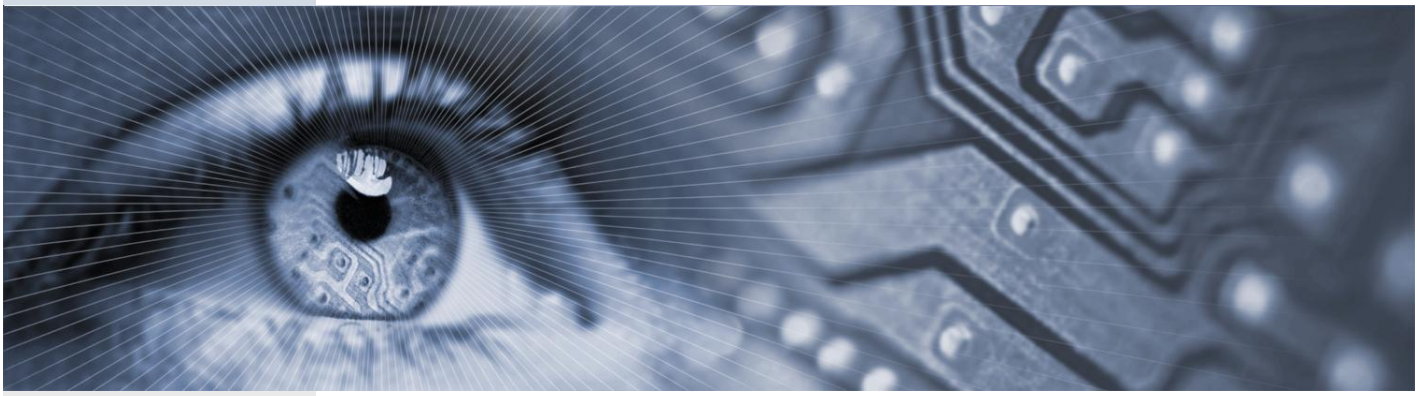

Near Field Communication in the real world

Turning the NFC promise into profitable, everyday applications

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Contents

1 Introduction

Now that international standards have been agreed and published for Near Field Communication (NFC), the market is set for widespread adoption of the technology in a whole range of applications.

Innovision sees three key areas of application for NFC: service initiation, where the technology is used to ‘unlock’ another service (such as opening another communication link for data transfer); peer-to-peer, where NFC is used to enable communication between two devices; and payment & ticketing, where NFC will build on the emerging smart ticketing and electronic payment infrastructures.

The initial mass-market applications of NFC are likely to build on existing communications infrastructure and user behaviour, where the user benefits are most compelling, the business case is strongest, and the commercial risks are lowest. This implies a need for low-cost NFC integrated circuits (ICs) that can be applied to a broad range of uses cost-effectively in a way that is compatible with the broadest range of devices and reader infrastructure.

This paper sets out Innovision’s view of emerging NFC applications, technology and markets, and describes how the company’s existing technology and development expertise is being adapted to help ensure successful take-up of the technology.

2 Technology and standards in line

The technology that NFC is based on – Radio Frequency Identification RFID – is nothing new. However, it is only recently that the technology and standards have reached a point where a whole host of real-world applications are now not only technically feasible but also commercially viable. Now the opportunity is here to develop and roll out profitable applications for NFC that enhance users' everyday lives, based on technology that is cost-effective enough for the mass market and that meets internationally-agreed standards.

What is it about NFC that will open up these new applications and what are the latest industry developments that are making this possible?

2.1 An application enabler

The real beauty of NFC lies in its role as an enabling technology that opens up various forms of communication and transaction in a very comfortable, user-friendly way. In the same way that people use a straightforward switch to light a room, or turn a handle to open a door, NFC allows people to use the simple act of touching or placing their device close to something to initiate the desired service. This makes using any form of electronic 'service' and other interactions more accessible to more people, whatever their age or ability.

In simple terms, NFC does this by performing a 'handshake' between two devices that are brought close together (typically within a few centimetres). While the initiation of this handshake is always under user control, NFC removes the need for the user to perform complex manual configurations. Once the connection is established – within milliseconds – information can be exchanged between the two devices using either NFC directly or via another wireless technology like WiFi, Bluetooth, UWB or ZigBee.

