NFC: ADVANTAGES, LIMITS AND FUTURE SCOPE

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ABSTRACT

Near Field Communication (NFC) Technology represents short range (practically up to 4 cm) wireless communication offering safe yet simple and intuitive communication between electronic devices that we use on a daily basis. Users of devices having NFC application in it can simply touch their devices to other similar elements having NFC application to communicate with them, making application and data usage easy and convenient. NFC can be called as the next generation of Radio Frequency Identification (RFID) as technically its working principal is based on RFID however from application point of view it is similar to Bluetooth in some ways since it allows communication between two active devices. NFC can be the future medium of contactless electronic payment as it inhibits eavesdropping on NFC - enabled transactions pertaining to its short range, however range can be extended by attackers using some range extension system. In this paper we briefly discussed the advantages, limits or challenges of NFC technology along with its applications which opens up exciting new usage scenarios for mobile devices.

KEYWORDS

Near Field Communication, NFC, RFID, Bluetooth, Contactless communication.

1. INTRODUCTION

Near Field Communication or NFC is a type of technology that soon will be a must for each gadget and is an integration of Radio Frequency Identification (RFID) technology with mobile devices which allows them to communicate with each other by simply touching or bringing them very close to each other. RFID is used mainly for applications like indicating or identifying goods or persons without a line of sight while NFC on the other hand is used for more sophisticated and secure transactions like contactless access or payment. NFC is the outcome of joint work done by NXP Semiconductors (formerly Philips Semiconductors) and Sony Corporation [1]. Near field communication technology has already come in existence in many of the smart phones but still due to lack of awareness of people it is not in that much use. But with the growing popularity and demand for android applications, soon NFC will be found in every nook and corner of the world due to its compatibility with almost every existing technology in one way or the other. In this paper we will learn about different modes of communication and operation of NFC and discuss its advantages, limits or challenges posed by already existent technology, applications and future modifications required by the technology in a detailed way.

2. NFC STANDARDS

Near Field Communication (NFC) standards were first developed by the NFC forum, which was founded jointly by Nokia, Sony and Philips in the year 2004 with an aim to spread knowledge about NFC among people [2]. In December 2003, NFC was accredited with the standard ISO/IEC 18092 (NFC IP-1) which specifies the interface and set of rules to be followed for simple wireless communications between devices kept closely that does communication with transfer rates of 106, 212 and 424 kbps. In 2005, NFC also earned a further internationally accredited standard ISO/IEC 21481 which meant in the future it will soon become a known technology all over the world and will have various applications. According to the ISO standard, NFC is not encrypted which makes it compatible with previous RFID technologies [1].

3. MODES OF COMMUNICATION

Using NFC, communication could take place between two active devices such as cell phones called active mode or even between a NFC device and a passive (or unpowered) *'tag'* called passive mode [3]. In active mode, both the initiator and the target generate the RF signal on which the data is carried while in passive mode, RF signal is generated only by the initiator, and target communicates back to the initiator using a technique called load modulation (like using smart cards while travelling in metro) [4]. Also, battery less rewritable NFC tags are available that can store up to 4096 bytes of data. Thus nowadays mobiles are equipped with NFC reader and writer, which can be used to send data to and receive stored data from these tags [5].

Table 1: Coding and modulation schemes varying according to data rate [3].

kbit/s	Active Device	Passive device
424	Manchester, 10% ASK	Manchester, 10% ASK
212	Manchester, 10% ASK	Manchester, 10% ASK
106	Modified Miller, 100% ASK	Manchester, 10% ASK

4. NFC MODES OF OPERATION

NFC has three operating modes; *Peer-to-Peer, Reader/Writer,* and *Card Emulation*. In order to standardize and spread the knowledge about NFC, NFC Forum [6] was formed which defined these operating modes because the communication way is different in each NFC mode and these differences effect the field of operation and usage areas accordingly.

- In card-emulation mode the data is copied from a NFC enabled mobile device to NFC-Reader. The most important feature of card emulation mode is elimination of physical objects and providing access control through user's respective smart phones. Thus the most used mode of NFC too.
- In reader/writer mode data is copied is from NFC tag to cell phone or vice-versa. This is a novel technology proposed by NFC and will become the user selling point of NFC in coming future.
- In peer-to-peer mode data commutes between two NFC enabled active devices. But it is rarely used because of tough competition given by other wireless technologies like Bluetooth as it is more widely spread compared to NFC.

