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## NFC: A New Trend in the Field of Device Communication

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### **Abstract:**

*The world of electronics is on the move from one machine to multi-purpose devices, by moving from device to network devices. On the other hand, users face the complexities and problems of establishing a network of connections between devices. Near Field Communication (NFC) is a specification for contactless communication between two devices. NFC is based on the technology used for RFID (radio-frequency identification). NFC is a very important technique which is the integration of technology in mobile phones to make people's lives much easier. Using NFC consumers do not face complications in the hardware configuration for the establishment of a network mobile phone manufacturers, banking institutions and mobile network providers are attempting to apply this technology to Smartphone's and other handheld services because of the opportunity to enable the consumer to use commercial services more easily. To communicate between two devices, bring them together using Protocol NFCIP-1 and establish the wireless network to deal with them is achieved by the exchange of configuration data using NFC. This technology is faster than protocols such as Bluetooth or wireless Ethernet (Wi-Fi).*

**Keywords:** Information security, near field communication, smart phones, tags

### **1. Introduction**

NFC is a very important technique. Here will be the integration of technology in mobile phones to make people's lives much easier. Some of the companies in the market today including Nokia are trying to implement the NFC in mobile phones of their own. NFC will be part of every mobile phone in the future. NFC has a lot of applications in everyday life. We need not carry cards such as access cards, debit cards, credit cards and identity will be the cards that are already in the cell phone and we can use them anywhere we want and will not transfer data easily from any device to another. There is also no need to repeat the keys because we can use only one phone instead of keys. Even more, we can buy and store e-tickets on the cell phone and there is also a set of criteria to determine the work of smart phones and similar devices to be the wireless contact them by touching each other or make them side by side, and not more than the distance of a few centimeters. There is also the current and anticipated applications include data sharing, and simplified setup of more complex communication such as Wi-Fi. Communication is also possible between the device and the NFC chip unpowered NFC, which is named "tag".

### **2. Theoretical Consideration**

Now there is a technology shift from one machine to the network and the devices connected to a single concept from hardware to multiple devices purposes. It is important that consumers do not face complications in the hardware configuration for the establishment of a network. This leads to near field communications. NFC is a combination between identity and connectivity through technologies that uses contactless proximity and communicates information. It becomes easy to communicate between small electronic devices as it creates magnetic field induction between the antennas of two devices to transfer the data. It can also establish peer-to-peer network for data exchange. Once you create a communications network, other wireless technologies such as Bluetooth and Wi-Fi can be used to exchange a large amount of data.

For example, if you have a laptop and cell phone equipped with NFC, then you can easily download data from Internet into your cell phone by simply touching your cell phone with laptop. Like that you may take pictures from your cell phone and if you want to show those pictures to your friends on big screen (TV), then you may just touch your phone with TV and show them. If you want to print those pictures then by touching the cell phone with NFC equipped printer will give you the prints of those pictures. This principle works with any kind of devices equipped with NFC to communicate with each other. There is no need to set up the communication

link initially. Suppose you want to transfer a file from one laptop to another by using novel technologies, like Bluetooth or Wi-Fi. You need to manually set up the communication link between laptops. But if you are using NFC enabled laptops, then you may transfer the file by just touching both laptops. In another situation you may establish the link using NFC and once communication link is established, Bluetooth or Wi-Fi can be used to transfer data. The advantage of using this method is to transfer larger data or continuing the communication session if devices go away after touching each other [1].

NFC enables two way communications between electronic devices and has the capability to write to the RFID (Radio Frequency Identification) chip. Therefore, bidirectional communication between NFC-equipped cell phone and NFC reader can be established. This makes it possible to develop complex applications like payment, secure exchange of data and identity's authentication [2]. NFC implements touching paradigm. Touching is a famous and interactive method in human lives. This makes NFC technology easy to learn and use. This touching paradigm was initially used in RFID (Radio Frequency Identification) technology. In RFID technology items marked with tags contain transponders which emit messages in the form of signals. RFID readers were used to read those messages. NFC is now integrated with this RFID technology.

