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The Next Mobile Revolution: Near Field Communication (NFC)

Shabnam Kaur[1]
Principal
KMS College of IT and Management
Affiliated to IKG Punjab Technical University
kmscollegedasuya@gmail.com
Manav Saini[2]
Director
KMS College of IT and Management
Affiliated to IKG Punjab Technical University
manavsaini@yahoo.com

Abstract : *In this paper, we explore new ways in which Near Field Communication (NFC) can be used on smart phones. Imagine a world where a tap of your mobile phone provides secure, keyless, and card-less access to your home, car, hotel room, workplace even mass transit automatically paying and checking you in as necessary. Or maybe you wave your mobile device at a product or an advertisement to access more information, read reviews, and compare prices with other suppliers in your local area. Even walk through a museum or gallery and launch companion audio and video presentations to enhance your experience with a swipe of your phone, connecting the virtual world to your physical world. This Paper presents the promises and the pitfalls of NFC technology that will change the coming world.*

I. INTRODUCTION

NFC is a radio technology that supports transactions at distances of a few centimeters. Near field communication (NFC) is a standards-based wireless technology that is typically implemented as a chip in a mobile phone or other mobile device, or in a card. It enables short-range communication between the NFC-enabled device and another NFC device, reader or tag generally with just a wave or a tap of the device. As such, it can be used for an almost limitless range of applications, including mobile payments. As a technology, NFC traces its roots back to work done by Sony and Phillips, which led to an accepted ISO standard for NFC in 2003. It is essentially an outgrowth of RFID (Radio Frequency Identification) technology the basis for various contactless payment applications. The technology gained traction in 2004 when the NFC FORUM was created 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 organization also offers a certification program for NFC--enabled device manufacturers to provide credibility and assurance that the manufacturer's device conforms to NFC Forum specifications. NFC standards cover communications protocols and data exchange formats, and are based on existing radio-frequency identification (RFID) standards. NFC is a set of short-range wireless technologies, typically requiring a distance of 10 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 possible, provided both devices are powered.

We envision widespread adoption of NFC in future generations of smartphones. We envision widespread adoption of NFC in future generations of smartphones. The primary driver for the adoption of NFC on cell phones is contactless payments and ticketing. NFC, in the form factor of a credit card, has been used widely in Japan and Hong Kong for many years and now in San Francisco : for public transportation, vending machines, and convenience stores. A third important use of NFC is for making connections between electronic devices--simply touching the devices together will configure them to connect over a longer-range protocol such as Bluetooth or Wi-Fi.

So, what is NFC and how is it different from other wireless technologies, such as Bluetooth and Wi-Fi?

A. Differentiating Characteristics

NFC is a two-way, peer-to-peer wireless technology that differs from most wireless technologies in a number of important ways, including the following:

1. Limited range: NFC is inherently short range, unlike other wireless technologies. From a practical perspective, it can share data and power over a distance of approximately four centimeters, or a little more than one and a half inches.
2. Speed: NFC is typically slower than alternative technologies, such as Bluetooth and Wi-Fi
3. Power: consumption NFC requires less power than most other wireless technologies.
4. Simplicity: NFC-enabled devices don't require a set-up or pairing process to work with each other, unlike Bluetooth or Wi-Fi. In fact, NFC can be used to establish the connection between such devices and then hand it off for longer-range communication.
5. Active or passive: NFC features can be used by active, powered systems such as cell phones, or can be passive sticker-type labels similar to RFID tags.
6. Security: In large part, NFC's security features derive from the fact that NFC-enabled devices are extremely short range. Mobile phones, tablets, or other devices must be in close physical proximity to communicate using NFC. For additional security, communications can be encrypted- and in applications where security is important, many already are-although the NFC specification does not require encryption.

B. Advantages

According to the NFC Forum, NFC offers a number of important advantages. It is simple and intuitive, and inherently application-agnostic, so it versatile enough to be used in a broad range of industries and applications. It's also sufficiently flexible to work with existing and legacy technologies, such as contactless cards.