One example of the simplicity brought by NFC is when two people wish to exchange electronic business cards using a Bluetooth wireless connection between their mobile phones. With NFC, setting up the connection is simply a matter of touching their phones together – there's no need for the users to get their phones to scan the local area to locate and then identify the other's phone, no need to enter passcodes or other settings, and no risk that they establish a connection with the wrong device.

These capabilities will not just be available to the 'lucky few' either: according to ABI Research, half of all mobile handsets will support NFC by 2010.

2.2 Commercial drivers

While NFC, like so many other technologies, has been the victim of some degree of over-hyping, it is clear that it offers real commercial benefits for service providers and device manufacturers.

First and foremost, NFC makes new revenue-generating interactive and content-rich services easier and more convenient to use. NFC-enabled devices will simplify the process of becoming aware of, purchasing, storing, playing and sharing rich media content, for example. Convenience is a strong differentiator, and consumers will tend to adopt the most convenient way to access and pay for goods and services.

In areas such as ticketing particularly, NFC will help reduce the cost of issuing tickets and of maintaining the ticketing infrastructure – as has already been proved in mass transport and airline ticketing. Furthermore, NFC is based on existing contactless infrastructure that is already in daily use by millions of people around the world.

At a more strategic level, NFC enables product and service providers to establish a new communication channel with their customers. When consumers elect to ask for further information or participate in a promotion by touching an NFC tag, they could be asked if they would like to participate in other information or promotional programmes.

2.3 How NFC works

NFC is a short-range, standards-based wireless connectivity technology, based on RFID technology that uses magnetic field induction to enable communication between electronic devices in close proximity. It provides a seamless medium for the identification protocols that validate secure data transfer. This enables users to perform intuitive, safe, contactless transactions, access digital content and connect electronic devices simply by touching or bringing devices into close proximity.

NFC operates in the standard unlicensed 13.56MHz frequency band over a distance of up to around 20 centimetres. Currently it offers data transfer rates of 106kbit/s, 212kbit/s and 424kbit/s, and higher rates are expected in the future.

For two devices to communicate using NFC, one device must have an NFC reader/writer and one must have an NFC tag. The tag is essentially an integrated circuit containing data, connected to an antenna, that can be read and written by the reader.

There are two modes of operation covered by the NFC protocol: active and passive. In active mode, both devices generate their own radio field to transmit data. In passive mode, only one device generates a radio field, while the other uses load modulation to transfer data. The NFC protocol specified that the initiating device is responsible for generating the radio field in this case.

The passive mode of communication is very important for battery-powered devices like mobile phones and PDAs that need to prioritize energy use. The NFC protocol enables such devices to be used in power-saving mode, so that energy can be conserved for other operations.

2.4 International standards and co-operation

NFC is supported by the leading mobile device, infrastructure and technology manufacturers, and by all major payment providers. In 2004, leading mobile communications, semiconductor and consumer electronics companies formed the non-

profit industry association, the NFC Forum, to advance the use of NFC technology through standard specifications that ensure interoperability. The Forum now has over 80 member organizations worldwide (as at the end of June 2006).

The underlying layers of NFC technology are ISO, ECMA and ETSI standards. Because NFC is compliant with the main international standard for smartcard interoperability, ISO 14443, it is compatible with the millions of contactless smartcards and readers already in use worldwide.

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 (derived from the ISO 18092, passive communication mode, standard). Tags compatible with these mandatory formats are available initially from Innovision, Philips, Sony and other vendors, and more than one billion tags are already deployed globally.

The NFC Forum chose the initial tag formats to cater for the broadest possible range of applications and device capabilities. Types 1 and 2, based on ISO 14443 A, have small memory capacity (1 and 2 kilobytes), which means they are low cost and suitable for single-use applications. They operate at relatively low speed (106KB per second), and are driven by specific command sets. Type 3 is based on FeliCa, and has larger memory (up to 1MB) and higher transfer speed (212KB per second). This means it is suitable for more complex applications, but also more costly. Type 4 is based on ISO 14443 and specifies memory of up to 64KB, with transfer speeds of between 106 and 424KB per second – making it suitable for multiple applications.

3 Touching people's lives in new ways

NFC makes people's lives easier and more convenient by building on existing systems and human behaviour. It will make accessing new media and content services more intuitive, make it easier to pay for things, easier to discover, synchronize and share information, and easier to use transport and other public services.

