

NFC Technology: Today and Tomorrow

Hongwei Du

Abstract—Technology in the mobile industry has been moving towards integration of Near Field Communication (NFC) technology into mobile commerce. Low estimates show that by 2014 over 150 million mobile devices will be NFC capable. The driving force behind NFC is the public's ever increasing dependence on, and demand for smart phone functionality. This trend provides many easy ways for businesses and consumers of mobile commerce to conduct all varieties of transactions using NFC integrated on mobile devices. The many benefits and potential uses of NFC technology will continue to drive the technology and push innovation in the application fields.

Index Terms—Near field communication, NFC technology, M-commerce, mobile communications

I. INTRODUCTION

As we are living in a digital world today, most of our daily activities involve the digital technology around us. E-commerce is one of the most popular developments in communication between business and consumer transactions. In the recent years, advancements in technology have allowed us to migrate to the development of Mobile-commerce. Mobile-commerce is the ability to conduct commerce and transaction using a mobile device such as smart phone or other mobile device. It has become one of the most essential and fundamental bridges to the completion of our daily tasks in an efficient and effective manner. The integration of NFC technology in mobile devices has been expanding; it allows us to be connected to a variety of Mobile-commerce opportunities in every part of our lives. Evolving from Radio Frequency Identification (RFID) technology, NFC is developed from short range radio communication technology which brings two NFC-compatible devices together in less than four centimeters. NFC chips are embedded in device that can send encrypted data at a near field to reader located to conduct transaction. This technology is becoming very popular and soon we will be using it almost every day in our daily lives. NFC was developed by Sony and Philips in late 2002. Up to present, there are over 140 NFC forums and 130 countries are participating in such advance technology.

To envision for future benefit from the integration of NFC technology into mobile device, Smart home and smart health will be the next development of such technology. We will be able to use our mobile to control our home appliance at home with the NFC tags; or we will be able to use our phone to identify our healthcare identification. Currently,

Apple is actively pursuing development of mobile payment system employing NFC for new generations of iPhone, iPod, and iPad. Google has announced the Google wallet and Android application that will make use of NFC to payment at store. Research In Motion will development NFC technology for the nextversion of Blackberry. We shall be expecting more and more parts of our lives involving with the NFC technology in the near future.

II. CURRENT USES OF NFC TECHNOLOGY

NFC technology is gaining significant traction as the next big thing. Low estimates show that by 2014 over 150 million mobile devices will be NFC capable [13]. The driving force behind NFC is the public's ever increasing dependence on, and demand for smart phone functionality. People are using their mobile devices to make life easier through the use of thoughtful applications. Mobile phones are now being used much more in place personal computers, and the trend is rapidly growing. Seeing this rising trend, Innovative technology companies are finding new ways to simplify people's lives by combining mobile devices with the use of ultra-short radio waves. Most of the innovation of NFC is so new that many of the applicable uses are still being perfected and are on the brink of production. However there are some uses that are already available and providing a glimpse of what is to come.

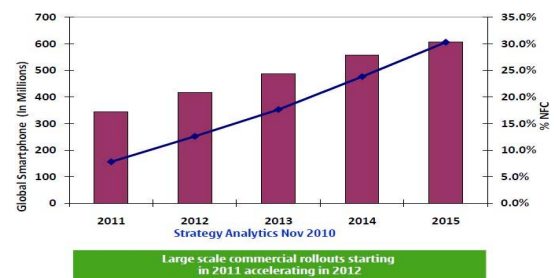


Fig. 1. Source NFC forum Dec 2010

III. MOBILE COMMERCE

For many people, having an ample amount of cash on hand can often be a challenge. Many of us have found ourselves at a dinner party without enough cash to throw in to the communal tab, or at cash only retail stores having only brought our credit card. Rather than having to unexpectedly run to the nearest ATM and pay a 5 dollar fee to withdraw cash, one can now use NFC technology on their mobile device to pay for things in a new ways. This is a popular new idea. A recent Canadian study done by PayPal revealed that 34% of those polled would rather use mobile devices to pay for things than traditional hard currency [19].

