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OPINION

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Near field communication (NFC): an expertise primer

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ABSTRACT

NFC is a short range wireless technology that allows communications to take place between devices that either touch or are momentarily held close together. The technology works via magnetic field induction and operates on an unlicensed radio frequency band. "Tags" are embedded within devices (these could be mobile devices such as mobile phones or PDAs, or NFC stations such as ticket barriers or cash registers). NFC enables devices that are held together to share information either in one direction or both. NFC is based on Radio Frequency Identification (RFID) technology, which is compatible with most of the contactless transportation and ticketing solutions that are commonly used around the world to enable quick and smooth flow of people within public transportation systems or ticketed environments. NFC is an open platform technology and was approved as an ISO/IEC global standard in December 2003.

Keywords: NFC; Communication; RFID; Bluetooth; Mobile.

Abbreviations: NFC - Near field communication; RFID - Radio-frequency identification; PANs - personal area networks.

1. INTRODUCTION

Near field communication, or NFC, allows for simplified transactions, data exchange, and wireless connections between two devices in close proximity to each other, usually by no more than a few centimetres. It is expected to become a widely used system for making payments by Smartphone in the United States. Many Smartphone's currently on the market already contain embedded NFC chips that can send encrypted data a short distance ("near field") to a reader located, for instance, next to a retail cash register. Shoppers who have their credit card information stored in their NFC Smartphone's can pay for purchases by waving their Smartphone's near or tapping them on the reader, rather than bothering with the actual credit card. Co-invented by NXP Semiconductors and Sony in 2002, NFC technology is being added to a growing number of mobile handsets to enable mobile payments, as well as many other applications (NFC Forum, 2011).

The Near Field Communication Forum (NFC Forum) formed in 2004 promotes sharing, pairing, and transactions between NFC devices and develops and certifies device compliance with NFC standards. A Smartphone or tablet with an NFC chip could make a credit card payment or serve as keycard or ID card. NFC devices can read NFC tags on a museum or retail display to get more information or an audio or video presentation. NFC can share a contact, photo, song, application, or video or pair Bluetooth devices (Mary Catherine O'Connor, 2006). The 140 NFC Forum members include LG, Nokia, Huawei, HTC, Motorola, NEC, RIM, Samsung, Sony Ericsson, Toshiba, AT&T, Sprint, Rogers, SK, Google, Microsoft, PayPal, Visa, MasterCard, American Express, Intel, TI, Qualcomm, and NXP (NFC, 2011).

2. HISTORY

NFC traces its roots back to Radio-frequency identification, or RFID. RFID allows a reader to send radio waves to a passive electronic tag for identification and tracking.

- 1983 The first patent to be associated with the abbreviation RFID was granted to Charles Walton.
- 2004 Nokia, Philips and Sony established the Near Field Communication (NFC) Forum
- 2006 Initial specifications for NFC Tags
- 2006 Specification for "SmartPoster" records
- 2006 Nokia 6131 was the first NFC phone
- 2009 In January, NFC Forum released Peer-to-Peer standards to transfer contact, URL, initiate Bluetooth, etc.
- 2010 Samsung Nexus S: First Android NFC phone shown
- 2011 Google I/O "How to NFC" demonstrates NFC to initiate a game and to share a contact, URL, app, video, etc.
- 2011 NFC support becomes part of the Symbianmobile operating system with the release of Symbian Anna version.

3. ESSENTIAL SPECIFICATIONS

NFC is a set of short-range wireless technologies, typically requiring a distance of 4 cm or less. NFC operates at 13.56 MHz on ISO/IEC 18000-3 air interface and at rates ranging from 106 kbit/s to 424 kbit/s. NFC always involves an initiator and a target; the initiator actively generates an RF field that can power a passive target. This enables NFC targets to take very simple form factors such as tags, stickers, key fobs, or cards that do not require batteries. NFC peer-to-peer communication is of course possible, where both devices are powered. A patent licensing program for NFC is currently under development by Via Licensing Corporation, an independent subsidiary of Dolby Laboratories. A public, platform-independent NFC library is released under the free GNU Lesser General Public License by the name libnfc (Fig.1).

