF.

4.4 The SWP protocol

The Single Wire Protocol is a digital full duplex protocol based on a single active wire. The data rate is scalable from 212 Kb/s until 1.6 Mb/s for short distance less than 10 cm. On the top of the physical layer, a bit oriented MAC layer based on a tailored HDLC (ISO/IEC 13239) is implemented.

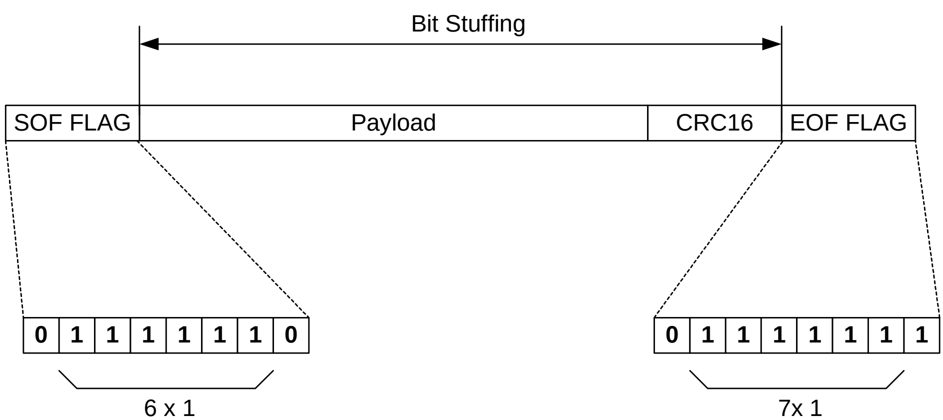


Figure 30. SWP MAC Layer.

The SWP is connected to the application layer but allows the tunnelling technique. So any frames (encrypted or not) can be encapsulated in a SWP frame from/to the SIM card.

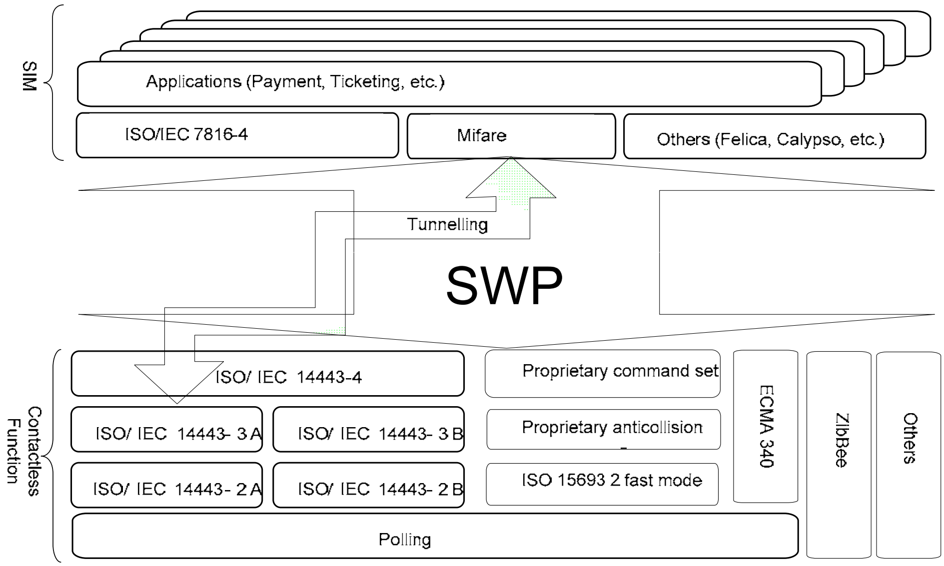


Figure 31. Contactless Protocol Stacks.

The SWP protocol is able to carry short packets (payload less than 30 bytes) to several nodes and allow the routing of messages to different entities (e.g. The RF front end, the settings, the host terminal…) in a proactive manner.

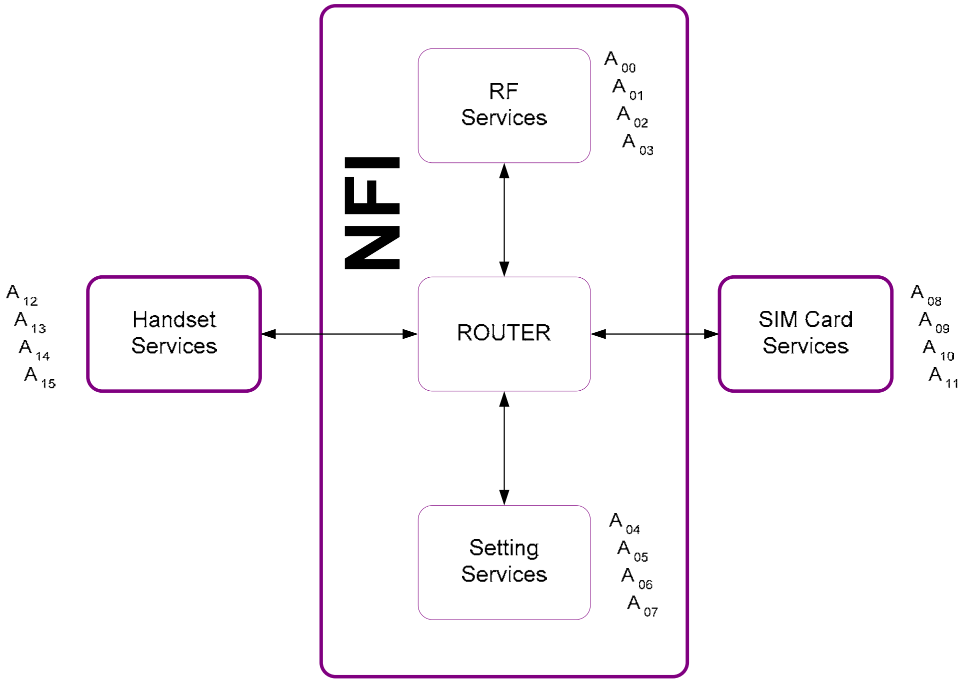


Figure 32. Routing service.

Short packets and pipelining allow a low latency communication between the SIM card and the RF interface (Near Field Interface).

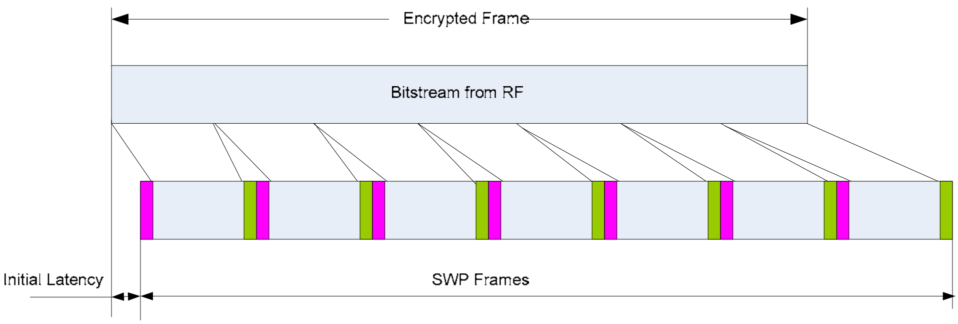


Figure 33. Tunneling in the SWP.

The tunnelling technique allows carrying any encrypted frames by protocol encapsulation. Consequently, no security feature is required in the RF interface.

The standards based on the ISO 14443 and the ECMA-340 have few timing constraints defined. No timing constraint forbids the tunnelling technique between the RF front end and the SIM card. So proprietary cryptography technique (e.g. MIFARE I) can easily be processed in the SIM card under the control of the SIM card issuer.

The physical and MAC (Medium Access Controller) layers of the SWP protocol has been originally defined by a working group of the MEDEA+ Onomatopic+ project. This proposal has been put as an ISO NWI proposal (ISO/IEC JTC1/SC17 N 2902) to widely open this technology that has been finally approved as an official ETSI standard.

Host Controller Interface (ETSI TS 102 622)

This specification has been finalized by some of the SmartTouch partners (in particular Gemalto) in the scope of the Project. The Host Controller Interface is a logical interface, allowing an NFC front end to communicate directly with an application processor and multiple secure elements in various electronic devices such as cell phones, PDAs and PC peripherals, enabling faster integration of NFC functionality. The HCI defines so the interface between logical entities that operates one or more service(s), also called “hosts”. According to the ETSI terminology, a network of two or more hosts id a called a “host network”, and one of the “hosts” that is also responsible for managing a host network is called the “host controller”.

The current ETSI specification for the HCI has three levels:

- a collection of entry point towards a service that is operated inside a host (also called “gates”) that exchange commands, responses and events
- a Host Control Protocol (HCP) messaging mechanism
- a Host Controller Protocol routing mechanism that may optionally segment messages when required.

The lower level protocol level assumed in the ETSI TS 602 622 specification is the SWP.

The figure below illustrates the HCP stack in a possible host network.

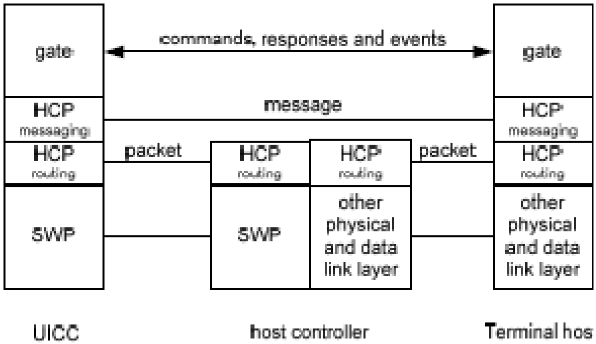


Figure 34. HCP protocol stack in a host network.

For proper operation, the HCP has the following requirements on the underlying layer:

- The data link layer (e.g. SWP) shall be error free and the order of the received/sent data shall be respected.
- The data link layer must provide its own data flow control.
- The data link layer shall deliver packets of the upper layer up to a maximum size specific to the data link layer.
- The data link layer shall report the size of each received packet to its upper layer.

In the HCI protocol, the host identity is coded on 1 Byte, with the predefined values for the host controller, the UICC host and the terminal host.

Gates

A gate provides an entry point to a service that is operated inside a host. The HCP enables gates from different hosts to exchange messages. There are two types of gates:

- management gates that are needed for the management of the host network
- generic gates that are not related to the management of the host networks.

Each gate type is identified by a gate identifier. Gate identifiers are either unique within the scope of a host (values ‘10’ to ‘FF’ in the ETSI specification), or their values refer to the same gate type for every host (values ‘00’ to ‘0F’). Each host must however have several predefined gates, including administration, identity management, link management and loop-back gates.

Pipes

Gates communicates themselves though logical communication channels called “pipes”. There are two types of pipes:

- static pipes that are always available, i.e. they do not need to be created and can not be deleted
- dynamic pipes that can be created and deleted.

The state of a pipe is either open or closed. The state shall remain persistent after the powering down and up of the host and also if a host is temporarily removed from the host network and is not replaced by a different device in the meantime. The state of a dynamic pipe after creation and the initial state of a static pipe shall be closed.

The pipe identifier, PID, is 7 bits long and is used in the header of HCP packets as routing information. For static pipes the pipe identifiers are predefined. For dynamic pipes, pipe identifiers are dynamically allocated by the host controller.

The following rules apply to gates and pipes:

- a static pipe always connects a host to the host controller
- a dynamic pipe connects two gates from different hosts
- a gate that accepts a static pipe shall not accept a dynamic pipe
- a static pipe can only connect to one type of gate
- dynamic pipe identifiers shall be unique in the host network.

HCP Protocol description

The structure of the HCP packets exchanged between the hosts and the host controller is described on the figure next page, where

- CB is the chaining value (‘1’ is no chaining of last packet of a fragmented message, ‘0’ if the packet belongs to a fragmented message)
- pID is the pipe identifier.

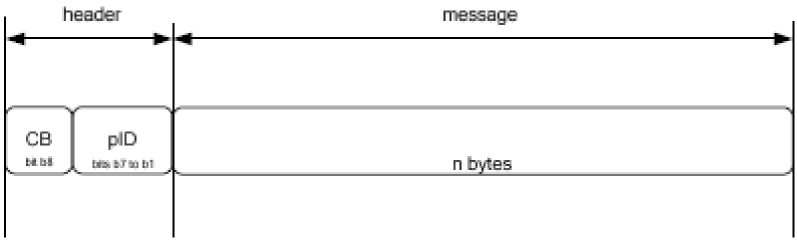


Figure 35. HCP message structure.

The length of a message is application specific. A message carries one instruction and optional data as defined on Figure 36 below, where

- TYPE identifies the type of instruction
- INSTRUCTION identifies the instruction.

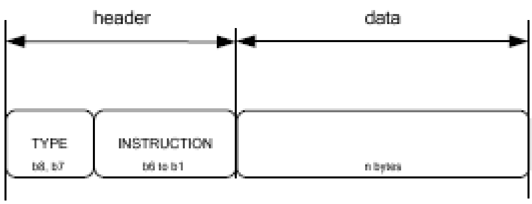


Figure 36. HCP message structure.

INSTRUCTION is either a command (TYPE = 0), an event (TYPE = 1) a command response (TYPE = 2).

A gate shall only accept a command or an event on a pipe when the state of that pipe is open unless otherwise stated. A gate shall not send a command or event on a pipe when it is waiting for a response to a previous command on that pipe unless otherwise stated.

Registries

With every gate a registry template may be associated that defines parameters that are related to the gate. Parameters are identified by 1 Byte-long identifiers. Such identifiers are unique within the scope of the gate.

A new instance of the registry is created for every pipe that connects to the gate. Upon pipe creation all registry parameters shall be set to their default values.

A host is responsible for managing its associated registries. The persistence of a registry and the default values for parameters shall be indicated with each registry description.

When a pipe is deleted its registry instance is also deleted.

HCI procedures

The following procedures are defined in the ETSI TS 602 622:

- pipe creation that describes how a given host A requests the creation of a dynamic pipe, between one of its gates and a gate in host B
- registry access that describes how host A can read/write parameters in the registry of host B
- host and gate discovery that describes how a host may discover the hosts in a host network and the gates that a host supports
- session initialization that describes how a host A detects that the host controller has changed and specifies the subsequent recovery mechanisms
- loop-back testing, that specify how host A can verify the pipe connectivity to host B.

4.5 GSMA

4.5.1 NFC Project

GSMA have a NFC project, purpose of this project is to define technical guidelines for NFC usage in mobile handsets. Target environment for NFC usage was payment, public transport ticketing and loyalty card usage. Technical Guidelines can be found here: http://www.gsmworld.com/documents/nfc/gsma_nfc2_wp.pdf.

Twenty of the largest Mobile Network Operators (MNOs) have been working together, in a GSM Association (GSMA) initiative, to develop a common vision on Mobile Near Field communications (NFC) services, promoting the development of a stable and efficient ecosystem and to prevent market fragmentation.

In February 2007, the GSMA NFC initiative released a Mobile NFC Services White Paper [1]. That white paper was produced from an analysis of the mobile NFC ecosystem and related business requirements. In April 2007, the GSMA NFC initiative released a Mobile NFC Technical Guidelines White Paper version 1.0 [2]. That white paper was produced from an analysis of

- the Universal Integrated Circuit Card (UICC) to NFC Chip interface (lower Open Systems Interconnection [OSI] layers)
- the Mobile to Contactless reader interface
- the Multi-application UICC framework.

In this Mobile NFC Technical Guidelines White Paper version 2.0 MNOs have performed an analysis of

- the UICC to NFC Chip interface (Host Controller Interface [HCI])
- UICC Run-Time Environment
- Over-The-Air (OTA) Provisioning
- Mobile NFC Device Security.

This white paper presents the results of the above analysis as a series of technical guidelines intended to support NFC standardisation and technology implementation activities. These technical guidelines are provided as input to standardisation bodies and fora, to support their standardization of NFC technology. This white paper should also provide valuable information to other third parties who are defining and developing in their roles within the Mobile NFC ecosystem.

These guidelines are intended to provide the MNO vision for mobile NFC solutions, identifying technical options and providing recommendations. The participating MNOs expect that the detailed requirements and specifications will be either developed by the relevant standardisation bodies and/or issued by MNOs as required to meet their specific market and deployment requirements.

These guidelines are not intended to be used by other parties as final technical requirements.

4.5.2 GSMA NFC Mobile Payment

GSMA has an NFC mobile payment project having two Phases: M-Payment Initiative (Phase 1) and Pay-Buy-Mobile project (Phase 2). The aim of the project is as follows:

- create a common global approach to enabling mobile phones to be used to pay for goods and services at point of sale
- achieve global interoperability between handsets, chip cards and point of sale terminals and create economies of scale
- catalyse the market by having as many trials/launches as possible.

Project started in February 2007 with 14 operators and currently the number of operators in the project is 45 representing over 1.5 bn subscribers around the world.

Objective

The objective of this project was to define a business model that identifies the benefits to be gained by UICC based contactless M-Payment over a traditional IC credit card payment model.

Scope

- Analysis of various UICC based contactless M-Payment business models for Debit and Credit card services (encompassing: Use case definition, Service definition considering the scenario of using MasterCard PayPass and Visa payWave on a UICC, regulatory environment, value chain analysis and business requirements definition and interoperability policy).
- Review the merits, demerits and lessons learned from the various NFC M-Payment models analysed above.

Achievements

GSMA has produced two public white papers:

- GSMA Pay-Buy-Mobile Business Opportunity Analyses, vs 1.0 released Nov 2007
- Requirements for Single Wire Protocol NFC Handsets, released Nov 2008.

Documents can be found from: http://www.gsmaworld.com, Document Library.

NFC payment pilots are underway in 8 countries out of 14 planned. GSMA Pay-Buy-Mobile project has established collaborative co-operation contracts with ETSI, EMVCo and European Payment Council concerning NFC payment development.

4.6 Mobey Forum

Mobey Forum is a global non-profit forum, driven by the finance industry. Mobey Forum promotes secure and user-friendly mobile banking and payment services.

Mobey Forum released June 2008 a public white paper, Best Practice for Mobile Financial Services – Enrolment Business Model Analysis. Document describes different business models, when UICC is used as a secure element for NFC payment credentials. Document can be downloaded from http://www.mobeyforum.org, documents & press releases.

4.7 Contact-less standards

The interested reader will find much more details on the standards mentioned in this section by consulting the following references:

[1] ISO/IEC 14443-2: “Identification cards – Contact-less integrated circuit(s) cards – Proximity cards – Part 1: Physical Characteristics.”

[2] ISO/IEC 14443-2: “Identification cards – Contact-less integrated circuit(s) cards – Proximity cards – Part 2: Radio frequency power and signal interface.”

ISO/IEC 14443-3: “Identification cards – Contact-less integrated circuit(s) cards – Proximity cards – Part 3: Initialization and anticollision.”

ISO/IEC 14443-4: “Identification cards – Contact-less integrated circuit(s) cards – Proximity cards – Part 4: Transmission Protocol.”

ISO/IEC 7816-4: “Information technology – Identification cards – Integrated circuit(s) cards with contacts – Part 4: Inter-industry commands for interchange.”

ISO/IEC 18092 Information technology – Telecommunications and information exchange between systems – Near Field Communication – Interface and Protocol (NFCIP-1).

ISO/IEC 21481 Information technology – Telecommunications and information exchange between systems – Near Field Communication Interface and Protocol-2 (NFCIP-2).

ISO/IEC 22536 Information technology – Telecommunications and information exchange between systems – Near Field Communication Interface and Protocol (NFCIP-1) - RF interface test methods.

ISO/IEC 23917 Information technology – Telecommunications and information exchange between systems – NFCIP-1 – Protocol Test Methods.

ISO/IEC 28361 Information technology – Telecommunications and information exchange between systems – Near Field Communication Wired Interface (NFC-WI).

ETSI TS 102 622 V7.0.0 (2008-02) Smart Cards; UICC – Contact-less Front-end (CLF) interface; Host Controller Interface (HCI) (Release 7).

ETSI TS 102 613 V2.0.0 (2007-10) Smart Cards; UICC-CLF interface; Physical and data link layer characteristics (Release 7).

5. SmartTouch in Use

5.1 NFC for payment and ticketing

Payment and ticketing applications are perhaps the most well known practical everyday application of the NFC technology. Most commonly, to goal is to integrate payment and ticket processing (for example, public transportation tickets) into the mobile phone of the user.

5.1.1 Contactless payment with “Payez Mobile”

Author: Vincent Veran, Gemalto, France

The “Payez Mobile” experiment is a joint initiative launched in November 2007 by six large banks (BNP Paribas, Groupe Crédit Mutuel-CIC, Crédit Agricole and LCL, Groupe Caisses d’Epargne, La Banque Postale and Société Générale) and four mobile operators (Bouygues Telecom, Orange, SFR) alongside NRJ Mobile) to launch a joint field trial, aimed at testing a mobile contactless payment service involving a thousand customer testers and 200 stores in the towns of Caen and Strasbourg.

This project, overseen by the French “Secure Electronic Transactions” (TES) Competitiveness cluster in Lower Normandy, relies on the combined capabilities of the above-mentioned groups and makes large usage of the technologies developed in the ITEA SmartTouch project.

The participants in the “Payez Mobile” trial have got the technical assistance from many different equipment suppliers. The technical components needed at the beginning of the trial have been supplied by

- three mobile manufacturers: *Motorola* (L7 device), *Sagem* (My700) and *LG* (L600V)

- two EPOS manufacturers: *Sagem Monetel* and *Ingenico* (now combined under the Global Ingenico, operations)
- two providers of SIM/UICC cards and secure OTA applications management platforms: Gemalto and Oberthur Card Systems
- one NFC secure component supplier: Inside Contactless.

Technically speaking, the “Payez Mobile” experiment relies on a combination of the following elements:

- The Bank payment applications are installed in a multi-application enabled SIM/UICC card of the mobile phone.
- The NFC (Near Field Communication) technology is used for handling the payment from the end-user mobile handset to the merchant terminal.
- The recently standardized Single-Wire protocol is used for managing the communication between the SIM/UICC-based application payment and the NFC Secure element within the handset.
- Advanced OTA mechanisms have been put in place to deploy securely multiple-applications (e.g. payment, transport, loyalty, access) from the bank remote office.

The contact-less payment scheme used in “Payez Mobile” is fully compatible with the existing Mastercard and Visa international specifications. MasterCard and Visa applications (e.g. MasterCard PayPass and Visa VSDC) can be hosted simultaneously in the same SIM card (several instances of these applications can coexist), hence preserving the Banking interoperability that is currently perceived a strong advantage by the customers in France.

The global objective of the participants in the “Payez Mobile” trial is to define a common solution for Banking and Mobile Telecom Operators in the area of mobile payment, with the ambition to be a strong basis for national and hopefully international standards definition.

The mobile contactless payment applications proposed by the Banks in the “Payez Mobile” consortium indeed endorse fully the international EMV standards and, in the long run, are aimed to prepare the definition of the future mobile payment solutions that will be needed to support the introduction of the SEPA framework (Single EuroPayment Area) throughout Europe.

This Mobile contactless payment solution uses the existing bank card infrastructure. One or more payment applications (one for each customer’s bank), installed on the SIM card, can be used to make payments, with the following risk management policy:

- For amounts less than €20, customers can pay, if they wish, without using a PIN.
- For payments exceeding €20, the transaction requires a PIN.

The customer's bank account linked with the application is then debited by the amount paid, exactly as in a classical bank card scheme.

At the store, two types of user experiences are available for completing the mobile contactless payment.

The first step if common to both user experiences, asking the merchant to enters the amount to be paid, which is then displayed on the payment terminal. Then two possible flows can take place

Method 1

1. The customer enters the menu on their mobile phone and selects the "Pay" function.

2. The customer enters his PIN on the mobile and validates it.

3. The customer places the phone in front of the Terminal. A payment receipt is then printed out.

Method 2

1. The customer places their phone in front of the terminal. If the amount is less than €20, the payment is made and a ticket is printed out.

2. If the amount exceeds €20, the customer enters his PIN on his mobile and validates it.

3. To complete the payment, the customer places the mobile in front of the terminal once again. A payment receipt is then printed out.

“Payez Mobile” Trial

The “Payez Mobile” trial was launched in November 2007 in Strasbourg and Caen. In involves around 1000 users (about 500 in each city), representative of the French population and regular users of CB Visa or Mastercard.

After some months of experience, some positive trends can be observed:

- Regular usage increase:
  - 30 % of customers are regularly using « Payez Mobile ».
  - The number of transactions per user is regularly increasing from 2,3 transactions per month in January, 3,0 in February and March.
  - 75 % less than 20 € but with a large distribution (from 0,80 € to 158 €).

- Wide range of usage concerned:
  - 200 merchants are now equipped between Caen and Strasbourg.
  - The nature of equipped stores varies from petrol stations to hyper/super markets including also local shops (bakeries, restaurant…).
  - Around 15 transactions per merchant were recorded in the March period, showing some spread in purchase values:
    - Petrol = 24 €
    - Supermarket = 24 €
    - Hypermarket = 56 €.

Perceived benefits and key lessons from the "Payez Mobile" experience

After several months of trials the "Payez Mobile" benefits can be identified as follows:

- Value for customers:
  - Speed: The payment method allows checkout queues to move more quickly by several time (no cash to manipulate, cheque avoidance…).
  - Simplicity: the simultaneous handling in the SIM/UICC of several payments means avoids the need of manipulating physical wallets, while keeping the same usual user experience.
  - Physical Security: The mobile phone is a personal device that people always keep on them. The increased number of usages, makes it unlikely to be forgotten and quickly noticed/invalidated when missing or lost.
- Value for stores:
  - Fast and smoother waiting lines: small payments do not require any PIN, and recorded practices show that they can be made in less than a second once the total is displayed on the payment terminal.
  - Savings: Setting up a unique new payment method, complementary to bank.
  - Cards: aiming to reduce the cost of handling cash.
  - Innovative Brand image: Bringing in new payment solutions is seen positively by customers who are keen to take on innovations.
- Value for banks:
  - New revenues for low value payment: Cash replacement.
  - New services for end users.

    - Innovative Brand image: Bringing in new payment solutions is seen positively by customers who are keen to take on innovations.
    - Customer acquisition.

- Value for operators:
    - New revenues streams from partnerships from banks.
    - Capability to address mass markets, through the standardization effort made in the project.
    - Innovative Brand image.

The "Payez Mobile" project has introduced several distinctive features over other ongoing international experiments currently running:

- It is the first pilot bringing together all main banks and operators from a large country, with a real attempt to develop a nation-wide (and later international) standard.
- The two main acquiring networks, Visa and MasterCard, have been heavily involved in the trial definition.
- The trial architecture allows supporting customers handling multiple cards and accounts from different banks.
- The technical solution is a replicable one that can be extended easily to other business segments.

Finally, "Payez Mobile" offers technical advantages in terms of

- multi-application management (payment, transport, loyalty, access, etc.)
- the ability to remotely manage the SIM/UICC card in a secure manner through advanced OTA and remote personalisation mechanisms
- easy to understand user interface: the security scheme for "large" payment implies indeed the use of a PIN code on the mobile, which is common practice in classical payments in France.

In all these aspects, "Payez Mobile" benefited from several key achievements made by Gemalto (with the help of other partners) in the scope of the ITEA SmartTouch project:

- finalization of the SWP physical layer protocol, now standardized at ETSI/3GPP

- secure multi-application SIM/UICC
- specification and development with the SmartTouch partners of advanced OTA remote management mechanisms
- specification and development with the SmartTouch partners of advanced remote personalisation schemes.

5.1.2 SmartParking with NFC

Author: Outi Rouru-Kuivala, City of Oulu, Finland

The pilot study aimed to find out how NFC technology could be enabled in street-side and garage parking. Preparations for the pilot began on November 2006; the actual pilot took place between September 3 2007 and November 28 2007. The pilot group consisted of 55 randomly selected persons, the only criteria being a minimum three parks per week in the city centre. To initiate parking, the user simply touched an NFC tag on the windshield with an NFC enabled phone then a tag at the selected parking zone, or alternatively selected the correct parking zone from the phone application. After parking, the user only needed to touch the tag on the windshield or at the parking zone. In a parking garage, parking was initiated and ended by touching a tag adjacent to the entrance and exit gates with NFC phone.

Traffic wardens were equipped with their own NFC enabled phones and dedicated software for parking fee control. When an attendant touched a tag on a parked car, the phone automatically connected to a backend system and checked the parking status. Billing could have been carried out in real-time, but the necessary backend system for monetary transfers was not realized in the pilot. The Technical Centre of Oulu, the authority responsible for parking control, has a total of five traffic wardens who were all trained to use the monitoring application. Due to delays in phone deliveries, only two phones were available during the seven first weeks of the pilot. During the last week of the pilot, all five traffic wardens were equipped with a monitoring phone.

VTT Technical Research Centre of Finland, conducted usability research and business analysis based on the pilot study. According to the usability research, attendees found the NFC based parking system to be easy to use and a quick way to carry out parking. That you need only pay for the actual parking time – and the possibility to pay without cash – was received particularly positively. Research also shows that traffic wardens consider the NFC based monitoring system quick, easy, and fast, though they wished for consistency in the positioning of the windshield tag, so that the status could be easily checked using the NFC phone.

The pilot was conducted by the city of Oulu's Technical Centre, by Oulun Pysäköinti Oy, and by TopTunniste. TopTunniste provided the technical solutions such as the software for mobile phones, tags, and gate reader devices. Nokia 6131 NFC phones were used in the pilot study. A two-minute demonstration video by Klaffi-tuotannot was made to showcase the pilot.

http://www.ouka.fi/video/smart/index.html

The Figure 37 illustrates the SmartParking pilot. Photos by Juha Sarkkinen.

Figure 37. SmartParking pilot.

5.1.3 "RMV-HandyTicket für NFC-Handys"

Authors: Peter Preuß, Dirk Reddmann, Franz Weigt,
Rhein-Main-Verkehrsverbund (RMV), Germany

In the last years the Rhein-Main-Verkehrsverbund GmbH (RMV) has gained a lot of experiences in the field of mobile ticketing by initiating numerous projects and trials. Since 2004 one of the development paths has been the usage of JAVA based mobile ticketing in combination with the NFC technology. As part of SmartTouch the RMV and its partners conducted a friendly user trial in Frankfurt on NFC ticketing called "RMV-HandyTicket für NFC-Handys" from July 2007 to November 2007.

Finally, the "RMV-HandyTicket" and especially its NFC domain have been notably successful. In February 2008 the Rhein-Main-Verkehrsverbund transferred the NFC based HandyTicket into a productive system. Meanwhile all 750 stops in Frankfurt are equipped with approximately 2,500 radio chips (ConTags). Now Frankfurt is the first city in Europe with a ubiquitous NFC tag infrastructure.

The ConTag

Basic elements of the NFC ticketing approach are the mounted radio chips at the stops and stations called ConTags (see Figure 38). They are the interface between customers and RMV information and ticketing services. The round blue ConTags enable an automatic starting of the ticket program on the mobile phone. Moreover the radio chips integrate two NDEF data sets. First set encompasses the info pool number of the station, the tag number and the name of the station. The second data set is a WAP link to the schedule of the respective station.

The NFC tags are provided by SmartTouch partner ToP Tunniste. To protect the tags from physical damage and all types of weather they are built in a plastic tag-protection cover, developed by RMV.

Within the trial 600 ConTags have been installed at 59 stops and stations in Frankfurt City and at Frankfurt Airport. The selected stops and stations were the most frequented ones in the municipal area of Frankfurt.

To keep the functional capability employees of RMV and the local public transport operators controlled the ConTag infrastructure during the trial with a Nokia 6131 NFC. For this purpose RMV and its partners developed a specific service MIDlet. The results of the maintenance were transferred to the data base in the backend system via GPRS.

Within the trial there were nearly no damages on the ConTags – at the end there was just one single case of intentional damage. The only technical problem which occurred has been invaded water in the plastic tag protection cover. The problem was solved by a technical modification of the cover. However, in all cases there was no impairment of the radio chip functionality.

Figure 38. ConTag attached to a station pole.

Ticket purchase

To purchase a ticket at a stop or station the customers had to touch one of the ConTags mounted at the stations with their mobile phone. The ticketing program automatically launches on the mobile phone and displays automatically the appropriate station name. Users select only the desired type of ticket, choose their destination, and confirm the transaction. Within three clicks the ticket is purchased and the desired ticket is stored on the mobile phone. Previously, the customer had to enter all data manually (Figure 39).

Step 1:
The ConTag is touched with the NFC-mobile phone at the starting stop.

Step 2:
The programme opens automatically The desired kind of ticket is to select.

Step 3:
The desired area of final destination (rate) is selected.

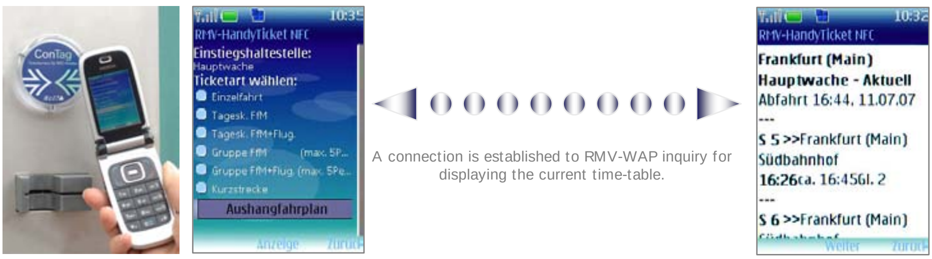
Step 4:
The ticket price is shown. This one has to be confirmed with "Buying".

Step 5:
Storage and indication of the ticket

Figure 39. Outline on buying tickets via RMV-HandyTicket for NFC-Mobile Phones.

Apart from the simple purchase of a ticket customers can use the ConTags also to get information on the current time-table of the appropriate stop in a matter of seconds. At the lower end the starting screen displays “Aushangfahrplan”, which customers can use to reach the current departure time-table.

Customers who had a NFC-capable mobile phone without a RMV-HandyTicket application were able to call up online the current time-table by only one click at the respective stop (Figure 40).



Step 1:
The ConTag is touched – as described – at the stop.

Step 2:
Selection of the displayed time-table

Step 3:
Display of the current departure time-table

Figure 40. Outline – Calling up the current time-table via the NFC-function.

Trial

The project was examining the technical and organisational feasibility as well as the customer acceptance of NFC in the field of public transport ticketing. 270 pilot users tested the new RMV ticketing scheme to buy single trip tickets and daily passes. They were selected out of more than 500 applicants. Two thirds of the participants were acquired from the pool of the existing RMV mobile ticketing customers. The others were those ones who had never gained any experiences with the RMV mobile ticketing. Just as it was to be expected, particularly techno freaks were very much enthusiastic about this technology. The average age was 32 years. In this regard, men were predominating with a portion of 85 %.

All participating customers obtained a Nokia 6131 NFC of one’s own.

To participate in the trial all customers had to register on the Internet and provide payment information. This information was used to charge the customers for all ticket purchases at the end of the month. After registration the customers received a WAP-Push message and downloaded a personalised J2ME MIDlet via a GPRS connection to an NFC Nokia 6131 mobile phone. The destination selection and tariff approval are part of the ticket purchase and use also a GPRS connection. The ticket control takes place as visual control. If needed an online validation is possible (Figure 41).

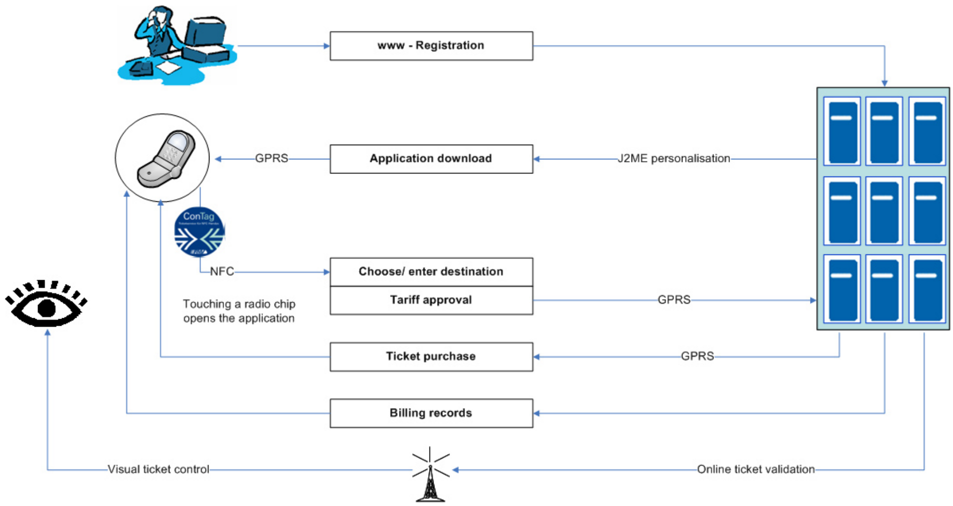


Figure 41. Processes within the RMV-HandyTicket.

Results

Because of transferring the ConTag ID to the RMV backend system it was possible to evaluate the ticket sales. Within 17 weeks the customers bought 2,215 tickets over the ConTags. Nearly two thirds of the sold tickets have been single trip tickets.

Part of the trial was a detailed online user survey, which was realised in cooperation with the SmartTouch members RMV and VTT. 90 % of the customers took part in these voluntary online interviews. The participating persons were obliged to give some information about their experiences they have gained as well as their level of satisfaction.

In general testers are full of commendation for the tremendous convenience the system provides and the speed with which they can now purchase tickets; 80 % of them would like to continue to get their tickets “out of thin air” instead of wasting paper. Furthermore the intuitive application of the ConTags was particularly convincing (Figure 42).

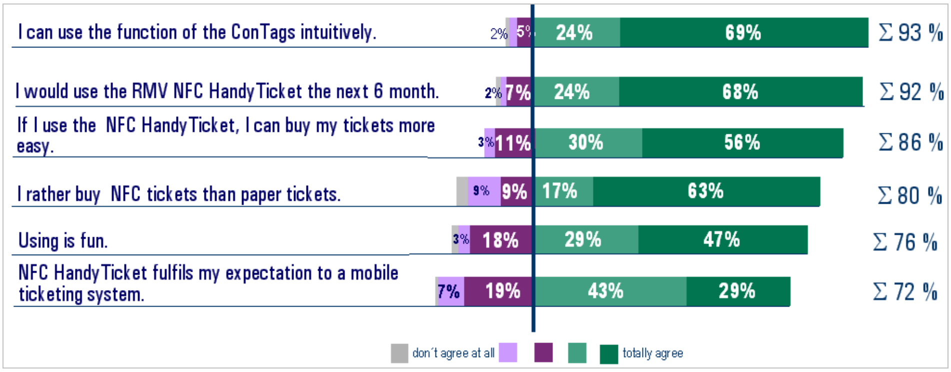


Figure 42. General assessment of the “RMV-HandyTicket für NFC-Handys”.

It has been satisfactory that the assessment of the ticketing improved from the first up to the third interviewing period. The system was assessed at 2.17 on average. Highest satisfaction was demonstrated during the third interviewing period. 81.7 % of the users were absolutely satisfied or just satisfied with the “RMV-HandyTicket für NFC-Handys”. Generally the system delivered convincing results in a sustainable manner in all three market research waves (Figure 43).

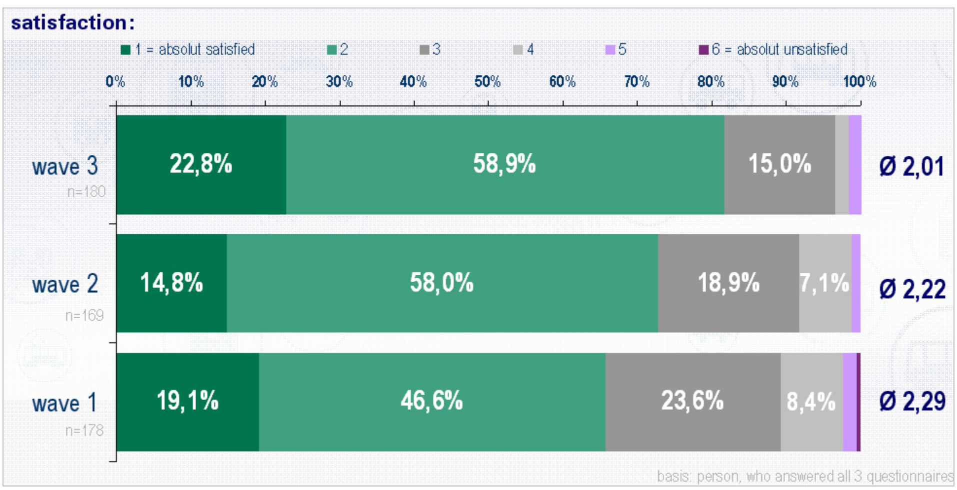


Figure 43. Satisfaction with the “RMV-HandyTicket für NFC-Handys”.

Besides the long list of positive reactions, there was also one point of criticism. Those who tested the system were complaining about the small amount of stops which are equipped with the radio chips in Frankfurt. 54 % of the participants stated that there had not been enough ConTags at the stops. During the interviews the users also identified such issues, which are decisive for them for the successful further development of the NFC-Ticketing-System. Apart from the functionality of the ticketing programme and of the ConTags the testers mainly mentioned the local extension of the NFC-infrastructure and of the RMV-HandyTicket to be an important issue.

Compared to the RMV-HandyTicket without ConTag, nearly ¾ of the test persons have given preference to the use with ConTag. Persons who get the mobile ticket manually stated the non-existence of the ConTag to be the main reason for this fact (Figure 44).