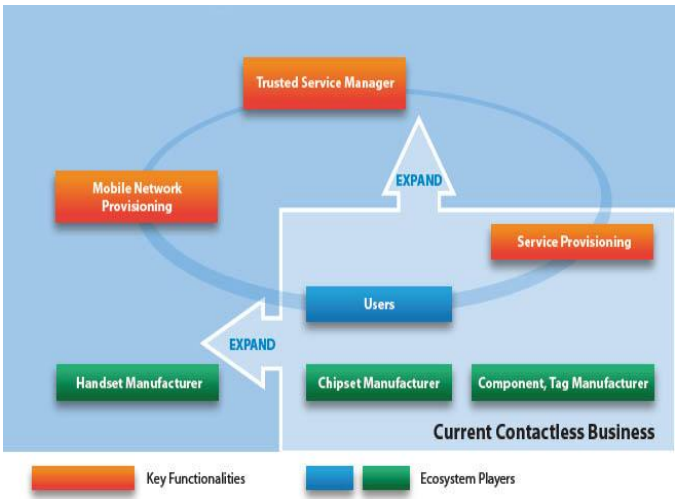
The technology itself is open and standards based, facilitating interoperability. Because its range is severely limited, it offers security advantages over other wireless technologies especially when combined with certain built-in security capabilities.

Finally, it can be used to set up or enable other wireless devices that would otherwise require more complex processes, including Bluetooth and Wi-Fi.

NFC-enabled devices are commonly, but not necessarily, mobile phones. When NFC is implemented in a smartphone or other device containing memory and a processor, the potential sophistication of its NFC-enabled applications increases as a result.

II. ECOSYSTEM

The ecosystem for NFC is a complex one particularly when it comes to phone-based financial transactions and involves collaboration among a range of research and manufacturing organizations, telecoms, merchants and other consumer-facing businesses, financial institutions, and consumers. NFC mobile services are an important emerging area for NFC technology with great potential for growth.



As shown by the arrows in the above diagram, the current contactless business domain is expanding into domains including NFC mobile business opportunities. In some mass market businesses such as transport or payment, a contactless infrastructure already exists in a growing number of schemes, and users have some experience with those contactless services. The NFC Mobile Phone will enhance these existing services and provide opportunities for new revenue sources. The NFC Mobile Ecosystem can

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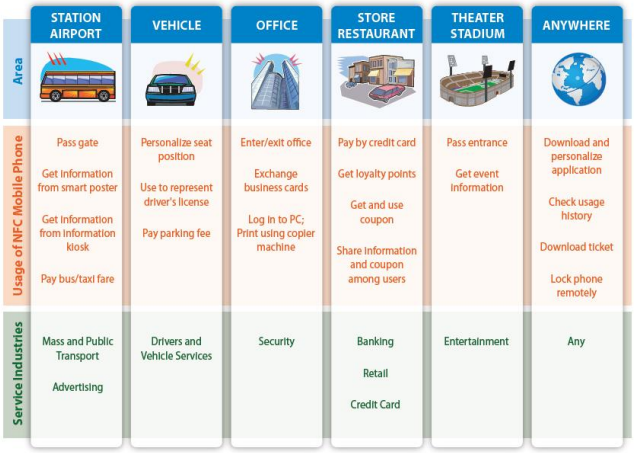
be built as a new marketplace, and its success depends on the win-win relationships among all the stakeholders. The NFC Mobile Ecosystem extends the current contactless ecosystem model with additional functionality. There are multiple possibilities for ecosystem players to provide these mobile system functionalities.

III. APPLICATIONS

Enter NFC with its promise to consolidate all the contents of our wallets and so much more. When the functions of a contactless card are combined with the wide variety of functions of a mobile phone, the card evolves into a device whose resulting value is greater than just the value of the two devices added together. This newly defined device is an NFC Mobile Phone. It is an intelligent mobile network-enabled device that can connect with other NFC devices in close proximity (hence the term Near Field Communication). This unique combination of both mobile and NFC technology enables users to enjoy innovative services. Users can access myriad NFC services in their daily lives by having an all-in-one personal device that provides them with a highly personalized and interactive environment.



The above picture shows a typical day in the life of an NFC Mobile Phone user s and how the device will be integrated into everyday life in the near future.