	NFC
RFID compatible	ISO 18000-3
Standardisation body	ISO/IEC
Network Standard	ISO 13157 etc.
Network Type	Point-to-point
Cryptography	not with RFID
Range	< 0.2 m
Frequency	13.56 MHz
Bit rate	424 kbit/s
Set-up time	< 0.1 s
Power consumption	< 15mA (read)

Figure 1
Specifications

NFC tags contain data and are typically read-only but may be rewriteable. They can be custom-encoded by their manufacturers or use the specifications provided by the NFC Forum, an industry association charged with promoting the technology and setting key standards. The tags can securely store personal data such as debit and credit card information, loyalty program data, PINs and networking contacts, among other information. The NFC Forum defines four types of tags which provide different communication speeds and capabilities in terms of configurability, memory, security, data retention and write endurance. Tags currently offer between 96 and 512 bytes of memory).

- As with proximity card technology, near-field communication uses magneticinduction between two loop antennas located within each other's near field, effectively forming an air-core transformer. It operates within the globally available and unlicensed radio frequency ISM band of 13.56 MHz. Most of the RF energy is concentrated in the allowed 14 kHz bandwidth range, but the full spectral envelope may be as wide as 1.8 MHz when using ASK modulation.
- Theoretical working distance with compact standard antennas: up to 20 cm (practical working distance of about 4 centimetres)
- Supported data rates: 106, 212 or 424 kbit/s (the bit rate 848 kbit/s is not compliant with the standard ISO/IEC 18092)
- There are two modes:
- Passive communication mode: The initiator device provides a carrier fields and the target device answers by modulating the existing field. In this mode, the target device may draw its operating power from the initiator-provided electromagnetic field, thus making the target device a transponder.
- Active communication mode: Both initiator and target device communicate by alternately generating their own fields. A device deactivates its RF field while it is waiting for data. In this mode, both devices typically have power supplies.
- NFC employs two different coding to transfer data. If an active device transfers data at 106 kbit/s, a modified Miller coding with 100% modulation is used. In all other cases Manchester coding is used with a modulation ratio of 10%.

- NFC devices are able to receive and transmit data at the same time. Thus, they can check for potential collisions if the received signal frequency does not match with the transmitted signal's frequency.

4. IMPORTANTCE OF NFC

4.1. Reach and availability

NFC has the potential over time to be integrated into every mobile handset in the world. This would give the technology a potential reach as global as the mobile phone itself. By integrating NFC technology into a mobile handset, users could gain access to a number of new services via their phone.

4.2. Variety of use

NFC can be used for a number of tasks, from payment for goods to ticketing and from pairing devices to sharing information or discovering new services. Examples of these applications are outlined in this document.

4.3. Ease of use

Because NFC only requires that two devices touch in order to communicate, NFC can simplify many tasks, from opening a web browser on a mobile phone to pairing two Bluetooth devices automatically to accessing wireless hotspots simply and easily.

4.4. Security

NFC requires a user to actively wave or hold their mobile device against another device or NFC station to activate a service or to share information. In so doing, the technology requires the user to make a positive action to confirm the transaction or exchange. In addition it is possible to build multiple levels of security into an NFC enabled device.

4.5. Value added services

NFC enables users to access value added services that would otherwise be unavailable with a traditional ticket or payment card. Just as users of prepay mobile services are able to access their current credit balance through the phone's menu system, so users of an NFC enabled phone will be able to access similar information through their device. Furthermore, NFC enabled devices could access the mobile network to add credit to the device when it runs out or is low, or alternatively on a set date each week or month.

4.6. Infrastructure

NFC is compatible with the current contactless infrastructure used as a platform for ticketing, transportation, and increasingly payment, across the world. NFC mobile devices could easily be made compatible with the major transport systems world-wide that use contactless access to services, for example those based on the MIFARE system. It is also compatible with the increasingly popular "wave to pay" credit and debit cards that are being rolled out in many countries. The roll out of NFC to existing contactless environments is straight forward. Users know how the system works and much of the infrastructure is in place already. The roll out of NFC is an extension to services that already exist, but enhanced with the additional element of a mobile phone's user interface and a connection to the internet.

5. USES

Emerging NFC standards allow customers to quickly purchase products and transfer secure information by touching devices. NFC allows companies to reduce staffing, printing, and point of sale costs. Globally, 100 million people use mobile payment outside the U.S., but only 3.5 million use the technology in the U.S..