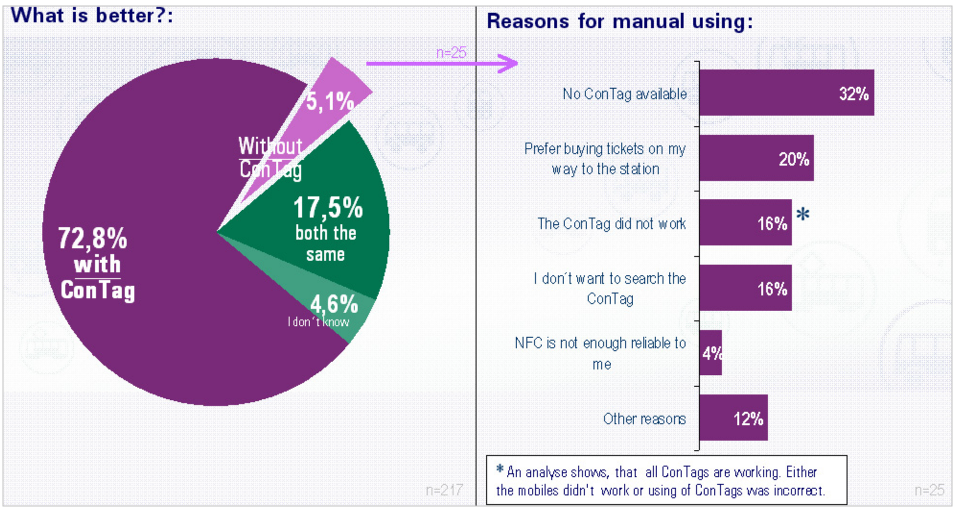


Figure 44. Comparison of RMV-HandyTicket with and without ConTag.

It is motivation for the RMV to open up new marketing channels and to create an attractive alternative to the existing distribution infrastructure. The RMV-HandyTicket shall also mobilise the ticket machines. A comparison between the ticket purchase at the ticket machine and the NFC ticketing shows a clear preference of the participants. Whereas the quickness to buy a ticket at the machine was assessed with the mark 3.72, the ticket purchase via the ConTag with the NFC-mobile phone obtained the mark 2.01 (Figure 45).

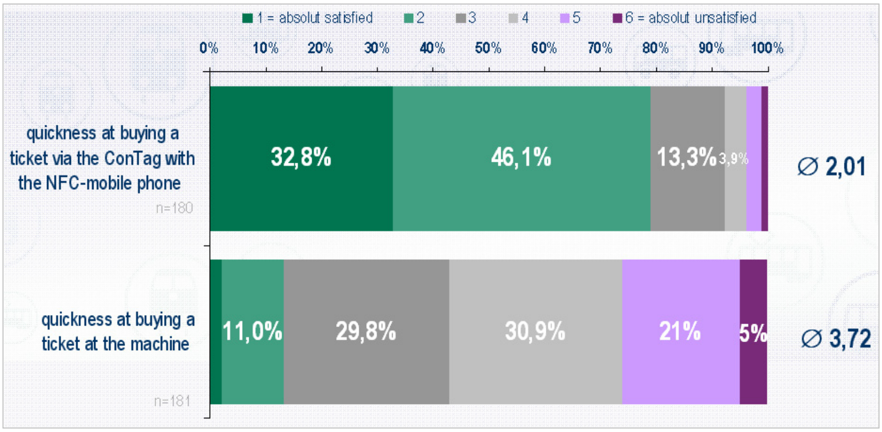


Figure 45.Comparison – Purchase of tickets at the ticket machine and via a ConTag with the NFC mobile phone.

The good acceptance of the "RMV-HandyTicket für NFC-Handys" among the users has also been shown in the fact that 82 % of all interviewed persons would recommend the NFC-Ticketing Systems their friends without any restrictions. In the final interview 87.7 % of those who were interviewed agreed to the statement that the "RMV-HandyTicket für NFC-Handys" has fulfilled their expectations.

Summary

Frankfurt is the first city in Germany, which offers an NFC ticketing and information system that is accessible to everyone. Since the end of the year 2007 all of the around 750 stops and stations in Frankfurt are equipped with radio chips. The extension of the NFC infrastructure is a supplement to the start of the RMV mobile ticketing within the entire RMV-area. Now it is possible by touching a ConTag in Frankfurt to get single trip tickets and day tickets for the entire RMV-area quickly. The latest market research results from the field test encourage RMV's intent to offer the solution to the entire transportation network, even beyond Frankfurt's borders.

One crucial factor for the success of a working NFC ecosystem is the availability of NFC mobile phones. Since March 2008 SmartTouch partner Nokia and an independent phone shop operator sold the Nokia 6131 NFC in ten retail stores in the city of Frankfurt. The mobile phone is embedded in an interesting NFC package. This included NFC cards which contain links to the current cinema agenda in the Rhine-Main-region, to information sites of the city of Frankfurt as well as to a special Nokia ring tone. Moreover the customers can save for example personal phone numbers or address cards in some NFC chip cards. For the transfer of the information from the mobile phone the NFC interface will be used. Via the cards the customers should recognise other possible usages of the NFC technology apart from the ticketing.

Concerning the NFC domain of mobile ticketing RMV is pursuing two goals in the near future. First goal is the adaptation of the present mobile ticketing processes to the VDV Core Application (CA), which is the German standard for electronic ticketing. Second goal of RMV is a step by step expansion of the ConTag infrastructure to other cities and regions in the RMV area.

Finally, the success of the mobile ticketing trial “RMV-HandyTicket für NFC-Handys” in Frankfurt is also a great success of the whole SmartTouch network. Within the project RMV and the other involved SmartTouch partners were learning a lot from each other and were benefiting from the creative cooperation.

Annex

RMV is one of the largest Regional Public Transport Authorities in Europe and provides its services for five million inhabitants in the state of Hess/Germany. RMV is responsible for organizing and co-ordinating the operation of regional rail services as well as for integrating long-distance, regional and (sub) urban rail services into an overall mass transit system, including 156 public transport companies.

5.1.4 Public transportation ticketing in eCity pilot

Author: Jukka Suikkanen, TeliaSonera, Finland

The first goal of this pilot was to test is it possible to use NFC handset as travel card in public transportation network and can user purchase and download more value or tickets to this handset without going to the kiosk or ticket sales office.

Currently City of Tampere uses plastic cards with Mifare classic 1 K tag for paying public transport trips. The chip contains balance that is deducted every time a trip is purchased. The deducted amount depends on customer status, for example students and pensioners pay less than ordinary customers. More value can be downloaded in distinct downloading points like in some dedicated kiosks.

Another goal was to get feedback from users that would they like to use this kind of service together with their mobile handset and is there some other needs what can be served also.

Idea for this pilot came from Tampere Public Transportation company (TKL), they were in the process to start implementation for next generation ticketing infrastructure and they would like to know that is it possible to use mobile handset as a part of their ticketing infrastructure and what benefits it would bring to users and TKL.

TeliaSonera have had a long partnership together with City of Tampere from earlier smart card implementations and TeliaSonera was carrying the overall responsibility about this pilot. TeliaSonera have had activities in R&D organisation around RFID and NFC for some years and this was very good concrete case to evaluate how NFC technology can be used in handset and especially in public transportation.

TietoEnator made backend solutions for TKL and they made web site for users for value purchase and value download for NFC handsets.

The idea was to make the system simple and easy to use and implement. This means that the user interface for travel card should implement only necessary commands for showing cards current balance and history information as well as actions needed for balance download. The eCity application interface is presented in the Figure 46. NFC handsets used is buses is shown in the Figure 47 and the user card value balance is displayed in the Figure 48.

Figure 46. eCity application interface.

Figure 47. NFC handset used in bus.

Figure 48. User card value balance.

Web pages were also designed simplicity in mind. They should only enable straightforward downloading. In real life before downloading money into her travel card a customer should first do a payment for service provider in web bank. This functionality was left out from the pilot. The elements used in eCity pilot are demonstrated in the Figure 49.

Figure 49. eCity pilot elements.

The actual pilot was implemented so that 20 mobile phones were delivered to 10 students and workers of TeliaSonera and City of Tampere. Handset was Nokia 3220 with NFC payment and ticketing shell. NFC shells for payment and ticketing were initialized with € 20 starting balance for city of Tampere travel card. Accounts for downloading pages were also created for every attendant.

The users were able to travel in City of Tampere busses during the pilot free and without limitations. Attendants were expected to use NFC enabled mobile phone for travel payments as much as possible and they were also asked to use Over The Air downloading as much as possible.

Pilot was done October-November 2006 and users were basically pleased with the service. Especially the possibility to download more balance in internet was appreciated. During the pilot there were some technical problems that caused dissatisfaction. Also Service provider (City of Tampere) as well as TeliaSonera, TietoEnator and Nokia were pleased with the results of the pilot.

Conclusion from this pilot is that NFC handset can work together with ticketing infrastructure of public transportation, OTA based value purchase and download gives lot of benefits to users and company which is responsible for ticketing solution and users would like to use this kind of service.

5.1.5 Pilot plan for Bilbao public transportation

Author: Estibaliz Barañano, Telvent, Spain

In Bilbao, the railway operators are thinking about upgrading the existing ticketing system: frequent travellers will use contactless cards (ISO 14443), instead of magnetic-stripe paperboard tickets.

This upgrade aims to achieve several goals:

- better exploitation data, for transport service optimisation
- more robust physical ticket for frequent travellers that have long-term passes?
- less use of magnetic readers/writers, which have high maintenance costs
- reusable, more environmentally-friendly tickets
- higher level of security, and improved antifraud system.

Together with the normal contactless ISO 1444 tickets, there is a chance to add NFC functionality. This will allow the travellers to use their NFC-enabled mobile devices in the entrance and exit gates in the underground stations. The tickets embedded in the mobile will have the same price and validity as the magnetic ones currently in use: same discount rate, same frequent-traveller schemes.

Having the ticket embedded in the mobile phone allows travellers to check some contents of the ticket: how much stored value is currently remaining, its expiry date, where and when have they previously used public transportation with their mobile...

Apart form the fact of reducing the number of plastic cards, the public transport operator will ensure a future-proof design, since NFC-enabled devices (passive tags or active devices) will probably come massively in the market: not only in mobile phones, but also in handheld computers, and probably in pen-drives, key-rings, or any other gadget.

As a first step, a pilot project with NFC-enabled mobile phones will be done. The pilot project will ensure the system's capability, will make it possible to collect the users' feedback, and allow for corrections if needed.

The transport operator will load a ticketing application in the travellers' mobile phone. The main actors included here are

- the public transport operator that provides the testing platform: entry and exit gates, ticketing vending / reloading machines, customer information desk, back-end system
- Telvent, as the technology provider: as a member of the SmartTouch Project, Telvent has developed the necessary technological elements for the NFC system (the Hardware and SW applications)
- Nokia: provider of the NFC-enabled user terminals
- users: a group of frequent travellers who will use the NFC enabled mobile phones, and will give their feed-back to the operator and technology provider.

The users will have mobile terminals with NFC capabilities that will contain a valid ticket for travelling within the transport operator network. During the trial, they will use their mobiles in the entry and exit gates.

For reloading the tickets, either stored value or validity period, users will have the possibility of doing it remotely (establishing GPRS sessions), or directly in the train station, by means of a BlueTooth connection with the Ticket Vending Machine.

Figure 50. NFC phone at the gate.

The travellers selected for the trial will use a NFC-enabled mobile phone, with their own SIM card inserted (so they do not need to change their mobile number). They will have to go to an operator's Point of Service and have the ticketing application installed in their phones, before they can use it.

A number of entry and exit gates in several stations will have NFC functionality implemented: they will be equipped with NFC readers ready to connect to the mobiles.

The Ticket Vending Machines will be equipped with BlueTooth interfaces. When the stored value in the ticket is over, users will have to connect to a Server that will authenticate and validate the reload. They will have the choice to connect to the Server Over The Air (with a GPRS connection), or through a Ticket Vending Machine with a BlueTooth connection.

Of course, special care will be taken to avoid fraudulent reload or copy of the data contained in the ticket. Security mechanisms will be implemented to protect forgery and unauthorised access to the Server and the data stored in the ticket.

5.2 NFC for special people

One of the expected and observed benefits of NFC enabled user interaction is the simplicity and robustness. Touching does not require reading nor perfect hand-eye coordination, making interaction possible for people who would not be able to use traditional user interface paradigms that heavily rely on sight and hand coordination. Also, the simplicity of NFC infrastructure can introduce possibilities for using NFC supported applications, for example, with children.

5.2.1 NFC supported audio labels with BlindNFC

Authors: Alfonso Dominguez, Ander Izquierdo, Isidoro Cirion,
Robotiker, Spain

Goal

The aim of BlindNFC is to overcome the obstacles that visually impaired people (not only but especially blind) have at home to identify particular items and their content. BlindNFC allows for labelling of music, the clothes, food or medicines with the simple help of a SmartPhone or PDA and some tags. The concept avoids the use of dedicated devices, used up to now, giving an extra functionality to a device that blind people use in their daily life.

BlindNFC has been designed to be intuitive. The ways to enter and recover information into and out of the system are very simple. A user will label the items with inputs such as their voice or a text written through a Bluetooth Braille keyboard. Once the information has been recorded, it can be recovered whenever the SmartPhone or PDA is approached to the tag attached to the item. The information will be then played and the user will be able to listen to it knowing more about the item.

Agents

BlindNFC has been designed for visually impaired people. This group includes not only totally blind but also visually handicapped people such as those who suffer from low vision. Although blind people constitute the main group to whom the system is oriented, BlindNFC could help people with other disabilities such as those with cognitive problems and elderly people.

The system will be used mainly in the home environment. Taking into account that not all users may have a computer at home, the infrastructure has been designed to be quite simple. No back-end system is needed; the information can be stored on the tag or in the user’s device depending on the way the user introduces the information into the system. The infrastructure will consist of some tags, a PDA or SmartPhone and a SD-NFC card. Therefore tag, SmartPhone or PDA and SD-NFC card providers are needed in order to make the basic infrastructure available.

The BlindNFC concept can be extended and applied to other environments such as libraries, supermarkets and so on. In these cases the information stored in the system will not be created by the user, but by the system operator or administrator. Users will only have the possibility to recover the item information from the back-end system through Bluetooth, GPRS or another wireless technology. These scenarios will require the participation of other kind of agents such as information provider or item distributor.

Description

The BlindNFC system consists of a PDA or SmartPhone, a SD-NFC card (in case that the PDA / SmartPhone is not NFC enabled), some tags and the software installed in the PDA / SmartPhone. The User Interface is very simple and intuitive and will guide the user throughout all the process (via speech synthesis messages).

The software has been designed to be flexible, so it accepts different types of input. For example, in order to label an item the users can either make use of their voice or of text typed with a Bluetooth Braille Keyboard. Approaching a tag to the PDA or SmartPhone, the information will be associated with the tag and it will be stored onto the tag or in the user's device depending on the size of the file (a text file takes up less space than an audio file).The main advantage of storing the information on the tags is that the information will be available for other users.

In order to read the information about a previously labelled item, users only need to put their devices near the label (NFC tag) and the device will retrieve the information and play it using speech synthesis for a text or the media player for audio files. The Figure 51 describes the functionality of BlindNFC.

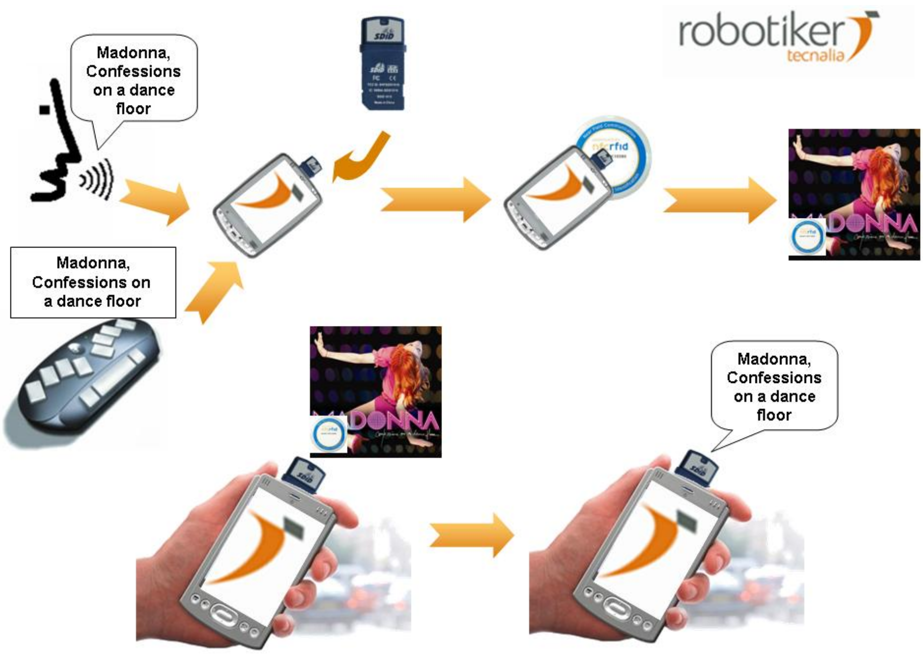


Figure 51. Blind NFC: functional description.

5.2.2 Meal ordering for elderly

Authors: Juha Häikiö, Arto Wallin, Minna Isomursu,
VTT Technical Research Centre of Finland

In city of Oulu, elderly with severe problems of cooking balanced meals themselves are offered a possibility for ordering daily meal delivery from the city elderly care. NFC-technology was used to enhance the meal service by providing the clients an opportunity to choose the meal they would receive the following day, or alternatively cancelling the meal delivery. Without the digital service interface, the same meal was delivered to all clients daily, and in the case of cancellations, the clients called the service provider by phone. The average age of the users was 76.6 years (see Table 6). The service interface was constructed by attaching NFC tags into a meal menu that was placed in a plastic stand. A mobile phone with an integrated NFC reader was used to make a selection, i.e. the user touched a tag in a menu with a mobile phone (see Figure 52).

To use the meal ordering service interface, the user did not need to use a keypad of a mobile phone nor did they need to navigate in the menu structures of a mobile application. If the user made several selections during a day, the last selection made was valid.

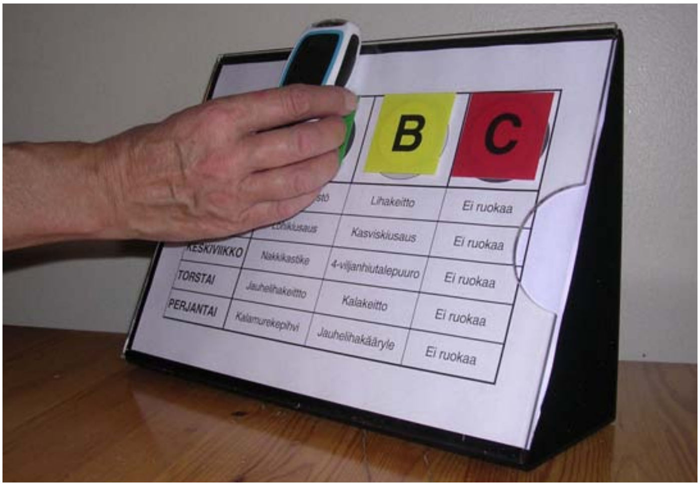


Figure 52. The plastic stand with three NFC tags and a replaceable paper menu.

Kitchen and elderly care personnel were able to monitor and follow meal orders and related delivery processes through a web-based service backend system. Following day of the meal selection, the logistics service delivered meals to the clients’ home. Personnel of the logistics service provider used also NFC-enabled mobile phones for reporting about the status of meal deliveries. After each meal delivery a driver of the logistics service touched a tag located in the home of the client to confirm a successful delivery. This generated automatically a timestamp of the delivery and sent it with other delivery information to a back-end system. Thus, the elderly care personnel were able to monitor the delivery progress in real-time, react immediately to the problems in the delivery, and provide accurate information if a client requested information about the status of the delivery. A driver also replaced paper menu in the plastic stand with the new one every Friday, and helped the elderly users with the mobile phone in case they had problems.

The phases of the complete ordering and delivery process are illustrated in the Figure 53. Red arrows represent actions that are initiated with NFC-enabled mobile phone. Blue arrows represent materials transferred in the process.

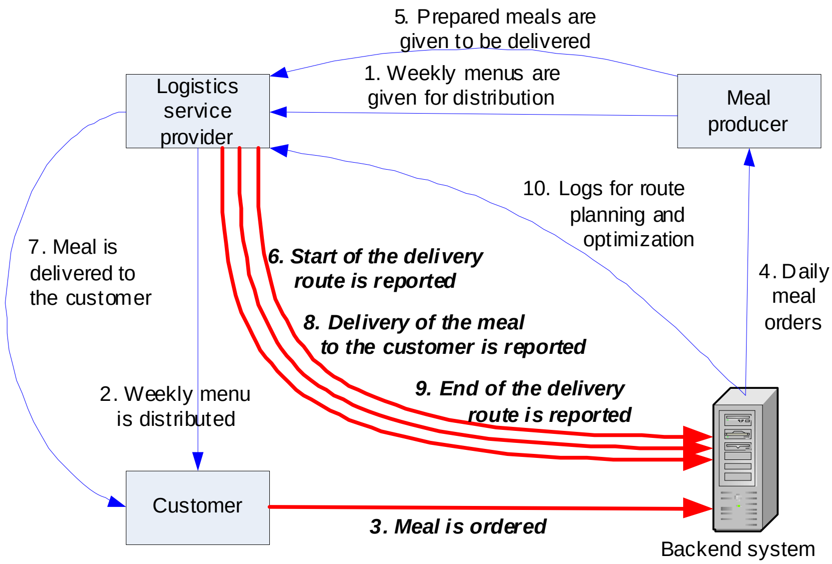


Figure 53. Ordering and delivery process of the meal service trial.

Results

Even though the meal service interface did not require the users to use the keypad of the mobile, we found out that the use of a mobile phone's keypad was difficult to many participants due the decline in vision and motor skills. In a training session some users had difficulties to press the keys and some of interviewees commented that the keys were too small for them. Regardless of the reduced motor skills all participants were able to learn and adopt touching with a mobile phone easily during the training session. Those participants who had difficulties with keys of a mobile phone were able to adopt touching equally with those who were able to use keypad more fluently. Problems with the keys of the mobile were observed during the study as the clients and delivery personnel reported that some clients had problems in turning the power of the mobile on and off because of the placement and size of the power key.

Placing a meal order required only one action: touching a tag. It did not require remembering multiple activity steps and thus it did not cause much memory load. The interviews indicated that the participants usually had no problems to remember to place their orders. Only one user told that he knew he had forgotten to place his meal order once. Although participants told that they remembered to place their orders, some of them experienced that remembering to place an order daily caused them worry and stress. Many users created strategies for memorizing, for example, by placing their orders routinely at the certain time of a day.

NFC reader was placed in the changeable shell of a mobile phone. Finding a right touch point often required a little bit of training in the training session. However, all users were able to touch a tag with ease during the training session. However, we believe that the users would not have been able to use the application without the hands-on training.

The menu table decreased intuitiveness of interaction. Prior to touch the user had to check the meal that corresponds with a tag label A or B and also read the row, which showed the meal for the following day. Interpretation of the menu table caused some problems in the beginning of the training session. However, all participants said in the final interview that the menu table was easy to use.

The final interviews pointed out, that attitudes towards the NFC-based meal order application varied among the elderly participants. Table 6 presents preferences for the meal ordering practices. Five out of nine participants preferred the NFC-based ordering over the earlier practice and they were also willing to use the service in the future. Four participants considered the old, conventional practice as a better option. As the Table 6 shows, willingness to adopt the new practice was correlated with whether or not the user owned a mobile phone before the trial period. Even though prior use of a mobile phone clearly correlated with the willingness to adopt the application, it did not have an impact on ability to learn and use the trial application. Touch-based interaction technique was easily adopted by all users. Although earlier experience of a mobile phone did not have effect on the fluency to use the application, it had an impact on how the users were able to use the phone. The users with no prior experience about mobile phones had difficulties with basic functionalities of a mobile phone, such as loading batteries and turning phone on and off.

Table 6. Preferences for the meal ordering practices.

User	Age	Gender	Own mobile phone	Preferable meal ordering practice
U1	<60	Male	No	Conventional
U2	69	Male	Yes	Touch-based
U3	72	Female	Yes	Touch-based
U4	80	Male	No	Conventional
U5	80	Male	Yes	Conventional
U6	80	Female	Yes	Touch-based
U7	81	Male	Yes	Touch-based
U8	84	Male	Yes	Touch-based
U9	88	Male	No	Conventional

Many elderly clients also refused to participate to the trial, when they heard they should use a mobile phone. Many of those clients, who decided to participate, were unsure about their abilities to place their orders without help and needed a lot of encouragement in the beginning. None of them broke off the trial, and all were able to successfully use the service interface.

The delivery personnel experienced the touch-based service interface as very easy to learn, adopt and use. The primary benefit the logistics service gained from the digitally enhanced service was a possibility to monitor deliveries in real time through the web interface. With real-time monitoring possibility, the elderly care personnel were able to give an accurate estimation about delivery time, if it would be asked by the clients. The meal producer regarded also the improved quality of the service as a main benefit. Importance of exact information about meal deliveries is emphasized due to the health regulations obligating that warm meals have to be delivered in the time frame of two hours. Since automatic logs could be generated by the back-end system, logs can be easily used for the quality assurance of meal deliveries. Delivery monitoring may also enhance the quality of customer service, for example in case where client complains that the meal has not arrived. In this situation, elderly care worker is able to check the status of deliveries using web-application and provide accurate information to worried customer. Moreover, improved transparency may also increase efficiency, since logistics service provider can use reported delivery times to optimize service delivery processes.

5.2.3 NFC for children

Author: Outi Rouru-Kuivala, City of Oulu, Finland

NFC-enabled services were piloted in schools in Oulu with children ranging from seven to sixteen years.

5.2.3.1 "VIKSU" Info Channel

The pilot was conducted at Laanila Upper Secondary School, in the City of Oulu. The pedagogical goal of the NFC based "VIKSU" Info Channel is to provide NFC based homework assignment functionality and the active timetable support the following cross-curricular themes:

- *growing as a person* (the students' life skills grow as they are better able to plan their timetable and meetings, and take care of homework assignments)
- *technology and the individual.*

Additionally, these two NFC-based services save teacher time for activities that better support learning.

The NFC information channel supports

- *the communication and media skills.* (The students themselves produce material for the information channel; this increases understanding of communication and bring students into a situation where they have to consider the sense and content of the information being published. It also encourages community spirit in school.)

The NFC functions at school environment were designed and planned in cooperation with Oulu City Department of Education in order to utilize NFC to serve pedagogical goals. NFC functions at school environment were reflecting the Finnish National Core Curriculum (by National Board of Education). Figure 54 shows the architecture of "Viksu" Info Channel.

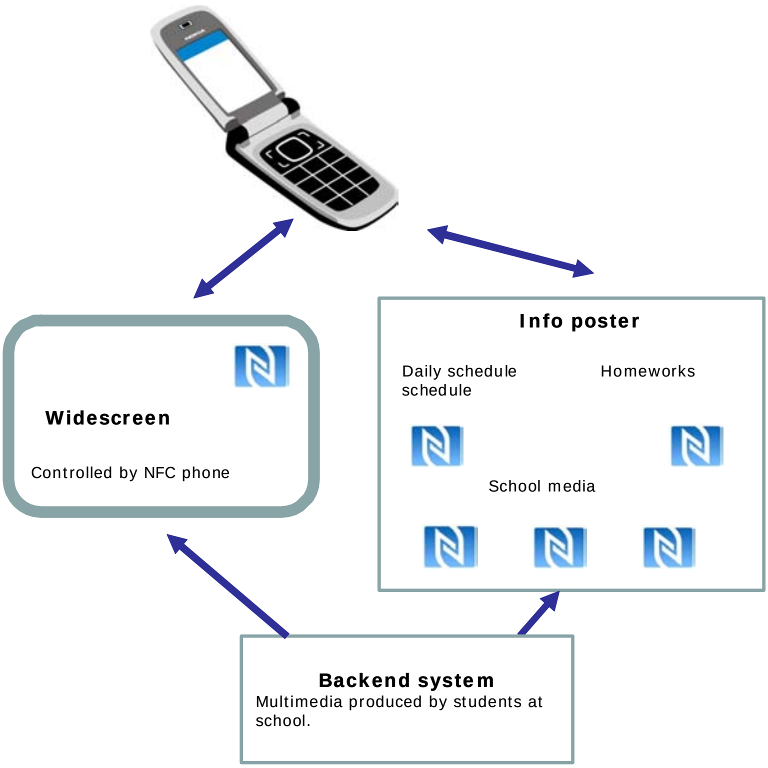


Figure 54. “Viksu” Info Channel.

“VIKSU” Info channel consisted of active timetable/homework and school media contents. All students (113 persons) taking part in the project had a smart poster at home with NFC tags for their timetable, homework, and for the school information channel. There were also smart posters in many school locations. Pilot was implemented in Laanila upper secondary school.

Active timetable & homework

By touching a tag the student received an active timetable on his/her NFC mobile phone (containing, as well as the daily timetable, all possible doctor and other appointments, changes in classroom/teaching space, and other exceptions to the timetable), and homework assignments with instructions. The pedagogical goal was to strengthen cooperation between home and school by ensuring that everyone had up-to-date, reliable information, and to reduce absences due to lack of information. Changes in the system were carried out via the calendar function built for the project. Entries in the calendar could be made by the school staff, by guardians, and by the student. The student could choose whether his/her own entries were visible to others.

School Media Content (Media Screen):

Preparation of the content for the school's media screen began in May 2008. The content was material produced by students about school events, celebrations, and, for example, school interviews and class introductions. By touching a tag a student could choose the content of choice from the list of links received. The content of the information channel was stored on a server available to the entire school's students and staff. Also, in the entrance hall of Laanila Secondary School was a wide screen on which the information channel content could be shared. An NFC-enabled mobile phone, when touched to an NFC tag next to the giant screen, operated as a remote control for the giant screen for a period of three minutes.

AavaVisual (outside consortium) planned the graphical appearance of the NFC School pilots.

The project was implemented through a pilot group formed of all the eighth grade students in Laanila upper secondary school. Written permission to take part in the project was requested from the students' parents, and also for the limited use of information obtained from the project for research purposes. All participants were given, for the duration of the project, an NFC-enabled mobile phone (Nokia 6131) with which to take part in the pilot activities. Two teachers from Laanila secondary school trained the entire teaching staff to use the pilot functions. The parents of students participating in the project were informed via the Helmi 'trip booklet' system. Also, an information seminar was arranged for the parents, involving a representative from Helmi background system provider Nextime Solutions.

Technical solutions for the school projects were realised by MSG Software and Nextime Solutions Oy, both outside the consortium. TeliaSonera's 'tag management' service was used in the project. VTT carried out usability tests on the school NFC projects. Oulu University's Department of Electrical and Information Engineering (outside consortium) made the application for controlling the wide screen and examined the usability of NFC-based control of the giant screen. In addition, the Faculty of Education at the University of Oulu initiated a study into the relationship between NFC technology and learning.

A video about the NFC-enabled school functions in Laanila secondary school, around 2 minutes in length, was made for demonstration purposes.

http://www.ouka.fi/video/smart/school/

The video was produced by Klaffi Productions.

VTT carried out usability research on the pilot. The Figures 55–60 represent "Viksu" Info Channel functions at Laanila Upper Secondary School.

Figure 55. A student checking school info with his NFC mobile phone.

Figure 56. "Viksu" SmartPoster located at students home and at school.

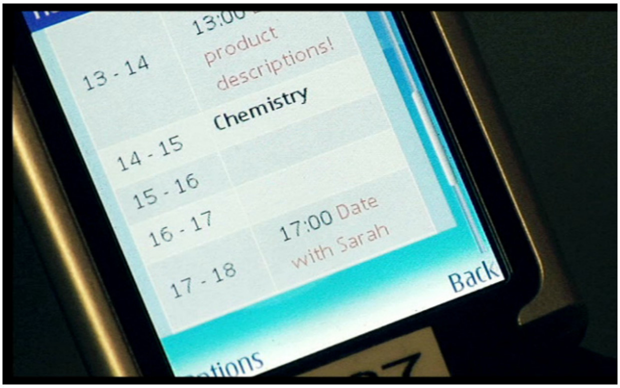


Figure 57. Individual daily timetable with personal calendar.

Figure 58. Homework with instructions at students NFC mobile handset.

Figure 59. Parents' receiving online information about their child's attendance.

Figure 60. Students using their NFC phone as a remote control to share the content from "Video Gallery".

5.2.3.2 Attendance Supervision for secondary school

The practice for attendance control in Laanila upper secondary school is described in the following scenario. When students enter the class, the teacher marks them as present in the HELMI backend system with the help of a PC. If students are late or arrive in the middle of a class due to an authorized absence, monitoring is difficult, and time used by the teacher for marking attendance is always out of actual teaching time. Idea is to replace manual attendance supervision with NFC Attendance Application.

In the upper secondary school, students have mobile phones in any case and feel that the phones are, for them, a very personal device. The idea is to expand the use of this device – perceived as personal – to facilitate school life. The pedagogical idea is also to transfer a little responsibility for marking attendance to the student (who logs into class by him/herself), although primary responsibility remains with the teacher.

The system is also focused to prevent drop-outs by informing tutors, administrators and parents of absences in real time, enabling instant intervention.

NFC Attendance Control in the upper secondary classes: The Pilot phase lasted 8 weeks and the piloting group consisted of 5 classes of 8th graders, altogether 113 pupils.

A student 'logs' into lessons by touching a tag attached to the teacher's desk with an NFC-enabled mobile phone. A message that the log-in was successful appears on the screen of a mobile phone. The student's attendance details are visible through the HELMI system to his/her parents and to the school staff. So-called authorized absences (for example, for a special education or a dentist appointment) are marked in the backend system in advance and the student is not obliged to give the teacher an explanation.

If a log-in did not happen, the backend system marked the student absent by default. If a student logged in late, the backend system received information about that lateness. Authorized absences and, for instance, doctor's appointments, could be marked in the system in advance. The Helmi backend system's attendance marking in presented in the Figure 61. A student logging for the class at Laanila School is shown in the Figure 62. The system's response is illustrated in the Figure 63.

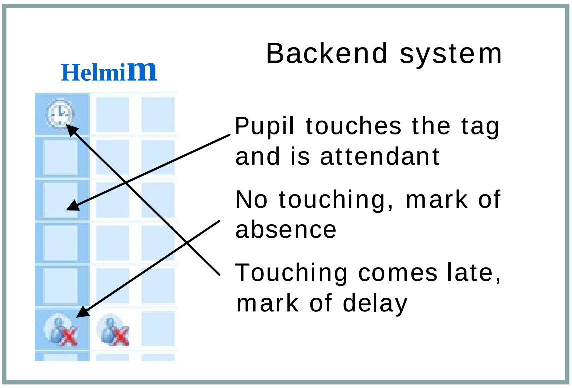


Figure 61. Attendance markings at the Helmi backend system.

Figure 62. A student logging in for the class at Laanila School.

Figure 63. Accepted presence shown for the student.

Two changes were made to the system during the pilot. A student needed only to log into a double period once; students were not required to log in again in the middle of, for example, a two-hour sports period. In addition, lateness was calculated – after the change – to begin 3 minutes after the first student logged in (previously, a student was marked late by the system three minutes after the presumed starting time). This change request was done by the teachers. (Teachers did not want the system to monitor their lateness from the class. This is because teachers sometimes were late due to the i.e. phone calls to/from parents etc.)

Technical design and implementation was provided by Nextime Solutions, which is outside the SmartTouch consortium.

A two minute demonstration video was also made to showcase the pilot(s) in school environment. The video was produced by Klaffi Productions.

http://www.ouka.fi/video/smart/school/

VTT carried out usability research on the pilot.

5.2.3.3 NFC Attendance Supervision for primary school

Children beginning school in Finland travel to school (after the first few weeks) largely independently, either on foot, by bicycle, or by bus. The goal of the pilot is to determine whether NFC technology can support safety aspects of the journey to and from school and afternoon supervision. The idea is to give parents real-time information about their child’s arrivals and departures.

Children starting first grade 'log in' to school by touching, with an NFC 'card', an active reader device that records the card ID (the child's name), the 'direction' (arrival in school), and a time stamp in the backend system. Parents receive information about their child's arrival in and departure from school either through the Citizens' Portal, or, should they so choose, as a text message to their mobile phone.

The NFC contactless cards are intended to be suitable in appearance for the world of a six to seven year old child. In afternoon supervision, attendance control happens by touching the teacher's NFC-enabled mobile phone with a card (Figure 64).

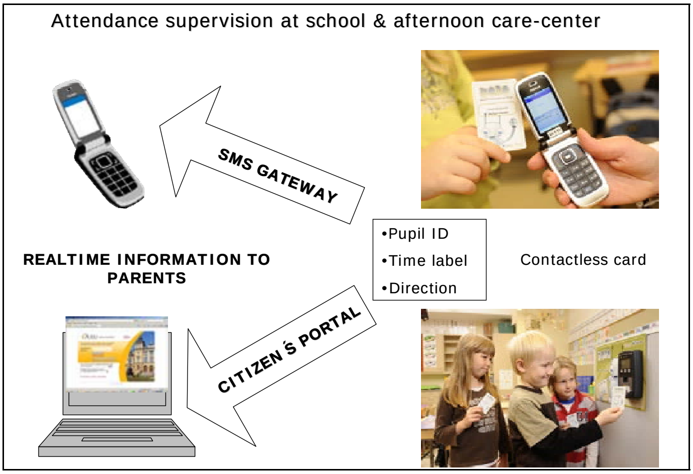


Figure 64. Attendance supervision at the school & afternoon care-center.

NFC technology based attendance supervision began on 9/2008 in Hintta Primary School, emphasizing the security aspect. The goal of the project was to test the usability of NFC technology with 6 to 7 year old children, and to emphasize security aspects of attendance control for children who have just started school. The project continued until 12/2008. Piloting phase lasted 14 weeks.

The project group was composed of one first-grade class (20 students) and one combined first and second grade class (7 students). The group of 27 students was given 'smart cards' (Oulu cards) entitled 'Robo' cards, the graphical layout of which were designed by AavaVisual to appeal to 6–7 year olds.

The children taking part in the project with their 'Robo' cards 'logged' in and out of school, and in and out of afternoon supervision. A 'Robo' card contained the student's ID, which was visible as the student's name in both in the reader device and the phone application. The application in both the reader device and the mobile phone recorded the time of the log-in; it was possible to choose the ‘direction’ of the student registration (in or out) through both devices. Parents were able to receive, through the Citizens’ Portal, real-time information about their child’s arrival and departure to and from school, and to and from afternoon supervision.

For the twenty-student class participating in the project, logging in and out of school happened by touching an active reader device with their ‘Robo’ cards. The reader device was chosen for the larger project group because it works faster than an NFC-enabled mobile phone for large groups.

In the small class (of 7 students) and in the afternoon supervision programmes (of Hintta School and the local church), teachers had an NFC-enabled mobile phone that the students touched with their ‘Robo’ cards.

Bank codes were used to log onto the Citizens’ Portal, and details of each child’s arrival and departure to and from school and afternoon supervision were available to the child’s parents only. Parents could receive, should they so choose, information about the child’s arrival and departure to and from school and afternoon supervision as text messages to their mobile phones. This feature was developed with Kuulalaakeri, which is outside the consortium.

Technical implementation of the project was carried out by MSG Software (outside consortium), Fara, and Oulu Information Technology (for the Citizens’ Portal NFC interface). VTT conducted usability research on the project.

A two minute demonstration video was made to showcase the pilot. The video was produced by Klaffi-Productions.

http://www.ouka.fi/video/smart/school2/

Figures 65–68 illustrate the attendance supervision in practice.

Figure 65. Teacher using NFC mobile phone to log in children at Hintta Primary School.

Figure 66. "Robo" card (Oulu Card) used in the pilot.

Figure 67. Fara Light Validator used in the pilot.

Figure 68. Children logging in to Hintta Primary School with “Robo” cards.

Information about child’s attendance is available only for his/her parents. Citizens’ Portal security is guaranteed by logging system using bank codes. VTT carried out usability research on the pilot.

5.2.3.4 “Amazing NFC”

“Amazing NFC” is a City orienteering for pedagogical purposes and it has two routes, a survival track and a culture/historical track. On the culture/historical track, students become familiar with Oulu’s culture and history. On the survival track pupils get to know Oulu’s offices and institutions.

The pedagogical goal of the NFC-based Urban Orienteering project was to teach secondary-school age students skills and knowledge to cope with everyday life, and to familiarise students with the culture and history of their own city. By transferring the educational setting from the classroom to the actual contextual environment, the project aimed to influence the students' motivation to learn.

Amazing NFC is aiming to teach 'Life-management skills' with the idea that school is part of surrounding society and we learn for life in general. The Figure 69 explains the urban orienteering scenario with "Amazing NFC".

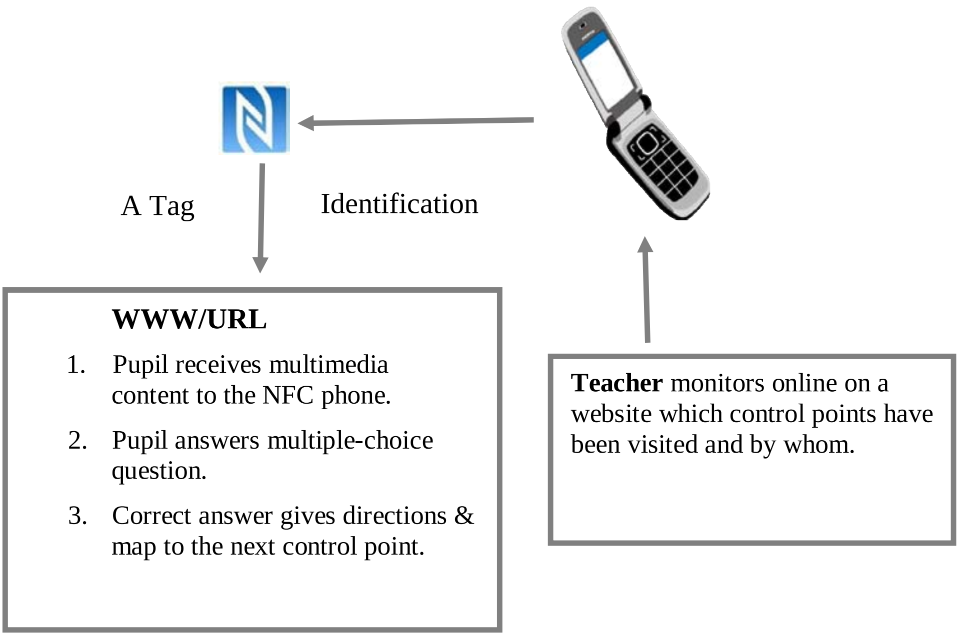


Figure 69. "Amazing NFC" Urban Orienteering.