Mode of communication of the device whether active or passive, cannot be changed while the transaction is going on unless and until the target device vanishes i.e., removed or deactivated [7].
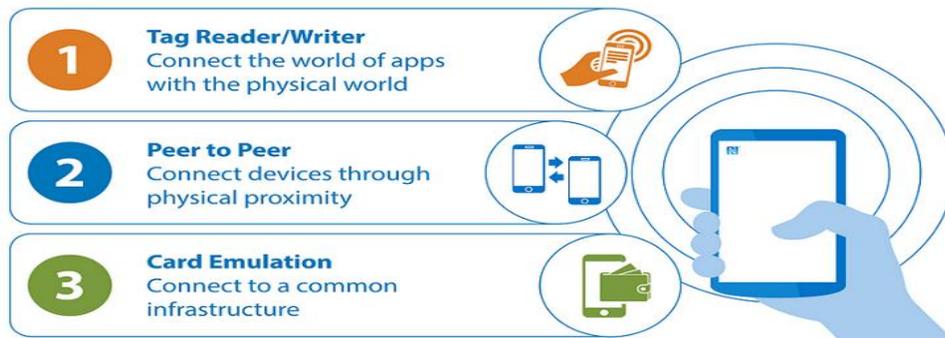
Figure 1: Modes of Operation (Source: NFC-Forum)

5. ADVANTAGES

- NFC technology has several advantages over other wireless technology because it provides *bidirectional communication* for exchanging information i.e. both devices can send and receive data simultaneously unlike Bluetooth which promotes unidirectional communication [8].
- NFC consumes *less power* in comparison of Bluetooth while working in active mode while more in case working in passive mode but Bluetooth has only active mode so NFC is more advantageous in this case [8].
- Also *less battery is utilized* because NFC is built with built with lower transfer speeds of 106 kbps to 424 kbps [2].
- Also there is *no* requirement of *setting up a connection* between two devices in action in case of NFC unlike that of Bluetooth. Thus NFC is easier to use especially in crowded places.
- NFC can be used for *handshaking* i.e. setting up a connection between two devices without the need for any complex manual configurations. After connection setup within milliseconds other wireless technologies can come into play for work like data transfer etc.

- *Less* probability of *unknown connections* setting up due to short range of communications like you don't reset your phone just because you might have walked beside a smart tag. For that you need to knowingly make a connection.
- Because of the simplicity NFC provides with along with simplifying other wireless technologies when integrated with them, it makes it easy enough for even the *non-technical persons* to use them.
- *Mobile devices* can be used both as an information storage device or a NFC reader. They can read information from NFC tags which can further be manipulated and worked on accordingly. Also information like website account passwords or such type of confidential information can be stored thus it acts as a *digital storage*.
- NFC can be used to *build small devices* as there will be no need for embedding any display unit in a device having NFC. The equipment can be touched by an NFC-enabled device and readings can be displayed.
- *Compatible* with other contactless approaches, such as ISO 14443A, implemented in Philips' Mifare and Inside Contactless' PicoPass products; and ISO 14443B, the most popular standard, used with Sony's FeliCa technology which too operate in the 13.56-MHz frequency range like that of NFC [9].
- As the communication range for NFC is nearly 4 cm practically, thus when the devices are separated even a little distance apart, the communication ends which depicts in built *security*.
- Components for NFC module can be *integrated on one chip* device as shown in Figure 3, saving space on the device which can be utilized for including other necessary functions and still keeping the size of the gadget small and handy.
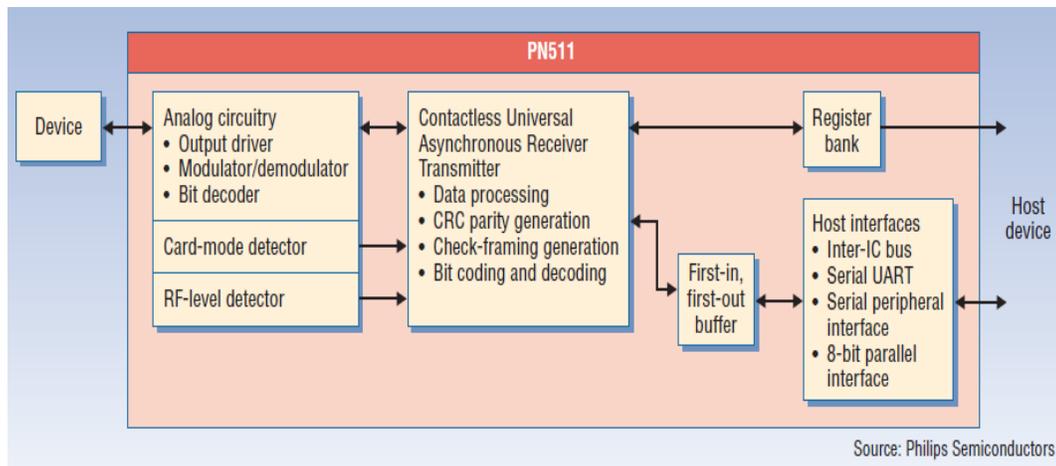