A. Travel and Transportation

A gated system at the station like Metros equipped with NFC readers/writers, allowing entry only to passengers with legitimate tickets read from contactless cards or devices. One has bought a train ticket that is stored in his contactless card or his NFC Mobile Phone. He enters the gate by touching his contactless card or his NFC Mobile Phone to the reader/writer and is granted access. The same action occurs at the destination station in order for him to exit. The NFC Mobile Phone brings services in addition to those enabled by a contactless card. One can download and purchase a new ticket using his NFC Mobile Phone without the need to go to a physical ticket booth. While waiting for a train, he can touch his NFC Mobile Phone to a nearby information kiosk to obtain the latest updated train information and local information such as maps and the weather forecast, transferred directly to his phone. As some transport systems rely on an honor system and don't have gated systems, Eric can touch his NFC Mobile Phone to a ticket confirmation machine, thereby activating the ticket and recording the activation time. During his travel, a train conductor may confirm his ticket activation using a portable NFC reader/writer device. The concept of using NFC Mobile Phone for faster check-in is equally applicable to the rental car and the hotel / hospitality sectors as well.

B. Mobile Payments and e-Commerce

It is assumed that the growing popularity of NFC Mobile Phones will provide an incentive to retailers to enhance the functionality of their current Point-of-Sale terminals equipped with NFC readers/writers so that they can read coupons from NFC Mobile Phones. It is also assumed that retailers and consumer goods manufacturers will offer a variety of mechanisms to obtain coupons, such as a "push" or "pull" to

NFC Mobile Phones or reading them from conveniently placed smart posters. Using NFC Mobile Phone, User chooses which credit/debit card application to pay with, depending on whether his lunch is a business or personal expense. He can link to a mobile banking site to check the balance of a credit/debit card prior to making a payment or view his usage/purchase history. He can receive messages indicating that the balance of a credit/debit card is low or indicating that a payment to a credit card is due. Depending on the transaction amount, Eric may be prompted by the NFC Mobile Phone to authorize the payment. For example, authorizations might range from simple and quick confirmations in the case of lower amounts all the way to special authentication mechanisms such as biometrics for large amounts. Upon entering the shopping center, User touches his NFC Mobile Phone to a conveniently located kiosk and Receives shopping center loyalty points for returning to the center, Receives information linking the current coupons on his NFC Mobile Phone to stores within the center offering those consumer goods and possibly additional discounts, Receives special offers customized to his profile directly to his NFC Mobile Phone. Walking through the center, User notices a smart poster offering him a discount on a product that he has been considering purchasing. User touches his NFC Mobile Phone to the poster to retrieve the coupon. User chooses some products to buy in a store, and during the checkout process he touches his NFC Mobile

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Phone to the Point-of-Sale terminal to automatically redeem coupons matched to the items he is purchasing and make the purchase also receive new special offers for future purchases customized to his profile. User can check the history of purchases and remaining loyalty points on his NFC Mobile Phone whenever he wants.

C. Gaming and Other Entertainment

Out of all the activities that people perform on their mobile devices gaming tops them all. Mobile gaming is another space that is seeing the effects of NFC. Few moths back, Rovio announced the launch of Angry Birds Magic, which connects the company's popular mobile game to the physical world using NFC and GPS. Players using supported devices can tap their phones together or wave them in front of Angry Birds NFC stickers to unlock new levels and birds in the game. The latest game to get the NFC treatment is Fruit Ninja, another very hot game for iOS and other mobile platforms. Like Angry Birds, this new version of Fruit Ninja will enable players to unlock features - in this case, shiny new blades with which to massacre fruit. NFC can also be used to initiate two-player gaming. Like movies? One day soon, people will be able to use NFC to purchase tickets or other events, such as concerts, museum showings, and theater performances. Swipe an NFC tag to see the movie's trailer or launch an audio or video clip.

Instead of just looking at a small screen and pressing buttons, Nokia's new class of "tangible" games let you have fun-naturally-in the real world with physical objects, just as you would when playing traditional family and party games. In addition, you can play these games alone or with friends anytime and anywhere using any NFC tags you already have. There is no need to wait for merchants to set up posters or tags, and you can use the same tags with any number of different games. NFC mobile games can go beyond making simple real-life games interactive by offering discounts and rewards for your customers playing.

D. Secure Identity and Authentication

How does any person or any entity know that you are you, either online or in the physical world? User names and passwords, student IDs, employee IDs, government IDs, driver's licenses, healthcare cards, insurance cards, the list of personal credentials to support your identity goes on and on. Many believe that the smartphone (or other similar mobile device) will be the secure hub to manage all aspects of person's identity, and NFC may play an important role in that. In fact, over time, identity and credential management may rival mobile payments as the killer app for NFC, and become a significant revenue source for a company able to position itself to claim leadership in this space.