A study by ABI Research says that by 2007, higher-volume NFC deployments will be common – initially in mobile handsets, then in other kinds of consumer electronic devices, including PCs, set-top boxes, cameras and printers. Other devices and equipment likely to become NFC-enabled in the near future include: cash registers and other point-of-sale equipment; cash machines; posters, street signs, bus stops and points of interest; vending machines and parking meters; turnstiles, entry systems and door openers; and product packaging.

An important point to make here is that NFC is not enabling 'ubiquitous computing', where everything is connected to a network, but rather 'ubiquitous communication', where people have the choice to establish *ad hoc* connections appropriate to their needs at the time.

Potential NFC-enabled applications are endless, but Innovision has identified several that can be delivered profitably today, or in the near future. These fall into three categories: service initiation, peer-to-peer, and payment & ticketing.

3.1 Service initiation

In the service initiation scenario, the user touches an NFC-enabled device – such as a mobile phone – against a specially located NFC tag, which then typically provides a small amount of information to the device. This could be some lines of text, a web address (URL), phone number or other simple piece of data, which the user has decided to obtain.

One example of this type of application is the smart poster. This poster could be promoting some kind of new product or service, or an event, and by touching his or her device against an NFC tag embedded in the poster, the user receives the URL for a web site where the user can get further information or book tickets.

This type of application could also be useful for obtaining further information about a product in store, or for downloading information about medication, simply by touching the NFC-reading device against the packaging. There could also be applications in room climate control, where the user touches a particular point on a table to initiate control of the air conditioning, for example. Lone workers such as security guards could use NFC-enabled devices to 'check in' as they move around a building.

NFC tags have already reached a price point where it is feasible to print off batches of NFC stickers that enable users to create special 'short cuts' that make their lives easier. For example, when a child gets home from school, he or she could touch an NFC sticker just inside the door that sends an 'I'm home from school' message to a parent. Older people with poor sight or suffering from arthritis could have NFC stickers

containing friends' and family members' phone numbers saved on them – these could be stuck to the corners of photographs of these people and, when touched with an NFC-enabled phone, would initiate a phone call to the right person, without the need to look up phone numbers or use the keypad.

3.2 Peer-to-peer

In the peer-to-peer scenario, NFC is used to enable communication between two devices so that data can be transmitted locally between the two. If the amount of information is relatively small (up to one kilobyte), it is possible to use NFC to transmit the data itself. However, a more common peer-to-peer scenario is likely to be when NFC is used to establish another wireless connection method (such as Bluetooth or WiFi) to carry the information to be shared.

One example of this kind of application is when a user has taken a series of photos using a camera mobile or digital camera, and wants to print them out. The user simply touches the device against the NFC-enabled printer, and a Bluetooth connection is established to transmit the digital photos from the device to be printed out on the printer.

Peer-to-peer NFC communication could also be used in an Internet café to obtain the correct WiFi settings, without having to key them in manually. The user would touch his or her mobile phone on a spot on a table to download the settings, and then touch the mobile phone against his or her laptop so that the WiFi connection can be established automatically.

3.3 Payment & ticketing

Payment and ticketing applications were one of the drivers for the creation of the NFC standard. Banks and mobile network operators are very interested in putting payment and ticketing applications on NFC-enabled mobile phones. Research conducted by Visa International found that 89 per cent of those who tried phone-based transactions preferred its convenience to alternative payment methods.

Device manufacturers realized they needed a short-range communication standard that was compatible with the smartcard readers and other systems being rolled out by the transport industry. NFC enables smartcard payment and smart ticketing scenarios to be developed further by enabling any NFC-enabled device to be used as a payment and ticketing device – an 'electronic wallet'. Ultimately this would replace the myriad credit, debit, loyalty, pre-paid and other cards that people carry around in their wallets today.

Initially, however, NFC-enabled cards and devices are likely to be used for small payment situations, like vending machines and parking meters. In smart ticketing schemes, NFC-enabled mobile phones could be used to check how much credit is left on a multi-use smart ticket, without the user having to visit a ticket machine. Ultimately, when all the NFC reader infrastructure, transaction handling and security checking routines are in place, NFC-enabled devices could be used in any payment situation, just as credit cards are today.