Figure 2: Philips Semiconductors'PN511 near-field-communication transmission module illustrates how elements of an NFC system can be integrated on a single chip within a host device [9].

6. LIMITS/CHALLENGES

- Major hardware manufacturers outside of Motorola, Nokia, and Philips are not yet supporting it due to its *less demand and popularity*. A recent survey concluded that 60 % of population had not yet heard of NFC [9].

- *Lack of information* about NFC is another challenge which needs to make people aware about how to make payment by their mobile phones instead of credit cards, debit cards or cash.
- As NFC uses radio waves for data transfer there can be a number of *possible security attacks* while transmission or transaction which can be categorized as *Eavesdropping, Data corruption, Data modification, Imposter attacks*(man in the middle), and *Theft* (NFC device is stolen).
- People find selfish benefits out of every new technology. Same is the case with NFC where *fraudsters* can direct victim to a wrong website by replacing original tag at public places with their corrupted one.
- There is urgent *need for a secure channel* and complex data encryption techniques along with device protection using a code or password in order to avoid above mentioned security attacks [8].
- Using NFC devices can *affect personal privacy* as someone could read UID of a NFC tag from a distance and identify the person's in and out time when the same phone passes at a later time [7].
- NFC's *operating range* is just 10 cm as inductive coupling works for short distances, compared to Bluetooth's 10 meters and Wi-Fi's 100 meters.
- Maximum data transfer rate for NFC is 424 Kbits per second making it *unsuitable for large amount of data* transfers, compared to Bluetooth's 3 Mbps and Wi-Fi's 54 Mbps.
- *Mafia Fraud attack* or the *relay attack* can defeat the protocols with a assumption of proximity by placing two special communication devices (called the "ghost" and the "leech") between the victim reader and the victim tag. This range extension by the attackers can lead to high level of insecurity especially in the case of NFC-enabled transactions [10].
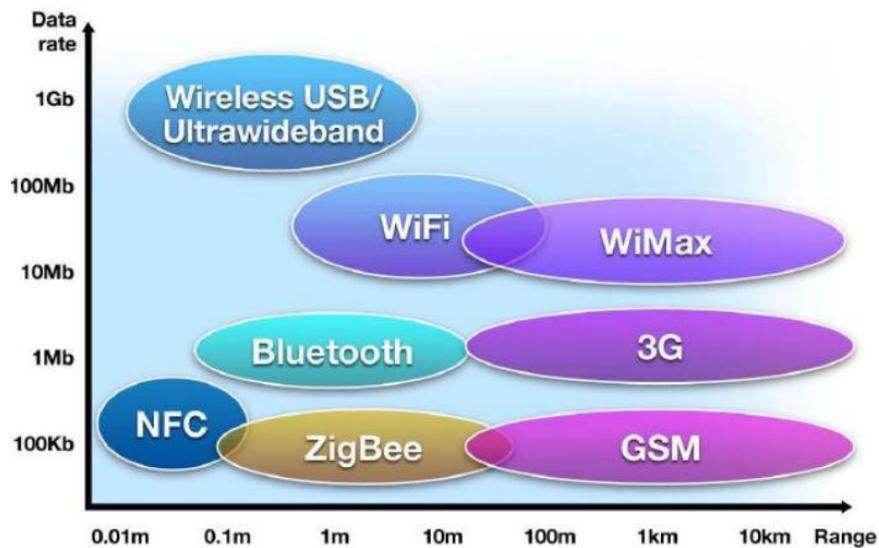