E. Access / Keyless Entry

An extension of NFC's-enabled tags and readers offer the potential to consolidate and replace the handful of keys and access cards most people carry with them throughout the day. NFC credentials can provide for keyless access to homes, offices, and other commercial buildings, cars, parking garages, as well as hotel and motel rooms to name just a few. Most colleges and universities, and many corporations already use NFC-capable readers to control access to secure buildings.

F. Social Networking

NFC has high potential to enhance social media engagement. Imagine a quick tap of the phone and within an instant, a consumer has posted your content to their Facebook or Twitter. With NFC allowing the constant sharing of information, your consumers can circulate and share branded content, increasing your brand visibility within the social space. Further, NFC tags available on your storefront and other posters can allow customers to quickly download information such as hours of operation, other locations and reviews and share this information with their friends. Similar to social media engagement, location-based networking will allow content sharing to soar. Imagine the possibilities of allowing your customers to check in with a tap of their phone and connecting with others who have already checked in at the same location. Real time sharing of photos and comments as you are experiencing them is invaluable, as is providing your customers unlimited opportunities to share and spread content your content.

G. Bluetooth and Wi-Fi Connections

NFC devices do not require pairing or configuration processes to communicate unlike Bluetooth and Wi-Fi. As a result, NFC can dramatically simplify both Bluetooth and Wi-Fi communications. Tap two NFC-enabled devices for instant Bluetooth pairing. To configure a Wi-Fi network, tap an NFC-enabled device to an NFC-enabled router. After the handover from NFC to Bluetooth or Wi-Fi, the devices can move beyond NFC range without losing contact and data transfers at faster Bluetooth or Wi-Fi speeds.

H. Smart Objects and Content Delivery

NFC ability to connect people to information what has been referred as ability to hyperlink the physical world is a remarkable application. NFC stickers can add content and intelligence to a virtually limitless range of physical locations and commonplace items, such as posters,

advertisements, coupons, gifts, products, and pharmaceuticals to name just a few. There's even an application to read NFC tags on gravestones, providing the human story of the deceased. Google is providing NFC-enabled window stickers to local businesses in test cities as part of the rollout for its Google Places and Hotpot local recommendation services. This use of NFC holds broad promise for the delivery of healthcare. Smart tags can identify physical items such as rooms, beds and medications. NFC can also deliver secure content, including personal healthcare data, patient history, remote monitoring data, diagnostic tools, and treatment recommendations. One NFC application connects to a post-surgery kit that allows doctors to remotely monitor progress and check for signs of complications. As a result, patients can return home sooner. Another application links the NFC device to a diagnostic sensor that enables self-testing for a range of conditions and diseases, including pregnancy, drug allergies, and AIDS. Home healthcare workers use NFC-enabled mobile phones to track the date and time of visits and record the services provided.

IV. CHALLENGES TO ADOPTION AND POTENTIAL OPPORTUNITIES FOR INNOVATION

Despite the promise of NFC technology and the burgeoning interest, there are hurdles to widespread adoption that must be overcome before the technology is integrated into everyday life. Among them are security and privacy issues, consumer apathy or ignorance about the technology and its potential benefits, an underdeveloped infrastructure, and a lack of coordination among all the players in the ecosystem. These areas also represent opportunities for entrepreneurs who can leverage their expertise to move adoption forward.

A. Security and Privacy Concerns

Not surprisingly, security and loss / theft of the device are top concerns for consumers. According to data compiled by Compete, people who were not inclined to use their phones for mobile payments cited security issues and loss of their phones leading to unauthorized access to their bank accounts as major reasons why they won't. Such concerns are not unique to NFC applications and the fact that NFC technology requires devices to be within a few centimeters to transmit data is a definite advantage in terms of security. The close proximity limits the opportunity for data theft, eavesdropping, and hacking. The use of encryption, PIN numbers, and designs that isolate sensitive information from the device's operating system can provide additional security. NFC payment options afford another security advantage in that consumers aren't required to surrender credit or debit cards to a server or other salesperson for payment, which can often involve taking the card out of sight or into another room for processing. However, critics claim that NFC, like other competing technologies, still has security vulnerabilities that must be addressed, including signal jamming, spyware, and malware. The possibility of loss or theft of a mobile phone or other NFC device is a very real concern. Suppose you accidentally leave your phone in a public place, or someone steals it. What are the protections to ensure that this unscrupulous person cannot access your bank accounts, home, hotel room, or workplace? A variety of solutions are being considered and, in some cases developed, which include coding, encryption, and password-protected devices. Remote locking capabilities and remote data wipes are other examples. Privacy advocates have also expressed concern about the amount of personal data that would be available to carriers when personal information, such as bank account numbers and shopping habits, are transferred to smartphones. Adequate safeguards and boundaries with regard to acquiring, sharing, selling, and protecting data are still being drawn for other technologies, and NFC will be subject to the same concerns and potential solutions.