NFC-enabled payment and ticketing are much easier and less costly to handle than cash and other traditional payment methods. In addition, users will have a record of even the smallest payments, which they do not with cash today.

4 Chips in everything?

Key to the commercial viability of NFC-enabled devices and applications is the capability and cost of NFC integrated circuitry, which could be applied to anything from low-value product packaging to high-value tickets. Critical to meeting this mass-market need will be platform-independent, memory-efficient and low-power NFC tags and other IC implementations.

Innovision R&T has adapted its expertise and technology developed in the successful Jewel™ RFID IC for limited-use smart ticketing applications to the needs of NFC equipment and application developers.

Innovision believes the first mass-market applications for NFC will be in relatively low-financial value applications – with low risk of fraud – that do not require large investment in new back-end infrastructure.

For example, low-cost NFC/RFID tags will be used in smart ticketing applications. Here, one benefit of having standardized NFC read/write protocols is that consumers can use their NFC-enabled phones to check how much credit they have left on a multiple-use ticket, without having to find a ticket machine. Only the existing smart ticketing infrastructure is needed for this to happen. Ultimately, once the phone-based payment infrastructure has been put in place, people will be able to use their phones as the ‘tickets’.

Likewise, in smart poster applications, people only need a standardized way to use their NFC-enabled phones to read the NFC/RFID tags in order to get the information they are looking for (typically a web URL or other piece of text).

4.1 Small, and inexpensive, is beautiful

An initial NFC mass market driven by low-cost, low-risk applications will drive the need for low-cost, low-power passive NFC tags. It will also demand the low-cost integration of NFC read-write capabilities into mobile phones and other devices.

To meet the need for a small, low-cost NFC IC that can be used in multiple applications, Innovision R&T introduced its Topaz™ NFC/RFID read/write IC family in 2006. The initial Topaz implementation measures approximately 0.59mm x 0.59mm and is designed to be compatible with ISO 14443 parts 2 and 3 – as well as being targeted for operation with NFC devices that work to ISO 18092 (NFCIP-1) and/or ISO 21481 – making it suitable for a wide range of NFC applications.

Topaz is suitable for use in NFC devices in reader/writer mode. An initial ‘request and answer’ communication cycle is set up between the device and the tag, which follows ISO 14443 and ISO 18092 standards, after which data can be read and written to (or cancelled on) the tag.

The first Topaz implementation is a two-terminal integrated circuit designed for connection to a loop antenna to produce a passive NFC/RFID tag operating in the 13.56MHz frequency band. It is based on a physical EEPROM array size of 120 bytes,

with the 96-byte user read/write memory area organized as 12 blocks of 8 bytes, which can be individually locked to be read-only or to prevent further modification of data. In addition there are 7 bytes of unique ID data – programmed and locked during manufacture – for use in data authentication or anti-cloning, and 6 bytes of One-Time Programmable memory, which can be used as single-use tokens.

Memory capacity has been deliberately kept relatively low, so as to keep the cost of the tag as low as possible. In most mass-market NFC applications, there is no need for large memory capacity on the tag, and any excess would simply be wasted.

For systems working on 16-byte blocks, the pairs of 8-byte blocks can be written to and locked together by the reader. There is also a command for reading all memory content in one go, rather than having to read each block separately to assemble the complete piece of data.

One key advantage of the Topaz NFC IC is that it has the storage capacity to hold up to 80 characters of text, which could be useful when storing the potentially long URLs needed on smart posters or on product packaging, for example.

Topaz has been designed to be customizable for a very broad range of applications, whether in stand-alone NFC tags or as an enabling IP block for System on a Chip (SoC) implementations.

5 Glossary

Bluetooth	Short-range (10–100m) wireless communication protocol
ECMA	European Computer Manufacturers' Association
ETSI	European Telecommunications Standards Institute
ISO	International Organization for Standardization
ISO 14443	ISO standard governing proximity smartcards
NDEF	NFC Data Exchange Format
NFC	Near Field Communication
RFID	Radio Frequency Identification
RTD	Record Type Definition
UWB	Ultra Wide Band
WiFi	Wireless Fidelity – wireless networking technology based on IEEE 802.11 standards
ZigBee	Short-range wireless communication protocol based on the IEEE 802.15.4 standard

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