A. Consumer to Business Transactions

Major mobile device makers such as Nokia, RIM,

Samsung and Motorola are teaming with Google and making NFC technology available in their newest phone releases [26]. Major financial institutions and credit card companies are teaming with the mobile developers to make easy to use applications for consumers to exchange funds with business.

Google is the most prominent player in this aspect of mobile commerce with its Google Wallet application. Google's app is already available on the sprint network and uses Citigroup and MasterCard as the financial intermediaries for consumers to pay for goods and services at participating merchants [1]. Google claims that currently, over 300,000 merchants are already set up to accept Google Wallet payments [13].

The technology works like this. Google provides pay pass mobile payment terminals to merchants. Google also provides the downloadable Google wallet application to mobile phone users with installed NFC chips. The application allows users to set up a virtual credit card or pre-paid card using MasterCard or Citibank. When the user purchases goods at participating retail stores, they can pay for the goods simply by tapping their mobile device on the Google Payment terminal which reads the payment information through the NFC medium [4]. Currently, companies such as Macys, Whole Foods, CVS, Jamba Juice, Petco, and 7 Eleven are set up to accept Google wallet payments [13]. The Technology is also beneficial to the merchant because Information can be instantly gathered about the shoppers buying habits for marketing purposes [7].

Currently about 10 percent of retail establishments are set up to accept payments for goods using Pay pass NFC enabled mobile devices [26]. However, Google plans to grow the list of available financial institutions and the number of retail stores significantly in the near future. The current growth plan involves Google specifically focusing on the consumer applications while the credit card companies and banks will focus on furthering the use of NFC terminals amongst merchants [7].

B. Peer to Peer Mobil Payment

Another form of Mobil commerce that is newly available through the use of NFC technology is person to person financial exchange. Released In July 2011 PayPal has updated its Android mobile app to allow for person to person financial transactions. The technology allows a person to send payment to another person simply by tapping NFC enabled phones together [4]. In peer to peer payment niche PayPal faces competition primarily from startups like Square, a startup with heavy financial backing which uses Non-NFC technology in its mobile payment applications for the iPhone [8].

One roadblock to NFC domination is the lack of NFC integration for mobile payment in the iPhone platform. Recent insights show that Apple is partnering with a company called square to develop mobile payment functionality. Square uses a small credit card reader that attaches to the iPhone allowing virtually anyone to accept credit card payments [8]. Though NFC faces strong competition there is no doubt that simplicity will be a major determining factor in deterring popularity amongst users.

C. Mobile Coupons

Another way NFC technology is changing way business is done is through the use of mobile coupons. Instead of

clipping coupons from the local newspaper, a consumer can now redeem a mobile coupon with a NFC enabled mobile device. Google again is the primary innovator in this niche with its Google offers platform. Similar to Groupon, Google offers sends out daily deal type coupons to the email inbox of consumers and integrate Google wallet. The consumer can redeem the coupon by tapping their FC mobile phone on a Google Pay Pass reader at a participating merchant [13]. This further shows how NFC has the ability to radically change the way companies market to consumers allowing for more direct, specified targeting based on personal wants.

IV. NFC CORPORATE / HOME SECURITY

NFC technology is making things easier and more secure in the home and workplace. Though technology has already increased productivity, NFC is providing new innovative ways to conduct basic functions and make home living easier. The major concept driving NFC innovation in the workplace is similar to that in the mobile payment sector. Take an everyday workplace task and make it faster and easier and more secure by allowing it to be done on a workers mobile device. This theme is also gaining popularity in on the home front as well as companies are finding ways to simplify everyday tasks like unlocking doors and logging in to computers.

A. Transportation

At this stage in its life cycle near field communication's (NFC) possibilities are limitless. This phenomenon is capable and possible to be "the thing" of the future. This idea of transferring data and/or information via a mobile device is what innovative technology is all about. Currently NFC is hitting the market in full speed with no stop in sight. There are key markets in which NFC is currently in and preparing to dominate; one of which is transportation. Whether in China or Germany transportation is a necessity in the lives of us all. Simplifying the transportation process as a whole is what the idea of NFC is striving for.