Figure 3: Data rate versus Range plot for different wireless technologies (source: NFC-Forum)

7. APPLICATIONS

7.1 Contactless payment

With the use of NFC in the smart phones, they can be used in place of wallet, credit cards, debit cards etc. Cards with a direct physical contact interface are known as *contact smart cards* which receive power from the reader they are inserted in and exchange data with it using physical contacts while cards with a remote contactless interface are known as *contactless smart cards* which are waived from a very short distance so that electromagnetic wave from the reader will be used as the energy source, and wireless communication like NFC will be used for data exchange at the same time. *SIM* (Subscriber Identity Module) cards which are a must requirement in cell phones, in addition to authenticating users to the cellular network, contain a secure storage area, which provides necessary security conditions and performs data encryption and decryption. Mobile Network Operators (MNOs) and service providers such as banks use this area to provide value added services such as mobile financial services, e-government services, digital signature services, etc. to the users. Thus NFC is used for the electronic payment in which SIM card acts as a contactless smart card while the users smart phone acts as a mobile wallet [11].

Figure 4: Google wallet

7.2 Keeping Records

NFC can be used to keep records of information about people like their medical history in a tag, thus, saving a lot of time and resources required for documentation of important information which is now less prone to human errors as well making it accurate and reliable and easily accessible too [5].

7.3 Transit and ticketing

Contactless tickets, once introduced, will result in increase in speed and ease with which all consumers can use public transport like buses and access controlled environments like parking garages, transportation gates or get into events etc. Thus making travelling quite comfortable and fast [12]. Also provides flexibility of choosing sources and destination compared to present format and decreases wastage of resources like paper and time making it an eco friendly option along with providing better monitoring thus giving way for transparency of the system [13].

Figure 5: Different applications of NFC (Source: NFC-Forum)

7.4 Automated Check-in system

NFC-enabled smart phones can be used as a room key in hotels making the check-in and check-out procedure free of standing in queues and waiting. Instead a person can directly enter their allotted rooms after making a booking and in return receiving a soft-key to their rooms [14].

7.5 Advertising

Reading information and scanning or enrolling in money saving offers from smart posters gets easy. Information can be exchanged regarding products using posters saved in a tag which can easily be accessed using NFC and read at reader's convenience anywhere and anytime. This results in two benefits. One is the reader don't need to stand in front of the poster grabbing everybody's attention and secondly the information need not be limited according to the size of the banner and its visibility. Thus the quantity and quality on information being exchanged increases many folds.

Figure 6: Depicting advertising using NFC tags.

7.6 Easy Connectivity

The act of transferring a file from one laptop to other by using novel technologies, like Bluetooth or Wi-Fi may need to manually set up the communication link between laptop which is really time consuming but by using NFC enabled laptops, file transfer can be done by just touching both laptops thus providing easy connectivity between two gadgets which can be a TV and a mobile phone for displaying pictures or may be a laptop or a camera and a printer for printing documents or images respectively [7].

7.7 Electronic voting

In electronic voting application, information about candidate can be stored in a NFC tag with the help of which users can vote for in any type of voting that includes for in college, at state level or may be national level using their NFC-enabled devices. This application is beneficial as that anyone can cast their vote from anywhere using a secured application by first registering in it and then log in for voting by using the allotted NFC tag containing their details[15].

7.8 World Cup Tickets

World Cup tickets have had embedded RFID tags since 2006. The relative small increase in cost of using RFID over conventional football tickets is outweighed by the additional security provided. These new tickets cannot be duplicated which is one advantage. Also FIFA can maintain a record of all the fans watching the World Cup in all the stadiums at any one time including their ID's.

7.9 Health Care

Impak Health Company are involved in home-based cardiac, pulmonary and sleep monitoring and have incorporated NFC in devices such as "Rhythm Track" that tracks a person's ECG, and "Sleep Track," which tracks the sleep cycle and duration. Similarly, FITBIT (a fitness monitoring company) has incorporated NFC for transferring details like calories burned, number of steps taken and other details from a wristband to the user's smart phone which houses a user-friendly application [9].