There are two NFC orienteering routes, the survival track and the culture track. On the survival track students became familiar with the offices and institutions of the city of Oulu, and made a bus journey to Oulu University's Zoological Museum.

Ticketing was done by NFC-enabled mobile phone. It was also possible for the students to create a citizen's initiative by touching a tag on the bus. In the Zoological Museum, students made use of their NFC phones by downloading content from the museum's tags, which were part of the Oulu University NFC project. On the culture track students became familiar with Oulu's cultural history.

Activities on the Orienteering Routes:
The teacher distributed the phones to the students in the Oulu City Tourist Office. Each student received a different starting point. If a pair of students wanted to orienteer together, both students received the same route from a ‘friend tag’ in the Tourist Office. The students answered an initial questionnaire organised by VTT, the questions for which they received by touching the ‘Initial Questionnaire’ tag with an NFC-enabled mobile phone. Arriving at the checkpoint, the student touched the tag and a browser page relating to the checkpoint was sent to the mobile phone, containing three links:

1. Read text / Watch video / Listen to message
   The student either read the text relating to the checkpoint, watched a relevant video, or listened to an audio file.
2. Answer questions
   The students answered multiple choice questions relating to the checkpoint.
3. Directions to the next checkpoint
   The student received a map and directions to the next checkpoint.

The text, video, audio, and map files were fetched to the mobile phone. The teacher could, with a laptop connected to the internet, monitor the students’ progress in real time through the checkpoints. After the orienteering, the students answered VTT’s concluding questionnaire, which they have downloaded to their mobile phones via the ‘Concluding Questionnaire’ tag. MGS was responsible for the pilot project’s technical implementation. University’s (outside consortium) TiPo application was used at the Zoological Museum. TeliaSonera’s dTag manager was used in both orienteering routes.

Implementation of the pilot phase

The pilot phase of the Oulu city orienteering route–implemented on NFC-enabled mobile phone (Nokia 6131) was launched with the survival track on 5/2008. During May 2008, 228 students from Laanila and Kastelli secondary school and from the higher classes in the Pateniemi and TervaToppila schools navigated the route. Completion of the cultural/historical route was delayed to autumn 2008 because of a delay in the availability of videos belonging to Oulu University's 'Rotuaari Doc' database. Amazing NFC ended on 30.5 when school ended for the summer vacation, and continued in the autumn.

Until October 2008, the orienteering route was used only by Laanilan secondary school students: all the terminal devices available in the project were used in the school's eighth grade pilot. Also, participation in the culture/historical track was limited by poor availability of NFC terminal devices from the supplier. The Amazing NFC orienteering route continued until the middle of December 2008. By the reporting phase, it is estimated that a total of 400 students had taken part in the orienteering.

A video about the project, around 2 minutes in length, was made for demonstration purposes.

http://www.ouka.fi/video/smart/amazing/

The video was produced by Klaffi Productions. The Figures 70–72 show the "Amazing NFC" orienteering in practise.

Figure 70. A student learning about the history of Frantzen Park.

Figure 71. A map and the instructions to the next control point.

Figure 72. A student picking files to user's Personal Container by touching a tag at the Zoological Museum.

At The Zoological Museum University of Oulu Department of Electrical and Information Engineering carried out research on the physical user interfaces using mobile phones. Their research focused on the usability and feasibility of the TiPo application. VTT carried out usability research on the pilot.

5.2.4 Health Monitoring

Authors: Rosa Iglesias, Nuria Gómez de Segura, Cristina Cruces, Jorge Parra, IKERLAN, Spain

Goals

It is a fact that the number of people over 60 is growing in the world. By 2020, it is expected that the 20 % of the European population will be over 65 [1]. This increase will have a considerable impact on health services. Actions to prevent diseases, such as gathering and assessing accurate information on health issues everyday will be of vital importance to overcome this problem.

The main goal of this scenario is to help family members look after their health from home. They can identify themselves by using an NFC tag and following, they can proceed to measure different physiological magnitudes (i.e. weight, blood pressure, temperature, heart rate). These data will be automatically stored in the back-end system according to the identified user and they can be checked at anytime. Moreover, these data collected over time are proceseed to suggest life and good dietary habits or give health-related alarms/needs if necessary. The Figure 73 shows the Health Monitoring scenario.

Another important goal of this scenario is related to patients who need special cares so that they can prolong living by themselves at home. Those elders can be supervised by this Health Monitoring application in order to check whether they correctly take their medicines. This supervisory task is achieved by using recorded videos which can be then analyzed by a caregiver or doctor once accessed the system.

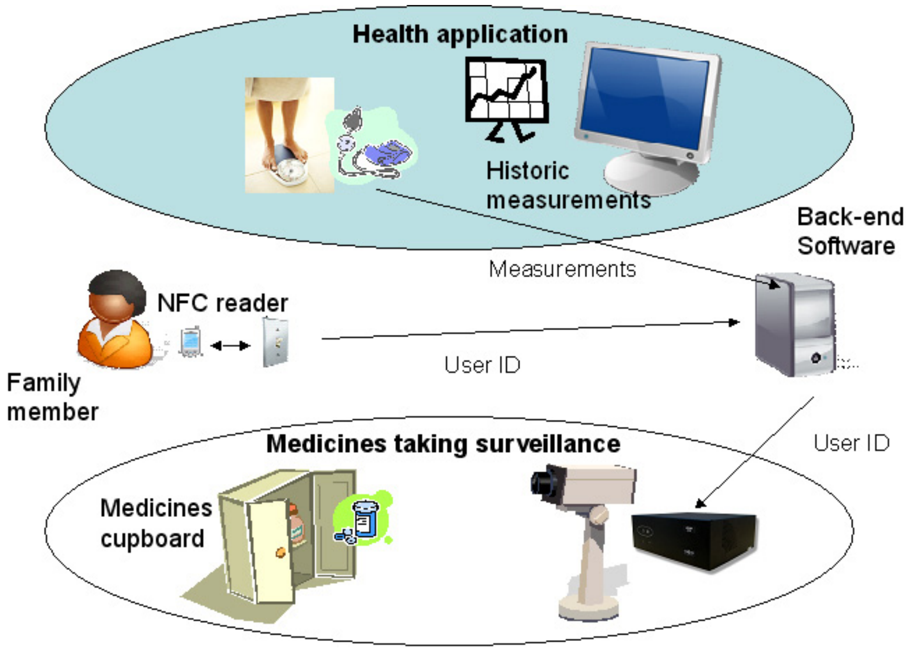


Figure 73. Description of the Health Monitoring scenario.

Actors

The Health Monitoring Application has been designed for family members and caregivers (but not limited to).

By simply touching the NFC reader with an NFC-enabled object, family members identify themselves and all health measurements carried out will be transmitted and stored in the back-end system. Hence, these measurements are immediately shown to users, although they can access historical measurements displayed by means of charts for easy understanding. In particular, in the case of elderly people who need special cares, they can also use the application to be supervised in everyday pill taking.

Another important group of actors are caregivers. The caregivers can remotely access an elder's historical measurements and watch the recorded videos, in which this elder is shown when taking his/her pills. The latter enables to make sure that users took the correct medication. They can also change or associate NFC IDs to different family members accordingly to their preferred NFC identification device.

Description

The Health Monitoring application could be installed in any device (i.e. PC, PDA) located at home. In the following example the Health Monitoring application is available in the bathroom.

The bathroom is equipped with an NFC reader, different medical devices, a camera, and a display. A practical solution is to integrate the display on a mirror located in the bathroom through which the user can look at current or historical measurements. In this case, a PDA/keyboard is used as user input interface. When a family member comes into the bathroom, he must touch the NFC reader with his bracelet, his NFC-enabled mobile phone or any other NFC-enabled object. Once the system has identified the family member, his user profile appears on the mirror display and he can start measuring different health parameters by using the medical devices (Figure 74).

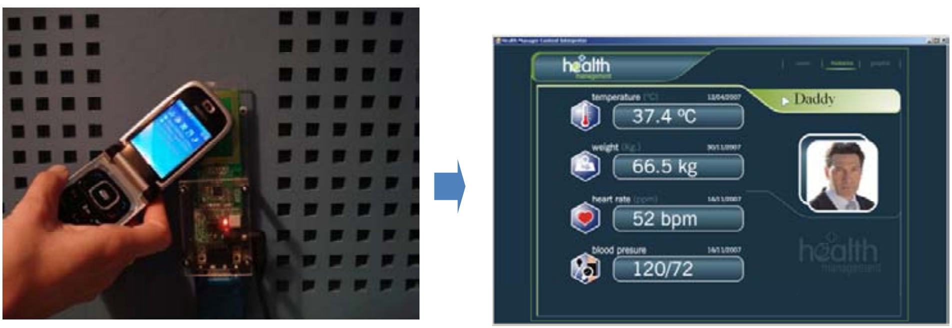


Figure 74. Left: Touching NFC Reader at the bathroom for identification. Right: Health measurements of the identified user shown in the mirror.

The medical devices send their data to the back-end system which stores them in a database according to the identified person. As the physiological parameters are stored, the historical measurements can be searched by each family member (Figure 75, right), or these can be sent to the doctor after clicking on the corresponding menu option/icon.

Figure 75. Left: user weighting, Middle: health measurements shown in PDA, Right: Chart with blood pressure measurements over time shown on the mirror.

When it comes down to pill taking by an elderly family member that is forgetful, once he gets in the bathroom and identifies himself, the system recognises him and records this action. Figure 76 shows the action sequences. This video is stored in a database with date and user name and it shows whether or not he took his medication.

Figure 76. Left: an elder in the bathroom, Middle: touching the reding with an NFC-enabled watch, Right: the elder is about to take his pills and the camera is recording this action.

When a caregiver identifies himself after touching an NFC reader with an NFC-enabled mobile or any other NFC-enabled object, he can access to a specific application – the Health Caregiver application – in which he can take two actions. This Health Caregiver application allows remote supervising and configuring users with an NFC ID. On the one hand, the caregiver can access to the remote supervisor application for recorded video monitoring (Figure 77). It allows caregivers to look for a certain video of some elder taking his/her medication on a day. On the other hand, the caregivers can configure a user name or identification and associate it with a concrete NFC ID. This ID is the corresponding to the NFC ID tag embedded in a bracelet/watch, a cell phone or any everyday object used for identification.

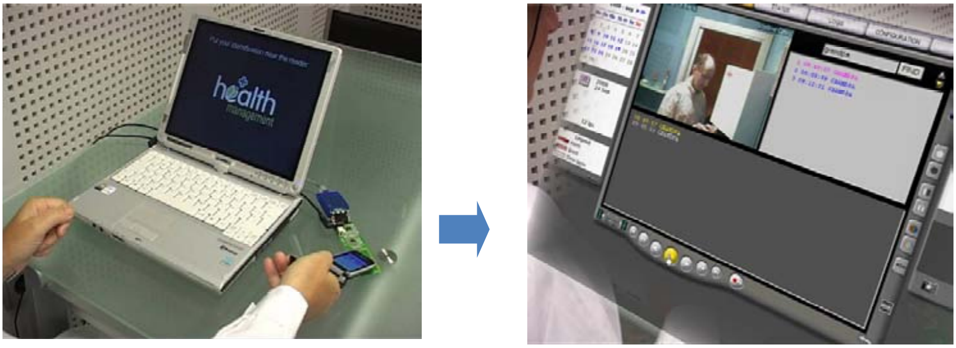


Figure 77. Left: Identification of the caregiver. Right: Watching the video where the elder is shown taking his medication.

Implementation

The Health Monitoring application needs a first step in which the different users identify themselves by touching an NFC reader with an NFC ID tag. Hence, each user needs an ID tag (i.e. Nokia 6131 NFC cell phone, NFC bracelet, NFC card). Furthermore, an NFC reader is needed in the bathroom and in our case we used Philips PN531 reader. This NFC reader is connected via serial connection to a PC, where the Health Monitoring application should be installed. Therefore, the NFC reader sends the user identification information to the Health application via serial port.

The diverse medical devices have a 433MHz wireless connection, and they send the measurements to the radio receiver in the PC which is connected via USB to the PC.

The family members can look up their historical measurements or send them to the doctor by selecting the link/option through a keyboard or PDA. If a PDA is used, the communication between the PDA and the PC platforms is made via Wi-Fi.

The different health application views could be shown in any display, such as a TV display.

In order to record and store users' videos while taking their medicines, a Digital Video Recorder system from Visual Tools is used [2]. This recorder was designed to match a recorded video with the identified user. It enables a supervisor application which is accessible over the Internet by the caregiver to check a patient's pill taking. Authorized caregivers can only have access to a patient's videos (in this case caregiver identification is carried out through the NFC reader).

References

[1] Europe in Figures – Eurostat Yearbook 2008: http://epp.eurostat.ec.europa.eu.

[2] Visual Tools: http://www.visual-tools.com/en/company.html.

5.3 NFC for home

5.3.1 Auto-adaptive remote controller

Authors: Estanislao Fernández, Jorge Lorenzo, Eva Reguera,
Marta Torre, Telefónica I+D, Spain

In a digital home there is a big amount of domestic appliances that can be remotely managed: television, lights, oven, and washing machine. This, more than making life easier for the user, complicates it due to the great number of different controlling devices required by each domestic appliance.

The basic idea of the auto-adaptive remote controller is to use a high-portable device (mobile phone, PDA or Ultra mobile PC) as remote controller of a wide range of domestic appliances.

In this way, the user will not need to change or look for the proper remote control when he wants to interact with an appliance.

The auto-adaptive remote controller is designed for inhabitants in a digital home, making the domestic appliances easier to manage. The following actors will be required:

- NFC tag provider that will facilitate in each tag the information necessary to identify and control each of the devices
- NFC-reader enabled mobile device provider
- digital home inhabitants.

The typical scenario would be a user wanting to manage a domestic appliance at home. He will only have to touch one appliance tag with the NFC-reader enabled mobile device and the touch-sensitive interface of the remote controller will be auto-configured. Then he will be able to interact with the selected appliance.

The technical solution has been implemented in a PDA supporting SDIO. In the SD slot of the device, a Near Field Communication (NFC) / Radio Frequency Identification (RFID) Secure Digital (SD) Card will be inserted. This SDIO card must offer NFC two-way communications.

Two software applications have been developed for the technical solution in the PDA.

The first application has been developed in C#.net with the API the manufacturer provides. It manages the NFC communication.

The application implements two threads. One of the threads is always running as a tag listener and the other starts the socket server.

The other application has been developed in Macromedia Flash and it implements the different interfaces of the remote controller for each of the domestic appliances. Apart from these interfaces, there is a main menu interface that allows the manual use of the device (Figure 78).

The flash application has a socket client that connects to the socket server of the C#.net. This application has also a thread that calls the web service that allows the domestic appliances management.

Figure 78. Home Controller Interface.

The software applications described work in the scenario presented as follows (Figure 79). When the NFC detects a tag, the identification number of the tag is sent and the flash application shows the corresponding controller in the PDA screen.

Buttons in each controller interface have their own identifier, so when the user touches one of them on the touch-sensitive interface in the NFC-reader enabled mobile device, the corresponding identifier is sent to the socket server.

Then, the thread in the flash application calls the domestic management appliance web service to interact with the corresponding appliance.

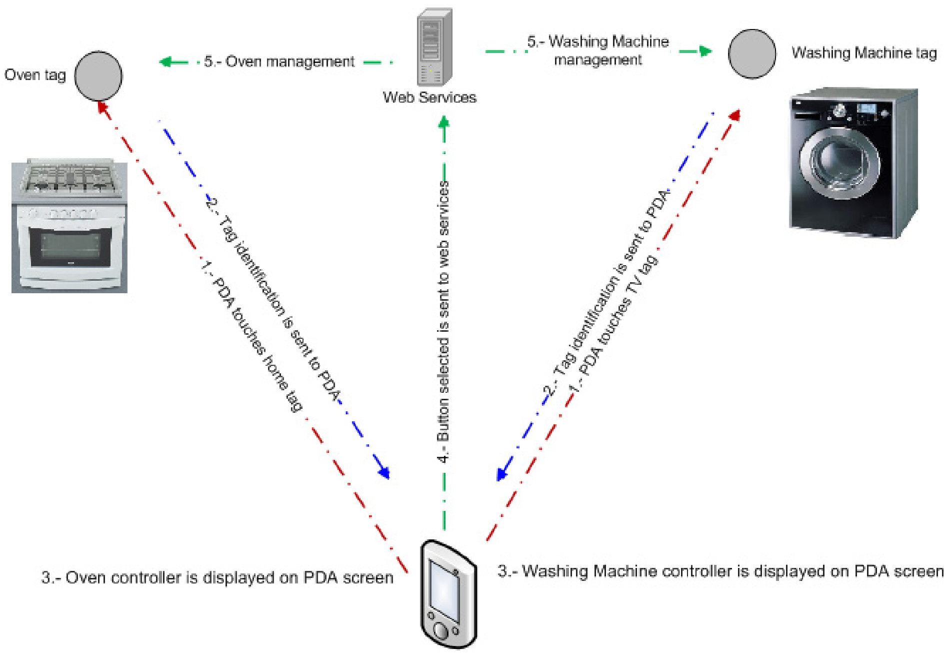


Figure 79. Smart touch architecture.

5.3.2 Renting washing machine

Authors: Julen Ugalde, Imanol Lukas – Fagor and Ikerlan, Spain

Goal

Most people own domestic appliances (washing machine, refrigerator, cooker, dishwasher,…) in their homes. However, there are a number of situations where purchasing these devices is not a good choice for the customer, as the use of the appliances is not intensive enough to amortize them over the years. For instance, second residence owners would only use the appliances a few weeks per year. The Figure 80 shows some domestic appliances.

Figure 80. Some domestic appliances.

Instead of purchasing these domestic appliances, it would be possible to offer a ‘pay-per-use’ or renting service whereby a customer could have as many appliances as necessary, and pay for their use. This would be applicable to washing machines, dishwashers, ovens, cookers and in general appliances which are not continuously working and whose action depends on the customer’s specific request, which leads to the choice of a certain program or mode and a switch-on order.

Although manufacturers and users had been interested in this service, it has not proliferated on the market until now. The most important problem to be solved is to provide the user with an easy and quick way to be identified and authenticated by the system, in order to control the activation of the appliance. Traditional identification solutions do not offer the desired performance:

- Systems based on user name and password are tedious, and remembering these data is sometimes problematic.

- Identification cards force the users to carry the card with them.
- Biometric identification methods (fingerprints, voice recognition) are still quite expensive and many people are reluctant to use them.

A far more simple solution, which is discussed here, is based on applying the NFC technology for the remote activation of the domestic appliance, being the user's cell phone the actual identification device. An experimental set-up for this service, has been developed for the SmartTouch project. The selected domestic appliance for this set-up has been a washing machine.

Actors

The potential user for this renting application is any person who does not make an intensive use of his domestic appliances, and considers that renting, instead of buying it, is a better option for him. It would also be a good choice for the owners of rental houses or apartments, who could offer a 'pay-per-use' fee to their tenants.

From the service provider's point of view, no human intervention is required, apart from the setting up and maintenance of the domestic appliance. During the normal use of the application, the user identification and washing machine activation processes can be fully automated.

Description

As explained before, the user will have a washing machine installed in his home. This device will be part of Fagor's automation network, i.e. it will be part of a set of domestic appliances connected to a bus and controlled by means of a Domotic Controller, named Maior-Domo, which is shown in the Figure 81.

Figure 81. Fagor's domotic controller (Maior-Domo).

The user will also have an Internet connection at home, and the domotic controller will be connected to the router in order to communicate with Fagor's Call Center.

The washing machine will include a NFC tag identification in a certain and visible place. The start button of the washing machine will be disabled or removed, so the only possible way to activate the appliance will be an order from Maior-Domo.

The user should be previously registered in Fagor's washing machine renting database and his ID should be associated to the appliance. A number of payment methods could be applied, but in this particular case we consider a prepaid account: the user has already paid a certain amount of money for several uses.

Finally, the user's cell phone, which will be the identification device, will have a NFC system. The ranting application scenario is illustrated in the Figure 82.

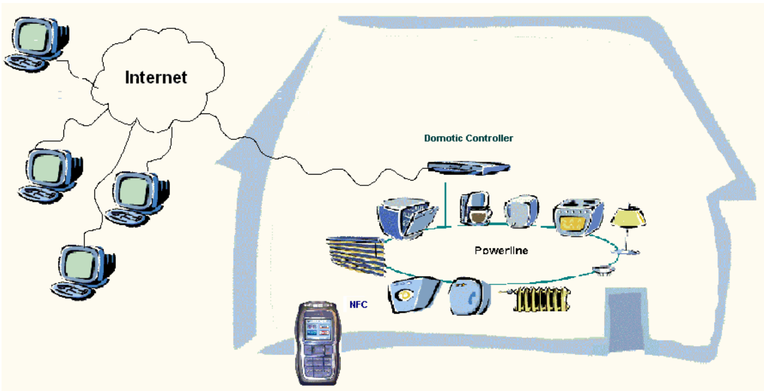


Figure 82. Renting application scenario.

When the user wants to use the washing machine, first of all he will choose a washing program. After that, he will approach his mobile phone to the NFC tag attached to the washing machine, which will be clearly visible. The mobile phone will read the washing machine code and the SIM card identifier and will automatically create a SMS message containing this data. The message will be directly sent to Fagor's Call Center. The washing machine activation process is shown in the Figure 83.

Figure 83. Washing machine activation process.

In Fagor's Call Center this information will be automatically received and a number of conditions will be checked:

- If the user code is not included in the database, then a SMS including "User identification error. Please call the customer service" will be sent to the customer.
- If the user exists, but the washing machine code is not correct, then a SMS with "Washing machine identification error. Please call the customer service" will be sent to the customer.
- If the user code is included in the database and the washing machine code is correct, but the client has no credit, then a SMS with "No credit error. Please send SMS asking for credit or call the customer service" will be sent to the customer.

When the Call Center confirms that the identification is correct and the client has credit, an activation order will be sent to the Maior-Domo domotic controller through Internet and the washing machine will start with the selected program.

Implementation

For the application, a Nokia 6131 NFC cell phone, which has built-in NFC capabilities, has been used. A passive NFC tag has been attached to the washing machine. When the application running in the cell phone reads the tag, a SMS message is prepared and sent to Fagor's Call Center through the GSM network.

On the Call Center's side, a GSM modem receives the user's SMS, extracts the data inside and checks the information against a database, which contains information about the user, the appliances installed in his house and the remaining credits.

If an error occurs, the application automatically prepares a SMS message and sends it back to the user with the appropriate information. On the other hand, if everything is correct, the application connects to the user's home network in order to activate the washing machine. The domotic controller, which is connected to the Internet through the user's home router, is accessed by the Call Center, and orders the appliance, in this case the washing machine, to activate. A standard web service is implemented for the communication between the Call Center (client) and the domotic controller (server).

If a standard, unencrypted TCP/IP connection had been used for this communication, it would be possible for a malicious user to replicate the verification data and, by replicating the packets, activate the washing machine himself without paying for the service. In order to avoid this problem, a secure SSL connection is established, and the transmitted data are protected.

Finally, when the domotic controller receives the order to activate the washing machine, Maior-Domo uses the power line to remotely control the appliance. Narrowband power line communication (PLC) is used for the connection of the diverse domestic appliances, in the 3 KHz to 148.5 KHz frequency band. Fagor's proprietary Domotic Bus protocol (BDF) is used over the PLC connection.

The user can stop the washing machine at any time before the program is completed, either manually or by means of the domotic controller.

5.3.3 Pinboard

Authors: Estanislao Fernández, Jorge Lorenzo, Eva Reguera,
Marta Torre, Telefónica I+D, Spain

Almost every family has a pinboard where they can share any type of information: shopping list, pictures, messages...

Considering that nowadays we use the mobile phone to write reminders, to take pictures, to exchange personal messages and as an agenda, it would be quite comfortable to move automatically the information from our mobile to the family pinboard.

The end user of the application can be any family member. Due to the simplicity of the application, the only requirement for the user is to have an NFC-enabled phone. A tablet PC interface simulates accurately the cork board texture, so the user experience results very familiar and pleasant.

The “Family pinboard” instead of using paper and pins, uses the mobile phone to send notes, lists, appointments and pictures by touching an NFC tag with the phone. Moreover, a new functionality is provided: each member of the family can exchange personal messages that will be written to and read from his mobile phone.

The pinboard has two main elements, on the one hand, a tactile screen forms the electronic cork board where the user can “pin” the information to share, on the other hand, the interaction with the electronic cork board is performed through a mobile phone, equipped with NFC.

When the application is in stand-by mode, the pinboard screen, embedded in the house wall, works as a photographic frame showing a sequence of the uploaded pictures. When any interaction is produced, the “Family pinboard” application shows the main interface, where the user can see the notes, shopping and tasks lists, pictures or dates in the agenda that any family member has uploaded to the cork board (Figure 84).

Additionally, it is possible to leave private messages to any family member that only the receiver will be able to read.

From this interface, the obsolete elements can be deleted just dragging them with the finger to the “DELETE” button. Pictures can also be dragged to the “SLIDESHOW” button, which produces the inclusion of the pictures in the sequence the screen plays in the stand-by mode. After 30 seconds without activity, the slideshow will be shown as a screensaver. By clicking the “SLIDESHOW” button, the slideshow will be displayed without waiting for the 30 seconds.

The user can register at any moment his post-its, lists, dates, pictures to share or private messages by touching the “Family pinboard” tag with his mobile phone. Then, all the information will be synchronized in the electronic board, and the user will receive in his mobile phone any private message addressed to him.

Figure 84. Family Pinboard.

The “Family pinboard” demonstrator is built around a tablet PC, an NFC-enabled phone, a Bluetooth USB adapter and a NFC tag.

The technical solution has been implemented with NFC and Bluetooth technologies. The NFC technology is used for triggering events by reading a NFC tag and for the synchronization between the mobile phone and the screen installed at home (Figure 85). Once the synchronization has taken place, the files exchange will be made via Bluetooth.

Three applications have been developed for the technical solution:

- a Flash application for the tablet PC to implements the system management and the user interface
- a J2ME application in the mobile phone for the interaction with the Family Pinboard
- a J2SE application in the tablet PC for the Bluetooth and Flash connections management. The application has an interface with the following functions:
    - <u>Pictures</u>: configuration for the sent pictures location

- Bluetooth: Bluetooth devices search
- Flash: configuration of the socket server connection between the java and the flash applications
- Message Log: messages exchanged between the J2ME, J2SE and Flash applications.

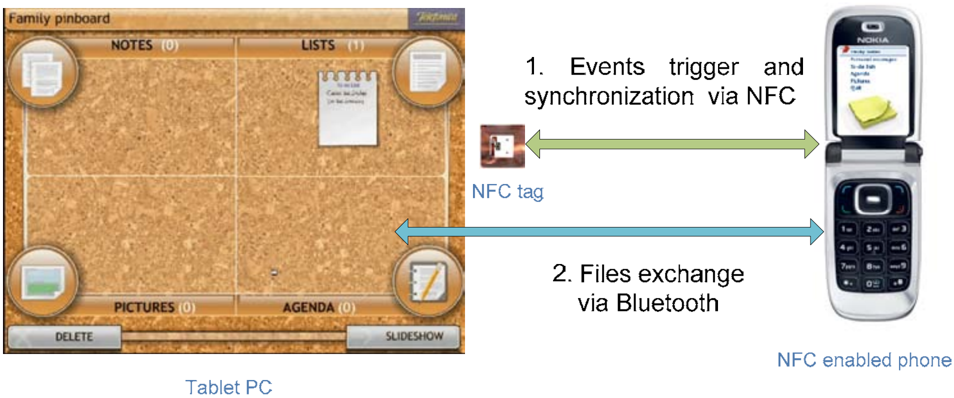


Figure 85. Pinboard scenario.

5.3.4 Smart NFC Interface platform and its applications

Authors: Arto Ylisaukko-oja, Mika Hillukkala, Esko Strömmer, Erkki Siira, Vili Törmänen
VTT Technical Research Centre of Finland

The established (Bluetooth) and emerging (NFC, Bluetooth Low Energy Technology) short-range wireless technologies of mobile phones bring along a cost-effective and easy-to-use access to various sensors and appliances in our environment. The sensors and appliances can take advantage of the mobile phones both as their user interface and networking gateway. This often makes the dedicated user interface and networking parts of the sensors and simple appliances unnecessary and thus reduces their costs, power consumption and physical size dramatically.

Smart NFC Interface is a multi-purpose platform by VTT, intended for developing and demonstrating this kind of applications. It is a light, matchbox-sized device with an 8-bit microcontroller, rechargeable Li-Ion battery with charging electronics, data logging memory, RS-232 serial port and other wired communications, as well as NFC, IrDA and Bluetooth wireless communications. The structure is modular to facilitate modifiability for different applications. There are connectors for extensions such as sensors. A temperature sensor is readily included, and the design supports ultra-low power operating modes. The microcontroller is programmable in C.

In the following chapters, application examples based on the Smart NFC Interface and demonstrated in the SmartTouch project are described.

5.3.4.1 Temperature measurement and NFC-Bluetooth Gateway

The temperature measurement is a basic demonstration of an NFC enabled sensor. The internal temperature sensor of the Smart NFC Interface is used. The temperature reading can be obtained by touching the Smart NFC Interface by a Nokia 6131 NFC phone or by VTT's NFC-Bluetooth Gateway. The latter option is illustrated in the Figure 86. Peer-to-peer communication mode of NFC is utilized.

Figure 86. NFC enabled temperature sensor is being read by touching with NFC-Bluetooth Gateway. Temperature readings are show on the display of the mobile phone.

The Gateway concept is an important application of the Smart NFC Interface. It enables adding NFC capability to mobile phones, laptops or other devices, currently lacking NFC support but supporting Bluetooth. As in the Figure 86, the Gateway is used to touch tags or NFC devices instead of the phone, but the data is communicated to and from the phone by Bluetooth. In practice, the Gateway could be e.g. a wrist unit or a pendant, or could be fitted or even mechanically integrated into the phone.

5.3.4.2 SeeingEyePhone

Goal

The SeeingEyePhone concept is designed for visually impaired people. The concept utilizes tags attached to objects that can then provide a visually impaired person with information about the object. The tags could be touched with a NFC-reader enabled mobile device (such as a mobile phone) that could then present the information depicted by the tag through audio. For example, a tag attached to a pill casing can point to or include information that identifies the medicine, and specifies the personal instructions for consumption. A visually impaired person can then listen to this information whenever needed by touching the tag. Similar concept can be used, for example, in grocery stores to mark items or shelf locations, or at homes to mark personal objects and information related to them.

Actors

The concept is aimed for people who have challenges in reading text in packaging. These include totally blind people, but also people who have difficulties in reading small print (such as elderly). Tag provider and NFC-reader enabled mobile device provider is needed for making the basic infrastructure available. In its simplest form, the visually impaired user stores personal information related to the personal objects, and no other actors are needed. However, the more advanced scenarios require, at least, following actors:

- point of sales, or item distributor, who attach the tag programmed to point to or include relevant information to the object
- information provider, who provides the content that is presented to the user upon touching the tag.

Description

Implementation of Seeing Eye Phone (SEP) consists of NFC-enabled phone, software installed on the phone, tags that are attached on the product or on the product shelves and a background system.

The software reads product ID from the tag. The product ID is sent to backend system which processes the ID. The processing consists of retrieving product information from database, modifying the information for correct format and sending the data back to the phone software. The phone software transfers the text to a speech via speech synthesizer. The voice is played to a user who listens to the product info.

The software itself is simple to use and has only few options because of the users' limited ability to see. NFC enables the software to launch from touching the tag. The speech is started automatically and the only thing that user needs to do is either stop playing the information, or close the software. Transferring the product information as a text leads to smaller data that is sent through wireless network than transferring voice files. This leads to faster response to user and less traffic in the network.

SeeingEyePhone is a prototype tool for the visually impaired. The basic idea is that objects can be identified and information about them can be heard spoken aloud by touching tags attached to them. Either the speech synthesizer of the phone is used to transform the text in tags to speech, or the contents of a tag are mapped to a certain voice sample that is played when the tag is read. Two versions of the demonstration have been implemented, one based on Nokia 6131 NFC phone, and another based on NFC-Bluetooth Gateway by VTT combined with Nokia N80 Series 60 smartphone, as illustrated in the Figure 87.

An important benefit of the NFC-Bluetooth Gateway based version is that a smartphone with a speech synthesizer can be used (smartphones equipped with NFC are currently not commercially available). This is not possible in Nokia 6131 NFC phone. The Gateway version may also enable usability advantages. For example, in a product version the Gateway functionality could be integrated to a wristwatch or wristband.

The Gateway version of the demonstration currently uses Mifare 1K type tags to store the data. It is also possible to combine the system with databases on a back-end server.

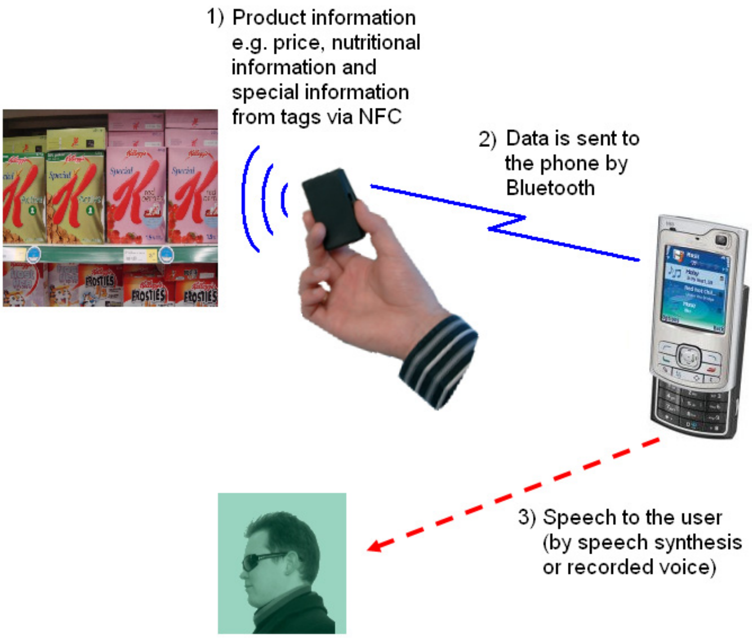


Figure 87. The NFC-Bluetooth Gateway version of the SeeingEyePhone.

5.3.4.3 NFC enabled blood glucose meter

A pilot testing blood glucose meter with NFC interface has been implemented in association with the city of Oulu SelfCare -project in August 2008. The pilot consists of a commercial blood glucose meter enhanced with NFC communications and back-end support for improved self-treatment of diabetes patients. The idea is to transmit the blood glucose level to a back-end system, which will provide instructions for care in return (instructions for insulin administration).

The NFC enabled blood glucose meter is based on a commercial blood glucose meter (One-Touch Ultra 2) combined with Smart NFC Interface prototype by VTT, a commercial NFC phone with application software, and a related back-end system. Using this system, the diabetes patient can transmit information about measured blood glucose level to the back-end system by simply touching the meter with the NFC phone after the measurement. The information can be made available to the health care personnel and instructions for administering insulin can be sent to the patient in return. The prototype is shown in the Figure 88.

Figure 88. The prototype of an NFC enabled blood glucose meter.

Figure 89 presents a block diagram of the system. The mobile phone NFC software implementation is based on JSR-257 Java API. Peer-to-peer communication mode is used for communications between the Nokia 6131 NFC phone and the Smart NFC Interface, which receives data from the blood glucose meter via a wired UART. A separate type 1 NFC tag is included to enable launching the application software at the phone by touching the tag – unfortunately, the JSR-257 Java API does not support launching an application based on peer-to-peer mode data. In a commercial product, the NFC parts would naturally be integrated to the meter itself.

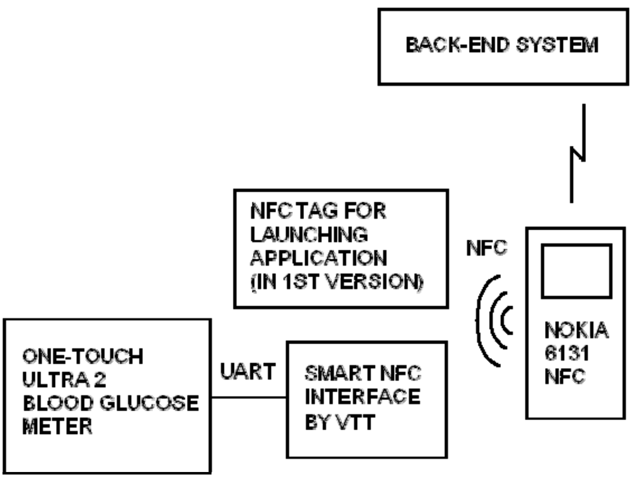


Figure 89. Block diagram of the system.

The user operates the system as follows:

1. User puts a test strip to the meter => The meter is powered automatically on.
2. User takes a blood sample to the strip => The results is shown on screen in 5 seconds.
3. The test strip is removed => Smart NFC Interface is automatically powered on, receiving the measurement result from the meter.
4. The user touches a tag with the NFC phone to open the application (this is an extra touch since launching an application from peer-to-peer mode data is not supported).
5. User touches the Smart NFC Interface => The phone gets the reading, shows it on display and sends it to the back-end system.
6. The phone gets instructions from the back-end and shows the instructions on screen.

The prototype has been specified and implemented in co-operation with VTT, City of Oulu and ProWellness Oy. The last mentioned partner is not within the SmartTouch consortium.

5.3.4.4 Power consumption measurement

The power consumption of any electrical appliance could be monitored by a tiny NFC or Bluetooth enabled sensor module that combines the Measurement Probe, Sensor Front End and Smart NFC Interface in a way shown in the Figure 90.

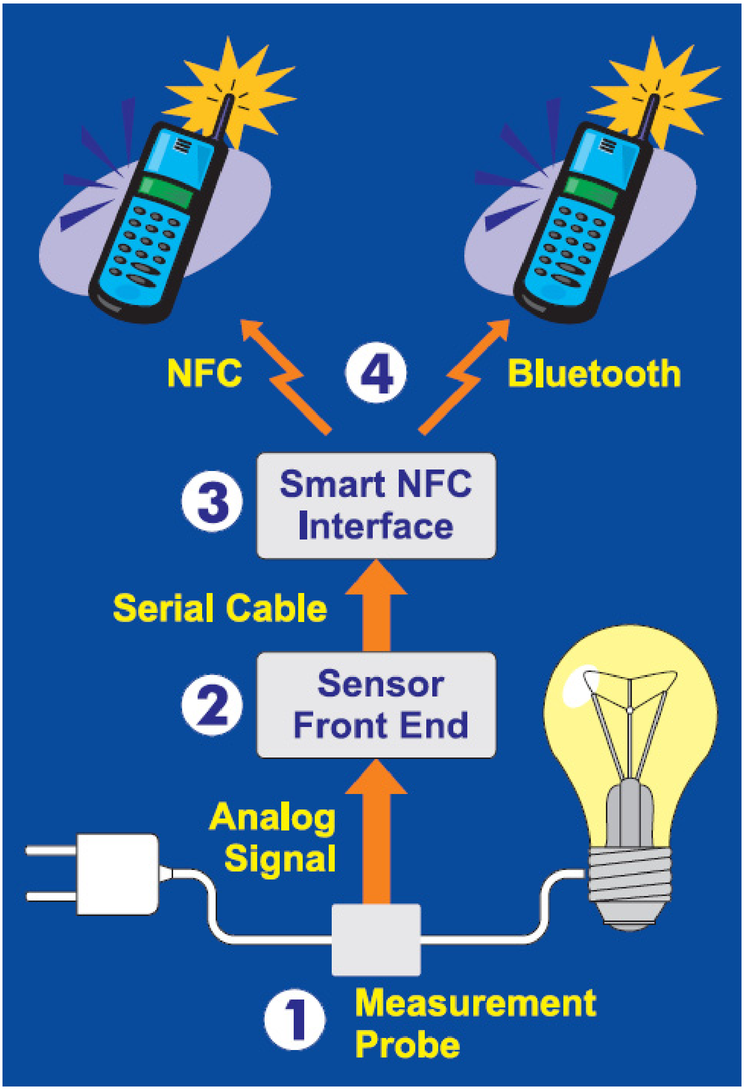


Figure 90. Power consumption measurement demonstration.

The numbered parts in the Figure 91 are described below:

1. The Measurement Probe monitors the current in the mains wire of the lamp inductively.

2. The Sensor Front-End amplifies and filters the analog signal from the Measurement Probe and converts it to digital format. The Sensor Front End is developed by VTT on Crossbow's MICAz platform.

3. The Smart NFC Interface accumulates the measurement results from the Sensor Front End, converts the results into human readable format, and sends the results to a mobile phone either by Bluetooth or by NFC. Contrary to Bluetooth, NFC enables ultra-low power consumption of the sensor and intuitive touch-based interaction with the sensor by a personal mobile phone.
4. The Mobile Phone displays the results to the user. The Mobile Phone incorporates application software developed by VTT.

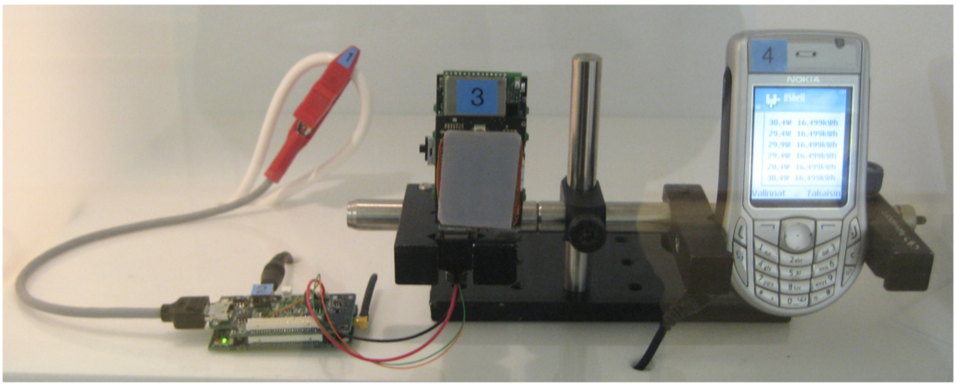


Figure 91. Measurement probe on a mains cord, sensor front-end connected to Smart NFC Interface, along with a Bluetooth phone collecting data. NFC phone is not shown.