B. Consumer Adoption

Early adopters may try anything, but mainstream consumers need a compelling use case to drive their adoption. When it comes to the general public, some express concern that mobile payments may simply be a solution in search of a problem. Others refer to it as a solution in search of a value proposition. For many people, they argue, removing a credit card or contactless card from a wallet to pay for a purchase is not a major inconvenience. In addition, mobile wallets may never completely replace a physical wallet, which consumers use for more than payment cards, driver's licenses and plain old cash, for example. So how can you make customer's payment experiences significantly better? Retailers see benefits and cost savings from moving customers through their stores faster and more efficiently or getting additional value from their customer loyalty programs. But they still need to convince consumers that NFC technology offers something more convenient and faster than our engrained credit card and cash payments systems. Most retailers have investments in existing automated systems that they and their customers currently use, and there is understandable concern that the transition from these legacy systems may be frustratingly long and difficult. There are also competitors to NFC vying for merchant and customer acceptance. The challenge for NFC is to ensure

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that the experience is markedly faster and easier than that afforded by other technologies.

C. Infrastructure Development

Mobile payments may very well be the significant app to drive adoption of NFC, but it requires a supporting infrastructure that has not fully developed. The lack of infrastructure resulted in a chicken and egg scenario merchants were reluctant to invest in upgrading their terminals for NFC when there weren't payment-enabled devices available in the market, and consumers had little reason to buy NFC phones if there weren't places to use them. Only a small number of the mobile phones and smartphones currently on the market have NFC capabilities, although predictions for growth are significant. However, recent history suggests that NFC may not be introduced to the marketplace as fast as evangelists for the technology expect. According to some, the biggest obstacle to the emergence of NFC at the retail level may very well be merchant resistance-both in terms of complexity (if adding NFC means supporting multiple payment systems) and potential costs. As a result, the deployment of NFC systems that also support contactless cards and other legacy systems is a vital element in the transition. Ensuring that the new systems won't dramatically increase transaction costs for merchants is another important success factor for adoption.

D. Industry Collaboration

Widespread adoption of NFC as a basis for mobile payments requires collaboration throughout a particularly complicated ecosystem. The main obstacle cited by respondents is the still undeveloped ecosystem among all the players, including mobile device manufacturers, carriers, retailers, standards and platform developers, and banks. Even in countries where cross-industry collaboration and standardization exist to drive NFC access, adoption and usage are poor. Investments in mobile NFC payments will fail if financial firms neglect customer attitudinal factors. Singapore and Hong Kong are currently experiencing this challenge.

V. CLOSING REMARKS

Any fundamental change requires a compelling story, especially when that change impacts habitual behaviors and entrenched process and technologies. The NFC Mobile Ecosystem is an expansion of the current contactless ecosystem, mainly targeting contactless card businesses. To be attractive and successful, it must create value, and to achieve that goal, it requires the addition of new functionality on top of the current card business. On the other hand, depending on the marketplace, the NFC Mobile Ecosystem must be open enough to support the variety of existing and future models. To be successful it must support a win-win relationship among all the ecosystem players. NFC mobile services are at an emerging stage. The contactless card business and the mobile communication business have developed on different paths and have different business cultures. To create and expand the new ecosystem, the participation of new players from different business domains should be encouraged.

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First Author Shabnam Kaur received MCA in 2003 from IGNOU, M.Tech in 2012, & M.Phil. in2009. I served as Senior faculty at EMTECH Computer World (IAP of IGNOU)from May 1996 to June 2001, as Center Head at EMTECH Computer World, Mukerian (PTU Learning Center) from June 2001 to April 2003, as Principal at Chaudhry Public School from April 2003 to March 2006, as Director Brilliant Student Center from April 2006 to July 2008, as AP at Satya Devi Mittal Public Co-Education College from Aug. 2008 to June 2013 and Now as PRINCIPAL with KMS College of IT & Management to till date.

Second Author Manav Saini, B.E. in computer Science, M-Tech, MBA