5.1 Applications of NFC

5.1.1 Ticketing and Payment

Many major cities around the world use contactless payment systems within the transport infrastructure. These systems rely on Radio Frequency Identification (RFID) smart cards to Provide access to transport services and tenable quick and convenient payment.Typically, a user purchases a plastic card with a certain monetary value embedded on a chip within the card. As the user accesses the public transport system, the cost of the ticket is taken from the card, leaving a new card balance. There is no need for users to purchase a card every day. Access to online top ups and monthly access fees also ensure less queuing at ticketing booths and the need for less staff. Ticket machines do not need to be emptied and single use tickets are not discarded.Whilst the service works well, the "smart" cards used within the system are not actually that smart. This is where NFC can add value to this existing application.By replacing a smart card with a NFC enabled mobile device, users can access all of the services they have with a smart card, with the added functionality of a user interface providing additional information (for example their current balance or the number of journeys left), as well as access via the mobile network to online top up facilities at the touch of a button. The phone could also use current mobile network technology to access the latest traffic information (such as when trains are delayed or cancelled) or mapping information.Users of an NFC enabled mobile device are not necessarily limited to topping up a card. It is possible to add a credit card element to an NFC device, enabling the user to "wave to pay" at any compatible station or retail outlet.It is also possible to add multiple separate credit or debit cards to an NFC mobile device. In this scenario, the mobile device becomes a "virtual wallet", carrying a number of different cards, some credit, some debit, some loyalty, within the device. Ultimately, the NFC mobile device could replace the need for a user to carry a wallet at all – providing a central facility for former cash transactions, debit card purchases and credit card facilities – all from one mobile device.

5.1.2 Touch to pair/Touch to share

A further application for NFC takes advantage of the data sharing capability to enable the simple and seamless transfer of data from one device to another, simply by touching the devices together. A number of activities associated with the transfer of data between devices require some degree of user interaction to set up. For example, many Bluetooth devices require a "pairing" process to take place before the devices can be used together. Whilst this is relatively straight forward, the functionality may not be immediately accessible within the menu system and the pairing process can be an inhibitor to using the technology. The most up to date core specification for the Bluetooth standard includes the capability to pair devices via NFC. Simply put, the whole process of activating Bluetooth on both sides, searching, waiting, pairing and authorisation on both sides can be replaced by touching the two devices together. This provides the user with a simple and engaging way to link Bluetooth enabled devices. In a similar manner, users of NFC could "touch to access" a wireless LAN hotspot.

Instead of the lengthy process of searching for a hotspot, accessing it and paying for use, a user could simply touch an NFC compatible wireless LAN point and the whole process could be automated, including the payment of any cost from the "virtual wallet" on the device.As the mobile device increasingly becomes the home for digital content, so the ability to easily share this content will become more compelling. NFC can enable an environment where people can touch devices to share business cards, touch to download their photographs to a printer, or touch to share their music with a friend. By embedding an NFC chip within a billboard advertisement or beside a product on the shelf of a retail store, users could touch to receive additional information. For example, an advertisement for a new record could allow users to touch to receive the track listings, download a free ringtone, or access the artist's mobile internet site.

5.1.3. Identity Management/Business Processes

Almost every office or factory based worker is required to carry an identity tag to access working premises. As businesses become more complex and global in nature, many workers require access to multiple premises. Managing this process can be complicated, even more so in environments where there are different levels of security for different workers. NFC can allow identity management to be added to a mobile device, providing one single integrated solution for identity management. The mobile device can be used to provide access to certain premises and, of course, deny access to others. Importantly, access can be upgraded over the mobile or wireless network, meaning workers are not required to physically visit a site to change their user profile. A further related application would be relevant anywhere that people are required to perform multiple tasks within a busy organisation. For example, a care worker that makes a number of home visits during a working day may "touch to inform" that a particular visit has been completed. The worker can then be assigned a new task based on what is most urgent or where the professional is located at that time. A security guard could touch on entering and exiting a room, providing a digital footpath of his movements during a patrol. A courier could touch on delivery of a parcel to receive local traffic information and directions to the next collection point.