VTT implemented a functional demonstration of the concept. This is publicly demonstrated in VTT’s showroom in Oulu. The NFC interface can be used over Nokia 6131 NFC phone or by VTT’s NFC-Bluetooth Gateway. The Figure 91 illustrates the sensor probe and front-end on the left, the Smart NFC Interface in the middle and a Bluetooth phone on the right, getting measured power readings at regular intervals. Peer-to-peer communication mode of NFC is utilized when data is read by Nokia 6131 NFC phone.

5.3.5 NFC-Enabled Household Access Control and Security

Authors: Francisco Gómez, Domingo López, Visual Tools, Spain

Changes in modern life of families call for more flexible ways to organize the access to a household in a way very different to what it was common years ago.

In effect, nowadays homes are very often empty for a relatively long part of the day because all family members are involved in their own activities outside the house. The return home takes place in different periods and other non-family members are required to have access to the house when it is empty. Typical examples are: teenagers coming back home when parents are at work, temporal access of neighbors or friends during vacation period to look after our plants, or timely access of a cleaning lady during certain hours. This situation must be handled even in the presence of increasing criminal activities against private homes that are demanding better level of intrusion protection.

The goal of the demonstrator described in this section is to empower the household with more flexible and more secure access control and higher level of protection thanks to the NFC technology present in mobile terminals. The demonstrator, called *Touch&Enter*, shows how NFC can be used to grant or deny home access to the actors mentioned above with great flexibility and a high level of security. Thus the actors of the demonstrators will be

- the family members of the house
- authorized neighbors or friends
- cleaning personnel
- service technicians.

To make this application real the value chain related to home access control must provide NFC-enabled products. In particular, household door manufacturers must provide doors with electronic locks equipped with NFC readers. Besides that, mobile phones provided with NFC technology must be widespread to allow household visitors to use the devices for getting access to the house.

The main purpose of this scenario is to prototype a NFC application to access the home. A visitor provided with a mobile terminal could use it to open the main door of the house. The system is complemented with a video camera to record a sequence of the event.

The following figure (Figure 92) shows the scenario and the main actors involved. The system works as follows. A visitor provided with an NFC mobile phone approaches the main door and touches with her mobile phone in the door lock. The NFC reader in the door lock verifies the visitor's credentials and decides, based on an internal authorization list, to grant or deny access. If access is granted the door is opened to allow the visitor to enter the house. At the same time, an optional relay output is activated. This signal can be used to start a video recording process in an associated video security system provided with a digital video recorder and a video camera. The recorded sequences can be reviewed later on by the home owner to check unexpected visitors who were denied access and also to verify the identity of the persons who entered the house.

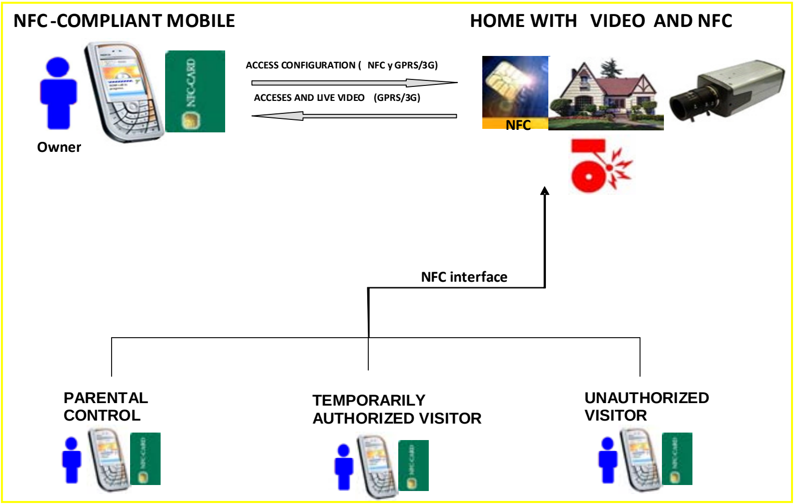


Figure 92. Diagram of the main actors on the scenario.

To implement this demonstrator, the following elements were used:

- a NFC-enabled Nokia 6131 mobile phone
- an embedded NFC reader developed by VTT
- an electronic door lock
- a digital video recorder with the ability to activate recording by activation of digital inputs
- a conventional video camera used in Closed Circuit Tele Vision (CCTV) applications.

The schematic diagram of the set-up is shown in the Figure 93. The VTT device features an NFC reader which is used to communicate with a NFC Nokia 6131 device. The VTT device provides digital outputs that can be activated to open the electronic lock, to ring the doorbell (e.g. in case the visitor is a non-authorized person and the house is empty), and to start a video recording operation. The digital video recorder is connected to a CCTV camera pointing to the entrance area.

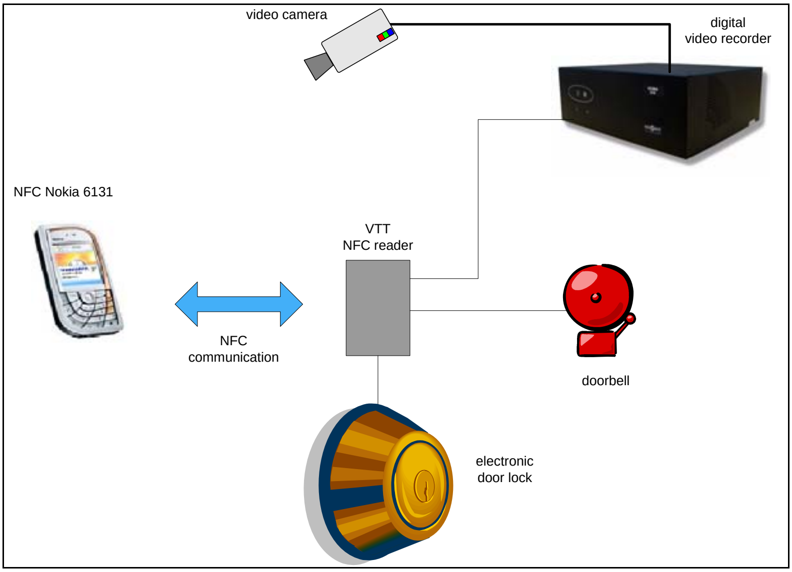


Figure 93. Diagram of the set-up.

Figure 94 shows the mockup of the demonstrator.

Figure 94. Mockup of the demonstrator.

5.3.6 User identification in Comfort application

Authors: Rosa Iglesias, Nuria Gómez de Segura, Cristina Cruces, Jorge Parra, IKERLAN, Spain

Goals

Up to now, houses and flats are usually provided with heating and/or cooling systems, and in some specific cases also other “comfort devices” (i.e. humidifiers, ionizers). Those systems are typically controlled by a manually-configured parameter located at each system.

The proposed scenario aims at identifying users in order to personalize their comfort parameters, according to their comfort operational preferences, in home-like scenarios. Automating different operations to regulate comfort systems in homes could have a positive impact on users and energy efficiency. Self-acting and self-regulating mechanisms for controlling comfort parameters, which are activated once users come home, not only will undoubtedly improve our wellbeing but also will have an important impact on energy saving.

In addition to this, these comfort magnitudes can be displayed by using ornamental elements. For instance, meaningful colors could be used in a table lamp to show that the actual temperature is the desired one (green) or colder (blue) or warmer (red) than the desired one. Comfort information is available at a glance.

Actors

The Comfort application can be used by any family member. It has been designed to be simple and easy-to-use. No prior knowledge or familiarization is required from users’ point of view. In particular, at first step the user preferences need to be defined (each user could change the configuration or profiles of each zone at any time.), but the system easily guides you to assign all the comfort magnitudes (i.e. temperature, humidity). Then, just by touching an NFC reader located near the front door (or in any other place/ room), the system automatically adapts the comfort conditions to the new context.

Description

The following paragraphs describe an example of how the comfort application works. For the sake of simplicity, regulating the indoor temperature is only considered, although humidity can be also regulated. At 3 p.m. nobody is at home, and the profile temperature is regulated to the one defined for a ‘no one at home’ case. Husband comes home by 4 p.m. and he approaches his cell phone to an NFC reader located near the front door (Figure 95). The system identifies him and activates his comfort preferences. He enters into the living room, sits down on his sofa and starts reading a newspaper. Therefore, the Comfort application sets the temperature of the living room according to his preferences. Following, his wife arrives home, identifies herself and enters into the living room. Both husband’s and wife’s comfort preferences are alike and then the system regulates the temperature according to both preferences. Over this time, an ornamental element at the living room – a table lamp – can visually reflect by means of a meaningful colour the difference between the current temperature and the desired one. If the temperature is below the desired one, the table lamp will be in blue. If the temperature is warmer than the desired one, the red colour will be displayed; whereas, if the temperature is very close to the desired, the lamp will be in green (Figure 96).

Beyond that, NFC-based identification in homes offers the potential to be used in a wide range of applications to offer a combination of useful services to users. For example, this comfort application could also be integrated within a home access system. As a result, the front door would be automatically opened, lights would be switched on/off, our favorite TV show or radio station would be tuned and at the same time, the user comfort profile/preferences would be activated.

Figure 95. User identifying himself when he arrives home.

Figure 96. Table lamps showing three different temperature statuses related to the desired temperature: green for optimal temperature achieved, blue for colder temperatures and red for warmer temperatures.

Implementation

The NFC reader is located near the home front door. NFC cell phones or any object with an NFC tag can be used for user identification. In this scenario, a bluetooth temperature sensor is selected.

Maior-Domo [1] remotely controls home appliances and other devices that are connected to smart sockets such as air conditioning, humidifiers or RGB lamps. In general, Red-Green-Blue or RGB lamps (in our case, the table lamp used is an RGB lamp) are used to glow different colours according to certain information. Narrow-band Power Line Communication (PLC) is used for the connection of diverse home appliances, with a frequency range between 3 KHz to 148.5 KHz. Fagor's proprietary Domotic Bus protocol (BDF) is used over the PLC to send and receive control commands.

References

[1] FAGOR: http://www.fagor.com/domotica/_bin/cast/maiordomo.php.

5.3.7 A Transdisciplinary Work Method: the Suitcase Experiment and the Christmas Media Gift case

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In this chapter we present our experiences in searching for innovative ambient communication applications in an R&I context, starting from the use of everyday life tangible objects embedded in people's social practices. A trial in the home context is presented. The technologies used are Near Field Communication (NFC) technologies and Web technologies.

We describe the used transdisciplinary research cycle that exists out of a collaboration that is evenly creative, design, engineering, and social centric. The thriving force is the collaborator's desire to communicate on his/her inspirations and passions. Experts from different disciplines and users are working closely together to explore a common design language resulting in innovative communication applications. Furthermore, one application concept that results from these activities will be presented.

5.3.7.1 Introduction

While the Near Field Communication (NFC) technology [1] has been commonly acknowledged and applied as a promising technology in the domains of payment, ticketing and health-monitoring [2], a new trend associating this technology with multimedia and communication applications, is coming up. It is said that: "This new kind of application will be engaging and will in high degree emotionally touch the end users. Users will be able to link the virtual world (again) with the physical world and will have the easier ways to interact with friends, media, explore the city and create stories – through touch" [3].

The concept of "tangible media" has already been researched in detail for years and a substantial amount of papers and demonstrators are available on this subject [4], [5]. The basic idea of “tangible media” is to associate a physical object with digital multimedia, enabling the end users to experience a seamless connection between the physical and the digital world. For instance, people can take a bottle of wine (NFC enabled) and put it on a table where a reader is embedded. A TV the starts up a personal movie of a visit people made to this wine production region. Adding the movie in a very intuitive and impressive way enriches the value of the wine. This simple example covers aspects like ‘stimulate involvement and expression’ and ‘playful learning’. However, we clearly see a natural evolution into more advanced scenarios, which contain aspects such as a higher degree of user involvement and the drive to learn and to communicate.

Two researches from the whole research cycle will be described. Firstly, The Suitcase Experiment. An experimental study whereby researchers visited citizens with a suitcase full of ‘smart objects’. Secondly, the pilot entitled “Christmas Media Gift”. This research took place during Christmas season of 2006. The “Christmas Media Gift” research was the final step in the transdisciplinary research cycle developed to learn about the vision and ideas of ‘ordinary users’ on RFID use regarding everyday life objects in the home environment.

The chapter is organized as following. First, we give a small insite on our vision on working in a transdisciplinary way and using co-construction of use and development within R&I. There after we describe the suitcase experiment and some conclusions that could be made of the experiment. We finish with a description of the Christmas Gift study. In this study we also discuss the technical solution.

5.3.7.2 Living Together Transdisciplinary: The Research Cycle

The Residential Networked Applications (ReNA) team within R&I Alcatel-Lucent is persuaded that two conditions must be fullfilled when developing residential networked applications. On the one hand, working transdisciplinary within a team, and on the other hand, co-constructing new applications with the participation of the end user. These goals are interlinked in different ways and are currently still under construction within ReNA in Alcatel-Lucent. Therefore we see this work as work in progress with the final aim to formulate a transdisciplinary research practice that is usefull within ReNA context.

Different Levels of Co-Construction as Challenge

Living and working transdisciplinary is not the easiest way to go. Within the Research and Innovation Group of Alcatel-Lucent Bell Labs we believe in doing transdisciplinary research and co-construction with end-users when developing applications. Therefore we effectively put energy and time in this way of working.

We believe that for 'really' working transdisciplinary there is a need for a research practice that takes into account the multiple disciplines (for our research group: design and usability engineers, marketers, creativity coaches, research engineers, and sociologists). Finding a common language to speak, developing common research questions and developing tools to work with are the first steps to take.

Working in a transdisciplinary team changed for example the way prototypes are designed and developed when discovering new, or to elaborate further, innovating ideas. ICT are mixtures of technical structures and human factors, they are social (constructed) elements. Human and social scientists should realize that the ICT as research subject contains scripts [6]. ICT may not solely be addressed as black boxes, but need also to be opened and to be studied on its internal scripting.

Only then the process of co-construction of use and development for the development of new applications can start. Following Crutzen [7], we state that co-construction can take place on three levels:

1. On the technological artifact level: the process of rejection, re-interpretation or acceptance of technology within the historical and social context and chosen technological trajects.
2. On the level of interaction between the 'worlds' of development and use: by bringing together engineers and users within the innovation process in a learning process.
3. On the level of interaction between actors and informatics representation: by opening embedded interactions and creating the opportunity for users to change the meanings.

The first level of co-construction only takes place after a product is introduced in the market, this level constitutes the body of sociological and communication sciences research about technologies or applications. This kind of research is not very interesting since Bell Labs is aimed at evaluating the potential of the applications as early as possible, even before and while coding the prototype.

The second level of co-construction, also called co-creation [8] has already been performed within our research group and has proven to be effective. Bridging the worlds of developers and users creates new types of applications. Transdisciplinary work is also central within this co-creation process.

The third level of co-construction seems the most difficult and challenging. It requires some fundamental changes in the vision on programming, programming languages, architectures and human skills from the transdisciplinary team members. It requires an open design debate that goes further then the existing user research methods. In the presented research project on tangible media we did a first attempt to realise co-construction on this third level.

Our vision on transdisciplinarity and co-construction served as the starting point when developing the research cycle for smart touch. This cycle consists of different iterations, in line with qualitative research methods in the human sciences [9]. In this paper we focus on the most important methods used in research projects where different levels of co-construction played a role and that explicitly influenced the Suitcase Experiment and the Christmas Gift cases that we will describe further in the article. These methods cannot be matched upon the different levels of co-construction, but some methods contain a certain level of co-construction.

Phase 1: Creative exploration; using following methods:

- brainstorming
- research on state-of-art
- design concepts
- use case flyers & moodboards
- business modelling.

Phase 2: Explorative user studies; using following methods:

- semi-structured interviews with a diversity of users (The Suitcase Experiment).

Phase 3: Casestudy ‘Christmas Gift’; using following methods:

- participant observations
- short questionnaires.

5.3.7.3 The Suitcase Experiment: Touring With a Suitcase Full of Smart Objects

The goal of the experiment was to get more inspiration on the use of RFID in everyday life objects by interviewing a diversity of people. We wanted to gather user ideas and perceptions on (mobile) interaction with RFID tags in everyday life world things.

This was one of the methods used to gather inspiration and information on the use of RFID in everyday life objects, next to brainstorms, literature research and websites of artists/researchers as Timo Arnall (http://www.nearfield.org/).

The goal of the gathering of these different inspirations and information was that when starting to develop technology, all different kinds of use could be taken into account. Therefore, the ultimate goal of the suitcase experiment was to develop a flexible, adaptable, multi-usable application on which different experiments could be done.

The suitcase experiment is therefore not a user-research to test a pilot application, but is a research done before the application building started.

The target group for this research was a diversity of people living in the Dutch speaking part of Belgium. We wanted to create an informal atmosphere during the research; therefore using the mother tongue of the respondents seemed necessary.

Eleven persons were interviewed. The socio-economic situation of the group of respondents looked as follows (see next figure):

Variable	Amount
Gender	
Female	7
Male	4
Age	
20-30	6
31-40	2
41-50	1
+ 51	2
Highest education	
Higher education outside university	2
University	9
Profession	
Student	3
White collar worker	6
Pensioned	2
IT-knowledge	
Low	2
Moderate	6
High	3

Figure 97. Socio-economic situation of the respondents.

Two researchers carried out the interviews together: one research engineer and one research sociologist. The research was afterwards also communicated to the rest of the SmartTouch team within Alcatel-Lucent.

During two weeks the researchers toured around with a suitcase full of everyday life objects. They visited family, friends, or friends of friends at their home with their suitcase. During a two-hour semi-structured interview they gathered the reflections of the respondents on ‘what the meaning of an everyday life object could be if it were augmented with RFID technology’.

In the suitcase following objects were gathered: a bottle of wine, an envelope, a book, a shoe, a music cd, a cross, a bracelet, a metro ticket, keys, a flower, Moroccan spices, a teddy bear, a poster, a picture (of the respondent), a flippo, a business card, a first aid kit, a birth card.

The basic technological functionality of attaching contact on objects was explained, and then were the respondents asked to imagine what these everyday life objects would be like when augmented with RFID. The answers of the respondents were gathered, together with some background information on their life in general, ICT use and possession.

Figure 98. Some environment pictures of the research.

We tackled three research questions in the Suitcase Experiment. The semi-structured interview was therefore divided in three phases. In every phase one question was treated. In turn one researcher did the interview and the other researcher made notes. The interviews were audio recorded, so they could be listened to again and transcribed for the analysis. For transcription the qualitative analysis software program MAXQDA was used. MAXQDA is a professional instrument for text analysis. The interviews were done end of 2006.

Phase 1: RFID enabled every day life objects from the suitcase

In phase 1 we presented the everyday life objects we brought in the suitcase to the respondent. We explained them briefly the way RFID works and asked them the following question: “Which (sort of) digital information, communication, application or anything else do you imagine to be ‘attached’ to the object?”

After respondents answered this question we asked them what they would like to have ‘attached’ to the object.

Phase 2: RFID enabled every day life objects from the home environment

The interviews took place within the home environments of the respondents. In this second phase we asked them the following question: “What objects from your home environment would you ‘tag’ with an RFID, and what (sort of) information, communication, application or anything else would you ‘attach’ to it?”

Phase 3: Mobile interface for RFID

In phase 3 we looked for initial ideas on the user interface on a mobile device for the application. The question we asked was the following: “Wondering that the RFID could be ‘read’ with a small device (we used the Dutch concept ‘machientje’ to point to it), what do you think or want to happen with the device when you touch a tag, and how do you want it to look like”.

We gave them a paper version of an interface where they could draw their ideas on.

The experiment was perceived as a source of inspiration by the SmartTouch team in Alcatel-Lucent Bell Labs. Although we initially didn’t have the time to do some proper transcriptions and were only able to do some superficial analysis, some important conclusions could be made. Moreover, we extracted for the development of the system.

Some conclusions

In general, the answers we received in phase 1 and 2 of the interview depended strongly of the life-context of the respondents. Their age, gender, life-world and personal interests were very much intermingled with the ideas they came up with.

The respondents were also much more exited about the idea to get something ‘personal’ attached onto the objects, than to get something ‘generic or automated by the company that produced it’ attached to the object.

More specific following non-technical conclusions can be made:

First, the respondents were always looking for ‘the best of the two worlds’. They tried to combine their preferred features from the ‘real world’ every day life objects with their preferred features from the ‘virtual world’. Looking for the optimal use of features of both worlds was what they were looking for.

Second, use of RFID was often divided in functional and emotional use. A functional use of RFID on a bottle of wine for example is to know the temperature of it and with what meals it matches best. The emotional use of RFID on a bottle of wine is for example the name of the person who gave it to you or with whom you drank the bottle (for persons who keep empty bottles). Mostly, to every object a functional and an emotional use could be given.

Third, respondents often were interested in the 'history' of objects. Which countries did it travel through to get in their hands, who were the former owners or where can I find more information of this objects? Or what is the story attached to for example an old picture.

Fourth, respondents were also interested in the community that possessed the same objects, sometimes they mentioned to do something together with them. For example: which persons do wear the same brand of shoes I wear or which persons are reading the same book as me at the same moment.

Fifth, respondents also mentioned possible negative consequences of the use of RFID: loss of privacy or loss of use of own memory.

Sixth, 'tagging' their own house was very difficult. Generally people were very happy with the way their house was organised and installed. Getting new ideas out of phase 2 was in that way a bit disappointing.

Seventh, for defining the interface of the mobile device all respondents came up with ideas very close to the existing mobile phone and Ipod interfaces. A more creative approach for this research question was needed.

Eight, when we asked the respondents for a name for the 'tagged objects' the word 'whispering things' was mentioned different times.

Ninth, sharing and collecting from content seemed important to the respondents.

Tenth, the 'touch paradigm' was perceived as very intuitive and easy in use.

And to finalize this first experiment some conclusions regarding the impact on the application and system development:

Although it is difficult to define the real impact of this user research on the code written, the research has for sure given inspiration to the software architects and developers and influenced the decisions they made during the development process. This can be seen on different levels of the actual application and system design.

Firstly, the framework provides different templates of the (digital) content that can be attached to the objects. People can choose the most appropriate template for what they want to reach. The framework allows easily creating and modifying existing templates. Moreover different templates support people in their creativity.

Secondly, all sorts of ownerships can be defined for content access and association access between the content and the object/tag. People can give read/write/execute rights to different persons or groups. This allows communities to create and share the content attached to the objects together.

Thirdly, new concepts were defined, for example the “bag” and “history” are defined as basic concepts in the framework. People can store interesting content on objects in their ‘bag’. These content can then be consulted afterwards. Moreover, bags doesn’t have to be individual but can be shared between persons or groups of persons.

The last but maybe the most special remark can be found in the naming of the components and classes in the framework. Discussing the naming and interactions in the framework in a transdisciplinary way (and taking the user research into account) resulted in heavy discussions and allowed more profound understanding between human scientists and software developers during the whole developments cycle. Having a technical researcher that participated in the human research and a human scientist really going deeper into the technical details probably made these interactions between the groups more easy.

5.3.7.4 The Christmas Gift case as co-design study

The Christmas Gift scenario is an example of a fine-tuning of the Media-Gift experience in the Christmas context with the focus on the social practice of preparing and giving Christmas presents to relatives and friends.

The whole Media Gift scenario is illustrated in the cartoons shown in Figure 99.

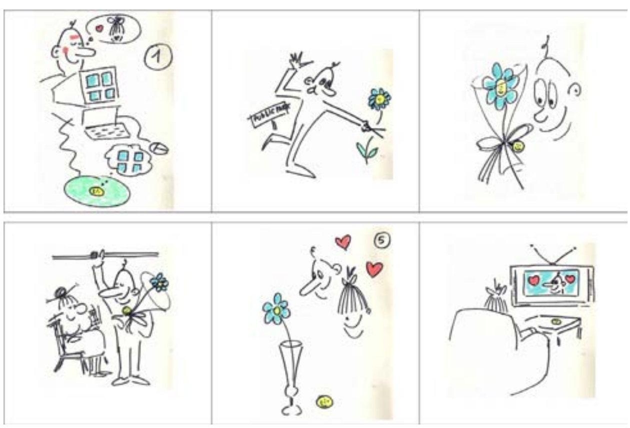

Figure 99. Media Gift Scenario Cartoon.

The aim of the experimental Christmas Gift research was defined as: "exploring the meaning of a media gift experience from the perspective of 'ordinary' users within the existing gift exchanging experience of Christmas evening". Since the innovation was still ongoing and needed to be treated on a confidential level, the pilot study has been designed as a friendly user test.

The three families that participated were all families of members of the ReNA research team. The three families consisted out of parents (mother and father) and children. The final aim was that on Christmas evening some family members would receive a material gift that was extended with media and that media got displayed on the television screen.

The results from this pilot cannot be generalized and are only important to a lesser extend. The most important aim of this case is to have an insight on how to design the transdisciplinary research cycle. Nevertheless following observations were made.

The media gifts have been enthusiastically created by the family members and exchanged as a personal token of appreciation towards one another. The creation of a media gift involved not only the creation of a media item that adequately transfers the intended message but also the exploration for ways of how to attach that media item to their physical gift of choice. Different media types like movies, slideshow, PowerPoint and audio were used in various formats. *"It makes it easier to say something emotional"* and *"It changes gifts from something commercial into something emotional"* are some of the comments made by one of the participants. *"It gives people the opportunity to say something in a more original and creative way"* was also heard different times.

The addition of this personal media message to a physical gift makes the gift more precious to the receivers. It was observed that the perception from the time and energy someone has put in creating the media gift contributes to its value. Current analysis of the created media artifacts, and recorded observations indicate that the Christmas media gift is integrated fluently in the existing ritual of exchanging gifts on Christmas evening.

While this new means of communicating an emotional message to love ones was perceived as non-intrusive and non-technological, it involves a number of new network services. These new services that are required can seamlessly integrate with existing telecom infrastructures and platforms.

Technical solution: the prototype

The prototype used in the Christmas Gift scenario as shown in Figure 100 consists of the following devices:

- mobile phone or a PDA with NFC reader enabled
- a TV
- an IPTV set-top-box (emulated via client PC)
- a web server hosting the Tangible Media System
- objects with NFC tags attached.

The IPTV set-top-box has to subscribe itself to the back-end hosted on the web server. The back-end will push the content to the subscribed devices when requested. Ajax technology is used to mimic this kind of "publish/subscribe" mechanism.

When the mobile phone (or NFC reader) detects a NFC tag, it sends the RFID together with output device identification to the Tangible Media System in a custom format via GPRS connection. In the prototype, the output device is left configurable on the mobile terminal and refers to the set-top-box, where the back-end has to send the associated content to. After the server resolves the RFID, it will send a short description of what the content is and how it looks like back to the mobile client. Meanwhile it will push the content that will be eventually displayed on a TV to the output device.

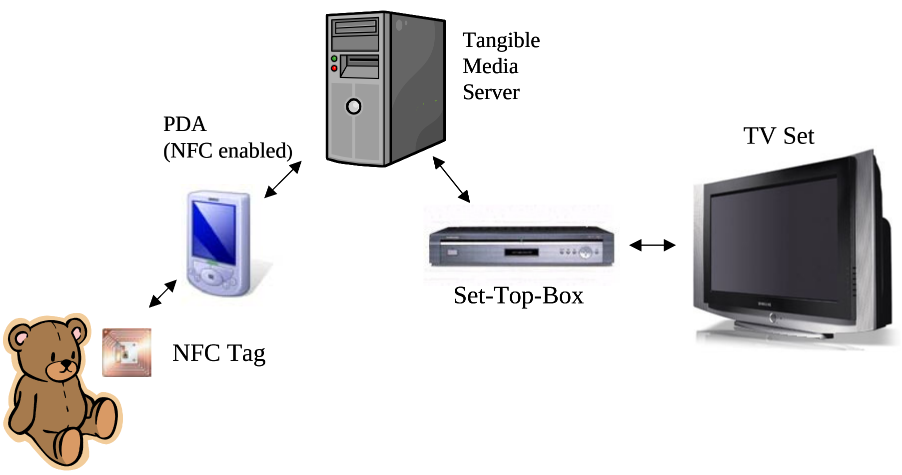

Figure 100. Tangible Media Scenario.

The pictures below show some impressions on the Media gift experience in one of the families. Labels were used to hide the RFID tags on the gifts. The parents helped the children with creating the media messages. By doing this, the experience became a warm family happening.

Figure 101. Media Gift experience during Christmas time.

Technical Solution: The Architecture

The network architecture that supports the Media Gift scenario is shown in Figure 102. It consists of 8 service components, NFC Reader Service (NRS), Tangible Media Core (TMC), Content Correlation Service (CCS), Reader Correlation Service (RCS), Response Dispatcher, SMS/MMS Service, Media Vault Service (MVS) and 3rd party Services. Except, the NRS and 3rd party services, the rest of service components can be implemented on a Service Oriented “Open Service Delivery Environment” (OSDE), which is based on the principles of abstraction of complex network protocols, of real-time, scalable and robust application platforms with open development environments, of “build-once and reuse” common capabilities and on exposure and openness to 3rd parties. The NFC Reader Service locates on the client side, whilst the 3rd party services are normally somewhere on the Internet.

- NFC Reader Service is a local application running on a reader device, which is responsible for collecting, filtering and aggregating information retrieved from the RFID tag and sending it to the back-end system.
- Tangible Media Core is the core of the Tangible Media System (TMS). Upon receipt of an RFID event, the Tangible Media Subsystem will first resolve the RFID by making use of the CCS. Then it verifies whether the output has to be sent to another or to a secondary device via RCS. When all necessary information is gathered, the TMC will instruct the Response Dispatch which actions to perform.
- Content Correlation Service is used by the TMC to obtain an XML orchestration document associated with the RFID. The service allows the operator to manage these associations.
- Reader Correlation Service: Different scenarios have different requirements towards the device where the content should be displayed. In a typical learning scenario, the apprentice could use a handheld reader to read tags while the related content should be shown on another (pre-configured) device. After each touch, the content related to the tag will be shown on that pre-configured device. On the other hand, for a typical purchasing scenario, the user holding the reader device wants that the content is shown not only on his handheld device but also and simultaneously on a secondary display device. Such information is stored in and can be retrieved from this service by the TMC.
- Response Dispatcher will accept a number of actions described in an XML document. It orchestrates the actions one by one thereby initiating service requests to proprietary services, to 3rd party services or a mix of both. Such orchestration descriptions can e.g. inform the owner of the theater room via SMS when the movie has finished and finally add an ”end of movie” entry in an associated logging system.
- SMS/MMS Service is responsible for sending SMS/MMS messages.
- Media Vault Service is responsible for storing and streaming multimedia back to the client side.

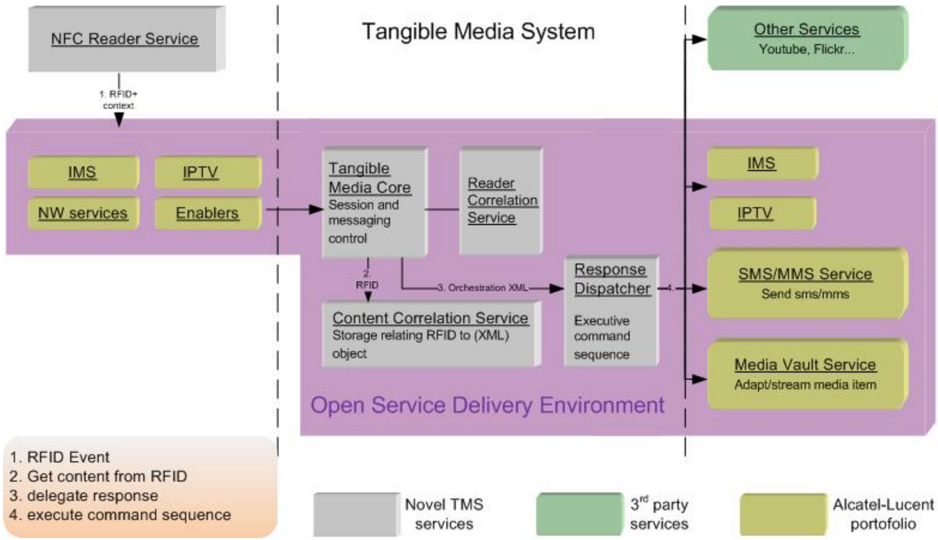

Figure 102.Tangible Media Gift Reference Architecture.

The TMS captures the input and feeds it to the Tangible Media Core that will ultimately output the desired result. The input side of the architecture collects and filters the RFID events from mobile phones, set top boxes or any other certified equipment and forwards it in a uniform format to the core of the TMS. The core resolves each RFID event into the address of the right server where the related content with optional contextual information can be retrieved. It then passes the retrieved information to a dispatcher that will take care of the content delivery by triggering the required subsystem(s) or external partner service(s) as needed.

Conclusion

In this chapter we discussed a pilot study for research into new tangible and ambient communication practices. The aim of the study was to understand how a transdisciplinary research cycle could be designed for the development of new tangible and ambient communication practices. We hereby tried to involve the users on the level of the coding and design process. We did this by keeping the coding of the prototype and the design open and discuss them with users before putting it into a final product. We discussed the experience, the usability but also the technological aspects of the application with them. We believe that the future challenge is situated probably in development of methods to do co-construction on this level to anticipate better on the complexity of emotional design.

Very general we learned from the Christmas gift case that the new means of communicating an emotional message to love ones was perceived as non-intrusive and innovative. It also involved a number of new network services. These new services can be seamlessly integrated with existing telecom infrastructures and platforms.

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5.4 NFC in urban setting

NFC-based services are finding their way to our everyday environment in public spaces. With NFC tags, easy, lightweight and cheap infrastructures can be constructed by service providers and communities. In SmartTouch, urban computing has been explored extensively in the City of Oulu, where trials have been specified, arranged and implemented in cooperation with the Oulu municipal authorities.

5.4.1 NFC-based services in theatre

Author: Outi Rouru-Kuivala, City of Oulu, Finland

Oulu City Theatre was the first cultural establishment in the world to pilot NFC technology in its services. The theatre pilot was carried out between November 8 2007 and December 19 2007. Applications were piloted during 9 performances; altogether, 158 persons took part in the study. The aim was to study how NFC technology can be used in the various service processes belonging to entertainment events. The pilot provided a whole service package covering the entire theatre evening for pre-selected user groups in two different plays. The groups consisted of the staff of different corporations, and of members of different communities.

Pilot participants received the theatre tickets wirelessly, either via TeliaSonera's backend system, or directly from the theatre's sales point to their NFC enabled mobile phones. The participants' billing information was stored in the backend system; billing took place after the event. On the day preceding the play, the pilot users were able to pre-order intermission services using an NFC enabled mobile phone, theatre applet, and a special NFC enabled menu card. The menu card also included a brief description of the NFC services available during the actual event. A play programme was included in the admission price, and could be purchased merely by touching the NFC tag. The users used NFC enabled phones to check the tickets. During the pilot, ticket control was implemented using a phone-to-phone function. In the theatre restaurant, NFC tags were embedded into the info stands, and by touching the stands, the pilot user obtained different content information, such as local news. A taxi poster in the theatre lobby made it possible to order a taxi by touching the poster, which was equipped with an NFC tag.

The theatre restaurant and lobby had smart posters enabling the download of i.e. videos and of the director's thoughts about the play. The videos were tailored for the small screens of mobile devices as part of the NeoArena project, controlled by the Cultural Unit of the Oulu University of Applied Sciences (OAMK). During the pilot, the videos were viewed by NFC enabled mobile phone a total of 345 times (the 'Niskavuori' video 130 times and 'Pudotuspeli' video 215 times). An NFC smart poster is presented in the Figure 103.

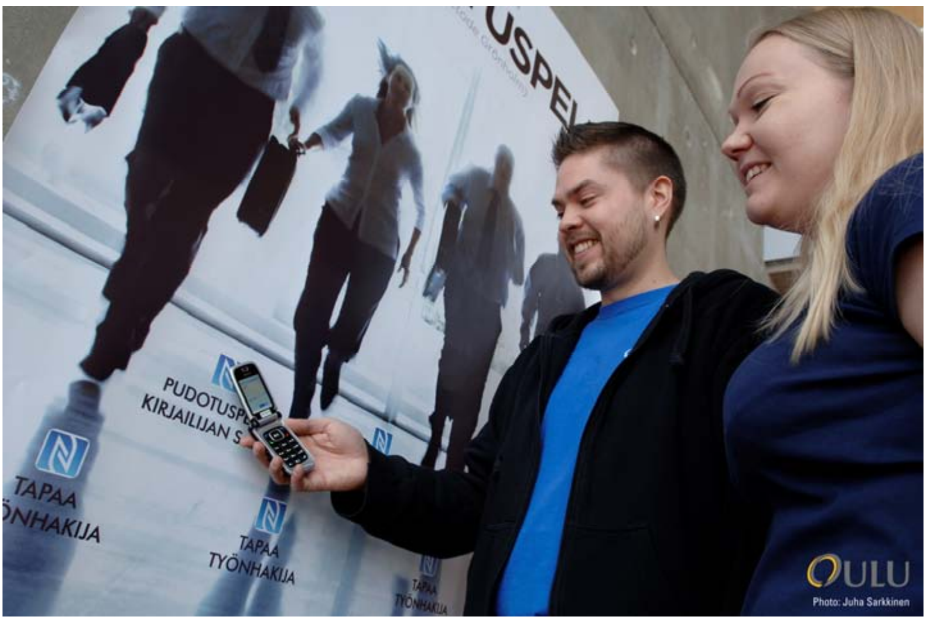

Figure 103. NFC smart poster in theatre.

The pilot was defined by Oulu City Theatre and by Kanresta, the theatre restaurant service provider. TeliaSonera was responsible for the technical solutions. A usability analysis and a business analysis were carried out by VTT

Technical Research Centre of Finland. VTT's analysis showed that pilot users found NFC based services to bring a pleasant added value to theatre services. A particularly positive feature was the possibility to carry out activities in advance; for instance, the ability to order intermission services, as well as to download and watch videos via mobile device. Ticket control using the phone-to-phone function was considered to be slower than regular ticket control – this could be corrected by installing a fixed NFC reader at the theatre hall entrance.
A two minute demonstration video was also made to showcase the pilot. The video was produced by Klaffi-tuotannot.

http://www.ouka.fi/video/smart/teatteri/index.html

5.4.2 Information tags

Author: Outi Rouru-Kuivala, City of Oulu, Oulu, Finland

During 2007–2008 NFC pilots, information tags in the Oulu city theatre, buses, and at certain bus stops (route 19) as well as in the Ravintola Pannu and Oluthuone Leskinen restaurants offered services belonging to Kaleva, Vaisala local weather service network, Oulu Theatre, Teliasonera, and the 'area Taxi.' The tags also offered KAMO, the 'metropolitan mobile guide' program whose 'value added services' are provided by VTT transport. Ravintola Pannu and Oluthuone Leskinen had tags from which a customer could receive extra information on the restaurant products. Also, buses on route 19 have had 'Aloite Oululle' tags from which a citizen's initiative can be started with a NFC phone.

English language tag stands were made for the theatre restaurant and displayed during the Nordic Innovation Seminar, which took place from 29 to 30 November 2007. The content of the tags included (for instance) local weather reports. TeliaSonera collected statistics about the use of the tags for their research. The content of the tags and their implementation was handled by the previous parties, as well as by TopTunniste.

Additionally a voting event based on NFC technology was implemented by TeliaSonera in association with the Nordic Innovation seminar (29.–30.11.2007). During the event, 200 participants voted for the best/most interesting seminar presentation by touching the NFC phone first to their own id card, then to the presentation of their choice in the voting poster.

Public ticketing pilot based on NFC technology was started on 28.2.2008. The pilot took place with 20 ‘piloters’ using bus route 19 in cooperation with Fara, Koskilinja and TeliaSonera. The pilot ended on 24.4.2008. VTT carried out usability research on the KAMO service, which is based on NFC technology.

The SmartTouch City of Oulu project enabled and supported the participation of local entrepreneurs Ravintola Pannu and Oluthuone Leskinen in implementing TeliaSoneria-hosted NFC pilots in a restaurant environment.

Also a two minute demonstration video was made to showcase previously piloted meal service for elderly citizens. The video was produced by Klaffi-tuotannot.

http://www.ouka.fi/video/smart/elderly/index.html

5.4.3 NFC Future Shop Concept

Author: Outi Rouru-Kuivala, City of Oulu, Oulu, Finland

A ‘Future Shop’ project based on NFC technology was implemented 4/2008 in cooperation with Oulu Innovation Oy, Tradeka, TeleSonera, VTT, the Lintulammi residents’ association, and Oulu Eldely Service. In the project, groceries are purchased at home by touching tagged shopping lists with NFC mobile phone. Households participating in the pilot have chosen 60–200 most frequently purchased food items to their tagged shopping binder. Delivery logistics are handled by the Lintulammi residents’ association. During the pilot, the customers of Oulu Eldely Service are offered also other domestic, NFC-based services such as call activation and SMS activation through tagged photographs. The pilot lasts 10 weeks. The pilot group has 30 households, of which 20 belong to customers of Oulu Eldely Service VTT will carry out usability research on the pilot. A demonstration video will be made to showcase the pilot.