The idea of NFC in public transportation is not new to NFC; how to implement it effectively is. Bay Area Rapid Transit (BART) a California transit system first implemented this trial back in 2008. With this trial select riders were given a NFC enabled Sprint phone. With this phone riders were able to enter the train gates and pay for their rides by tapping their phone on the platform of the gate entrance. Riders were also able to utilize "smart advertisements". These were ads that were inside the train station and allowed the participants to hold their phone up to a given advertisement and receive addition information from that ad such as locations and directions [6]. With the advancement of technology and more specifically technology within mobile devices other transit authorities have begun to implement this.

Currently transportation agencies have implemented the use of mobile enabled devices in the United States, Europe and Japan. A spokesman for Germanys National Railway indicated that they plan to implement NFC-based ticketing by the end of 2011. The emphasis on NFC enabled devices is the security. The "near connections" this secures information especially that of banking information.

B. Hotel Industry

Not only is it possible to get from one destination to the next using NFC but if your destination is a hotel this technology can also be utilized in the area. As mentioned in the security section using a mobile device to act as a key to enter into hotel rooms and even to register a guest is what a Clarion hotel is piloting. In Stockholm an urban area of Sweden Clarion has given a group of selected repeat visitors near field communication enabled mobile phones. With these devices visitors are able to register via cell phone as well as activate their hotel key. By simply waving the cell phone near to door guests are given access to enter the room. The advantage about this is Clarion will not have to change their radio enable locks that are currently used; NFC is fully compatible. Since no change is required this will allow visitors who are not equipped with a NFC device to still be able to use the standard hotel key. This will also lead to speedier check in times for guests since waiting in lines is no longer necessary and also allow room for staff reductions.

C. Social and Entertainment

No new technology would be complete if it too didn't add its footprint to the social networking, gaming and entertainment world. Some people are dependent on social networking sites to receive information and NFC is making taking the possible avenues to make it easier for this audience to receive their information.

1) Social networking

Facebook has become a worldwide success and a wide range of individual users, business user, companies and a wide variety of applications. The use of near field communication and Facebook complement each other. With NFC enabled devices users are able to "friend" other users by tapping devices together. The "check-in" application is also utilized with this technology. Patrons visiting stores, restaurants, etc. would scan their phone to check in to their destination.

Tranzfinitly a marketing service in Los Angeles has a special relationship with Facebook and NFC. Tranzfinitly works with advertisements postings using NFC. When consumers enter a specific location smart poster containing NFC tags are displayed. Consumers are able to wave their devices over the poster and receive special discounts at the place they're at. In exchange for the discount, Tranzfinitly automatically updates the consumers Facebook status.

2) Mobile gaming

We were first introduced to the mobile gaming industry when Tetris was introduced and later when Nokia introduced Snake. These games allowed users to "take a break" and play entertaining games on their mobile devices. Technology has come a long way from the "snake" days. Nokia has also created a few games using this technology as well. They refer to these games as "tangible" mobile games since physicals items are involved in the playing of the game (Sarah, 2011). The games they have thus far are matching games, nursery rhyme games and Shakespearean centered games. The matching game is similar to the matching game many played as children. With NFC, instead of actually flipping over cards, player will tap the cards to choose the cards they desire.

The latest craze is the Angry Birds franchise. This game was developed from touch screen based Smartphone to

allow the player to "tap" the slingshot and aim at its intended target. The game involves "angry" birds being launched at pigs to destroy them. Different features within the game occur as players progress throughout the game. NFC and Angry Birds teamed up to utilized the contact between two devices. When two NFC enabled Smart phones are tapped together while running the game simultaneously new levels are unlocked (Zach, 2011). While this is not a fully function NFC game it is a start and allows game developers to see "what could be".

V. FUTURE OF NFC

In the future, near field communication technology has the potential to become a staple of our daily lives. NFC technology is compatible with a wide variety of devices, giving the opportunity for future growth unlimited. Already, NFC technology is beginning to be compatible with several different smart phone manufacturers allowing users to do things such as make payments or unlock their hotel room doors by simply using a smart phone. We believe NFC technology will continue to grow and become pervasive throughout our society. One place where NFC technology can be especially useful is within our homes. The idea of a *smart home* utilizing NFC is very intriguing [21]. Basically, a *smart home* would incorporate NFC technology throughout someone's house. This application has the capability of making its way into many residences throughout the world.