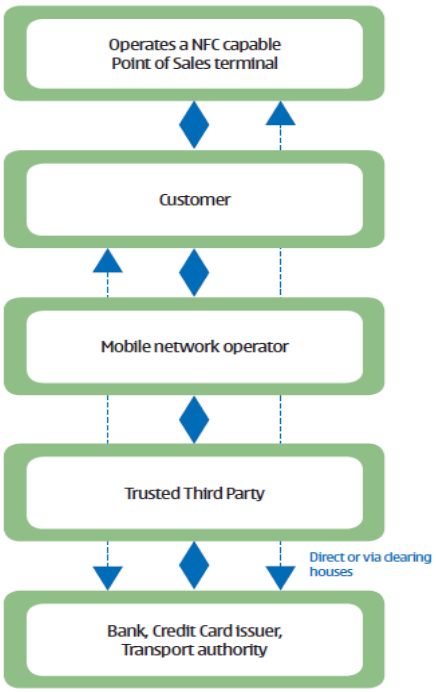

Figure 2
Payment through NFC

5.1.4. Further Applications

Many applications of NFC are clearly extensions to current solutions. Contactless payment and ticketing solutions are widely available across the world and, crucially, are compatible with NFC. Extending these applications to a suitably equipped mobile device will be the first steps on the road to NFC. However, to limit the technology to current scenarios is both unrealistic and unimaginative. More likely is that a number of applications will develop as the technology is rolled out. As more people use NFC and it becomes more ubiquitous, so further applications will be generated. To achieve this, an environment needs to be created within which NFC can succeed.

6. SECURITY

Although the communication range of NFC is limited to a few centimetres, NFC alone does not ensure secure communications. In 2006, Ernst Haselsteiner and Klemens Breitfuß described different possible types of attacks, and detail how to leverage NFC's resistance to Man-in-the-middle attacks to establish a specific key. Unfortunately, as this technique is not part of the ISO standard, NFC offers no protection against eavesdropping and can be vulnerable to data modifications. Applications may use higher-layer cryptographic protocols (e.g., SSL) to establish a secure channel. Ensuring security for NFC data will require the cooperation of multiple parties& device providers, who will need to safeguard NFC-enabled phones with strong cryptography and authentication protocols customers, who will need to protect their personal devices and data with passwords, keypad locks, and anti-virus software and application providers and transaction parties, who will need to use anti-virus and other security solutions to prevent spyware and malware from infecting systems (Fig. 2).

6.1. Eaves Dropping

The RF signal for the wireless data transfer can be picked up with antennas. The distance from which an attacker is able to eaves drop the RF signal depends on numerous parameters, but is typically a small number of metres. Also, eavesdropping is highly affected by the communication mode. A passive device that doesn't generate its own RF field is much harder to eavesdrop on than an active device. One Open source device that is able to eavesdrop on passive and active NFC communications is the Proxmark instrument.

6.2. Data Modification

It is relatively easy to destroy data by using an RFID jammer. There is no way currently to prevent such an attack. However, if NFC devices check the RF field while they are sending, it is possible to detect attacks.It is much more difficult to modify data in such a way that it appears to be valid to users. To modify transmitted data, an intruder has to deal with the single bits of the RF signal. The feasibility of this attack, (i.e., if it is possible to change the value of a bit from 0 to 1 or the other way around), is amongst others subject to the strength of the amplitude modulation. If data is transferred with the modified Miller coding and a modulation of 100%, only certain bits can be modified. A modulation ratio of 100% makes it possible to eliminate a pause of the RF signal, but not to generate a pause where no pause has been. Thus, only a 1 which is followed by another 1 might be changed. Transmitting Manchester-encoded data with a modulation ratio of 10% permits a modification attack on all bits.

6.3. Security for payment option's

Security is a critical requirement for NFC payment and ticketing and as such, it is important to understand the security within an NFC enabled environment.Mobile phones tend to come equipped with pass code that can be activated by the user. While many users activate these to secure their phone, an NFC enabled mobile device, especially one that could incorporate a number of credit and debit cards, needs to have a higher level of security to reassure the user against misuse.Inherently, NFC technology is built with a high level of security. Users can activate several options in order to store their data in a secure environment.A user can set a financial limit beyond which a pass code is required to authorise payment, or a user can also arrange for the mobile wallet

element of the phone to be switched on for only, say two minutes at a time. Further credit card and/or debit card applications could be activated only with a user pass code. An NFC enabled credit/debit card or ticketing application is held within a secure element of the mobile device. Using the same technology as chip and PIN cards, this secure element is certified and supported by the payment industry, providing as high a level of assurance to the end user as a traditional credit card.