5.4.4 NFC Elevator

Authors: Rosa Iglesias, Nuria Gómez de Segura, Cristina Cruces, Jorge Parra, IKERLAN, Spain

Goal

The main goal of an NFC Elevator is to provide easy floor access and multimedia content access while moving up/down in the elevator (Figure 104). An NFC-reader can be located near the elevator and by using an NFC-enabled device (i.e. mobile phone, bracelet) users can touch this NFC-reader and the elevator will go to their desired floor. In addition, a screen located in the elevator will show personalized multimedia content (i.e. news headlines, events, advertisements) according to user preferences (i.e. sports news, events, classical music, weather forecast) and user profile (i.e. visually impaired people).

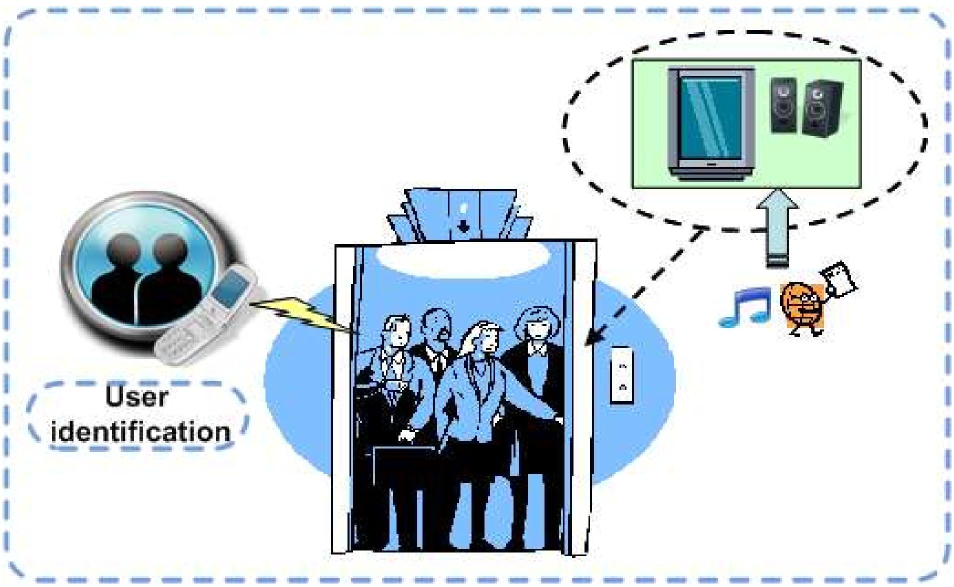

Figure 104. NFC elevator scenario.

Actors

Any person could use the NFC Elevator. The scenario has been designed in order to be “easy-to- use”. No special knowledge or familiarization is necessary from users’ point of view. Once the user identification is done by touching the NFC-reader near the elevator, the system automatically analyses to which floor the user wants to go and the user profile or preferences to show information according to. Once the user is identified by touching the NFC elevator tag, the elevator displays on a screen inside the elevator very personalised information (related to both content and formats) for presenting information. In case of more than one person in an elevator, general information is shown.

Description

The elements of the NFC elevator scenario are an NFC reader in the elevator, an elevator provided with speakers and a screen, an NFC-enabled device to be used by the passenger for identification and a backend system. The latter is made up of three components: a content provider, a user database and a graphical user database. The content provider will take information through RSS feeds over the Internet to be displayed on the elevator screen. On the other hand, the user database contains information about user preferences and profile and the graphical user database stores different graphical interfaces tailored for a specific user profile (i.e. visually impaired, business, childish), Figure 105.

The NFC elevator scenario is an UpnP-based application, it acts as a control point that discovers and controls UPnP devices. Therefore, the application searches for the required services (i.e. “identify a user”, “get content to be shown”) provided by the UpnP devices on a certain network because all the devices (service providers) may or may not be running on the same machine (i.e. a user database, elevator control system). For example, when a user touches the NFC reader, an UPnP virtual device is created that is used to get user identification. The elevator control and current information (i.e. actual floor, destination floor) is also abstracted by means of a UPnP device. For audio aids a TTS (TextToSpeech)-based UPnP device is used to give voice information to passengers; whereas another UPnP device is in charge of updating user interfaces displayed according to user profile. Displayed contents are continuously updated through RSS feeds.

NFC opens up real possibilities to develop new user-centred services that could change the relationship between manufacturers and passengers around elevators. This is a small step towards a new collection of services that can be offered in elevators. For example, knowing the user profile could help decide what emergency protocol should be used in case of an emergency situation, for instance for an elderly or handicapped person. Many examples can be drawn when it comes down to where the elevator is located. In a hotel, the NFC-enabled mobile phone can be used as the room key and the enabler for easily accessing to your room floor in the elevator. When having an appointment at a hospital or health centre, the elevator can take you to your destination floor where your doctor's room is on. In case of a building with security access to certain floors, the NFC elevator could allow or not a user to go to a specific floor.

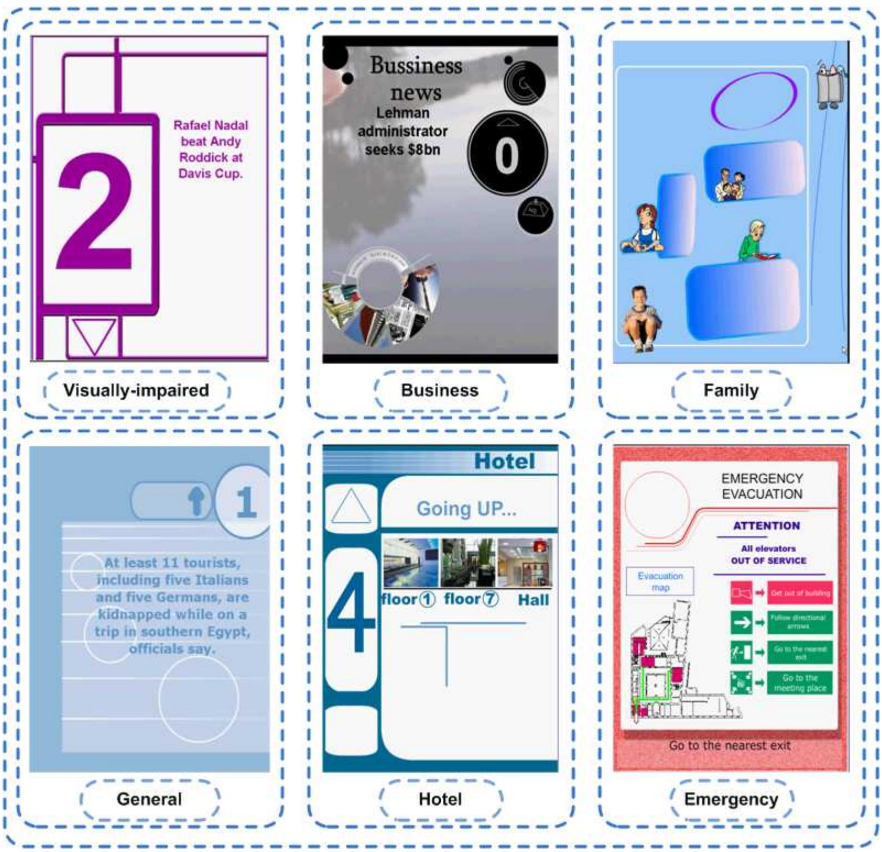

Figure 105. Different user interfaces according to user profile and preferences and an emergency evacuation if evacuation is ordered.

6. Perspectives to NFC ecosystem

Author: Arto Wallin, VTT Technical Research Centre of Finland

The concept of business ecosystem draws an analogue between biological ecosystems and business world. In both of these ecosystems entities (organizations vs. species) exists as a part of large network of interconnected participants who depend on each other for their mutual effectiveness. In addition, these concepts share some fundamental properties, such as competition, co-operation and the evolution of ecosystem. According to Moore (1993) members of a business ecosystem "work co-operatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations".

Member organizations of the business ecosystem tend to align themselves with the directions set by one or more central organizations. These leaders of the ecosystem may change over time, but the function of the community leader is valued by other members because it enables movement towards shared vision and finding mutually supportive roles.[9] Finding one natural community leader for the NFC business ecosystem has been difficult in many market areas, because there are several potential community leaders. For example, mobile network operators, public transport operators, and credit card associations and banks are all possible leaders of the ecosystem. Consequently, one of the main problems of NFC adoption has been that several stakeholders would like to be in control of the ecosystem, and thus, finding mutually supportive roles for all entities has been challenging.

The complexity of NFC business ecosystem is very high because there are several application areas where NFC can be used. Therefore, it may be easier to

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[9] Moore, J.F. (1996). The Death of Competition – Leadership & Strategy in the Age of Business Ecosystems. Harvard Business School Press.

view NFC business ecosystem as several separate niches around some special areas. These areas could be, for example, contactless mobile payment, public transport ticketing, information access or connectivity. Following sections introduce two business ecosystems (payment and public transport ticketing), which are extremely relevant when considering the general adoption of NFC technology. In addition, trusted service manager which is a new business model involved in these ecosystems is discussed more closely in section 6.3.

6.1 Contactless mobile payment

Author: Arto Wallin, VTT Technical Research Centre of Finland

Mobile Payment Forum[10] defines the concept of mobile payment as the *process of two parties exchanging financial value using a mobile device in return for goods or services*. Although there are several forms of mobile payments, at present one of the most promising ways to realize mobile payment is to use NFC technology. NFC-based mobile payment is often referred as contactless mobile payment or proximity mobile payment, since it operates on very short distance and it is compatible with contactless payment infrastructure in most market areas. Basic classification of mobile and contactless payment is illustrated in the Figure 106.

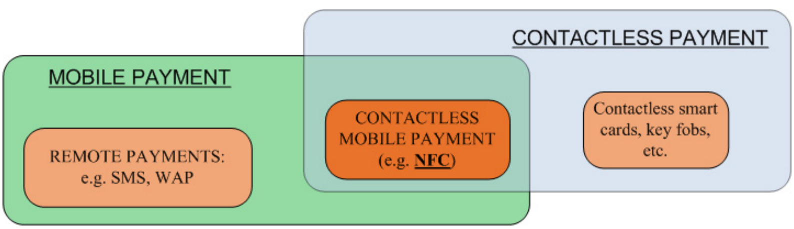

Figure 106. Categorisation of mobile and contactless payment.

There are also several other ways to classify mobile payments. Figure 107 illustrates the categorisation of mobile payments which is based on transaction

[10] Mobile Payment Forum (2002). Enabling Secure, Interoperable, and Userfriendly Mobile Payments. Mobile Payment Forum White Paper. http://www.mobilepaymentforum.org/documents/Mobile_Payment_Forum_White_ Paper_December_2002.pdf. December 2002.

value (and location). Although there are no generally defined limit for high and low value payments, most contactless and mobile payment service providers have specified exact limits for payment value which defines required security level for consumer authentication. For example, in the United States this limit of payment value varies from 20 to 30 dollars. Hence, when the transaction value is higher than the limit, customer has to enter PIN-code on a point of sales terminal. The reason for this is that the increase in payment value also increases possible losses caused by fraud or misuse. On the other hand, when value of payment is fewer than the limit, payment can usually be conducted without PIN-code authentication. In these cases consumer is only required to tap on a payment terminal to conduct a payment. Therefore, low value payments are also often referred as tap&go payments.

High and low value payments differ also from the viewpoint of common use scenarios and main competing payment methods which are depicted in Figure 107. In the field of high value payments, mobile payments face competition from well-established traditional payment instruments (debit and credit cards), which have firm foothold in the markets. Penetration to these markets requires huge efforts and it takes lot of time and financial resources. On the contrary, one of the main characteristics of low value payment markets is that cash is still preferred as a payment method by most consumers in these markets. For this reason, the most of the commercially released mobile payment systems have been focused on low value payments.

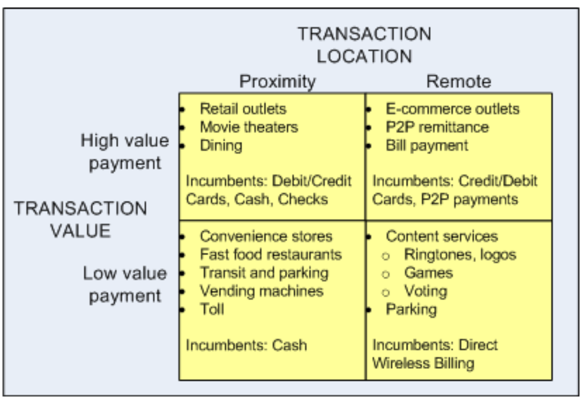

Figure 107. Classification of mobile payment based on transaction value and location.[11]

[11] Wallin. A. (2008). Adoption of contactless mobile payments. M.Sc. thesis. University of Oulu.

A mobile payment ecosystem consists of numerous stakeholders who have their own demands and expectations about the development of the mobile payments. Figure 108 illustrates different stakeholders that are involved in the ecosystem. Several stakeholders are similar as in the traditional card payment value network (e.g. banks, credit card associations and merchants). However, there are also a number of new stakeholders, such as mobile network operators and handset manufacturers, who are needed when mobile payment services are provided. Consequently, several new players are trying to break into the emerging mobile payment markets, while several other traditional payment industry players are trying to keep their prevailing market positions. As a result of stakeholder's conflicting demands and lack of coordination between them, the diffusion of mobile payments has been quite slow in most market areas. Hence, finding a sound business model for all key stakeholders has turned out to be one of the biggest issues delaying the adoption of mobile payments.

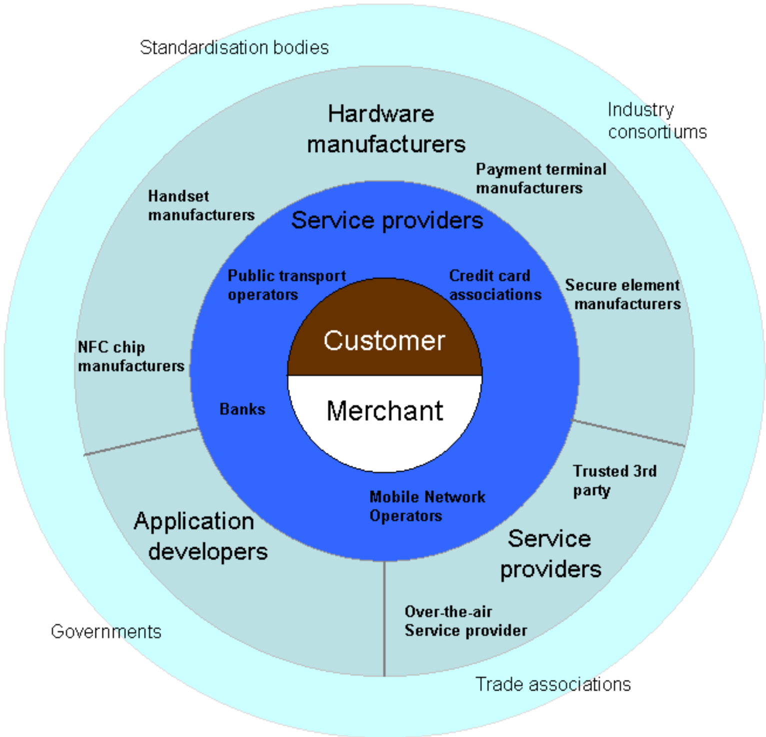

Figure 108. Stakeholders in the mobile payment ecosystem.

In addition to customers and merchants, financial institutions and mobile network operators are probably most important stakeholders in the adoption process of mobile payments, since they have great potential to speed up the diffusion of NFC mobile payments. On the other hand, they also have potential to cause delays and complicate the diffusion process. International players in these industries are able to push technology forward, but it will only happen if they can see healthy revenue streams from the business around the mobile payments. Therefore, the critical success factors of these players have to be considered carefully when the diffusion of contactless mobile payments is discussed.

Hardware manufacturers constitute another group that has influence on the diffusion of NFC mobile payments. This group includes several actors such as NFC terminal, NFC chipset and secure element manufacturers, but the influence power is mainly in the hands of large international device manufacturers who control the technology and capabilities of end-devices.[12] There are also several other actors who have some kind of impact on the value network. This group consists, for example, payment software developers, over the air service providers and system integrators.

In addition to separate business actors, several consortiums have impact on the development of NFC mobile payments. Industry consortiums and trade associations such as NFC forum, GSM association, and Mobey Forum are either directly contributing on the development of the technology or shaping industry and consumer beliefs by promoting the technology. Lastly, governments are indirectly involved in the development of mobile payment technologies. They set standards and regulations for the other players involved in mobile payments and ensure that there is possibility for the competition in the markets. Governments are also able to regulate the technological compatibility of payment technologies.[13]

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[12] Karnouskos, S. (2004). Mobile Payment: A Journey through Existing Procedures and Standardization Initiatives. IEEE Communications Surveys 6(4).

[13] Choi, Y., Crowgey, R. Price, J., VanPelt J. (2006). The state of the art of mobile payment architecture and emerging issues. International Journal of Electronic Finance 1(1), pp. 94–103.

6.2 Public Transportation

Author: Tua Huomo, VTT Technical Research Centre of Finland

6.2.1 Introduction

Several market studies estimate that the global market for Near Field Communication (NFC) solutions will experience significant growth in the next few years. Transportation ticketing solutions are expected to be the fastest growing NFC vertical over the next 5 years as the contactless infrastructure already in use in many places is compatible with NFC technology.

It is evident from many sources that the ability of individual company to create economic value from NFC technology is to a large extent dependent on its relationships. NFC business network in the public transport industry comprises several companies, each of which have different drivers and restraints related to the migration and upgrade of NFC technology. In addition, the interdependencies between the companies and changes in their relationships further complicate the markets. In other words, NFC ecosystem within public transport industry is a complex environment where the success, acceptance and form of NFC solutions depend upon the collaboration of many stakeholders. The most important are

- Public Transport Operators (PTO) and authorities
- Mobile Network Operators (MNO)
- Banks / Credit Card Issuers / Payment Providers
- Mobile Handset Manufacturers
- Smart card technology providers and manufacturers
- HW providers
- SW providers
- System integrators
- Trusted Service Managers (TSM).

This document summarises the results of the research, which purpose was to analyse and evaluate what factors influence the decision making of organisations in the public transport industry when they consider the potential upgrade of their systems and services to NFC. The main study was Oxford Brookes University (http://www.brookes.ac.uk) Master of Business Administration (MBA) graduation work sponsored by VTT (http://www.vtt.fi). The client organisation for the study was NXP Semiconductor (http://www.nxp.com).

6.2.2 Research Methods

Primary and secondary data related to NFC restraints and drivers as well as to the NFC ecosystem were collected by a purposive expert survey and a literature survey. The survey was conducted in July–August 2008. The questionnaire was sent to 150 experts, representing organisations within the public transport industry globally. The answering rate of different questions varied between 56 % and 80 %. The Figure 109 below illustrates the distribution of different organisations.

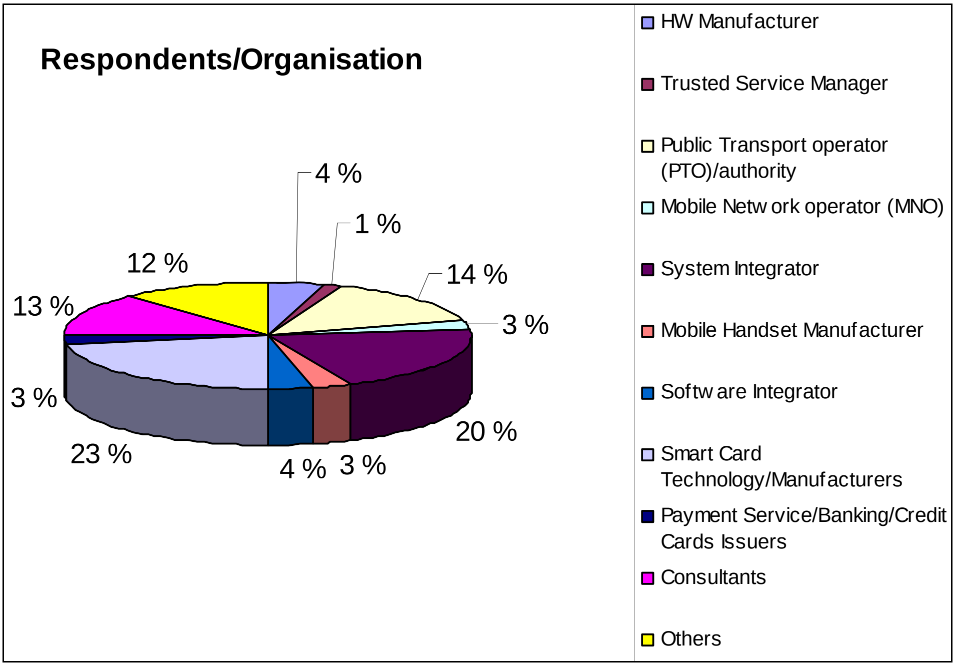

Figure 109. Expert Survey Respondents.

Data collected from different sources was cleaned, organised and summarised to provide a basis for the data analysis. Key NFC restraints and drivers from the questionnaires were categorised based on the roles of the organisations. Each of them was rated by the respondents according to significance. Those factors which were seen as significant or fairly significant by at least 75 % of respondents in each organisation group or by all the respondents were given priority consideration. The results were complemented and validated against the information gathered from various secondary sources such as market studies, white/position papers, publications and presentations.

This study has been conducted following the basic ethical principles of business research. All the participants involved in this research have been informed of the nature and scope of the study. The results of the questionnaire have been treated with absolute confidence. During the data analysis, individual confidentiality was preserved, while personal information has not and will not be used for other purposes. Equally responses have been combined with those of other respondents so that individuals or organisations can not be identified.

6.2.3 Public Transport Business Models in NFC Ecosystem

A business model can be defined as a framework for creating value. It describes the structure of a product or service and information/money flows and the roles of the participating organisations. A public transport ticketing value chain is described at a high level in the Figure 112. It illustrates the roles of different organisations in the contactless smart card and NFC ecosystem excluding the traditional contact or paper tickets or cash-based systems. The figure incorporates many business models i.e. variations on how public transport ticketing products and services are expected to be delivered to the end-users in the NFC ecosystem, which is expected to operate in parallel with contactless smart card based systems. In the figure, the term “Mifare” refers to NXP’s (http://www.nxp.com) Mifare technology family. The family includes four products categories: UltraLight, Classic, Desfire and Plus. Mifare Classic, which represents about 80 % of all contactless public transport ticketing systems, can be supported by NFC. The most common approaches for NFC-ticketing are summarised and analysed below.

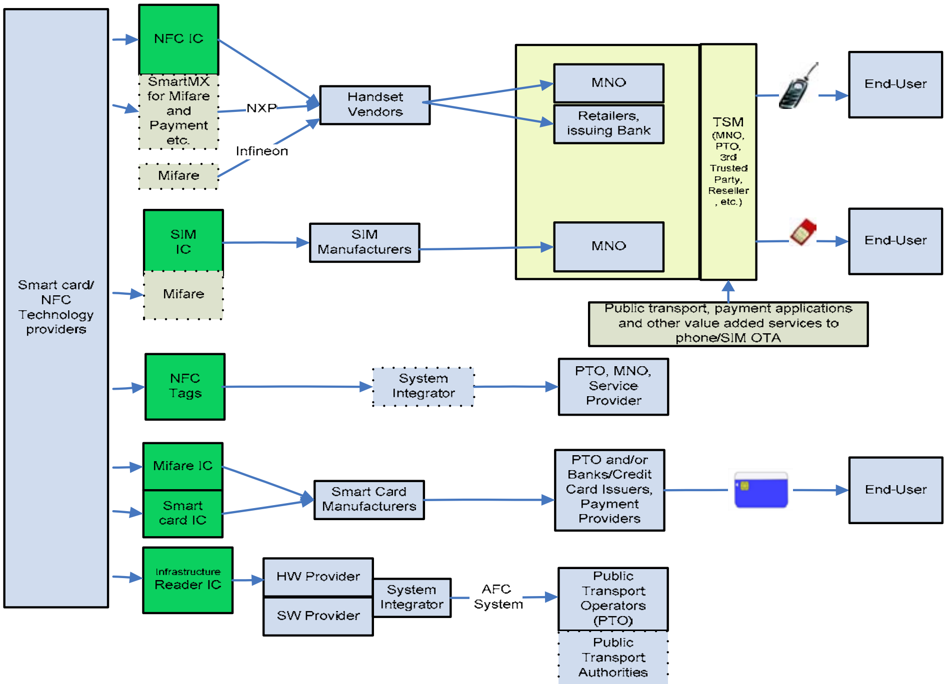

Figure 110. Public Transport Value Network.

6.2.3.1 Prepaid-Value Model

The prepaid-value model or stored-value model is currently the most common form of automatic fare collection (AFC) approach. In this model PTO issues a ticket based on the stored value payment model (e.g. amount of eCash, a fixed number of rides, time-based period pass). In the NFC ecosystem the fare ticket is stored securely on an NFC-enabled mobile phone acting as a smart card to an infrastructure reader on e.g. a gate at a metro station. This requires the end-user to have a NFC-enabled phone i.e. a phone which includes NFC IC[14]. AFC system can be based on generic smart card technology like ISO14443A or NXP's Mifare technology. If the AFC system is based on the Mifare technology, the Mifare technology in the NFC ecosystem supporting secure element must be

[14] Integrated Circuit, Electronic component(s) designed to perform processing and/or memory functions.

embedded to the phone during the handset manufacturing process or incorporated (based on licensing agreements) to the (U)SIM[15] card in the (U)SIM manufacturing process.

The SmartMX, embedded secure element for Mifare, is NXP's product. SmartMX is integrated to mobile handsets with NFC IC based on the customer's e.g. handset manufacturer's or MNO's requirements. Mifare functionality can also be provided by Infineon (http://www.infineon.com) as NXP has licensed the technology to them. However, currently Infineon's embedded Mifare does not have an over-the-air (OTA) capability. A TSM takes care of the lifecycle management of the applications and also helps in the initial issuing and enrolment process. If Mifare is embedded on the phone or to the (U)SIM card, the Mifare-based application can be issued over the air by TSM acting on behalf of the application owner i.e. PTO. The TSM's role can be taken by different organisations depending on the business case. For the end-user both embedded and (U)SIM solutions look the same. A phone acts as a smart card and value can be loaded at point-of-sales (POS) or OTA.

Enhanced Payment Card

In the enhanced payment business model, contactless credit/debit smart card or a payment application on NFC phone can be used directly to pay travel fares. The payment application can be supported either by the embedded secure element or (U)SIM-based product architectures. The payment application can be issued over the air by TSM acting on behalf of the application owner e.g. a bank. As earlier, the TSM role can be taken by different organisations depending on the business case. The end-user shows the payment card or NFC phone to a mass transit system infrastructure reader and a correct fare is calculated as the payment transaction is processed based on local fare rules defined by the PTO. This model is also called the payment-provider centric model where banks and/or credit/payment card issuers deploy the application to the end-user and ensure that the PTO's system has corresponding acceptance capability.

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[15] Subscriber Identity Module (SIM). A SIM is the smart card that is included in GSM (Global System for Mobile Communications) mobile phones. USIM is equivalent of a SIM card, but for WCDMA/UMTS (3G) phones.

6.2.3.2 Post-Paid Model

In the post-paid model, the user's travel medium is an NFC-enabled phone or a smart card, travel fares are paid afterwards based on recorded usage. In this model, the user identification application can be based on use of Mifare technology or generic smart card technology. In the post-paid model, the user identification information is combined with an actual user location i.e. reader and travel information (user id, smart card or NFC phone) through PTO's own infrastructure to the AFC system. Alternatively, the user location and identification data can be provided over a telecom network to the AFC system. In the latter case, the NFC-tag provides the location data and the NFC phone acts as the medium for user identification. In pilot projects this approach has been applied in parallel with the basic post-paid system**.**

6.2.3.3 Combined/Enhanced Collaborative models

In the collaborative model, a smart card may incorporate several applications such as transit and payment. In the NFC ecosystem the end-user has either a combined smart card or NFC-enabled phone, housing multiple applications. The transit application can be prepaid or post-paid as described above. The payment application is used by the phone as described in the enhanced payment card section above. In the combined model, the transit application is used to pay transits and payment cards are used for other purchases. In the enhanced combined model, the end-user can select the payment method for transit services to be expedited through direct payment or through PTO pre- or post paid schema.

In all of the above business models NFC-tags can be used to activate different value added services.

6.2.3.4 Embedded Secure Element / (U)SIM

In each of the business models above the transit application in the NFC ecosystem may be located in the embedded secure element or (U)SIM. The overall business model is defined through the TSM role in both of these cases as illustrated in the Figure 111.

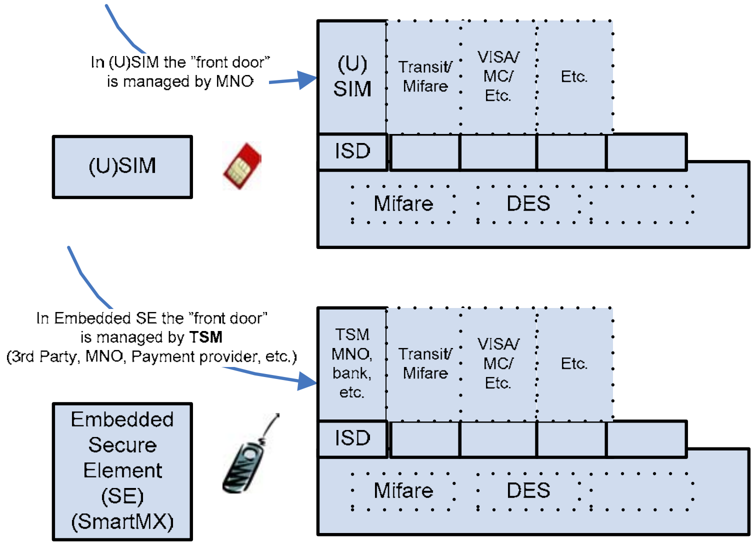

Figure 111. Role of TSM in (U)SIM and Embedded Secure Element.

In (U)SIM centric models, the MNO has the power to control the business rules as it controls the TSM role at the (U)SIM. The MNO may delegate the TSM role of a transit application to a 3rd party in order to scale for local diversity (in every country there are multiple PTO's and the MNO may not wish to make separate agreements with all of them). The (U)SIM based model allows the MNO to create business models based on OTA activity, for example charge a PTO based on the use of the transit application. According to many sources financial institutions are cautious about giving control over payment applications to other parties and hence put their applications on the (U)SIM. This indicates that the role of the embedded secure element might be a more natural choice for many payment applications.

The embedded secure element can be managed (TSM role) by an independent trusted party or one of the major partners such as MNO, bank or handset manufacturer. In any one of these cases the TSM is in the central position for creating the business rules. Currently, the ownership of the TMS role in the embedded secure element is not established and for any PTO it leads to confusion and creates one of the main restraints for NFC technology adoption. Eventually, the final decision on who will manage the NFC payment applications for public transport systems is made by PTO's. According to UITP

(2007) "fare systems may become managed by owners of the ticketing application rather than issuers of the electronic media".

6.2.4 NFC Restraints and Drivers in Public Transport Industry

6.2.4.1 Introduction

This chapter highlights findings extracted from a purposive expert survey. The results were complemented and validated against the information gathered from various secondary sources such as market studies, white/position papers, publications and presentations. Analysis reveals that the most important NFC restraints and drivers are related to the business, technology and end-user aspects. These are summarised in the following sections, in which the text in ***bold and italic*** refers to NFC restraints and drivers used in the expert web-survey.

6.2.4.2 NFC Restraints

1. **Unclear Business and Co-operation Models**
2. **Lack of Understanding Benefits/Costs**
3. **Lack of NFC Devices**

As is evident from the previous chapter, ***unclear business and co-operation models*** are the main brakes for NFC penetration as shown in appendix 5 and supported by a number of other sources. 82 % of all respondents (N = 103) of the survey indicate that the current unclear situation is significant or represents a fairly significant restraint for NFC. In other words, the real issues surrounding the commercial deployment of NFC in ticketing are value chain related. The roles of stakeholders, the lack of satisfactory pricing models and questions of how to share revenues between different stakeholders are the main concrete issues. The current situation in which a ***number of players with diverging interests*** are in different postures concerning their involvement in NFC ecosystem is seen as especially difficult by PTOs who should make long-term decisions about how and with whom to develop their core systems.

69 % of the respondents also indicated that ***lack of understanding of the benefits/costs*** of NFC in the public transport industry is the key restraint for NFC adoption. Numbers of NFC pilots in all regions have been done or are running. However, there is very little, if any, proper business and financial research available on how the different stakeholders benefit from NFC and what

are the real costs and return of investment (ROI). Also as stated by the respondents “neutral analysis reports are missing entirely, all of them are twisted towards a group of players” or “happily written advertising articles are not useful; we are interested in concrete examples how and what did you do to make it work”. In other words, it needs to be justified *why* NFC would be better than the current smart card-based systems or e.g. cheap paper based tickets. If the benefits can not be made concrete it will be difficult to defend complex business models or new costs caused by the NFC ecosystem such as transaction charges, OTA and application management. From this perspective it can be argued, that besides the testing of technical functionality and use-case concepts, the NFC pilots in the future should concentrate on business models, money flows, concrete benefits and real costs. This would also create the basis for ***robust business cases*** *and* ***mass market feasibility***, which are needed to encourage different stakeholders to make investment decisions. According to the primary data the real business examples and descriptions of best practices, were seen as especially important by financial institutions and system integrators.

The lack of NFC devices is slowing down NFC adoption. 69 % of all respondents argued that the key constraint for mobile ticketing is the availability of capable handsets. Mobile ticketing solutions are dependent on suitable handsets before widespread adoption can take place. Over the past few years there have been many over-optimistic projections for the number of mobile handsets that would support NFC. Slow progress is not only as a result of the technical development, but also because of handset vendors and their major customers may have been reluctant to commit to large manufacturing volumes before viable models of extracting value from the NFC have been defined. Today, it is estimated that by the year 2012 30–40 % of all handsets will be NFC-enabled, which would mean that handset technology will not be a barrier for the widespread adoption of NFC.

Besides all of the above mentioned restraints almost 50 % of all respondents, especially PTO’s (86 %, N = 8), had concerns related to the ***incompatibility between different systems***. The contactless ticketing infrastructure deploys the ISO 14443A/B standard and thus majority of AFC readers will handle NFC phone as if it would be a smart card. However, there are many open questions related to the AFC software, system design and implementation. These are related, for example, to Mifare for mobile solutions, USIM/SIM technology, NFC’s impact on reader technology and existing readers as well as the future of Mifare DesFire in the NFC ecosystem. Some of these issues are related to the open product roadmap decisions of smart card technology providers. However, it can be argued that some of these concerns include elements of inadequate communication by the technology suppliers.

The majority of PTO's and MNO's respondents saw also the ***lack or volatility of standards*** as an important NFC restraint. These concerns are specifically related to security certification for payment instruments, OTA management methods and the application development environment for (U)SIM.

6.2.4.3 NFC Drivers

1. **Minimise cash handling**
2. **Provide more information to customers (e.g. journey, value left)**
3. **Increase in customer convenience and experience**
4. **Compatibility with the existing systems**
5. **Compatibility with the banking systems**

87 % of all respondents (N = 95) of the expert survey indicated that ***minimising cash handling costs*** is the main NFC driver in the public transport industry. PTO's in general are interested in reducing cash in their AFC systems. Cash handling is expensive, labour intensive and payment with cash can be slow. It is argued that in the NFC ecosystem, customers would consequently reduce their use of cash and also smart cards. Hence, besides reducing cash handling costs NFC would also potentially reduce the need for smart cards. NFC OTA functionality has also argued to case for reducing costs from ticket sales and distribution through greater operational efficiency and increased automation. 78 % of respondents indicated that ***cost reductions in ticket sales and/or distribution*** are significant drivers brought by NFC with OTA functionality. Increased automation is closely linked to the other driver, ***increased customer self-service***, which was seen as an important positive factor for NFC by 78 % of all respondents. The NFC drivers above are all related to the main NFC restraints, specifically to unclear business models and a lack of understanding benefits/cost. Although there are some estimations available how contactless smart cards reduce PTO's operational costs, the exact estimations of concrete financial benefits of NFC are not based on concrete sample calculations.

According to UITP (2007) an ***increase in customer convenience and experience*** is the main goal for the public transport development projects. 84 % of all respondents supported this view. Customer convenience and experience includes components such as coherent and easy-to-use services with simple interchanges, the possibility to choose the favourite media (smart card or phone) and payment method as well as reduced time for checkout (***speed customer through gate***) and transactions. The end-user's experience is also improved by providing more information related to the ticket value and travel transactions as well as providing real-time information and value added services such as maps and schedules. To ***provide more information to customers*** was also seen as an important NFC driver by 85 % of all respondents.

NFC systems' ***compatibility with the existing and payment systems*** (bank, credit cards) were seen as important NFC drivers by 80 % of all respondents (N = 95). It is evident that interoperability, backwards compatibility and hence standardisation are essential prerequisites for the NFC ecosystem. Contactless payments are currently supported by all main credit card issuers and payment service providers. The payment systems are based on the same ISO 14443 standard as the contactless ticketing infrastructure. As is evident from the business model analysis shown earlier, the momentum towards payment system acceptance in transport ticketing creates the potential for enhanced and combined business models. The analysis of primary data also indicates that some public transport operators are interested in developing fully compliancy between travel and payment systems.

6.2.5 Conclusions

It is argued that usage and adoption of NFC technology will be widespread and the public transport industry will be in the front line in its adoption. This study has focused on NFC evolution within the public transport value chain. The purpose was to analyse and evaluate what factors influence the decision making of organisations when they consider the potential upgrade of their systems or services to NFC. As was evident from this study, one of the main factors that influence the public transport value chain is the existence of different NFC-based business models and the various opportunities or threats these present to organisations. NFC restraints and drivers, discussed in the previous chapter, influence the decision making within different organisations. Based on the analysis of the primary and secondary data, it can be argued that generally, there is a common understanding in the value network of what the factors are.

According to this study the main NFC restraints within the public transport value chain are unclear business and co-operation models and a lack of understanding of the benefits and costs. The analysis of secondary data also indicates that there is very little, if any, proper business and financial research available on how the different stakeholders benefit from NFC and what the real costs and return of investments (ROI) are. Thus, it can be argued that either the information related to the business models and benefits/costs has not been systematically collected or shared after the different NFC pilots. Either way, it is evident that there is a clear need within the public transport value chain for this specific information on different business models and their related benefits and costs. Consequently, it can be recommended that the public transport related trial data should be re-evaluated against the identified business models with a benefits and costs analysis, if feasible. Moreover, in preparation of future trials, there should be a specific emphasis on planning how this information is collected and analysed to provide the necessary material for decision making. Furthermore, the lack of NFC-enabled devices was seen as one of the main restraints for the NFC ecosystem. Based on the secondary data analysis it can be assumed that this will change over the next few years through technology diffusion.

The main NFC drivers were related to the increased operational efficiency of PTO's. It has been argued that NFC would, for example, decrease cash handling costs and the need for POS through greater operational efficiency and increased automation. However, there is a lack of public research information available about the exact level of savings and other operational benefits especially related to the different business models. In other words, as discussed earlier these drivers should be investigated and made more explicit when public transport related trials or cases are evaluated.

Increased end-user convenience and experience is one of the main NFC arguments in general. These drivers are also seen as strong NFC drivers within the public transport value chain. Some end-user surveys have been conducted as a part of the public transport pilot projects and those surveys indicate positive end-user response. However, there is no comparative research result available related to the end-user experience in the context of the different business models. In general, it can be argued that this discussion goes back to the business model analysis and which organisations take a key role in different public transport solutions. Hence, as pointed out earlier, the end-user perspective should be part of the business model analysis and any future trials.

Compatibility with the existing infrastructure and banking systems was seen as an important NFC driver. As discussed earlier in the public transport systems the contactless infrastructure as such enables interoperability between the existing

AFC systems and NFC-enabled devices. However, there are many open questions related to NFC compatibility and AFC system design and implementation.

To conclude, NFC will create more options for PTOs and their value and requirements should be the starting point for any product and service development actions. Furthermore, it is evident that there is no single exemplar of all aspects of a NFC adoption. Rather, there are plenty of examples from which to learn, and we believe that the results of this study can be used as a one aspect to provoke discussion, to learn and thus, to support NFC adoption within the public transport industry.

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6.3 Trusted Service Manager

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The beauty of NFC lies in the ability to offer consumers many new services on their number-one preferred personal device – their mobile phone. Whether it is mobile payment, transport fare ticketing, loyalty or something completely new like poster-delivered electronic coupons, consumers will want to get these applications in the same convenient way they get everything else on their mobile phone.

The primary role of the Trusted Service Manager (TSM) is in managing Over-The-Air (OTA) the lifecycle of NFC applications. Consumers will start the process with the service provider – their bank or transport company, for example. They will apply for the new mobile service, like a new bankcard or a monthly metro pass, at a branch, by phone or online based on business policies established by the provider. Once approved, the bank or other provider will use the service of the TSM to install the application remotely onto the consumer's mobile phone without any intervention by the user.

Behind the scenes, the TSM provides a comprehensive suite of technical OTA services to make this possible. It provides a single point of contact for service providers to access their customer base through mobile networks. These services are considered to be lifecycle management and include

- managing the secure remote download of personalized mobile NFC applications
- managing changes to services over the lifetime of the customer relationship (termination, new handsets, etc.)
- providing account security and recovery for lost or stolen handsets
- ensuring security, so mobile operators do not know anything about the service providers' applications, individual accounts or transaction, or managing keys
- ensuring the support of multiple MNOs – a critical requirement of service providers.

In addition, each application will have critical application-specific OTA requirements the TSM must perform. One example for mobile contactless payment based on EMV banking standards is OTA counter management.

Another example is OTA ticket reloading for transport operators, which has its own unique security and application requirements.

6.3.1 A Concrete Example: Banking Personalization on Mobile Phones

In the bankcard industry, personalization refers to all of the activities involved in preparing a bankcard for a specific customer. It includes putting electronic information in the banking card microprocessor chip such as the customer name, account number, expiration date and secret codes as required for authentication. It also includes graphical personalization, such as printing card artwork or customized pictures and embossing the card number.

Classic banking personalization centers on securely producing large quantities of physical cards, then personalizing them for an individual by matching their account information with the correct card stock, and then shipping it to them by post. Most of this work is done in facilities with high levels of physical and digital security, called personalization bureaus that must be certified by Visa, Master Card, American Express and JCB.