7.10 Routine Jobs

Daily jobs including a set of functions can be done all together in one go using a smart tag which are now available in the market and can be distinguished by varying colors. Tasks performed daily like snoozing off alarm and switching on wifi or hot spot and sending wake up messages can all be stored in a smart tag and the user just touches their NFC enabled device with the smart tag and all the tasks happen by themselves. Similar set of tasks can be stored in different tags for different places thus making everyday life easy.

8. COMPARISON WITH OTHER TECHNOLOGIES

Table 2: Comparison between NFC and other wireless technologies [3], [16].

	NFC	Bluetooth	RFID	Infrared
Set-up Time	<0.1 msec	~ 6 sec	<0.1 m sec	~ 0.5 sec
Range	Upto 10 cm	Upto 30 m	Upto 3 m	Upto 5 m
Speed	424 kbps (1 Mbps soon)	721 kbps	424 kbps	115 kbps
Network Type	Point to Point	Point to Multipoint	Point to Point	Point to Point
Mode	Active-Active, Active-Passive	Active-Active	Active-Active	Active-Active
Selectivity	High	Low	Partly Selective	Line of Sight
Usability	Human Centric, Easy	Data Centric, Medium	Item Centric, Easy	Data Centric, Easy
Cost	Low	Medium	Affordable	Low

9. FUTURE SCOPE

- The scope of NFC technology varies according to the mode of operation as listed in Table 3.

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- Also, people must get the power to select what part of selected piece of information they want to share and hide what they don't like a person may want to convey some part of their health records to the doctor while some other with a health insurance agent.
- A list of mobile phone having NFC can be obtained from http://www.nfcworld.com/nfc-phones-list/ and many more models are on their way to be launched soon.
- Soon, even the locking system will be replaced by personalized NFC enabled devices and NFC tags as door locks. Thus NFC will act as a farther step towards the world of automatic devices.
- Even for the basic needs there will be the need for an NFC-enabled device like for subscribing for personalized offers that will be made available to unique smart phone holders.
- The switches for using household appliances like tube lights, fans etc will be replaced by remote controls that further can be operated using NFC-enabled devices that results in personalization of the devices. Also a record can be maintained by the user in their smart phones of the usage of these appliances.

Table 3: Benefits and future scope varying for different modes of operation [14].

	Card-emulation mode	Read/ Write mode	Peer-to-Peer mode
Benefits	• Physical Object Elimination. • Access Control through mobile devices. • All daily objects combined at one place.	• Increases mobility. • Decreases physical effort. • Ability to be adapted by many scenarios. • Easy to implement.	• Easy data exchange between devices. • No Device pairing. • Increased security.
Future Scope	• Integration of id-cards, passports, finger-prints, driver-license • Storage area for critical information to provide user's privacy and authorizing people to access those information	• Some data need to be read from an NFC tag, and additional jobs will be done by NFC-enabled mobile phone. • Less space consumption and more data holding capacity leads to bright future in advertising agencies.	• Secure exchange of critical data. • Chatting. • Psychological effects need to be studied.

10.CONCLUSION

Near Field Communication has already begun to shape the future of electronic gadgets in people's life. As the prices of chip manufacturing falls, the likelihood is that NFC-enabled mobile phones will become standard and their applications will become a part and parcel of life. According to a survey [17] it is found that NFC technology was preferred by people over other

technologies including Bluetooth Beacons and QR codes. It is inferred that NFC technology works on the basis of RFID technology which uses magnetic field induction as a medium to establish communication between electronic devices placed closely and operating at 13.56 MHz as it is unlicensed frequency and can transmit data at a maximum rate of 424kbps [4]. NFC like any other technology has its own pros and cons. When compared to other technologies however presently it is less popular but with the increasing android applications, soon it will become a need. In the present world where digital transaction are so common, there exist people who try to manipulate, disrupt or misuse the data that is transmitted and so users will no doubt initially be concerned about the security of their personal data that is stored on the NFC devices. Still besides this, it is a must application for smart phones and people need to be made aware about how it works.

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