7. PROPOSED WORKS

7.1. INDIA

7.1.1. Tata DoCoMo, Megasoft XIUS ink pact on mobile touch solutions

(On Feb 16, 2011) IT firm Megasoft XIUS announced signing of an agreement with Tata DoCoMo to deliver mobile touch transaction solutions, based on near field communications technology. NFC is commonly used in malls, toll plaza and smartcards used by passengers in metro trains. The new service will enable Tata DcCoMo to provide anytime, anywhere electronic talk time recharge, bill payment and other value-added services in self-service mode. Tata DoCoMo will run trial of MTT services within Hyderabad, according to an official press. Initial transactions will include mobile phone top-up, download of ringtones (Polytones) and wallpaper. The MTT solution offers opportunity to increase retail points of presence, provide self-service to more non- traditional top-up and other value-added service points, like coffee shops and others through self-service Active Posters- part of offering from Xius, said the company. Active Posters or APs are a type of printed electronic technology with paper-thin self-service terminal device and glass touch sensing.

7.2. WORLD

7.2.1. Google Wallet

Google announced Google Wallet way back in May after months of rumours regarding a NFC (near field communications) system. Dubbed Google Wallet, the application represented a partnership between Citi, MasterCard, First Data and Sprint and promised Nexus S users the ability to pay for goods as well as store credit cards, offers, loyalty cards and gift cards. Today, Google launched Google Wallet for the public via an over the air (OTA) update. "We've been testing it extensively, and today we're releasing the first version of the app to Sprint," said Google's Osama Bedier, Vice President of Payments. "That means we're beginning to roll out Google Wallet to all Sprint Nexus S 4G phones through an over-the-air update—just look for the Wallet app." While Citi and MasterCard are launch partners, Bedier today revealed that Visa, Discover and American Express will be a part of future versions of Google Wallet. The company's goal is to eventually support all payment cards so that you can ditch your wallet altogether.

7.2.2. Inclusion of Technology in Handset

Both Blackberry and Nokia are betting high on the NFC technology. While Nokia has announced all there handset's to support NFC, Blackberry has recently launched their Bold 9900 with the same technology. Nokia has a critical role to play in the development of NFC. For the technology to become mainstream, the number of devices supporting NFC will need to be measured in the hundreds of millions. Because of Nokia's position in the global mobile handset market, it is uniquely positioned to play a significant part in enabling this. Many of the key players in creating an NFC environment are companies that Nokia has a relationship with through its current businesses. For example, Nokia has a close relationship with mobile network operators across the world and this partner-ship will be critical to ensure the success of NFC. Furthermore, Nokia regularly partners with SIM card providers, chip manufacturers, applications developers and industry bodies such as the GSM Association, all of whom have an important role to play in the development of NFC..

7.2.3. NFC Companies Prepare for Windows 8

Near Field Communication (NFC) technology vendors are already aligning themselves to provide solutions that could be used with Microsoft's upcoming Windows 8 operating system (OS), which will include built-in NFC functionality, according to Microsoft's product presentation and demonstration offered at the company's Build developer conference, held on Sept. 13-16, 2011. Although Microsoft has yet to set a date for the product's release, the company reports that the new system will include an NFC function known as "tap to share," enabling Windows 8 PCs, laptops or tablets to support NFC RFID readers. In that way, the firm indicates, the computing world will join a limited number of mobile phones that are NFC-compatible, acting as 13.56 MHz passive NFC readers and writers that can interrogate tags and capture as well as send data wirelessly when within range of those tags.

8. CONCLUSION

While NFC solutions are constantly evolving, introduced to market, and the subject of new research, we have learned from out research NFC applications have started to make an impact across diverse fields from health care to education.

SUMMARY OF RESEARCH

NFC is a short range wireless technology that allows communications to take place between devices that either touch or are momentarily held close together. The technology works via magnetic field induction and operates on an unlicensed radio frequency band. "Tags" are embedded within devices (these could be mobile devices such as mobile phones or PDAs, or NFC stations such as ticket barriers or cash registers). NFC enables devices that are held together to share information either in one direction or both. NFC is based on Radio Frequency Identification (RFID) technology, which is compatible with most of the contactless transportation and ticketing solutions that are commonly used around the world to enable quick and smooth flow of people within public transportation systems or ticketed environments. NFC is an open platform technology and was approved as an ISO/IEC global standard in December 2003.

FUTURE ISSUES

Similar to mobile advertising and mobile locations services currently under scrutiny, NFC has the potential to raise privacy concerns, as the technology has the potential to collect a wide-range of consumer-behaviour data, including financial and location-based information

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