Personalizing mobile phones for use as a payment device presents a whole new set of challenges. How do you put payment account information and other banking personalization over the air (OTA) and into the handset

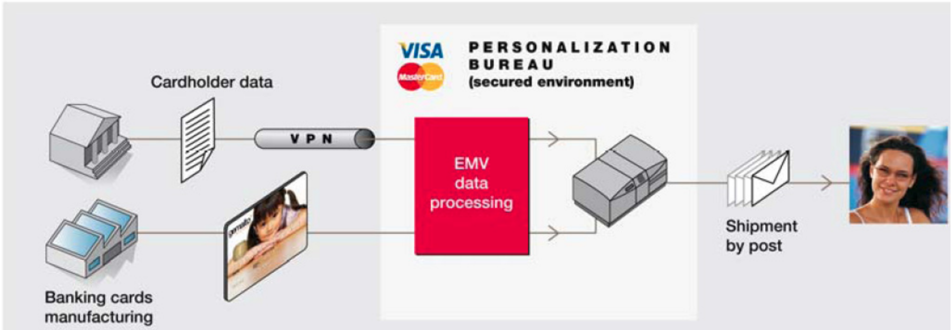
- without compromising the security?
- with any mobile operator’s phones?
- with a minimal impact on existing bankcard issuing processes?

Fortunately, the answer to these questions can be very straightforward with the right TSM connecting the two worlds of banking and mobile phones, as illustrated below.

The chart shows how the TSM architecture changes the process of preparing payment accounts and getting them into the correct handset:

- The EMV data preparation is the existing banking personalization done in the banking personalization bureau.
- Instead of a physical plastic card, the account information is securely placed into an NFC handset using an OTA network, an existing infrastructure providing remote administration of the end-user mobile environment for network operators; the TSM will modify the OTA platform to support NFC applications.

Today – Banking card personalization



NFC – OTA personalization of a SIM card

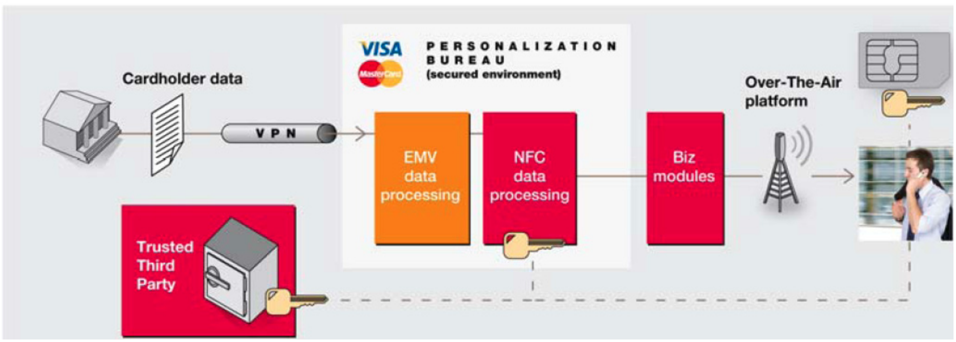


Figure 112. Process of preparing payment accounts today, and with NFC involving TSM.

Between those existing building blocks, the TSM must ensure three functions:

- Trusted Third Party: digital security of the payment system and its individual accounts is based on a secret master key and cryptography; a trusted third party must manage this key, which is unknown by operators and banks; this guarantees that the mobile operator cannot know the banks' secrets. (Requirement 1 – no compromise on security.)
- NFC data processing: extension of the classic banking personalization to generate secured commands that are encrypted with the trusted third party key. (Requirement 2 – minimal impact on existing system.)
- Contactless business module: managing the lifecycle of the application and interfacing with the mobile operators' OTA infrastructure. (Requirement 3 – support for multiple operators.)

This is just one example; there are many other activities ensured by the TSM. What they all have in common are the need for digital security, for working with multiple banks and operators and the capability to interface with the OTA platform.

6.3.2 OTA management platform

OTA management platform is used to manage the smart card environment. It takes care of Smart card application (applet) lifecycle management, security domain management and applet update. Applet lifecycle management means that applets can be loaded, installed, modified and deleted Over the Air. Applet lifecycle management is Global Platform compliant. Security domain is an isolated area on a secure element like UICC. It enables creating a secured area for third party smart card applications that require high security like credit card application. OTA platform takes also care of security domain lifecycle management. Applet update means communicating with a certain applet OTA instead of a traditional reading device. In addition to requirements listed previously the OTA platform must keep track about end users, secure elements, security domains and installed applets. OTA platform duties can be hosted in several locations.

OTA platform has high security requirements. This applies to all data transfer between OTA platform and mobile device's secure element including confidentiality, data integrity and authentication (both ends).

The management platform is needed only when the NFC device (mobile phone) is used in Card Emulation mode – for the management of applications on smart card.

6.4 "eCity" public transport case as an example

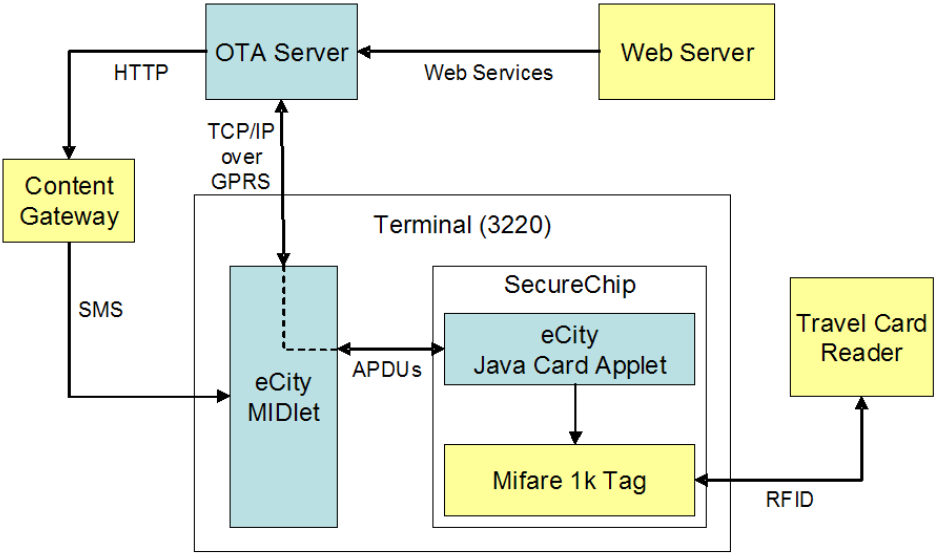


Figure 113. eCity architecture.

From backend point of view there are two servers namely OTA server and Web Server. OTA server is used for secure element management, applet management (installation and removal) and applet data management (downloading more money into travel card).

OTA server send APDUs over GPRS over TCP/IP connection to eCity MIDlet. The MIDlet conveys APDU to eCity Applet. Web Server communicates with the city of Tampere back end system and it provides a User Interface for downloading more money into travel card.

7. Getting in Touch with the Users

7.1 Co-Design and the city

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7.1.1 Introduction

In this chapter we want to bring forward the possible impact of context in co-design methodology.

The aim of co-design in SmartTouch is to involve the user in developing applications based on NFC/RFID technology. It is recognised that incorporating users into the design process will result in more valuable use cases, which will be more useful/likeable/practicable for the users.

Involving the users in design is becoming more and more important. This is mainly due to two main reasons. First, people experience problems related to the existing or missing interactions and/or problems related to the compatibilities between products. Second, the products are often not the users' interest but only the producer's interest [1]. Both aspects clearly come forward within the SmartTouch project, i.e. in what way should NFC be used in regard to other, to some extend similar, technologies like semacodes? Secondly, NFC and RFID are, from a technological point of view, very interesting mobile technologies to work with and to create applications for. However, the question what a user really wants to do with the technology is too often put aside. As a result, a potential domain of applications might be overlooked or missed out.

Co-design is often referred to as participatory design. Participatory design is seen as a method where the users are becoming a core part of a design team [2]. It is a method where “users get to play an active role in giving insight to support the design of new products” [3]. This has bridged the gap between users and designers [4]. It is advisable to involve these users at the earliest stage of designing [2]. Participatory design is a multidisciplinary approach. Engineers, designers and sociologists participate in the process [5]. It goes beyond explicit forms of knowledge, like for example written, defined, categorised, systematised or quantified things, but is also about tacit knowledge. By this we mean knowledge that people have but that they cannot put into words [6].

Co-design is already used in many studies. For example, [7] performed a co-design study to facilitate communication between generations of family members who are not living together. The EnComPAs (Enabling Community Communications – Platforms and Applications) project is another example [5], which aimed to investigate how communities interact with others and how this can be facilitated by technology. In most of these studies, co-design is linked to a home context with the aim to design products directly related to the participant’s personal space. With regard to a mobile context, the user interaction goes beyond the personal space into a public environment like, in our case, a city. By using co-design as a method, we want to get a better view on how the city is experienced and how existing co-design methods have to be altered and/or reinterpreted in order to be used outside the private user space. The methodology we describe is roughly based on the method used in the EnComPAs project [5].

7.1.2 The city

Before starting the co-design process within the SmartTouch project it was decided to do a contextual study in the city of Antwerp. Based on the investigation, the aim was to discover which physical places are important to which people in the city. Because a city context is very different than a home context, we needed to gain insight into some city mechanics and important aspects regarding the city. The performed research was based on some important city concepts like ambivalence [8], places and non-places [9] and symbolic nodalities [10]. This contextual investigation set out a general ‘framework’ for adapting existing co-design and participatory design methods to the context of the city.

7.1.2.1 The city, contextual study method

We conducted the research in three phases using different ethnographic research methodologies.

Qualitative content analysis

We analyzed several websites in order to discover how the city presented itself towards different groups like tourists, citizens and youngsters. We also studied some groups at the flickr website. These were mainly local people, discussing their pictures of Antwerp, their interests and experiences.

Ethnographic research into city nodalities

Based on the results of the qualitative content analysis, observations were done at places suggested by the website. The aim was to discover why and which people are coming there. Do they want to relax, meet people, sport, etc. With the tourist-bus was discovered which places this city service found important enough to visit.

Expert interviews

For the expert interviews people from the city services, some local people and some commuters were selected. Every group 'uses' a city in a different way and thus have a total different city experience. The aim was to discover which places, or city nodalities, are important to each group and why.

7.1.2.2 The city, contextual study results

No big differences or parallels were found between the three different groups of people (city services, locals and commuters). Participants mentioned different places, which were important to them. Those places have a special meaning because of a certain memory, which is mostly very personal. However, there were some similarities. All the participants liked the waterside, in this case the river "Schelde", and its unique relationship with the city centre of Antwerp. Furthermore, the participants agreed on the fact that it's not a physical place that determines the atmosphere or the mood in a city, but the things they experienced or that happened there at a given time. They defined Antwerp as a crossroad of cultures and enjoyed living and working in such a divers city.

The results show that a city is experienced on a very personal level and it's hard to draw defined conclusions. In the further co-design process we therefore chose to work in multiple groups of people that are connected through a shared interest or belong to the same 'social group'.

7.1.3 Co-design methodology

Following the aim of our research, we included two kinds of research questions: concerning use cases on the one hand and the used co-design methodology on the other hand.

Use case research questions:

1. How do people want to use NFC/RFID technology?
2. How do people experience NFC/RFID technology?
3. How do people want to communicate in the city?
4. About what do people want to communicate in the city?

Co-design method research questions:

5. Is co-design usable in a city context?
6. Does co-design work for different kinds/groups of people? E.g. people who have different relationships with the city: professional, inhabitant, social workers, artists, etc.

7.1.3.1 Participant selection

Based on the research questions two different groups were involved in the study:

1. people who are living and working in Antwerp
2. artists who are living in Antwerp.

The first group was chosen because of the probability that they would actually use the application. These people are working and living in Antwerp and therefore interact with the city on a regular basis. The second group was chosen because of their creativity. We expected that the artists would come up with more creative thoughts and future stretched ideas. Both groups were selected from one city. This was because the contextual investigation of the city pointed out that when talking about communication in a city, the nodalities in a city are very dependent on the city as such. Having the two groups above in mind, different kinds of efforts were performed to find enthusiastic people who were willing to participate. This was done by posting digital flyers on weblogs, spreading printed postcards in public buildings and contacting people directly.

7.1.3.2 Co-Design process

Our co-design process consisted of six phases. The process started with a contextual investigation, which was this time not aimed at getting to know the city but at getting to know the participants. This contextual investigation included phase 1 and a part of phase 2. The three techniques that were used are cultural probing, interviews and context mapping.

7.1.3.3 Phase 1: Cultural probing & interview

The first phase of the contextual investigation existed of cultural probing and interview in order to get to know the participants.

Cultural probing

In our study, the aim of cultural probing was to get to know the respondents. This is not about superficial information, but about deep emotions. This was done to be able to place and comprehend certain reactions, remarks, etc. during the following phases in their context. It also allowed the participants to prepare themselves for the group sessions in a way that they would have some material to talk about.

Figure 114. Cultural probes.

Our cultural probes consisted of a box filled with assignments. These ranged from taking photos to annotating a city map with emotion stickers. The cultural probing was done individually, this allowed participants to talk about their 'true' deep emotions.

Interview

The aim of the interview was to receive more explanation on the results of the cultural probing. At the end of the interview, the participants were asked to collect an artefact from the city and bring it to the next meeting – in which they met the other participants for the first time during the first group session.

7.1.3.4 Phase 2: Contextual investigation 2 & communication in the city

In this phase, the first aim was to get an idea about what people think of their city and how they experience their city. The second aim was to explore how people want to communicate in the city. This was done by creating collages (individual and in group) and by conducting brainstorms. An engineer and a designer of the project team were attending and participating, while a sociologist took up the facilitation role in these activities.

During the second phase, the participants got the chance to first exchange thoughts on their image of a perfect city by making collages. The project team then confronted them with an image of a city where there was no communication possible. Based on the topics that came forward in the collages, a group discussion was initiated to gain insights into how people would want to communicate in a city context.

Figure 115. Co-design session: making collages.

7.1.3.5 Phase 3: Exploration of RFID

The third phase had multiple aims. The first was to let people think about which type of content can be put on the RFID tags and how such a tag should look like. This was explored by allowing participants to creatively design and make their own interpretation of a “tag” by using material like clay, paper, felt, stone, etc.

Figure 116. Co-design method: making things.

The second aim was to understand how the participants experience the sense of “touch”, i.e. how do they value the fact that they can get information by touching objects? Does touching a created object give more information than simply reading something? The final aim of this phase was to trigger the participants so that they were able to come up with some use cases regarding RFID/NFC technology and to found out how they experience “touch” with a mobile phone. At the end, the participants were asked to think about how they could realise their own creations using objects and/or technology they know, this as a preparation for the next phase.

7.1.3.6 Phase 4: Use cases

The aim of this phase was to identify a set of use cases based on the designs they made during the previous phase. We first intended to introduce the developed application, “Fluisterdingen” (an online application that allows to link RFID tags to various media created by Alcatel-Lucent Belgium), to the participants, but decided not to do this because we wanted the participants to think in a very open way. Instead we used mindmaps.

Figure 117. Co-design method: defining use cases.

The participants made a collective mindmap of RFID/NFC ideas based on their input from the previous phase. At the end of the session the participants choose the three “best” and three “less good” ideas.

7.1.3.7 Phase 5: Event

The aim was to get to know everybody who took part in the co-design and to exchange ideas. Both groups (artists and citizens) met each other and were able to present and discuss their own creations. Based on these presentations and discussions, common conclusions were drawn.

7.1.3.8 Phase 6: External evaluation

The aim of this phase was to evaluate the method and results of the co-design process together with external people. By doing this we could come up with additional lessons learned and identify blind spots.

7.1.4 Results

The results of the co-design are divided in two parts: co-design content and co-design methodology. The first part describes the actual results of the co-design, which are technology-based and include a set of use cases. The second part elaborates about the used methodology.

7.1.4.1 Co-design: content

The first group session revealed that the artists experience a lack of communication. People do not communicate anymore; they don't have time and live in their own world. Furthermore, the artists also prefer more information about certain activities in the city, such as concerts, expositions, etc. Artists have the feeling that mass media are selecting the information for the public, which implies that it's hard for them to show/sell their own work because of the power of mass media. A central platform for art would be useful. The inhabitants, on the other hand, value social contact. They appreciate small talks like "hello" and "have a good day". Nowadays, information is often spread, difficult to find or even not existing. Information needs to be personalised and intelligent. For example, people want to know which activities are organized on this moment. So the system has to be up-to-date.

When thinking in terms of RFID/NFC, functionality seems to be important for the inhabitants as well as the artists. Examples are the following: where are the toilets located, where are the restaurants located, what are the weather forecasts, give me the most wheelchair-friendly route to the post office, etc. Personal contact is important in a city, but difficult to create with this technology according to the participants. No main differences were detected regarding the way the artists and inhabitants came to new ideas but the differences are more related to their personal background. The co-design resulted in many use cases and ideas for using RFID/NFC technology, however according to the artists and the inhabitants the following themes are the most important:

- The first is self-expression. This is related to "myself", to be able to express your own thoughts and ideas. An example is to "pimp" tags, which gives people the opportunity to create their own tags and to put their own pictures, movies, etc. on the tag.

- The second theme is information from the city. People need more information regarding opening hours, bicycle routes, restaurant reservations etc.
- The last theme is sharing. This means that people for particularly functional subjects like for example the message “I lost my dog” use community billboards.

Figure 118. The City Tagcloud.

When investigating the inhabitants and the artists separately, the inhabitants came to the following themes: “pimping” tags, tag billboards, route tags and profile tags (like address cards, “house for sale”, etc.). The themes of artists were information and layered maps. However, it seemed that the artists came to more sensitive themes and ideas like memories and emotions. Also entertainment seemed to be more important to the artists than to the inhabitants (e.g. music).

Important to notice is that touching something with a mobile phone does not create the same experience as touching something by hand. The general remark was made that the sensory feedback of a mobile phone is too artificial compared to really touching something with your fingers. So, touch ‘as is’ does not give such an emotional experience as we might had expected. A final remark is that the people expect/want the technology to be for free in order for them to use it.

7.1.4.2 Co-design: methodology

Working with the artists and the inhabitants, showed us that a creative co-design triggers them to think about a subject in a way that they like. The people were motivated and lots of ideas came out of the sessions. This section tries to give advice about how to perform a co-design, which stimulates the participants to think creatively.

In the past, co-designs were often done in a home context instead of a city context. In this co-design we decided to organize the sessions in the city, except for the cultural probing and the interview.

Performing a co-design in the city does not differ much from performing it in a home context. The main difference is the location, because it is not organised in a participant's familiar surroundings. Within the described co-design process the group sessions were held at different locations in the city. We noticed that the participants enjoyed going to a different location for each session, especially when they had never been at the location. That illustrates why the choice of location is important. However, it is advisable to do the first 'personal' phase, the cultural probing, in their own environment. In that way we can get more insight in their thought, living habits, surroundings, emotions, etc. Once the subject of the research switches from very personal to things related to the city, then it is advisable to bring the participants together at a location in the city. However, performing a co-design somewhere else than in the participants' own home, obviously has some disadvantages. The main problem is that it's more difficult to bring people together. A rather high amount of people did not show up at the meetings, which would probably be less the case when organising the sessions in somebody's home. This because people feel more personally involved when being at home and because they don't have to travel to a location outside their homes. Furthermore, in the city it takes more effort to feel comfortable then at home. Of course, working in the homes of people is only possible when working with families. So, when it is not possible to organise the co-design sessions in the homes of the participants, it is advisable to search for a location that is very close to their natural habitat as for example a pub. In the co-design process we described, the sessions were held in locations owned by the city council. These places were very 'generic' and did not motivate people to think creatively.

Regarding separating the participants in two groups, more specific the artists and the inhabitants, no large difference was found between the two groups.

However, this statement has to be balanced. It was striking that the people who were attracted by the co-design where rather creative people, which makes the difference between artists and inhabitants smaller. Furthermore, only a part of the artists were working full-time as an artist and during a session a difference was noticed between the full-time artists and the more recreative artists.

We noticed that working with smaller groups (around 5 people in total) results in more depth. It has to be mentioned that we might have guided the participants too much because of the extensive use of examples. Although lots of good ideas and results were obtained, the sessions could have been more creative. It is advisable to come to the ideas, which are in the top of your mind and then go a level further. This could have been obtained by introducing the technology at an earlier phase. Apart from that, it is important that the co-design team is multidisciplinary. Each discipline/background triggers the other. Every researcher (except the facilitator) has to actively contribute to the sessions and has to execute the exact same assignments as the participants. This results in feeling more comfortable and therefore in more creative ideas.

We noticed that at the moment the box with assignments is brought (first personal contact), people give a lot of information about themselves. This information was much richer than expected and should have been integrated in the process. This would also have been an extra motivator for the participants as it would be clear that the material they provided is indeed being used in during the sessions.

Including technology in co-design can block the though process of participants. It is advisable not to use the technology as such, but in a different more low profile way. However, this is also dependent on the kind of participants contributing to the co-design. This also points out the importance of the first phases, where it should become clear to what level technology should be abstracted towards the participants.

It’s very important that the content of a session is planned in a flexible way. Depending on the situation, the content of a session needs to be changed, this during the preparation phase as well as during the actual session. Furthermore, we have to be very explicit in the way questions are formulated. In phase 3, we asked the participants to design a tag, but instead they made art pieces about the kind of information they want to receive. In this case, the original planning of a session needs to be adjusted in order to suit the content that is being created by the participants.

7.1.5 Conclusion

We have proposed a co-design process with which we wanted to gain insight into how NFC/RFID applications can be designed in a city context. We were interested in what influence a certain context has on co-design as a method and how one method can be tweaked to suit various user groups within that same context. The question rises to what extend should this be taken into account and to what extend one should use a ‘dynamic’ method to compare various user groups.

Besides the exploration of methodology, our research aims to develop new mobile NFC/RFID applications where concepts like the importance of ‘touch’, personal vs. private space and the overall user reaction and appreciation towards the NFC/RFID “experience” are part of our interest. It can be concluded that co-design is a valuable method for both designers and engineers. For co-design to work fully, it should be placed upfront the development process, as a lot of valuable ideas can be gathered in a relatively short time by using the described process.

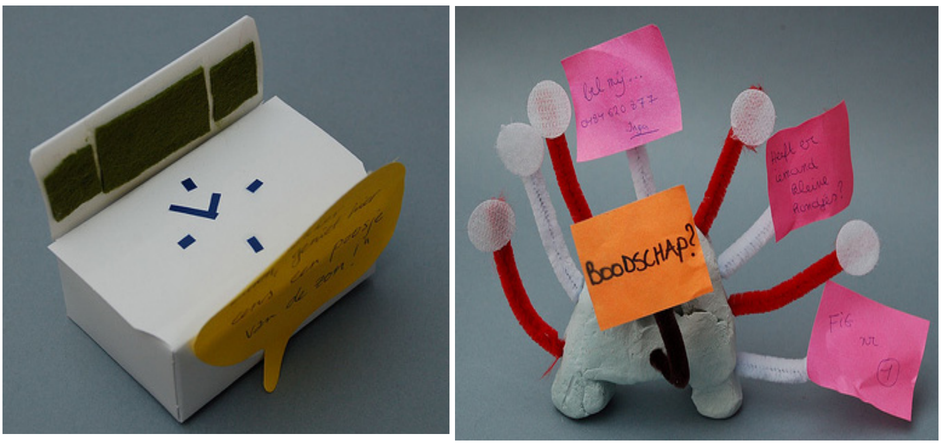

Figure 119. Some outputs from the co-design session.

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7.2 User experience evaluation

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NFC technology seems to have the power to penetrate into the everyday lives of the people. Touching is an accessible and easy to learn and use technology for most people, and NFC tags can be attached virtually everywhere. Therefore, NFC technology can influence on what kind of world we are going to live in the future.

As NFC has the potential to change the world we live in, the way we behave in it, and, ultimately, what kinds of human beings we and our children will be in the future, it is essential to explore how the technology affects its users. Designers, people who adopt new technology and make decisions on what technology to adopt and how need methods and tools for estimating and evaluating the possible and probable effects of the technology into the lives of the people, communities and the society in order to make responsible choices and decisions. One source of information for that is to explore the user experiences that are evoked when users adopt, use or abandon NFC technology and services that use NFC.

In the SmartTouch project, user experiences are explored and analysed through experimental pilots. Experimental pilots expose the technology to use outside laboratory, where *in situ* evaluations can be done for evaluating new technological solution or technology based service in a setting with real users in real use environment [1]. They aim at making the effects of technology visible for evaluation before technology is taken into broad use.

In this chapter, the term “experimental pilot” is used to characterize a setting that exposes the technology under evaluation to *in situ* setting, i.e. outside the laboratory and into the “real” world. Of course, the definition of “real” is relative and subjective. In experimental psychology, the goal of “experimental realism” is used for describing a research setup where the research setting is arranged in a way where experiment has an impact on the participants; it forces the participants to take the matter seriously, and involves them with the procedures under examination [2]. The evaluation settings described here can be said to aim at achieving high experimental realism.

However, achieving experimental realism with technology that does not exist yet is difficult. Arranging an experimental pilot requires that the technology under evaluation is mature enough that it can be used by real users in a realistic usage environment. However, the technology can be part of infrastructure or process that does not exists yet. The non-existing parts can be simulated during the pilot. These can be, for example, payment systems or legislation. Simulating crucial parts of the service creates challenges for interpreting and analyzing the results that must be tackled individually for each case by careful research planning. For example, absence of real payment action can have profound effect on how the users trust the service and what their expectations are for security, reliability, etc. (more discussion later in the paper).

Experimental pilots presented in this paper do not represent experimental research, because the setups used did not use, for example, manipulations of variables or control groups for testing hypotheses. Experimental pilots described here have been used in designing and evaluating new ubiquitous computing applications, and therefore were used as a design tool, not a research method. The word “experimental” is used to characterize the nature of the pilot, i.e. the goal is to explore how a novel ubiquitous computing application is adopted by a selected user group, and what kind of user experience occurs in a setting that aims at high experimental realism. The results of analyzing the data collected during the experimental pilot can then be used, for example, for evaluating a design artifact or a service concept.

The goal of the experimental pilot is to arrange a setting, where the technology is exposed and integrated with the everyday life of its users. This setting can then be used for collecting data that is relevant and descriptive enough for evaluating and estimating what kind of effects the technology has on its users and surroundings. One of the primary data sources are the user experiences [3] that are evoked during the experimental pilots by all users that are influenced by the technology. Another invaluable data source are the values associated with the technology and the issues affected by the technology. Values and implications of new technology often unfold only after the technology has been exposed to use and discourses of everyday life. This has been seen, for example, in introducing cochlear implant surgery for young deaf children, which has resulted in discussion of ethical dilemmas in adopting this specific technology [4]. As this example shows, even if the technology would be perfect from the technological point of view, the effects it can have on the lives of its user can be quite unexpected by its designers and people making decisions about adopting it. Also, the value expectations and appraisal of the users of the technology can differ from the value estimation made by the providers. The mismatch between the value estimation of technology providers and the value appraisal of the actual users will result in solutions that have little actual value for their users, or in worst case, only negative value.

User experience data collection can been divided into four phases: (1) before use, (2) during use, (3) after use, and (4) follow-up. Each evaluation phase has its specific goals, evaluation focus, and sets its own requirements for the evaluation methods. In the following sections, examples of real pilot experiments are used to highlight methods that have been found to be suitable or problematic in certain situations.

One of the guiding principles in data collection has been that it should not disturb the usage setting, as then the data collection would affect the results. However, the fact is that this is extremely difficult, as research has shown that mere measurement of a phenomenon has effects on the phenomenon itself [5, 6], and this was also found challenging in the pilots described here.

7.2.1 Before use evaluation

Before-use evaluations proved to be valuable especially for the following:

- recognizing all user groups that are directly or indirectly affected by the technology
- getting information about attitudes and expectations that are relevant for interpreting the results of the pilot
- understanding the values of the users that are and can be used to evaluate the value of adopting and using the technology under evaluation
- setting the baseline for the evaluation by describing and measuring the starting point so that improvements and changes introduced by the technology can be identified and measured.

For identifying the total effects of adopting technology, it is crucial to know who are involved in the value creation chain. It can be difficult to recognize especially user groups that are indirectly affected, so this must be checked and revisited later during the pilot. However, for successful data collection, the earlier all user groups are recognized, the better.

Before pilot use the attitudes and expectations the users have towards issues that may be relevant for evaluating the results and impacts of the pilot must be explored before the users actually start to use new technology. The findings indicate that prior attitudes towards technology can have an effect on how the users experience technology. For example, in the elderly meal-ordering pilot, the attitudes towards the use of mobile phone proved to be a strong impacting factor towards the perceived usefulness of the service. It has been noted that humans are not very good at memorizing their attitudes, as later incidents easily influence our memory of attitudes. Therefore, the attitudes need to be evaluated before the use of technology can have an effect on them.

Also, the pilot may result in attitude changes that can be identified only if the attitudes before and after the pilot can be measured and compared. In this project, information about attitudes and expectations were collected with contextual interviews when the amount of users was small (under 20 users), and questionnaires when the pilot involved larger amounts of users. In some cases, questionnaires were printed on paper forms, and on others, they were implemented through a web-based survey tool. However, the experiences show that it is difficult to predict before the experiment what could be relevant parameters related to expectations and attitudes that would be needed for interpreting the results, as the values and attitudes of users often unfold only during the piloting. This could be partly solved by deeper user study concentrating on the values and attitudes of the users already before the pilot. Also, better models and methods for describing and modeling expectations and attitudes towards ubiquitous technology would be needed.

The experiment often aims at improving or supporting the life of the pilot users in some way. For evaluating if improvement happens, the situation before the trial needs to be evaluated. For example, in the elderly meal-order case, one of the goals was to improve the satisfaction of the meal-ordering clients towards the meals offered. This could be done only by first evaluating the satisfaction towards meals before piloting, and then again after piloting. For evaluating improvement, it is crucial to identify right value creation parameters that are used for evaluation. For example, for some meal-ordering service users the social contact provided by the visit of the meal delivery person could be the most valued parameter of the service. In this case, measuring the satisfaction towards the meal delivered may not give a reliable or complete view of user experience related to the piloted service. Another value that could be identified only during the pilot was that for some users, selecting the meal “spoiled a surprise”, as they enjoyed experiencing a small surprise every day when they opened their meal box.

7.2.2 During use evaluation

At the beginning of the piloting period, the pilot users are often introduced with the new technology under experimentation, and perhaps trained for using it. Observing the introduction and training situations allows a good opportunity for exploring the issues related to the adoption of the technology in question. Observation of in-home training situation before actual use provided an excellent opportunity to get understanding on e.g. how the physical and cognitive constraints of elderly users affect adoption of touch-based user interface, how the pilot users placed the physical interfaces in their homes, and what were their first emotional responses towards seeing, touching and using the application. For example, one of the pilot users of elderly meal care service plainly refused to take the technology into use after seeing the menu stand, and spontaneously shouted “How awful!” when she first saw the menu stand. This provided very informative data about the emotional reaction to the design aspect of the menu.

Collecting information about user experiences at the time they happen require in situ data collection methods [1] that can be applied during the use of technology. This means that the tools and methods used for collecting user experience data need to be integrated into the everyday practices of the pilot users, just as the technology under evaluation. Our experiences show that when the technology under evaluation is well integrated into the everyday practices of the user and therefore quite invisible, the data collection method may actually “steal the show” (as described, for example, in [7]), if it is more visible and needs more attention and cognitive processing from the user, than the actual technology under evaluation. Humans are not very good at analyzing what actually caused an experience [8], so it can be difficult for users to identify if the experience was caused by the technology under evaluation, or the user experience evaluation method (or any other event in the life of the pilot user).

During-use evaluation can focus not only on evaluating the user experience evoked by the technology under evaluation, but also how the technology affects the lives of its users. For example, in the elderly home-care pilot it was planned to use a diary method for collecting user experiences evoked by new technology. However, the users used the diary to report how satisfied they were with the meals. This was quite understandable, as from the viewpoint of the user, the goal of the application was not to provide a pleasant user experience with technology, but to provide the home care customers with better meal service, and thus increase their satisfaction with their meals.

Integrating data collection methods into the everyday lives of pilot users often requires that the experience collection method is also well integrated into the everyday life of the users, often requiring support for mobile use and versatile usage environments [1]. If the technology can be used in versatile mobile usage environments, so should the evaluation method. In the RMV city map and city orienteering pilots, the data collection tool was integrated into the mobile device which was used for the NFC application. In some pilots, web-based feedback forms were used, and the users were instructed to report their experiences during the piloting period. However, it was noted that the vast majority of the feedback was received when the users were sent a notification that reminded them about the web feedback form. This indicates that the web-based feedback did not integrate well with the everyday life of the users, and was not necessarily done when actual experience happened.

Automated compilation of activity logs make it possible to follow the actual usage patterns that have emerged during use. For example, in the parking pilot the logs related to the parking activity revealed facts on often the users forgot to mark the ending of the parking payment period and how this contributed to the user experiences related to the trust towards the system. Activity logs generated from the use of information tags revealed which services were found valuable in which locations.

One of the most informative data collection methods used was the 24 hour support provided by technology designers and service providers for the users. For example, the elderly meal care clients were able to call the researcher responsible for user experience data collection or the meal service provider any time they had questions or problems with technology or service. This provided rich information about the problems encountered, and knowledge on how the users behaved and responded emotionally to problem situations. However, as one of the values that the users of meal ordering service attached to the meal service was the social encounters, for example, with the meal delivery personnel and other service personnel, this probably had an effect on the user experiences related to the technology. As the users of meal service were usually not able to leave their homes, all contacts with other people were very valuable and important for them. It would have been unethical to leave the pilot users without technical support with technology that is under trial use, but on the other hand, providing unlimited amount of personal support would not be possible in large scale of use.

7.2.3 After use evaluation

At the end of the pilot use the users usually discontinue using the technology under piloting. This is a point where typically a feedback survey is performed. At this point, the users can report about their experiences in the form of storytelling. However, as humans are naturally not very good in memorizing experiences, the limitations of after-use methods must be acknowledged.

After-use evaluation provides an opportunity to evaluate possible changes in attitudes of the users by comparing situations before and after use, and hearing the explanations of users for the possible attitude changes. We have collected this kind of data with interviews or questionnaires, or a combination of both. Our experiences indicate that the reply rates for questionnaires made after the pilot are higher than the questionnaires made before the pilot. One explanation might be that the pilot users feel they have more to contribute after the pilot as they are able to tell about their experiences by sharing stories. At this point of pilot experiments, users are familiar with the technology, its limitations and possibilities, and feel they better share the language and concepts used by technology developers and researchers. This can be exploited by combining after-use evaluation with brainstorming or other methods suitable for participatory design. The goal of brainstorming can be to create new ideas for using the same technology for other purposes, or creating improvement ideas. Brainstorming sessions can be used for collecting user experience data, as improvement ideas and new scenario proposals often are loaded with user experience knowledge. For example, improvement ideas might indicate which technology features have contributed towards undesired user experiences, and new application ideas can help in understanding what kinds of skills and contexts the users feel technology serves well.

7.2.4 Follow-up studies

Follow-up studies are valuable in estimating the long-term effects of the experiment. The attitudes of trial users can fluctuate with time, and this does not necessarily end right after piloting. As the pilot use often provides the users with new possibilities to control their lives, depriving them from this feeling of control may have negative and even tragic effects [9] that can be observed only after some time has elapsed after the experiment. The effects of the pilot experiment should be analyzed not only for collecting information about user experience, but also for evaluating the ethical issues related to the experiment. From the research point of view, it can be problematic to balance between avoiding negative impacts of the pilot and creating high-impact concepts. If the concept is found extremely valuable by the users and it is able to considerably contribute towards a higher quality of life for the pilot users, loosing the possibility to use technology after the pilot may have strong negative effect on the well-being of the pilot users (as described in [9]). The negative psychological effect of loss can be much stronger than the positive effect achieved through pilot. However, the goal of concept design is to create high-impact concepts that would be appreciated and valued by the users. Methods and examples for balancing between these two contradictory goals would be welcome.

In the studies reported here, the method used to collect user experience data in follow-up studies has been interview. The focus has been in observing changes in attitudes, and effects of the pilot experiment in the lives of the pilot users. Especially with the elderly users, it was noted that the users had difficulties in separating their experiences with the meal service in general, and the experiences related with the technology supported service.

Also, the follow-up study has involved participatory elements, as the users are asked if any ideas for improved or new uses of technology have emerged after the experiment. In the elderly meal-ordering pilot, the follow-up study confirmed the findings made in after-use evaluation about the role of the technology in the service, and values the users attached into the service.

7.2.5 Limitations and challenges

During the pilots and analysis of user experience findings, several limitations and challenges were identified. Here, the following are discussed:

- limited time of use
- use of simulated parts
- scales of use.

Limited time of use

The facts that experimental pilots are limited in time may and probably will have an effect on the collected data. As users are aware that the evaluated technology is part of their lives only for a limited period of time, their commitment to adopt the technology as an integral part of their lives may be weak. If the users would think that they are stuck with the technology (e.g. if they had invested a significant amount of their own money for buying the technology), they would need to create strategies to successfully integrate it into their everyday life. If problems would arise, knowing that they would need to use the technology despite of problems would trigger a process for reducing cognitive dissonance [10] which might make them feel and behave differently than in an experimental pilot. Irrevocability of decision has been shown to be an important contributor to user experience [e.g. 11, 12].

Use of simulated parts

As the everyday life applications often have interfaces and other dependencies with other systems and components, these interfaces and dependencies need to be simulated for the duration of the pilot. All actors required for fully operating service chain may not exist at all, for example, companies that operate on the maintenance of tag infrastructures do not exist, or NFC payment is not supported by current payment infrastructures. Simulating parts of the service chains can have effect on the user experience. Those effects must be somehow taken into account in collecting and analyzing user experience related data. For example, in the parking payment pilot, the system was not integrated with the billing processes of the city administration, which meant that the users were not charged about parking during the piloting period. This proved to have a strong impact, for example, towards the user experience related to trust and security issues, and for the motivation to use the service for both the users who used the system for parking their cars, and the parking control personnel. Also in other experiments, the findings indicate that the absence of realistic payment procedures for services affect the user experiences strongly.

Scales of use

Even if the service chain itself could be fully available and operational during the experimental pilot, there are often limits on the amount of users or service access points that can participate and be available in the pilot experiment. It is easy to imagine that, for example, an experimental pilot aiming at evaluating a mobile phone in a realistic usage setting would result in very different results if there is only limited number of users with mobile phones. The scale of use of mobile phone, i.e. the fact that the user can assume virtually all other people have a mobile phone and can be contacted through it, have effects on how valuable the users experience technology, and how they use it. This could be observed also in the research reported here. Especially, the user experience related to information tags would be probably quite different if the tags would be available everywhere and the there would be more variety in the service offering.

7.2.6 Summary

This chapter discusses how user experience data collected with experimental pilots could be used as a design tool to support designers, technology adopters and decision makers in estimating and evaluating how adopting new technology in new contexts may affect the lives of the users. The paper explores the challenges and limitations related to the pilot setting, and methods that have been found to be helpful in collecting data for analysis. The data collection methods described here mostly collect data about experiences and values that are relevant for evaluating the effects of the technology.

As ubiquitous computing technologies intertwine with our everyday lives in a profound and often unexpected ways, it is most probably impossible to fully understand and estimate the total effects of adopting new technology on all user groups, other people that are influenced by the technology, and the society as a whole. However, responsible decision making requires tools and methods that try to answer this challenge by providing as relevant and reliable data as possible.

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8. Vision: Touching the Future

8.1 Potential business scenarios

8.1.1 Mobile payment

Authors: Arto Wallin, VTT Technical Research Centre of Finland

8.1.1.1 Adoption of contactless mobile payment

From the viewpoint of innovation adoption, customers and merchants are the most important stakeholders in the mobile payment value network. The reason for importance of customers and merchants is that the payment markets are influenced by an *indirect network effect*. Accordingly, the number of merchants adopting it affects the value of customer using payment method. Thus, merchants' decisions to invest on NFC compliant payment terminals affects substantially on consumer preference to start using new technology.[16] On the other hand, merchant's value is related to the number of customer's using (or willing to adopt) that specific payment method.

Another important characteristics of payment markets is the existence of a *critical mass*, which means that minimum number of adopters (both customers and merchants) are needed for further rate of adoption to be self-sustaining. Hence, after a critical mass of customers has adopted the payment service, additional value provided by customers using contactless payment exceeds merchants' costs of adopting technology, and vice versa. Because of this critical mass problem, both customers' and merchants' require simultaneous large-scale

[16] SeeTo, E., Jaisingh, J., Tam K.Y. (2007). Analysis of Electronic MicroPayment Market. Journal of Electronic Commerce Research 8(1), pp. 63–75.

adoption of mobile payment. This would generate positive feedback and, thus, initiate self-sustaining demand for the mobile payment services.

Major factors affecting on the consumer and merchant adoption of contactless mobile payments are depicted in the Figure 120. As the picture depicts, two-sided network effect is essential mechanism of the adoption, since reaching the critical mass in one area would certainly impact positively on the acceptance in the other area. Costs and ease of use are quite intuitive success factors. If new payment method is much more expensive or difficult to use either for the customer or merchant, the barrier for the technology adoption can be considerably higher. Perceived risk may also have great impact on both actors. The perceived risk is not the same as actual security and privacy levels of the technology, because perceived risk includes also customers' and merchants' fears and images about the technology use. Therefore, marketing of the contactless mobile payment has to be considered very carefully in order to avoid unjustified risks and fears.