A. Future NFC Uses at Home

Currently, NFC technology has the capability to open the front door of a home simply by using the mobile phone of the homeowner. If somebody is walking up to their front door with their hands full, they could simply use their cell phone to scan the front door lock to open the door. This NFC door technology may soon be produced for the mass consumer market. In September of this year, Yale has developed the first front door lock (for consumer use) that can be opened with a smart phone using NFC technology [25]. Once the owner gets home, NFC technology has the capability of activating the heat or air conditioning of the house. A device with an NFC chip could be swiped near the thermostat of the home, activating the desired temperature. NFC also has several potential uses in the kitchen beginning with the *smart fridge*. A refrigerator with NFC technology could make keeping track of food and drink inventories much easier for the user. A *smart fridge* could keep track of every item within the fridge, letting the user know when things run out or when food expires. Already, LG and Samsung have developed a refrigerator with an HD screen and Wi-Fi capabilities. NFC technology could be made compatible to those systems in the future. Of course, this idea would only work if the food/drink items in the *smart fridge* contained a tag that could read by the NFC chip in the refrigerator itself.

NFC technology clearly has the potential to become a mainstay in the homes of millions of people across the world. Although NFC still has a way to go before transferring our households into *smart homes*, the technology is becoming more prevalent in our society. If user's become comfortable using NFC with their mobile

payments on their phones, they would most likely be comfortable with using NFC in their homes. The big hurdle to the idea of a *smart home* is that NFC technology would need to be incorporated into many devices throughout a home. This requires many different manufacturers to produce products which are compatible with NFC. However, if NFC does catch on and manufacturers start developing household products using this technology, it could change the way we live our lives.

B. Future NFC Uses in Healthcare

As NFC is finding its way in to almost every industry, healthcare seems to be equally competitive with huge prospects for his growing technology. NFC enabled mobile device could help the visually impaired find objects and navigate through areas conveniently. French supermarket chain, Casino is doing a pilot test on blind shoppers to understand the potential of NFC in shopping experience.

Past reports have shown that around 1% of deaths occur due to adverse drug events. If NFC could be used to maintain a database of drug compositions and doctors could access that database along with the patients past medications and allergies such accidents could be avoided [16].

Post-surgery monitoring comprises a huge percentage of the total healthcare costs for a patient today. Gentag is planning to develop a low cost wireless monitoring kit which would help patients monitor their self-recovery allowing an early discharge from the hospital and reduction in health costs drastically. The kit would facilitate post-surgery testing in the operated area and avoid complication by early diagnosis of any recurrence of symptoms.

VI. CONCLUSION

The many benefits and potential uses of NFC technology will continue to drive the technology and push innovation in the field. The keys to future success are evident in the intrinsic values provided by NFC. It is a more secure technology than RFID and Bluetooth due to its frequency and short distance specifications. Though the implementation of NFC is still in its infancy, it is evident that the future will see a proliferation in its use. Companies will benefit from the financial success of their innovations, consumers will benefit from increased productivity, and the economy will benefit from new product growth and increased competition.