There are two forms of compatibility (downward and horizontal), which both are very important for the acceptance of payment systems.[17] From the merchants' viewpoint the degree of downward compatibility depends on existing payment systems. If merchant has already invested on the ISO 14443 compatible contactless point-of-sales terminals, the downward compatibility should be achieved automatically or with small software updates. However, the diffusion of contactless payment point-of-sales terminals is currently quite low. Therefore, most of the merchants have to make additional investments on payment infrastructure in order to create downward compatibility for NFC technology. On the other hand, horizontal compatibility is one of the strengths of NFC technology, since the standardization should quarantee that NFC-enabled mobile phone is compatible with all point-of-sales terminals complying NFC standards. This lesson has been learned from the Japanese markets, where the lack of horizontal compatibility has been one of the main barriers for adoption of the FeliCa based mobile payments. In the beginning of FeliCa based mobile payments, merchant could need several different contactless point-of-sales terminals in order to create compatibility for all FeliCa devices of different service providers.

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[17] Mallat, N., Tuunainen V.K. (2005). Merchant Adoption of Mobile Payment Systems. In: Proceedings of the International Conference on Mobile Business (ICMB'05). Washington: IEEE Computer Society. Pp. 347–353.

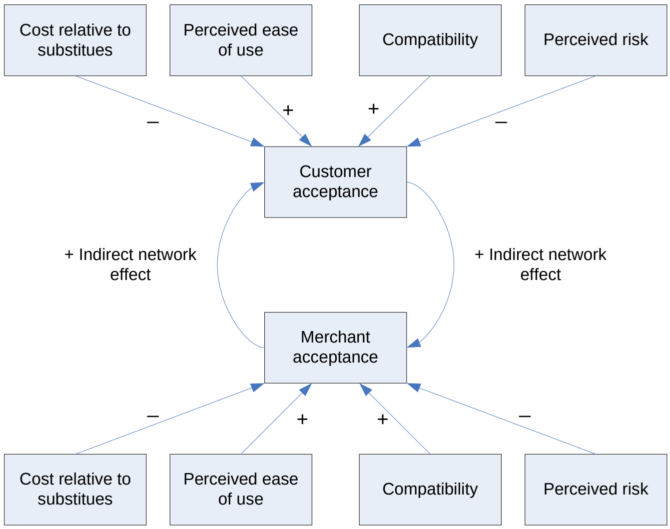

Figure 120. Factors affecting on the customer and merchant acceptance of contactless mobile payments.[18]

8.1.1.2 Contactless mobile payment market development

Because of the fact that contactless smart cards and key fobs require same contactless infrastructure as NFC-based mobile payment, contactless payment can be considered as a preliminary step in the development towards adoption of contactless mobile payment. Different geographical markets have specific drivers for the contactless payments and the diffusion speed varies quite strongly between different markets. However, at the moment it seems that all regions are moving towards the situation where transition from the use of contactless cards to NFC-enabled mobile phones is possible.

In the United States, credit card associations and banks have acted as the major driving force of contactless payment systems. Three major credit card associations, Visa, MasterCard and American Express have introduced contactless schemes (payWave, PayPass and ExpressPay, respectively) which are issued by tens of banks all around the U.S. Additionally, several international retail and

[18] Van der Heijden (2002). Factors Affecting the Successful Introduction of Mobile Payment Systems. 15th Bled Electronic Commerce Conference eReality: Construction the eEconomy. Bled, Slovenia, June 17–19, 2002.

fast-food companies, such as 7-eleven and McDonalds, have been early adopters of the contactless technology. The total number of contactless payment cards issued until March 2008 in the United States exceeds 35 million and there are already 400,000 contactless readers in 80,000 merchant locations that accept contactless payments.[19]

The most important drivers of the contactless payment in the Asian-Pacific region differ from those in the United States. In several Asian countries, such as Japan and Hong Kong, contactless ticketing systems have been used commercially for several years. Most of these systems were initially operating with contactless smart cards based on FeliCa technology. However, nowadays mobile phones can be used instead of contactless smart card to perform same contactless ticketing functions. Furthermore, contactless payment has diffused from the ticketing to be used in several other commercial areas, such as convenience stores, fast food restaurants and vending machines. In addition to Japan and Hong Kong, South Korea has also started to offering contactless mobile payment services to the public. As a result, deployment of contactless infrastructure is proceeding well in several Asian metropolises.

Except for several proprietary contactless ticketing systems, the development of contactless payment in the Europe has mainly been focusing on pilots. London's and France's mobile payment pilots have showed that customer's are very satisfied with pilots and they would be willing to use contactless mobile payments, if those were available[20] Despite of technological advances and several successful pilots, Europe is lacking behind Asia and the North America in the number of commercial rollouts. Retailers' recent investments on EMV-compatible card payment infrastructure have been one reason for that. In addition, the payment industry's transition to the single euro payment area (SEPA) might have also reduced simultaneous investments on contactless payment technology.

In addition to international credit card associations' contactless programs, there are currently at least seven mobile operators who are running contactless mobile payment trials and additional seven mobile operators plan to start new trials in the near future.[21] Thus, the number of contactless mobile payment trials is quite good and actions for contactless development have proceeded in all

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[19] Mohammed Khan, president of VivoTech, presentation 18.3.2008.
[20] http://www.finextra.com/fullstory.asp?id=18919.
[21] http://www.gsmworld.com/news/press_2008/press08_45.shtml.

geographical regions. However, the major barrier to the large scale adoption in several markets seems to be the problem of reaching critical mass of contactless customers and merchants. Public transport operators can provide a solution to this problem in the areas where high percentages of citizens are customers of public transportation (e.g. Hong Kong, Tokyo, and London). If the market area does not have high numbers of public transportation users, the need for contactless card payments as an intermediate stage towards NFC-enabled mobile payment is evident. In that situation, the contactless mobile payment development needs initial push from the big players of payment industry, who have more bargaining power against merchants and who are more easily able to initiate demand for contactless payment cards. In order to reach critical mass, payment industry players may have to use penetration pricing to attract early adopters (both customers and merchants) for contactless payment services. After the critical mass of customers and merchants is reached, pricing can be adjusted to cover actual costs of the service. Later on when contactless infrastructure is widely diffused, the transition from contactless card payments to NFC-enabled contactless mobile payments should be easy for customers who prefer to use mobile phone as a payment instrument. This market entry strategy is currently used in the United States contactless payment markets (with some exceptions) and it might work also in other market areas.

8.1.2 Ticketing

Authors: Jukka Suikkanen, TeliaSonera, Finland
Dirk Reddmann, RMV, Germany

Ticketing is expected to be one of the main drivers of NFC technology, especially in mobile handsets. Public transportation seems to be area where interest is very high. Most of the European and Asian PTOs (Public Transportation Operators) have already RFID technology in use on their ticketing infrastructure, so basically reader infrastructure exist, although sometimes there is still need to upgrade reader software to have interoperability with NFC standard. All other tickets like amusement parks, sport halls, events, gym clubs, exhibitions, clubs etc. are also very potential areas for NFC tickets.

8.1.2.1 NFC in public transport

In the branch of public transport NFC phones will be both a vending machine in customer's pocket and an information terminal.

There are different ways of using NFC for ticketing: RMV's HandyTicketing trial described in this book is just one example. In this case the installed NFC-Tags at the stations guarantee an easy and fast mobile ticketing. Furthermore NFC is offering the possibility to store tickets in the secure element (NFC-chip respectively UICC). So the mobile phone will act as a contactless smartcard. The whole ticket portfolio can be stored at the secure element. The ticket control is the same like the control of a contactless smartcard. No additional infrastructure is needed. So NFC mobile phones can be used for both open systems and systems with ticket gates. The NFC mobile phones are an essential part of the electronic ticketing system of the future.

Another important NFC domain in the future public transport is the information for the customers. The customers can use, for example, installed NFC-Tags at the stations and stops to get information or the current timetable. This system is an excellent solution especially in rural areas. Furthermore all means of transport can be equipped with NFC-Tags as access point to web based information. After reading out the URL of a NFC-Tag in the bus, the customers get information about public transport and timetables.

8.1.2.2 NFC tickets

NFC in mobile handset makes possible to think again the whole ticket purchases, validation environment and service processes. Normally tickets and validation is based on two different kind of solution:

1. Ticket is basic ID and backend system have a knowledge is this ticket valid or not.
    a. In this case reader device have to have on-line connection to backend system or full knowledge about valid tickets -> telecommunication availability (how long it takes to validate ticket) and cost of connection.
2. Ticket have value or time stamp in its memory.
    a. Reader device check ticket value or time stamps, calculated new value and store that back to ticket, normally this transaction will be also stored in backend system after some time.

b. No need to have on-line connection from reader device to backend-system -> faster validation and saves in telecommunication.

Another service what mobile handset can provide is reader functionality. With this reader functionality and secure element it is also possible to use handset as a ticket validation equipment. This could be very useful in cases where there is no need for permanent installation of readers, for example in one time events.

Mobile handset could also provide very useful information for customers and function as an ordering and payment channel. Users should be able to get information about events or services and purchase ticket with the same handset. This ordering and payment functionality could bring a lot of benefits comparing to existing ticket sales agents and physical locations.

Ticketing area has had lot of pilots and co-operation between players in this business sector. It seems that replacement of physical cards with virtual card in mobile handset won’t bring benefits immediately. Therefore, there is a need to keep physical cards available quite a long time until there is enough NFC based handset in market and use. Information channel and remote payment functions would bring more benefits to user, ticket sales and validation organisations. These functions can be done also without NFC functionality so, for example, PTO could start to get benefits of mobile handset right away using mobile for information search, ticket value order or even payment tool.

Availability of NFC handsets will be also risk for ticket sellers and valuators. There will be lot of devices out in market which could be configured to harm users tickets or even possible to create copy of real tickets to handsets. Therefore, it is essential to make sure that ticket or application which is emulating ticket cannot be copied or attached by other application. Also service processes to purchase ticket to mobile handset and secure element should be well designed in matter of security.

8.1.2.3 RFID/NFC versus 2D barcodes

Another solution for electronic tickets is 2D barcode based tickets. 2D barcode can contain few kilobytes of information and there are several different types of 2D barcodes in usage, for example, QRcode, Datamatrix. RFID/NFC based tickets seems to be more convenient for the users than 2D barcode basic tickets in matter of easiness of usage. The main benefit of the 2D barcode is that it can be printed easily even by normal printer. However, barcode can be also easily destroyed if ticket paper gets contact with other things in users pocket or wallet. With mobile handsets NFC is based on simple touch and with 2D barcode user have to open a ticket barcode to mobile screen and show that to reader device in correct position. 2D barcodes can be delivered and displayed with the most of the existing mobile handsets, and therefore, it could be more potential solution in near future. Probably both RFID/NFC and 2D barcode tickets will live side by side depending what is technology availability in handset market and which solution is more convenient for ticket provider's environment.

8.1.3 Business-to-business

Authors: Arto Wallin, VTT Technical Research Centre of Finland

Corporate and business-to-business NFC applications are closely associated to mobile field force solutions, since field workers are one of the main user groups for corporate applications. Field force solutions enable mobile workers (and mobile assets) to interact in the field in a very simple way. There are several tasks that can be enhanced using touch based technologies. These tasks include, for example

- identification
- work attendance reporting and monitoring
- proof of work task completion
- workflow management
- access control
- asset and inventory management.

Field force solutions utilize also other RFID technologies, which all are not so well standardized. Hence, NFC has several other substitutive technologies which may reduce the willingness to adopt NFC. For example, long distance RFID solutions have some benefits over the NFC, namely the range and diffusion rate, which may make that technology more interesting in some parts of logistic process.

8.1.3.1 Potential market areas and experiences from case studies

Even though there are several industrial areas where NFC has been successfully piloted, the number of solutions that are widely used in the industry level is quite low. *Security and guarding* has been one of the early adopters of NFC technology. In this industry area NFC technology can be used together with other positioning technologies to increase security of the guards on the field. NFC provides also an opportunity to increase transparency of the security service. Transparency can be achieved when security guards touch NFC tags on a certain fixed locations along their patrol route. This provides a possibility to automate security guards work attendance and reporting. Moreover, customers may be granted an access to this data so that they are able to check out the time and frequency of security guards visits. This type of service can increase customer satisfaction and provide increased feel of security to the customers

Other areas, where NFC (and especially other RFID technologies) has shown great potential, are industrial areas of *construction and facility management.* In the facilities management NFC related solutions can be used for managing tasks and workflows of service and maintenance personnel. A maintenance man case study provides an example how this could work in the reality: a maintenance man indicates that he has started his work by touching a NFC tag. He receives a pending maintenance task to his mobile phone, which he starts to perform. After the task has been finished he touches another NFC tag, which creates timestamp to the back-end system and sends notification for the work management that the task has been completed. Then the worker receives new task to his mobile phone, and the process starts from the beginning. The main benefit of this application is that it provides a proof about the completed tasks to the work management level. Management can thus monitor work performance better, find out the bottlenecks and allocate resources more effectively to the tasks that need more resources. Additionally, NFC technology may be used to provide a user interface for sensors providing specific measurement information. In that case NFC-enabled mobile phone may be used to read measurement information from NFC tags that are connected to wireless sensors.

Health care and home nursing sectors provide also various possibilities for the NFC technology. A possibility to improve elderly care business processes was detected in a meal service pilot, in which elderly people were able select daily meals using NFC enabled mobile phones. In addition to the selection of meals, logistics drivers used NFC enabled mobile phones for reporting the progress of delivery. The pilot indicated that logistics service provider might be able increase effectiveness and transparency of the delivery, if NFC-enabled reporting would be taken into use in large scale. The results of this case study suggest that NFC can provide added value for the monitoring and reporting tasks of the logistics service chain.

In another case study, clients of elderly care and home care workers used NFC enhanced electronic grocery ordering system. The aim of this pilot was to increase effectiveness of the elderly care, since the work amount and expenses of the elderly care are expected to rise in the future. Although the effectiveness was increased and some of the elderly users were able to order groceries easily using NFC-enabled ordering application, the case study provided an indication that the web-based application might be better solution for grocery ordering. The main problem of the NFC in this case was that the product information accessible from a tag must correspond to the product information printed on the tag. Thus, the tag management costs are considerably higher than, for example, selection management costs of a typical e-grocery store web-application. The main lesson of this case study is that even though NFC provides an easy and intuitive way for interaction, the choice for the used technology should be made carefully.

SmartParking case study provided evidence that NFC-enabled user interfaces can make the work of *traffic wardens* easier and faster when compared to traditional solutions that are used for checking the validity of parking. Although detailed measurements of the worker efficiency was not done in the trial (due to the small scale), results strengthened previous assumptions that the effectiveness could be increased with help of touch-based user interface that is easy to use. In addition, one of trials major conclusions was that in difficult weather conditions, especially when temperature is very low, touch based user interface can provide significant benefits to the traffic wardens (no need to take of gloves and press small phone buttons).

As a conclusion, NFC can be used in a wide range of business to business solutions. NFC has been already trialled in several industrial areas and new areas are only restricted by the lack of creativity and imagination. Most typical scenarios where touch-based interaction provides benefits are associated with benefit of transmitting or receiving information in a certain format between field workers and back-end system. From the business viewpoint, the increase in effectiveness and transparency of the business processes are main benefits of the use of NFC. Thus, NFC is basically a means of interaction for making things faster, easier and more effective.

8.1.3.2 Market development

Although most well known NFC applications such as payment and ticketing are mainly aimed for the business-to-customer markets, it is possible that business-to-business applications are the driving force for the demand of NFC technology in some geographical market areas. Actually Nokia tried to initiate the market demand with their Field Force Solution already in 2005. This solution was based on the local interaction (LI) server, which was later referred as a service manager. Nokia's Field Service solution was well branded and several successful case studies were carried out using it. However, their initial attempt to occupy emerging NFC markets failed due to the various reasons. One of the main barriers was naturally the lack of mobile phones, because Nokia had only two mobile phone models (3220 and 5140i) aimed at the markets of field force services. Additionally, NFC standardization was still premature. However, at the same time Nokia tried to generate revenues with their solution, which hindered the willingness to adopt solution in real business environments. As a result of the unsuccessful market introduction of Field Force Solutions, Nokia reduced their efforts to push NFC technology to the business-to-business markets. At that time they also backed off from the development of service manager.

Current state of the markets is that unfinished standardisation and thus the lack of NFC-enabled mobile phones are still slowing down the adoption of NFC in business-to-business services. Additionally, there are no major service providers providing substitute for the service manager. Therefore, NFC markets are quite open to new proxy server and back-end system solutions. NFC is currently used in various pilots and case studies, but commercial roll-outs are very rare. Even though some business-to-business applications, such as the reporting of security guards, can be done very easily and with low expenses, the poor availability of NFC phones is the preventing large-scale adoption. This situation has created demand for separate RFID-readers that are used for example in logistics processes. Also retail sector and construction industries are using other RFID solutions for their current needs.

8.1.4 Mobile Wallet

Authors: Jukka Suikkanen, TeliaSonera, Finland

Mobile Wallet emulates person's physical wallet in mobile handset. Mobile Wallet is an environment in mobile handset where user's personal daily functionalities, like payment and ticket card applications, can be used. Mobile wallet is more interactive than the physical version, because it can be "online" connected with the service providers systems, which makes possible to bring new services and functions to users.

NFC technology will bring new functionalities to mobile handset. User can use mobile phone like a contactless payment or ticketing card in shops or public transportation. Each of those payment or ticketing applications are individual vertical solutions, which are personalised for individual persons. At the moment user has to find and start individual payment/ticketing application from the mobile phone to be able to use it with contactless terminals.

Mobile Wallet could be a general application which brings all special payment, ticketing and loyalty applications within the same view (Figure 121). It should also make possible to select several applications for usage at the same time. Mobile wallet can be compared to other IT based solutions like Outlook which provides set of personal and communication services for user.

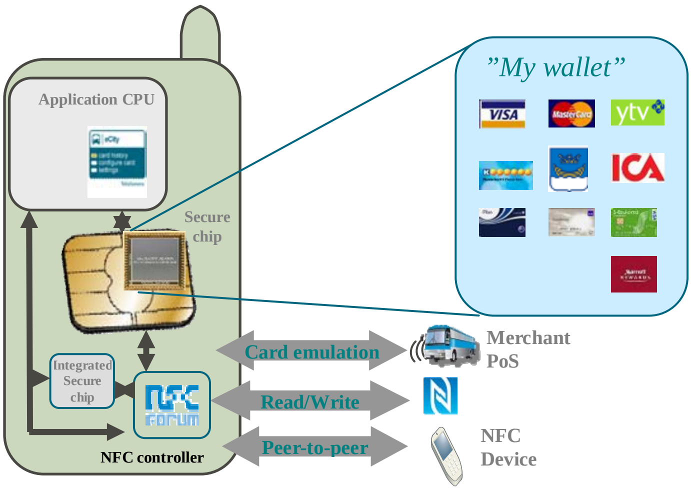

Figure 121. Mobile wallet.

The benefit of the mobile wallet compared to physical wallet is to be able to store several virtual cards or user identity to SIM or related memory area. This makes possible to carry basically all of your payment, loyalty, membership or identity cards and keys. Only limitations come from memory area, which is used for mobile wallet implementation, and user interface layout, which has to be designed so that all needed applications can be easily founded. Mobile operators will have great interest to create mobile wallet solutions for their customers, which is the way to bring applications stored to SIM environment easily for customers.

8.1.5 Cross media advertisement

Author: Marc Godon, Alcatel-Lucent Bell Labs, Belgium

This pilot developed by Alcatel-Lucent shows how to use your NFC-enabled device to “collect experiences” in the city and bring them home. With their mobile phone, users will be able to experience, collect and take home interactive multimedia snippets from the city. For example, when a user touches a billboard or a point-of-interest in the city with his mobile phone, he is instantaneously presented with a multimedia snippet that invites him to further engage in this experience (e.g. advertisement or tourist). Back home, simply touching his (IP) TV with his mobile phone, suffices to enter the next phase in the campaign: a full-screen HD movie is instantly started and the campaign continues.

In the pilot the application interface of the mobile phone was limited to text and images leaving the use of video for a further stage high bandwidth mobile infrastructure become widely available. The cross-media tangible media experience created by Alcatel-Lucent is a joint value-proposition for mobile and fixed operators supported by clear enablers in the network. The Figure 122 shows the general architecture of the pilot and the main elements involved.

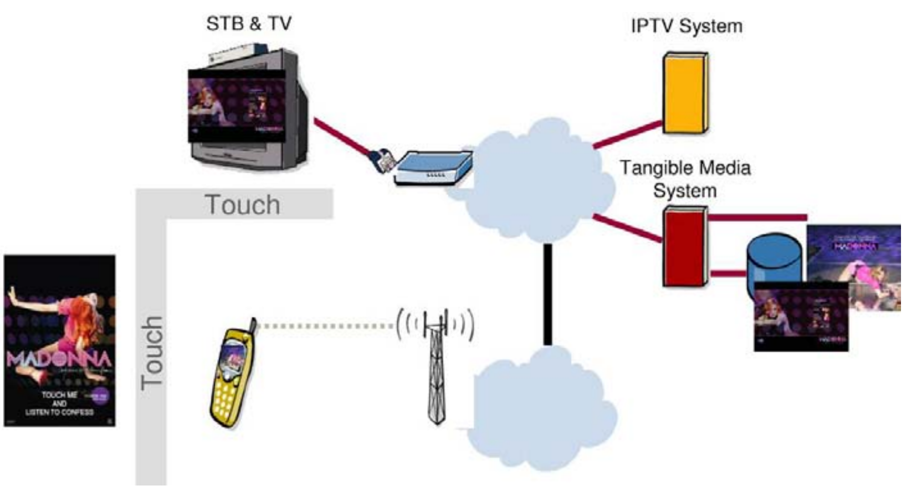

Figure 122. Cross-Media Advertisement (IP TV).

Enriching End-User Experiences

Advertisement and billboards are a familiar part of our city environment. These billboards inform people about new products, films, events that will take place in the region and so on. Cross media advertising enriches this function and enables the end-user to experience, collect and take home media snippets of their interest. Cross Media advertisement is a user-centric solution integrating traditional billboard, mobile and TV advertisement. It uses Near Field Communication (NFC) to create a total cross media experience with a flexible architecture bridging PC, mobile, and IPTV platforms and standards. For the end-user this means getting access to information and entertainment anywhere, anytime and on the desired device by one simple, intuitive and universal action: the sense of touch.

Experience, Collect and Take Home

Walking around in the city with their NFC enabled phones; users can touch the billboard, which is tagged with an RFID sticker. At that moment, a connection is made to the network and the requested (personalized) content is sent to the user. In case the user enjoys the content, he can collect it and put it in his "treasure box". This means that the information will be stored in his personal network vault. Back home, simple touch to the (IP) TV with mobile phone starts the next phase in the campaign: a full-screen experience instantly starts and the campaign continues... (Trappeniers & Lauwers 2007.) The Figure 123 describes the city experience and re-experience at home.

Figure 123. The city experience and re-experience at home.

Architecture

This scenario is embedded in the operator's infrastructure with multimedia content delivery elements being the most important point of integration. When a user touches a smart artefact with his mobile phone, a trigger is sent to the cross media server that maps the ID of the tag to the related content and instructs the content delivery platform to stream the content to the proper device. The architectural approach depicted in the Figure 124 offers clear functional cuts for B2B and B2C interaction making it robust for the chosen deployment model.

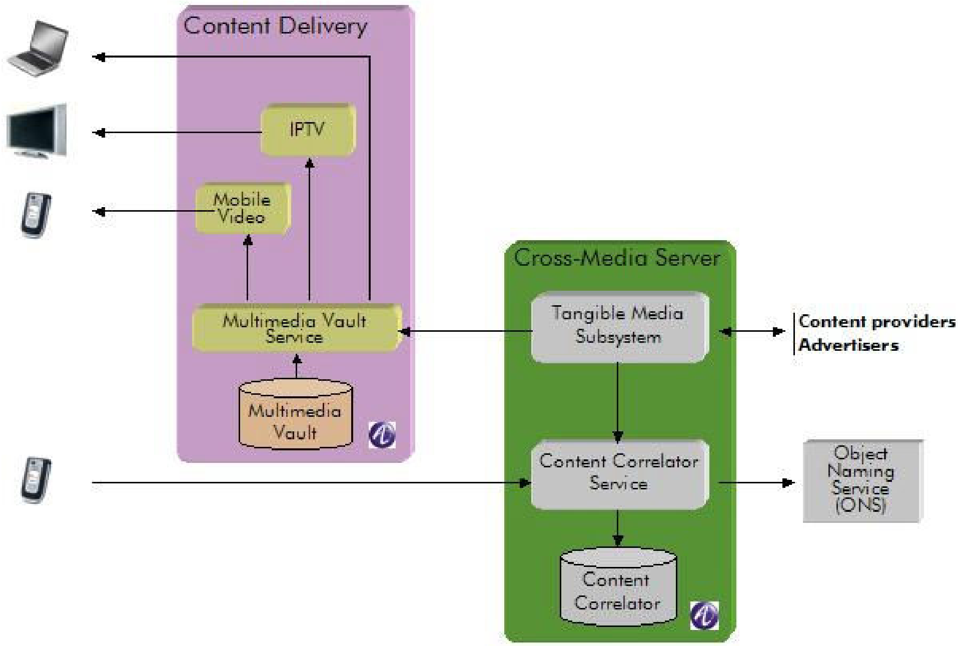

Figure 124. Architectural Approach.

Moreover, this network-centric solution (as opposed to solutions that focus on the mobile phone to host the application's intelligence) in which a media vault and a tangible media system closely interact, enables a truly cross media user experience offering intuitive access to all content (both personal and commercial) on all devices e. g. PC, TV and mobile (Lou et al. 2008).

Endless Possibilities

The cross media server supporting this scenario offers endless possibilities. Both in the artefacts that can be touched (billboards, tourist places, public buildings) as the type of content (text, pictures, movies or even quiz questions that needs to be answered to enter a competition). Moreover information can be adapted and personalized on the spot as the intelligence is placed in the network and not on the RFID tag.

Triple Win

The application offers significant advantages to all parties involved:

- The CONSUMER can actively demand more information about city artefacts of his interest, take it home and share it with friends.
- The ADVERTISER is being offered a new channel to reach its customers, communicate with them and inspire in their city experience.
- It provides the OPERATOR a means to expand his converged offer: Mobile and IPTV merged in one advertisement experience.

8.1.6 Public places

Author: Jukka Suikkanen, TeliaSonera, Finland

NFC technology is expected to be very useful method for creating interaction between physical locations and information or services related to these. NFC tag can contain, for example, a link to information page about product or location of some specific place in a map. You can also send SMS to make an order or initiate call to customer service by touching a tag.

Existing information posters or plates can have a NFC tag and more information can be mapped to this tag. NFC tags are especially useful in places where people are spending their time and they would like to find more information about services, products, history or culture. When you are walking on a street you might not know exactly where you are and touching NFC tag beside the road you could have address and information or services related this area.

You can create theme based orienteering walk through city based on these NFC location tags. It is also possible to order taxi based on those location tags. There are endless numbers of ideas how to utilize this kind of location tags. These places can be, for example, shopping centres, museums, libraries, event arenas, squares, historical places, sport centres etc. Even every house could have NFC tag in street side so that people passing by could locate themselves from map or find information about a person who lives there or a house itself. Even remote locations like hiking routes and national parks could have NFC tags for information, warnings and emergency purposes.

When this kind of public NFC tag infrastructure exists, there can be several public or commercial usages for this kind of environment. Following Figure 125 introduce the use of information tags in city of Oulu pilots.

Figure 125. Information tags of pilots in the city of Oulu.

8.1.7 Tourist services

Authors: Dirk Reddmann, Peter Preuß, Franz Weigt, RMV, Germany

The NFC technology provides many opportunities for uses in a tourist context. By using NFC based services, tourists are able to get access to site specific information, social networks etc. So tourists have the possibility to

- get information about a location
- share travel tips, ratings and stories
- upload pictures
- meet other people.

The named functions should be integrated by providing a minimum set of services. For this purpose an internet-based Travel companion especially for mobile phones has to be developed.

The Travel companion can be used before trip. After registration, tourists use the services for planning a trip and to get detailed information (travel diaries, tips, pictures) about the destination. Furthermore, tourists can define their own profiles. In this way the Travel companion can be used to find a travel mate before or during a trip.

The companion can be used also on trip. Tourists could have access over a map with a basic set of embedded NFC tags or over NFC tags at different points of interest. The tags respectively the links guide to corresponding mobile websites and services. Within the Travel companion tourists can also be active and can upload pictures with site specific information, can write a travel diary or can rate locations.

After a trip the tourists have a lot of information about their journey published at the Travel companion. They can remember the trip by reading their own travel diary or watching the collected pictures. Furthermore friends or other tourists will have also access to the travel diary or pictures. The Figure 126 lists travel companion services.

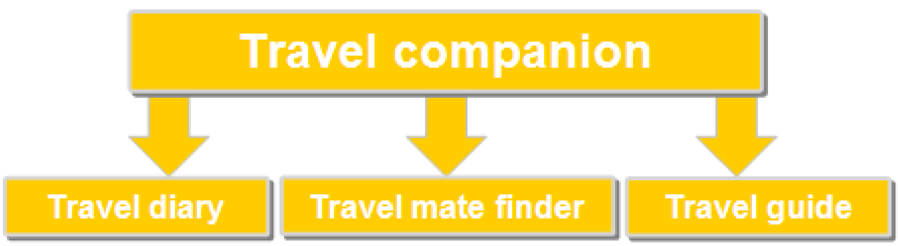

Figure 126. Travel companion services.

8.1.7.1 Travel diary

The travel diary integrates different mobile and personalized services. Tourists can use and share stories and pictures which are related to their location. Therefore, they can use the mobile phone frontend as well as the frontend of a personal computer. So different categories of the travel diary comprise following actions (Figure 127): The first category is the essential part of the service. Users can write and read tourist stories of a corresponding place. Moreover, there is a heading named “Most read stories”, where the top stories from all topics appear. A second category is the picture gallery. Tourists can see or upload pictures of the location. In a third category “Events” users could get information about events in the surrounding area of the touched NFC tag. Furthermore users are able to rate in a fourth category “Hot places” their overall experience or locations around the NFC tag. Within this category users can inform about other places like bars, restaurants or museum near the NFC tag.

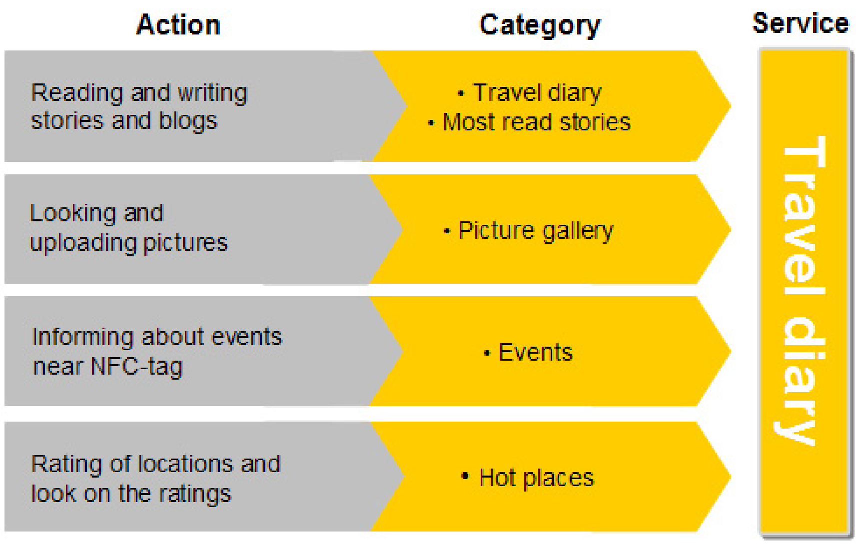

Figure 127. Actions and categories of the service Travel diary.

Mostly, before people become tourists they will plan the upcoming trip. For this they can also use the service “Travel diary” at the Travel companion website for reading the written blogs or for watching pictures and videos of the destination.

Figure 128 gives a general overview about possible travel diary services in the RMV area.

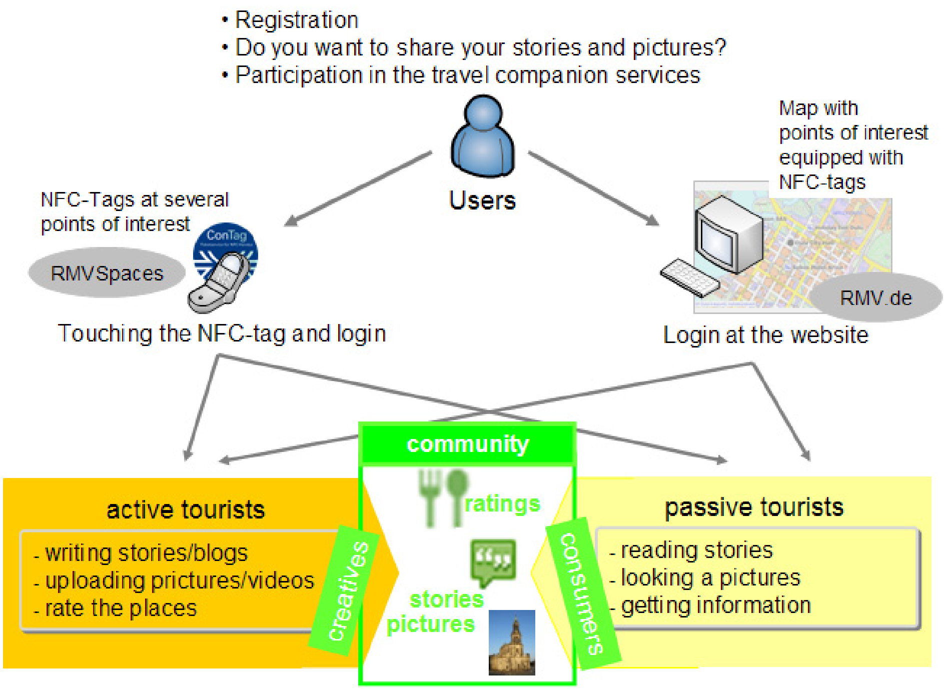

Figure 128. Travel diary – application flow.

8.1.7.2 Travel mate finder

One goal of Travel companion is that tourists are able to find other people for a trip or for holidays. There are already some providers which are offering different online platforms to find a travel mate. In this regard the Travel companion will provide a mobile platform for this purpose. In general it is like a mobile and local based dating agency.

Before using the “Travel mate finder” users have to apply for the service and have to follow an application process. Costumers are able to specify what type of traveller they are or what type of travel mate they looking for etc. (e.g.: backpacker, interested in arts and theatre, desired personal preferences of the travel mate).

There are two options to find a travel mate. The tourist can find a travel mate during or before the journey. In latter case the tourists use the Travel companion frontend for the personal computer. If the users want to meet other tourists on their trip at specific locations, they touch the NFC tag and choose at the mobile platform "Travel mate finder". In a next step the tourist will see all potential travel mates which fit the desired preferences and can get in contact.

8.1.7.3 Travel guide

More and more tourists want to discover the city individually. The NFC tag infrastructure offers the possibility to guide the tourists through the whole city. A travel guide could also offer different thematic routes in Frankfurt, Oulu or different towns.

By touching the NFC tags and choosing for "Travel guide" tourists are able to use different functions and get access to different media:

- written stories
- audio files
- pictures relating to the topic.

The Travel guide includes actions and categories, which are shown in the Figure 129.

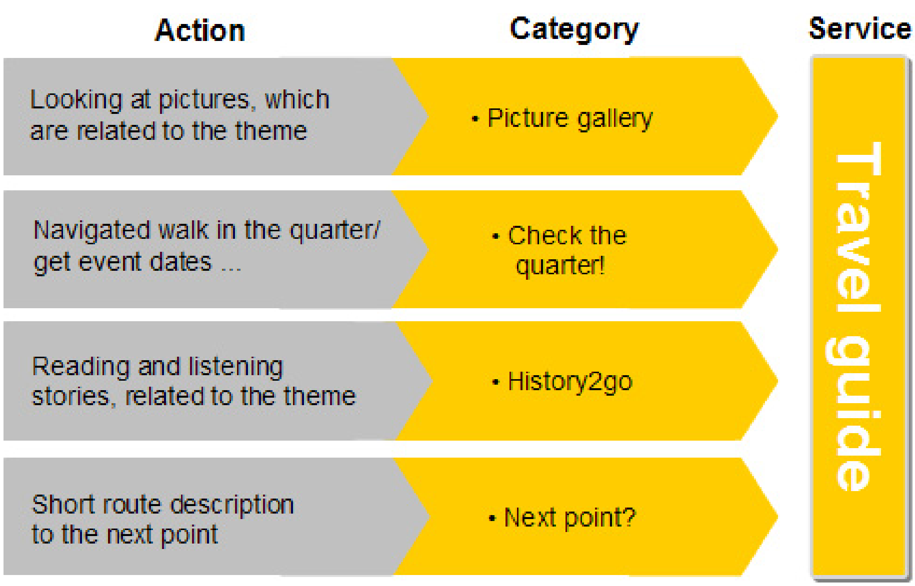

Figure 129. Possible actions and categories of the service Travel guide.

8.1.7.4 Access to the service

Users get access to the service via a mobile phone front end and a personal computer front end. Before using the mobile companion users must apply for the service and define their own profiles at a personal computer. After personalisation the tourists can organize their profile and can define their travel preferences.

More important is that users have an easy access with mobile devices to the mobile front end. As access points to the Travel companion platform NFC tags have to be where tourists arrive, stay or leave. So, NFC tags shall be installed at several points of interest in the Cities (sights, museums, hotels etc.). In RMV's area the ConTags can also serve as entry points to these services.

Furthermore tourists could also use a map with embedded NFC tags. The embedded NFC tags include a link to hotels or to train schedule within the Travel companion (Figure 130).

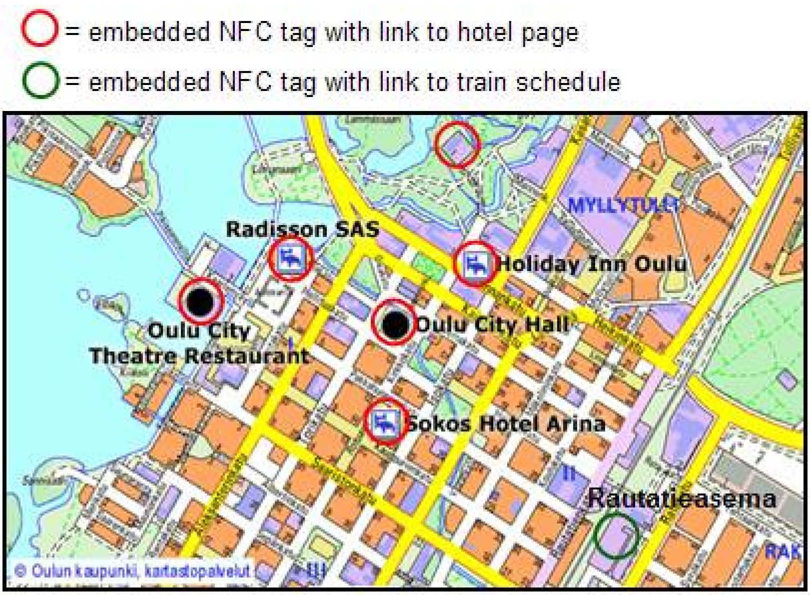

Figure 130. NFC tourist map (City of Oulu).

Additionally NFC tags can also be integrated in a pocket size interactive travel guide called NFC City-Guide (Figure 130). This guide provides a wide variety of links to different very useful services for the town tourists are visiting. This guide was produced within the SmartTouch project as cooperation by the RMV, the city of Oulu, VTT, ToP Tunniste and Nokia. The guide and its functionality were successful tested during the NFC Forum member meeting in Frankfurt in June 2008.

Figure 131. NFC City-guide including NFC advertising boxes.

8.1.8 City gaming

Author: Marc Godon, Alcatel-Lucent Bell Labs, Belgium

Throughout the course of the SmartTouch project different games were developed and played by different user groups. Fluisterdingen software and the NFC-enabled phones were used for all of the games organised by Alcatel-Lucent.

- Human resource management event organised by Alcatel-Lucent to attract young professionals to join the company. 70 users participated and followed a trail challenges distributed in the city of Antwerp. At each stop point teams got new assignments. After completion tags indicated the next stop for the next team challenge.

- Campus-game organised by Alcatel-Lucent in collaboration with students of the University of Antwerp (20 users). A trail of assignments with campus life as theme.
- Street-game organised by Alcatel-Lucent in collaboration with families of a small neighbourhood in Herentals. The format was a quiz with local neighbourhood life as theme. A trail of tags was created. Tags were hidden in front gardens and on public street furniture and even participants carried tags. This latter was perceived as very sociable.
- Educational game organised by Alcatel-Lucent in collaboration with two families. During holidays (at a holiday farm) a quiz, with farm live as theme, was created on the spot. Two teams of children competed in finding hidden tags and finding answers to the questions. The test showed that on the spot creation is easy and feasible. GSM technologies were user for connecting to the Internet.
- DIY city trails test organised by Alcatel-Lucent (5 users). A city trail along famous buildings was created by one of the researchers. Fellow researchers were invited to judge the extra information pushed on their mobiles after they found the hidden tags on the buildings. Following properties on the posted information were put forward as valuable:
  - Information should be personalized.
  - Information should be of that kind that users can’t obtain easily.
  - History, Culture and media made by my friends are popular.
- City game in Antwerp organised by Alcatel-Lucent in collaboration with students’ product design of the High school Antwerp (10 users). In this test more complex gaming rules beyond the simple hide and seek and simple quiz formats were applied. One of the important outcomes was the need for tangible spatial areas for indicating tribal space in the game. Also experience showed the need to include the public transport system in the game as the city can be a large playground and playtime could be exceeded beyond planning.

Within all the games the touch and use of tags in different modes were tested. Tags were used for communicating routes (locations) but also to ask questions, riddles and some actions (e.g. sending SMS, making a phone call). Not only the way the users used the NFC phones, but also the opportunities for real-time updates of the game and follow-up were researched. We believe, following the author Marshall McLuhan that games are popular art, collective, social reactions to the main drive or action of any culture.[22] Therefore we believe games are a good way to test new technologies as NFC and interaction modes as touch.

Making something visible, which was invisible, gives definitely surprise effects. Surprise is a key element in experience design and in game design. Also finding hidden things gives an emotional positive impulse and contributes to the fun level. Therefore it is not surprising that gaming is very suited social practices to embed NFC/RFID based mobile application. We may not forget that the quality of the content of the game still overrules the technology experience. But at least we could say that the used tag and mobile technologies expose certain inspiration and challenges us to play.

Some technology aspects are still open for improvements. Sticking tags on metal is to be discouraged. Radar functions to find tags are advisable to embed in future applications (GPS technologies). Fast delivery communication networks for distributing self-made movies are expected to be present in the end-user experience.

In spite of these small drawbacks the technology still embeds a potential high level of playfulness. This could be inline with the “SERIOUS PLAY™” concept of LEGO® where play, construction, and imagination are together experienced.[23]

Similar foundations are used in the visionary work on communications in the city. In “Let the Homo Ludens Conquer the City” (Godon & Claeys 2008) and “Cross-media experiences: Ambient community interactions in the city” (Trappeniers et al. 2008) authors discuss the potential use of tangible interfaces in elaborating a playful and social communication platform for the city context. A City Game in Antwerp in illustrated in the Figure 132.

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[22] http://www.scribd.com/doc/354130/McLuhan-Games.

[23] (refer to “The Science of LEGO® SERIOUS PLAY™ “http://www.rasmussen-and-associates.com/downloads/science_of_LSP.pdf).

Figure 132. City Game in Antwerp.

8.1.9 NFC – an enabling technology for impaired people

Authors: Alfonso Domínguez, Ander Izquierdo, Isidoro Cirion,
Robotiker, Spain

Disabled people represent 50 million people in the European Union, almost 10 % of the total population (Table 7). This number increases if elderly people are taken into account.

Up to now, most of the facilities aimed at people with a disability relate to providing access for wheelchairs or the installation of hearing aid loops. However, there are various infrastructures and services which remain inaccessible for some user groups. The advent of a range of new mainstream technologies offers exciting possibilities for providing new services which can greatly help people with disabilities. These technologies can be a major benefit both to the people who need these improvements and the public administrations, organisations and companies which provide the services (Gill 2007).

Table 7. Number and percentage of people with impairments in the European Union (Gill 2007, Tiresias 2008).

	Population with impairments in Europe (million people)	**Percentage of population with impairments in Europe (%)**
Mobility impairment		
Wheelchair user	2	0.4
Cannot walk without aid	25	5
Visual impairment		
Blind	2	0.4
Low vision	7.5	1.5
Dexterity impairment		
Cannot use fingers	1	0.1
Cannot use one arm	1	0.1
Reduced strength	14	2.8
Reduced co-ordination	7	1.4
Speech and language impairment		
Speech impaired	1.2	0.25
Language impaired	3	0.6
Cognitive impairment		
Dyslexic	5	1
Intellectually impaired	15	3
Hearing impairment		
Deaf	0.5	0.1
Hard of hearing	30	6
Ageing		
Over retirement age	10	2

NFC is one of these new technologies. NFC, like other contactless systems, is intended to be easy to use. The interaction between devices is carried out with a simple touch or tap. NFC is seen as an enabling technology:

- NFC technology allows a person to use a device they are familiar with, such as their mobile phone, to link to a simple interface. This makes the system easy to operate for people who are not familiar with technology. This can also be very helpful for people with disabilities.
- In order to make two NFC devices communicate, they need to be brought closer or make them touch. NFC eliminates indiscriminate readings which happens using RFID technology (RFID has a longer range than NFC). Touching an object with a mobile device is considered simpler, easier and more intuitive than interfacing through buttons. Touch-interactions are significant culturally and socially; our sense of touch is a large part of the way we understand and interact with the world (Arnall 2007). For the blind is the natural way of discovering and interacting with the environment.
- An NFC device has multiple modes of input and feedback and can present information in a perceptible way across many senses. At the moment screen based interfaces are the most commonly used. NFC phones may give tactile (vibration) and audio feedback besides visual feedback when touching a NFC tag. Therefore more usable interfaces can be designed, that do not require looking at the mobile screen in order to confirm an action.
- Physical browsing can be implemented through NFC technology. This is a new intuitive paradigm of interaction for mobile users. NFC technology enables connections between mobile phones and "intelligent" objects. This can be achieved by simple integration of tags into everyday things and places.
- An NFC mobile device can contain user personal data such as preferences, identification and so on. This information is stored in a file known as "user profile". User profile allows services to be tailored to the user's needs so users will obtain the information they want from them and in the way they need. Personal data is stored securely in the device, through encryption algorithms, and is only available for the services which have the right permissions.

Next some particular situations and cases of use will be presented. The aim is to show how NFC could help people with disabilities, especially those visually impaired.

Most information nowadays, for instance about a museum, public transport timetables, city information, advertising or a sports event, is provided in print. This option is of limited use to blind and partially sighted people. Therefore, they may rely on other people passing on the information, or try to obtain it from the internet or elsewhere. The problem is that these webs are usually difficult or impossible to use by people who rely on assistive technologies such as screen readers with speech output. By touching a mobile phone on a poster, for example, the information about an event could be easily downloaded. A standard icon at a consistent height would identify the area to touch. NFC-Forum is in the progress of registering a NFC target mark (NFC Forum 2008). It will identify the spot on devices or objects where NFC technology works when they are brought close together. It would also be helpful to have standardised feedback to indicate events in the connection, both visual and auditory.

On public transport, it is often necessary to purchase a ticket from a vending terminal. Many of these machines are not designed taking into account accessibility issues: the instructions can be difficult to read or the sequence of actions can be difficult to follow. Using NFC, tickets could be easily purchased and stored on a phone handset (Figure 133). On arriving at the entrance and when leaving, the user would only have to touch their phone on a reader at the gate (Gill 2007).

Figure 133. NFC applied to public transport.

At a bus stop, simply touching their mobile phone on a NFC enabled sign would automatically allow travel information to be read out using the phone speaker. Through NFC, a Bluetooth connection could be established easily when getting in the bus so blind users could receive many information on their NFC handset trough auditory warnings, such as the name of the following stop, the number of stops until their destination and so on.

In general, this technology could make the user interface on many public terminals significantly easier to use by many people with disabilities.

Another possibility, related to housework, would be a washing machine integrating a NFC reader. All the clothes would be labelled with tags that would contain information about colours, materials, washing temperatures and so on. Before putting the garment into the washing machine, it should be approached to the reader so the washing machine could know the features of the garment. Once all the pieces of cloth are put into the washing machine, it could automatically select the suitable washing programme.

Labelling pieces of cloth is very useful for blind people, not only for programming the washing machine but for matching the garments they wear. Up to now, the blind were only able to identify the colour or the pattern of a particular piece of cloth relying on Braille labels, colourimetre or electronic labelling devices. Neither of these alternatives is convenient enough. Braille labels can not be reused. Colourimetres only give information about the colours of the clothes and besides, they do not work as well they should. Electronic labelling devices have been designed for a single function: labelling items, as many other ad-hoc devices blind people use have been developed to solve other problems. NFC gives the user the chance of labelling clothes through a multi-purpose device that they already use for calling, sending text messages, arranging their agenda, etc. such as the mobile phone, the Smartphone or the PDA. Electronic labelling solutions are represented in the Figure 134.

Figure 134. Electronic labelling solutions.

The case of labelling garments can be extended to other items such as CDs, medicines, food and so on. Many people, even those with good eyesight, find it difficult to read labels on objects such as medicine bottles and other containers. Equipped only with a NFC device with speech synthesis, the user will be able to identify all the items and select the correct one. This BlindNFC case of use is dealt with in the section dedicated to SmartTouch experiments.

The last cases of use that will be presented rely on the capacity of NFC devices to store the user's profile. This data could contain information about how the user wants to receive the information from a particular system or machine. For example, a person with low vision at a ticket machine may prefer a specific size and colour of text on the screen. People with other disabilities may need more time, speech or audio output, more simplified choices or another language. As soon as the interaction is finished the machine can revert to a default setting.

People with low mobility in their hands find it difficult to open the front door using the knob or the handle. This could be solved by an electrical door with an NFC reader attached. When users want to open the door, they only have to approach their mobile phone to the reader and the door will open if the personal information stored in the mobile matchs the one stored in the reader.

These are only a few examples of how NFC technology can help handicapped people. NFC technology offers the possibility of making life easier for people with disabilities. Organisations should take this and other technologies into account to improve their services and make them available and usable to the widest possible audience.

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8.1.10 Wellness & Health

Authors: Isidoro Cirion Salazar, Alfonso Dominguez, Robotiker, Spain

Since the very conception of NFC the 'Wellness & Health' scenario has been repeatedly mentioned as one of the most promising application fields for this technology. The SmartTouch project has been an excellent opportunity to test concepts such as BlindNFC and SeeyingEyePhone (applications for the blind and visually impaired people), health monitoring, meal ordering for elderly people, an NFC enabled blood glucose meter, and many other personal and home and SOHO applications in some way related to the concept of 'wellness': access control and security, new accessible interfaces, personalisation of home appliances and preferences, etc. Most of this services and products have been tested in real conditions, and all of them have received positive feedback from users.

Given such a wide variety of small applications and scenarios it is inevitable to foreseen a future NFC personal health ecosystem in which a lot of sensors (wearable meters embedded into intelligent clothes, implants, portable devices, etc.) can be read with a simple touch, and their data represented by means of accessible interfaces (speech, special displays), their info stored, and interpreted in a portable personal device (Smartphone or PDA), or even sent to a remote supervisory centre (hospital, healthcare provider, etc.) via a cellular network, WLAN, etc. This concept is not only applicable to hospitals, but also to environments such as homes, fitness centres, old people's homes, or nurseries.

To make an exercise of imagination as the proposed above seems not to be very risky; all the needed technological building blocks are available, although there are still gaps to fill, especially in the business model. What could be not so evident from the users' and potential stakeholders' viewpoint is the role of NFC in this personal health ecosystem where NFC, with probably the only exception of the technical aids for the blind, seems to be a peripheral component, not part of the core, i.e., why NFC and not any other wireless communication interface? Although as NFC technologists, early adopters and forerunners, and in consequence enthusiasts, we could not be familiar with this kind of analysis, not even prone to it, it would be helpful to think about the future role and chances of NFC in a field, as Health & Wellness, where this technology will be at best an ancillary one, and the measure of its success will be its invisibility. In fact, an interface communication technology as NFC could be compared with the referee in a football match: the less you notice him, the better he is doing his job.

It is admitted that in order to be successful, a new technology needs to cover the three main aspects of the product ecosystem: technological viewpoint, business aspects and user's response. These three facets will be discussed in the following lines.

Technology

Functionality and performance; what it does, whether it performs a new functionality or whether it allows to do it in a more efficient, cheaper, or convenient way. What a technology does and how it does are subjects usually included in its definition. In a former section in this same book it has been discussed what NFC is: a short-range wireless connectivity technology, both a "read" and "write" technology, etc. According to this definition, in the foreseen health and wellness scenario NFC will allow the interconnection of sensors, wearable components, personal appliances, etc. Many other technologies could do the same. But NFC acts not only as a contactless communication means, but also as an enabling technology, as new interface to trigger other services and experiences. NFC goes beyond connectivity, it is an intuitive interface, easy to use, trustable, and appeals to a sense deep rooted in the human perception and emotional response: the sense of touch. This is probably the main strength of NFC as a technology, but there is no technology so wonderful itself not to need a business model.

Business

How the market will react? Why will the market make this technology succeed? Regarding the Health & Wellness scenario it should be pointed out that NFC is placed in the crossroads of several promising technological, social, regulatory and also political trends and structural deep-running changes. In the first place one should mention the eInclusion initiative: the activities and policies fostered and driven by the European Union to achieve an inclusive Information Society. The European Public Authorities endorse any new technologies and methods that allow reducing the "digital divide" promoting new regulatory frames and economic programmes in key areas (eHealth, eInclusion, etc.). People disadvantaged due to factors such as age, education or disabilities would obviously benefit from a so friendly, intuitive and easy-to-use interface technology as NFC.

The second observed trend, in this case sociological, is the progressive ageing of the population in the developed countries, and the obvious relationship among ageing, disability and dependency. In Europe, by 2060, the share of people aged 65 years or over in the total population is projected to increase from 17 % (85 million) to 30 % of the population (151.5 million). The dependency ratio of elderly population will have risen to 54 % in 2060, i.e. 1 of every 2 people who are older than 65 years. Similarly, the number of people aged 80 years or over is projected to almost triple from 21.8 million in 2008 to 61.4 million in 2060 (Eurostat, “Ageing characterises the demographic perspectives of the European societies”, 2008). This demographic trend exercises an increasing demand on the health system, but it is also an opportunity, and the ICT applied to the assistive technologies are among the most promising business areas.

A third remarkable trend is the Internet of Things, concept which proposes that every daily object in the physical world should be identified with radio tags (RFID) containing an URL where users could browse for any info about the object. The convergence of the Internet of Things and NFC enabled devices paves the way for the introduction of new services, especially for the blind and visually impaired people, and will turn the mobile phone or PDA into a powerful tool to explore the environment. The implications of this trend are clearly visible in the Health sector, where Public Authorities and laboratories have developed a lot of pilots on safe drug administration, and proved the benefits of the substitution of barcodes by RFID tags: safer administration, better logistics, efficient detection of counterfeit drugs, etc.

To end this business analysis: In a near future NFC will be so usual in devices as PDA’s and mobile phones as today is Infrared, Bluetooth or Wi-Fi. The use of mass-market devices allows the entrance of new players, service and content providers, reducing costs and broadening users’ alternatives.

Users

How the new technology will fulfil the unsatisfied requirements, some of them not always explicit. As it has been pointed out in this book, NFC allows to implement secure communications and transactions. From the user’s viewpoint, nevertheless, the ‘perception of the security’ is more important than any encryption technique, and NFC is trustable because it is short range communication and it is initiated voluntarily with so a natural and simple gesture as a touch. NFC is wireless but without the ‘natural’ association users do establish between ‘wireless’ and ‘insecurity’. It has been also mentioned the importance of interacting by touch: the so called ‘touch experience’. For nobody is this characteristic more important than the blind. The ‘touching experience’ fostered by NFC is the natural way of interaction and discovery between the blind and the environment. NFC has a great potential as enabler to access to enriched contents embedded in the objects and surroundings.

To sum up this analysis, it should be concluded that NFC has come in the right moment to the Health & Wellness area. Although the potential of the technology and the users’ positive feedback where known or maybe intuited before the SmartTouch project, only today have been overcome the barriers that casted a shadow over the business case. The convergence in the same sector of strong trends, such as the eInclusion initiative, the increasing ageing of population and the Internet of Things paves the way for the deployment of NFC in the Health & Wellness scenario.

8.1.11 NFC Lock

Author: Francisco Gomez, Visual-tools, Spain

The NFC lock pilots (Touch&Enter and Touch&See) developed in SmartTouch are aimed at prototyping the use of NFC as a convenient means to control a flexible access to the household while ensuring the protection of the premises. The prototypes improve the home security by integrating NFC in video surveillance devices.

The NFC-enabled Home Security Prototypes comprises two scenarios that combine video surveillance with NFC-enabled access control to the home. The first scenario (called “Touch&Enter”) enables the home dwellers to enter the home by using NFC mobile handsets. The second scenario (called “Touch&See”) enables a security guard of a condominium to view the cameras of a home in her NFC mobile handset by “touching” an NFC door lock. Both scenarios would be integrated in a whole Home Security installation comprising NFC-enabled access control and video surveillance for local or remote visual alarm verification. The following figure shows the scenarios of the Home Security application.

The main conclusion of the pilots is that there would be a clear added value of NFC-enabled Home Security and related applications for consumers but the main business stoppers are related to the very small diffusion of NFC mobile handsets and the associated lack of consumer culture in using the mobile phone as a smart touch device (e.g. virtual key). Other stakeholders of the ecosystem, notably the security service providers, could benefit from the technology to differentiate their current offer whereas locking system manufacturers who are already active in providing NFC-enabled products (e.g. handle sets and E-cylinders) are likely to start their offer in other market segments (e.g. hotel rooms, office buildings).

8.1.12 Do it yourself

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In his article on The Long Tail[24] Anderson argued that products that are in low demand or have low sales volume could collectively make up a market share that rivals or exceeds the relatively few current bestsellers and blockbusters. Although most examples illustrating The Long Tail are referring to media, the model is applicable for any product where storage & distributions costs are low; and thus also for applications and user-generated content.

What could this mean for applications and application creation? In his book *Democratizing Innovation*, Von Hippel introduces the concept of user-driven innovation in which lead users develop and modify products for themselves and often freely reveal what they have done.[25]

"Steady improvements in computer software and hardware are making it possible to develop increasingly capable and steadily cheaper tools for innovation that require less and less skill and training to use. In addition, improving tools for communication are making it easier for user innovators to gain access to the rich libraries of modifiable innovations and innovation components that have been placed into the public domain."[25]

The hype around Web 2.0 and Mash-ups clearly fits these lines-of-thought. Since platforms such as Facebook opened up their API[26] a complete ecosystem of Facebook-based applications has emerged (Figure 135).

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[24] Chris Anderson, Wired, Oct. 2004.
[25] Eric Von Hippel, Democratizing Innovation, MIT Press.
[26] http://developers.facebook.com/.

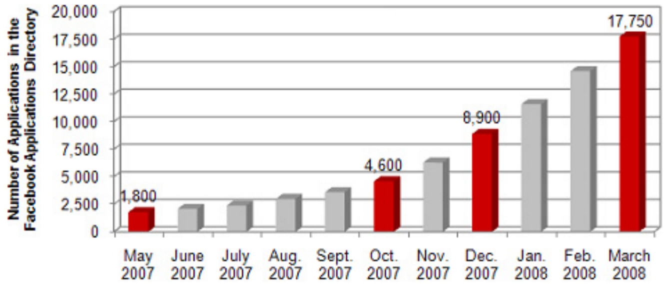

Figure 135. Number of Applications in the Facebook Applications Directory.[27]

However, we also observe 3 areas where the Web2.0 hype does not rise to people's expectations:

- Required skills. Up to now, the creation of an online application, widget or a mash-up of them requires a substantial technical training and insight in application development.
- Limited scope. These mash-ups typically only integrate software components or stored multimedia streams, and ignores sensors, actuators and real-time media sources.
- A participation inequality[28] a limited number of innovators engage in the creation of applications.

It was indeed found by Jakob Nielsen[28] that online user participation often more or less follows a 90-9-1 rule:

- 90 % of users are lurkers (i.e., read or observe, but don't contribute).
- 9 % of users contribute from time to time, but other priorities dominate their time.
- 1 % of users participates a lot and account for most contributions.

Although, still according to Nielsen, participation will always be somewhat unequal, there are ways[28] to better equalize it, including:

- Make it easier to contribute.

[27] http://developers.facebook.com/.
[28] http://www.useit.com/alertbox/participation_inequality.html.

- Make participation a welcome side effect.
- Edit, don't create. Let users build their contributions by modifying existing templates.
- Reward participants for contributing.
- Promote quality contributors.

Despite the disadvantages mentioned above, Facebook, GoogleMaps, Yahoo Pipes, Microsoft Popfly and the likes are indeed forming a de-facto marketplace in which technically savvy users exchange applications, components and API's. A recent, but already notorious marketplace for applications can be found at Apple's iPhone App Store.

On this online application market, available in 62 countries, users can share their iPhone application for free or on a commercial basis. Apple takes a 30 % revenue-share of all transactions on the marketplace and it has absolute control over the applications that are on offer. Apple can also revoke any application from any phone at any time[29]. Although it is essentially a closed environment for a dedicated device, Apple is selling an average of $1 million a day worth of applications and more than 100 million applications and games were already downloaded in the first 2 months of the service. More than 3,000 applications are currently available and more than 600 of them are available free of charge[30, 31]. Not surprisingly, a rough estimate[32] shows that 1 % (or less) of the iPhone users are developers.

Inline with the discussion and close to the context of SmartTouch is the initiative of Alcatel-Lucent Bell on Touchatag (Figure 136).

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29 http://www.appleinsider.com/articles/08/08/06/researcher_discovers_long_publicized_iphone_app_kill_switch.html, http://www.msnbc.msn.com/id/26872181/.

30 http://venturebeat.com/2008/08/10/with-60-million-downloads-in-one-month-jobs-throws-out-the-possibilty-of-a-1-billion-app-store-marketplace/.

31 http://online.wsj.com/article/SB121842341491928977.html.

32 http://www.philoking.com/2008/09/25/the-sad-truth-about-the-apple-app-store-drama/.

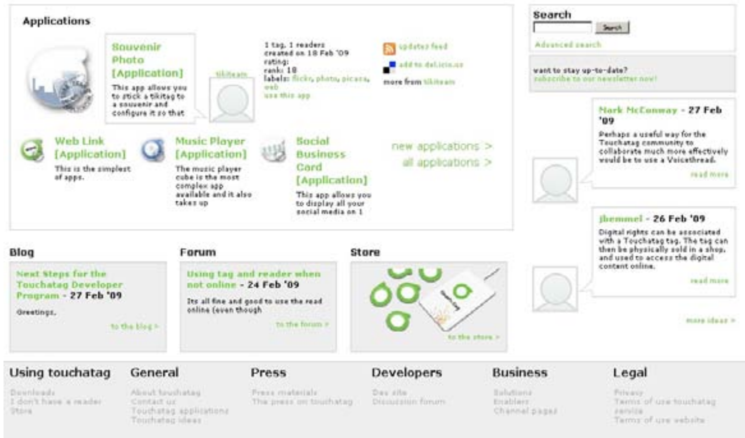

Figure 136. View of the Touchatag web-page for end-users (http://www.touchatag.com).

Touchatag, leveraging innovations within Bell Labs, enables consumers and third-party application developers to increase the value of everyday items by connecting them to online content or applications. The technology that Touchatag takes advantage of to establish this connection is Near Field Communications. The Touchatag service enables the launching of online applications by simply touching an NFC device such as a cell phone to an item tagged with an NFC chip. Touchatag can be used in a variety of environments: for example in an in-home application a father can use Touchatag to link his toddler's teddy bear to an online story about that same bear; in an outdoor environment Touchatag makes it possible for a visitor to an art gallery to wave his NFC enabled mobile phone at a painting and then see the painter's Wikipedia profile appear on the phone's screen; or in a business/logistics environment a cleaning company can, for example, use it to record that a room has been successfully cleaned through a simple touch of an NFC-enabled mobile phone to a Touchatag -linked NFC tag that has been placed in the room.

Touchatag started as a beta starter package on October 1 2008 through e-commerce Web sites. The package includes an USB-enabled NFC reader and electronic tags, and provides access to a community website where users can create and share new and off-the-shelf Touchatag applications. Initial applications available for download include the ability to link tags to URLs or linking tagged souvenirs to photo albums. Teenagers will be able to link a tagged photo to their social network profile at Netlog® or steer an online music services player to perform pre- programmed actions via a Touchatagged object. "Sharing gadgets and things linked to your social network profile can enhance both the online and real world experience of communities," said Lorenz Bogaert, CEO of Netlog, Europe's leading social portal (http://www.touchatag.com/press). Linking the teddy bear to an online story is presented in the Figure 137.

Figure 137. Linking the teddy bear to an online story.

8.2 Future challenges and research

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Marc Godon, Alcatel-Lucent Bell Labs, Belgium

8.2.1 Critical success factors and challenges

There are numerous different factors that affect on the diffusion of the NFC technology. In the following these factors are divided into two categories, which are critical success factors (CSF's) (Table 8) and challenges (Table 9). Main characteristics of the critical success factors are that they can seriously disturb or even totally prevent the adoption of NFC technology. On the contrary, challenges are not viewed as critical for the final adoption of NFC. However, the speed of adoption may be slowed down if challenges are not take appropriately into account.

Table 8. Critical success factors for the adoption of NFC technology.

Critical success factor	Actions for handling CSF	Impact area
Availability of NFC-enabled mobile phones	Standardization, new phone models	All NFC solutions
Sound business models for involved actors	Co-operation between stakeholders	All NFC solutions
Clear presentation of benefits and costs of NFC technology		All NFC solutions
Lack of user awareness and acceptance towards NFC-enabled services	Design and implement NFC related services so that there is clear added value provided for customers	All NFC solutions
Stakeholder co-operation	Co-operation between banks, credit card associations and MNO's. Trusted third party	Mobile payments and ticketing
Multicard operation	Standardization	Mobile payments and ticketing
Merchant adoption of contactless payment (background: in Europe merchants have just made SEPA and EMV related investments, low willingness for additional investments)	Address the added value: – faster and easier to handle. Reduce merchants' investment costs: – low cost point-of-sales terminals – temporary subventions to get this rolling.	Mobile payments
Legal and regulatory decisions	Increase awareness among decision makers.	All somehow connected, particularly mobile payments
Integration of NFC to existing solutions	Providing tools of integration	Particularly B2B solutions and health care
Perceived security/privacy: • general trend for increased privacy • threat of malicious tags in public places.	– Physical protection of tags – HW/SW protection (signature definitions,…) – Increase users knowledge about NFC in order to reduce unjustified fears.	ALL (particularly wellness and health care, tags in public places)

Table 9. Challenges for the adoption of NFC technology.

Challenges	**Actions for handling**	**Impact areas**
Adoption of high capacity wireless data services	Increase mobile network availability.	Entertainment (high quality content)
Difficulties of reading NFC on metal	Insulation needed → high cost	Entertainment, public tags
Location, how to find tags?	– Use NFC in combination with other positioning technologies (e.g. GPS). – Uniform visual outlook of tags.	Entertainment, public tags
Non-uniform visual outlook of tags (service providers willingness to pimp tags in order to make to more attractive)	Provide ways to differentiate tags.	Entertainment

8.2.2 Technological roadmap

Standards related to NFC applications like SWP (Single Wire Protocol) and HCI (Host Controller Interface) are approved at the moment (07.11.2008). Some specifications of test procedures and methods are still open, but it seems that now all the needed standards, e.g. for payment and ticketing applications in SIM environment, exist.

Mobile handset vendors and SIM providers have told that first commercial SWP enabled products will be shipped around summer 2009.

GSMA, M-Payment and M-ticketing projects are defining service and business models of payment and ticketing applications. These projects aim to define common models for payment and ticketing application usage in SIM environment. NFC technology and standardization roadmaps are illustrated in the Figure 138.

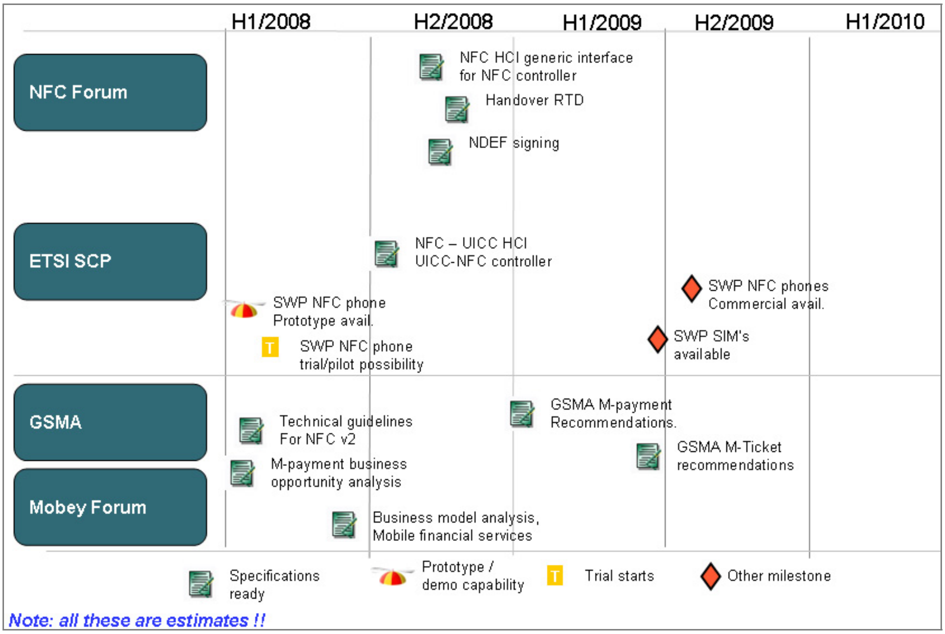

Figure 138. NFC technology and standardization roadmaps.

8.2.3 Business roadmap

This business roadmap describes our best estimate about the timeline when different business domains and areas could start using NFC as a common service element and technology.

Public transportation

RFID based ticketing solutions have been in use in several countries around Europe and most of those environments can be easily upgraded to NFC capable solutions. Most of the additional work still needed is around services processes and business ecosystem. Technical details need to be checked but there should not be any major issues or barriers to make NFC handset working as a ticket in ticketing infrastructure. Native Mifare and DesFire support in SIM card will take up to 2010 and this will slow down a little bit this integration.

Payment industry, banks, credit card companies

Banks, credit card companies and mobile operators are working closely and very actively to make it possible to conduct contactless payments with NFC-enabled mobile handsets. This work is done in GSMA M-Payment (also known as Pay-Buy Mobile) project and Mobey Forum. Banks and Mobile operators have also several activities in national level to fulfil local needs and standards. Roadmap of NFC related services and solutions are illustrated in the Figure 139.

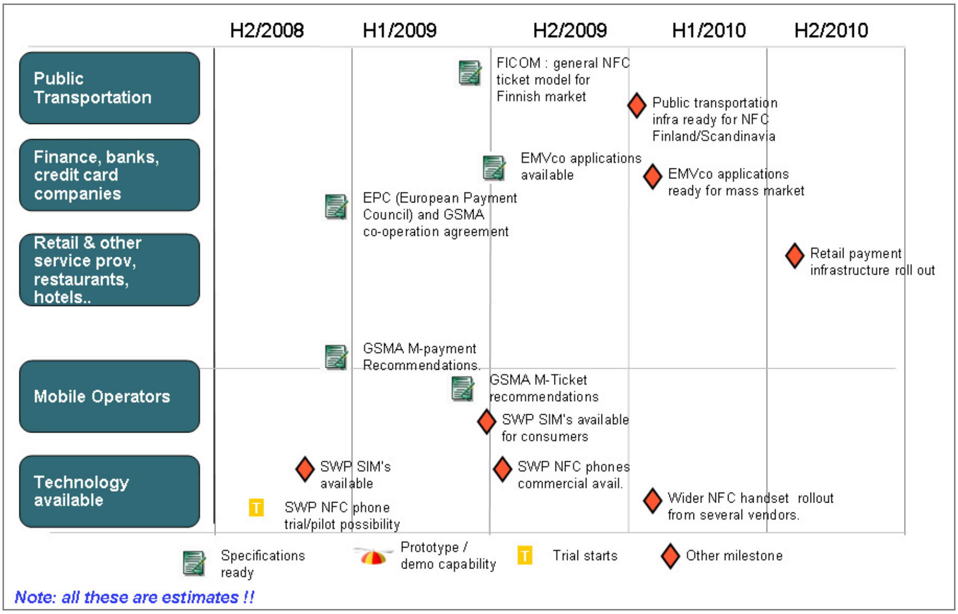

Figure 139. Roadmap of NFC related services and solutions.

8.2.4 Direct practical and emotional information

The previous applications of NFC show a clear business benefit by providing more convenient functionality to the consumer for some basic need (e.g. payment, ticketing, information gathering). However, the ability to use NFC to provide new “emotional experiences” could create a disruptive innovation boosting NFC technology well beyond the point of more conventional applications based on physical needs. NFC could create a synergic effect with the interactions enabled by social networks. Social networks allow us to connect to people that we care about as part of our “cyber-neighbourhood”, although they are not necessarily near to us in our daily life. This scenario will be reinforced by the mobile Internet that will cause people to be permanently on-line in all circumstances.

To uncover the potential of NFC in emotional experiences one could look at NFC technology as a sense of touch of the Cyber-world. Providing the Cyber-world with a sense of touch will enable humans to interact with it by “tangible experiences.” Contrary to what many people could think, the sense of touch has much stronger connections to our “emotional brain” than other senses like sight or ear. Some recent evidence seems to even indicate that many depressions of modern world could be connected to the poor use of the hands in our daily activity (Lambert 2008). This could be an explanation why people could eventually prefer an interaction with the Cyber-world through NFC as a tangible interface strongly connected with the internal structure and working mode of the human brain.

To examine some ideas on how NFC could be used to enable emotional experiences, it is worth looking at what elicit people emotions, i.e. why people care about something or someone. The studies of “what makes people move” have been largely based on the famous Maslow pyramid. However, unlike what Maslow originally thought, things that matter to people do not follow a strict hierarchical order (Heath 2007). Based on this fact, several strategies to make people care about things (i.e. to elicit their emotional responses) have been proposed in (Heath 2007) as follows:

1. *Using associations*: i.e. associating emotions to other emotions that already exist. This mechanism is used very often by marketing campaigns to connect an audience by associating things the audience already cares about to other things we want them to care about (e.g. smoking and risk of death).

2. *Appealing to self-interest*: People’s emotions are often connected to things that relate to themselves. To have influence on people, it is recommended to establish a clear connection between what interest people and the benefits for customers of a certain product or service.

3. *Appealing to self-identity*: Although self-interest is a category that makes people move, however it has been shown that the feeling to belonging to a certain group is one of the most powerful drivers for people sentiments and emotion (this happens even if the person does not belong in fact to the pretended group) i.e. what is in it for my group? (What is in it for what I want to be?)

Based on the above, we mention some applications that do not relate to basic people needs (i.e. the basement of Maslow pyramid) but to their emotional side (i.e. the upper levels of the Maslow pyramid). For each "NFC emotional experience" we mention a potential business opportunity.

- Imagine you are in an airport and your flight has been delayed. You feel frustrated and you would like to connect to friends to let them know how you feel. Surely you could call your best friend but you can better use your social network to express your feelings to a wider audience of friends. The airport (or any other transport space) could provide NFC tags expressing emotional states (e.g. emoticon tags) to help you inform your social network how you feel when you are travelling (e.g. maybe frustrated by delays, tired, happy to arrive in time,...). Information on how people feel could be used to assess the customer satisfaction level with the transport service.
- Imagine that you are on vacation in a wonderful tourist area. You feel very relaxed and happy and you are admiring the landscape and the tourist places you are visiting. Surely, you could send a postcard to your best friend but the tourist resort could possibly provide NFC tags in certain places to make it easier for you to let your social network know what a great time you are having. The tourist resort to promote the place online could collect the information transmitted by NFC.
- Imagine that you are shopping and you would like to know your friend's opinion on some article you would like to buy but for which you need some advice to make up your mind. A retailer could provide NFC tags on the articles to make it easier for you to poll your social network on a certain article that is of your interest. The retailer could collect the information on the articles for what people showed interest and use the information to tune the offer to the customer's preferences (see http://www.thisorthat.ws/ for a related non-NFC experiment on social shopping).
- Imagine your old mother lives on her own. Her memory has declined and she only seems to enjoy remembering "the good old days." One could imagine some NFC tags with photos of old family members (some already dead) and some devices like digital photo frames or IPTV. Your mother could approach her mobile phone to a photo of some person of her past life and get a slide show in the photo frame of that person. Some other

family member (e.g. a grand child) could enrich the slide show by some description of the scenes shown in the photos. Conceivably, the ability to select stories of her own life and watching associated pictures will have a positive impact in the mental state of your mother.

8.3 Conclusion

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Francisco Gomez, Visual-tools, Spain

NFC technology will bring totally new way of interaction with environment and person-to-person communication for mobile handsets. Possibility to touch tags, standalone devices (readers), and other mobile handsets will create more interactive and informative environment in the near future. Figure 140 provides an overview of the potential application areas where NFC can be used in the future.

Figure 140. Future NFC experience.

The NFC technology seems to provide very potential way for user interaction related to payments, ticketing, access control, and information and services discovery. NFC is also already used in field work solutions and there seems to be lot of benefit in matter of work reporting, delivering location specific information, and speeding up organizations' overall workflows. Hence, there are lots of expectations to increase productivity, reduce cost and create better user experience with this new interaction technology. Moreover, individual users can use NFC technology to create their personal environment more interactive, for example in their homes or personal properties.

Value proposition is generally defined as a unique value that business has to offer to its customers. In the NFC technology context, the value proposition identifies reasons why service providers and customers would like to use NFC technology. Addressing of the specific value proposition for NFC technology is quite difficult, since the value creation that technology enables differs between different application areas. For example in the public transport ticketing, customers experience added value of the NFC as a shorter queuing times. However, on some other areas the value may be totally different. Therefore, in the following we try to identify general value proposition of the NFC technology:

- **Easy user interface:** Touch paradigm offers intuitive, easy-to-use and natural way to interact.
- **Augmenting physical environment:** NFC provides a way to connect physical and digital worlds, which can be achieved by tagging physical objects with NFC tags.
- **Personalisation of services:** Wide set of mobile services and functions will be available for users in the future; NFC is the key for personalisation of these services.
- **Openness:** Since NFC is available for all parties, persons can create their own "touch based" environments; NFC supports open innovation and innovations can be produced by everyone.
- **Interconnection:** Touch paradigm is glue for interconnection. NFC can be used for connecting devices fast and easily together. Moreover, NFC enables new ways of creating interconnected experiences between different application domains.

In the future the role the mobile network operator should be extended with facilitator and federator responsibilities. As being said: the touch paradigm plays the role of the glue for creating interconnection experiences between different application domains. For example: public services, infotainment and entertainment become interconnected. Interfacing with social networks and the Do It Yourself (DIY) creative world becomes mandatory (Figure 141).

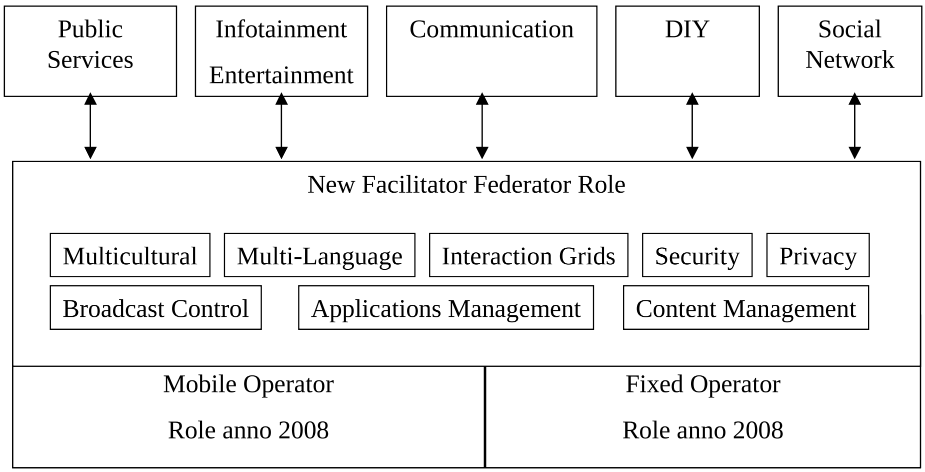

Figure 141. New Operator Roles.

The application of NFC technology is the beginning of the implementation of the Internet of Things. In the future many objects will become identifiable, interactive, and digital communicative. In its limit, the current cooperative operator business model (setup to support the experience economy paradigm) could be insufficient to handle the vast amount of creative needs. In the long run we could move to the DIY self-operator model. Each user will virtually operate personal created interaction experiences. Figure 142 illustrates the evolution of mobile network operator's roles.

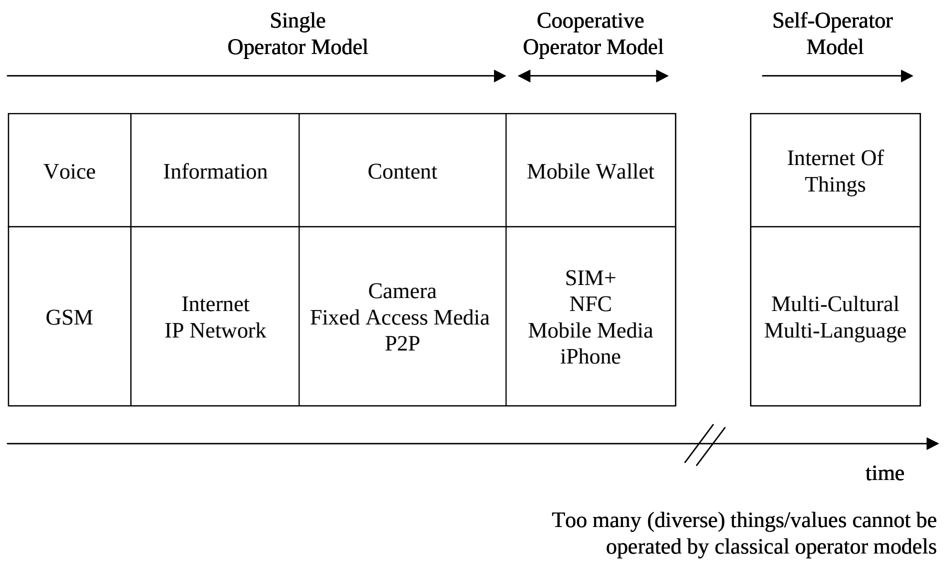

Figure 142. Roadmap Operator Roles.

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Title

Touch the Future with a Smart Touch

Abstract

NFC – Near Field Communication – is a very short range wireless communication technology that supports the use of mobile handsets by touch-based interaction, which is an intuitive and user-friendly way of establishing connections and exchanging information between mobile handsets and other devices by just setting them side by side. The SmartTouch project (ITEA No 05024) has been the largest effort on piloting NFC technology in the European Union. The project started in 2006 and lasted to the end of year 2008, examining the role of NFC in City Life, Home, Wellness and Health, and its Technological Building Blocks, Security and Privacy, and Business Building Blocks. The extraordinary combination of partners in SmartTouch, including technology and service producers, researchers, and organizations setting up first pilots, has been pushing the NFC technology forward in many fronts. This book collects those developments by starting with NFC and its basics and continuing through genuine pilot cases towards an understanding of NFC enabled business areas. Therefore, this book is a valuable source of information for those who want to study NFC as a technology in their business, e.g. as a technology primer, or collecting experiences of NFC in use.

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