REFERENCES

- [1] D. Aamoth, "How the New Google Wallet Mobile Payment System Works," *Time Magazine Techland*, May 2011
- [2] D. Balaban, "Germany's National Railway to Roll Out NFC," *Touchpoints*, August 23,
- [3] C. Brown. NFC kit lets patients leave hospital earlier and monitor Available: their return to health from home. [Online]. Available: <http://www.nfcworld.com/2011/05/19/37484/nfc-kit-lets-patients-leave-hospital-earlier-and-monitor-their-return-to-health-from-home/>
- [4] L. Chambers, "PayPal Uses NFC to Make Peer to Peer Payments Easier than Ever," *PayPal Blog*, July, 2011
- [5] S. Clark. Transfinite adds NFC to Facebook. [Online]. Available: <http://www.nfcworld.com/2009/10/24/32136/transfinity-adds-nfc-to-facebook/>
- [6] K. Drey. BART: Transportation's NFC Visionary. [Online]. Available: <http://www.vivotech.com/blog/index.php/2011/10/25/bart-transportations-nfc-visionary/>
- [7] K. Eaton. Google Eric Schmidt Reveals NFC Smartphone Plans: It's all about advertising. [Online]. Available: <http://www.fastcompany.com/1728241/eric-schmidt-gives-away-google-nfc-smartphone-plans-its-all-about-advertising>
- [8] S. Finz, "Square Allows Mobile Payment Processing," *SF Gate*, October, 2011
- [9] A. Greenspan, "What are the advantages and disadvantages of payment with phones via NFC?" *Quora*, January 2011
- [10] J. Hendel. Future pharma: What near field communication (NFC) means for pharma. [Online]. Available: <http://social.eyeforpharma.com/uncategorised/future-pharma-what-near-field-communication-nfc-means-pharma>
- [11] J. Hyatt. "HID Global and Sony Announce NF enabled Contactless Smart Card Reader Platform for Global Laptop and Mobil Device Market," *Wall Street Journal, Market Watch*, November, 2011
- [12] J. Liebenau, S. E. Calderwood, P. Karrberg, and G. Hosein, "Near Field Communications; Privacy, Regulation & Business Models A white paper of the LSE/Nokia research collaboration," *London School of Economics and Political Science*, October 2011
- [13] R. King, "Google Wallet NFC Payment Program, Google Offers announced," *May*, 2011
- [14] E. McBride, "NFC Timing Restrictions," *Nfcsec*, August, 2011
- [15] H. McLean. French retailer tests NFC as aid for visually impaired shoppers. [Online]. Available: <http://www.nfcworld.com/2011/09/06/39711/french-retailer-tests-nfc-as-aid-for-visually-impaired-shoppers/>
- [16] J. Morak, D. Hayn, P. Kastner, and G. Schreier. Near Field Communication (NFC) technology - An Enabler of the Internet of (Medical) Things. [Online]. Available: http://www.medetel.eu/download/2008/parallel_sessions/presentation/day2/near_field_communication.pdf, April, 2008
- [17] R. Noor. 7 ways Near Field Communication (NFC) will revolutionize our lives. [Online]. Available: <http://www.irnovo.com/2011/03/7-ways-near-field-communication-nfc.html>
- [18] S. Perez. Nokia Launches New NFC-Enabled Games. [Online]. Available: <http://techcrunch.com/2011/10/17/nokia-launches-new-nfc-enabled-games/>
- [19] S. Planck, "PayPal Canada Mobile Wallet Study," *NFC Forum*. June, 2011
- [20] S. Planck, "Consumers have smartphone security concerns but don't install security apps as NFC payments," *Nfcumors*, September, 2011
- [21] V. J. Raitil. Tag, you're it - NFC in a home environment. [Online]. Available: http://www.tml.tkk.fi/Publications/C/23/papers/Raitila_final.pdf
- [22] M. Rising, *Cell Phone Replacing Room Keys, Clarion Hotel Tests Mobile Phone System*, *Hufington Post US Edition*, November, 2010
- [23] M. Rising, *Cell Phone Replacing Room Keys*. [Online]. Available: http://www.huffingtonpost.com/2010/11/03/cell-phone-replacing-room_n_778097.html
- [24] J. Shah, "Mobile NFC Features Raise Security Concerns," *Mcafee*, November, 2010
- [25] C. Sorrel. Yale Lock Opens Doors with NFC Phones. [Online]. Available: http://www.tml.tkk.fi/Publications/C/23/papers/Raitila_final.pdf
- [26] J. Titlow, "The Future of NFC, From Mobile Wallets to Angry Birds," *Read Write Web*, June 14, 2011



Hongwei Du is a professor of Information Technology Management in the Department of Management at California State University, East Bay. He holds a PhD in Operations Research from Florida Institute of Technology and a MS in Computer Science from Bowling Green State University. He also received a MS in System Engineering from the Research Institute of Automation in Beijing and a BS in Computer Science from Shandong University in China. Dr. Du possesses a broad knowledge in a wide range of areas. This has qualified him to teach and conduct research in multiple disciplines. His current research interests are artificial intelligence, database, electronic commerce, decision support systems, information technology management, computer networking and telecommunications. His works have been published in the *European Journal of Information Systems*, *International Journal of Innovation and Learning*, *International Journal of Information and Decision Science*, *International Journal of Electronic Healthcare*, *International Review of Business Research Papers*, and elsewhere.