The tags to be readable by NFC reader should have 4 to 10 byte unique ID. This unique ID is used for the identification of the tag. There are multiple manufacturers in the industry, so ID's length may vary in size [3]. From the technical point of view, NFC is blend of contactless smart card technology and cell phone. NFC equipped devices normally operate in three different modes like Card emulation mode, peer-to-peer mode, and reader-writer mode. In card emulation mode NFC device behaves like a reader, e.g. NFC tag. This tag has the capacity to store data securely and the applications of this mode are electronic ticketing and payments. In peer-to-peer mode two devices equipped with NFC can exchange data directly by touching each other. Applications of P2P mode are transferring data between laptop and cell phone. In reader-writer mode NFC device can read or write the tags in similar fashion like RFID tags [4].

NFC can read and write data on RFID chip. The RFID (Radio Frequency Identification) chip can be embedded in everything starting from paper to machinery. RFID is mainly used for tracking and identification through radio waves. NFC core applications include connecting electronic devices, Accessing digital contents and making contactless transactions. Figure 1 shows the various modes of communication.

### 2.1. NFC Modes of Communication

Three modes of communication are defined by NFC forum

- Read/Write mode
- Tag emulation mode
- Peer-to-peer mode

In read/write mode NFC phone can read or write to the tag. For example, smart poster.

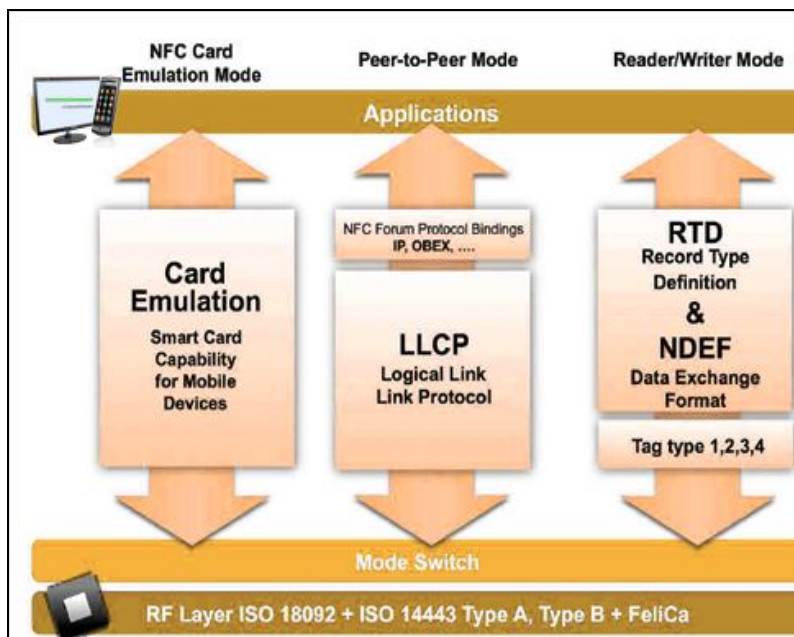


Figure 1: NFC Modes of Communication [5]

In tag emulation mode NFC phone acts like smart card. For example, the mobile can act as an electronic wallet. Third mode is peer-to-peer mode in which link level communication is established between two NFC phones. The example is shown in Figure 2.



Figure 2: Examples of NFC Communication Modes

## 2.2. NFC Modes of Operation

RF signal transmission between transmitter and receiver creates the main distinction between NFC and other RF wireless communication modes. NFC depends upon straight magnetic/electrostatic coupling between devices instead of freely broadcasting of radio waves, such as in Wi-Fi. NFC devices can operate on low electric or magnetic field strengths due to its short range communication property [vi]. ECMA-340 is the standard which defines the modes of operation. Table 1 gives the ECMA Standard description.

Field Level	Field Strength	Description
$H_{\text{Threshold}}$	0.1875 A/m	Minimum field detection level
$H_{\text{Min}}$	1.5 A/m ms	Minimum un modulated field strength
$H_{\text{max}}$	7.5 A/m ms	Maximum un modulated field strength

Table 1: ECMA-340 showing Magnetic Field Strengths

### 2.2.1. Active Mode

In this mode both devices generate RF (radio frequency) field to transfer data. In this situation any of the devices can be the initiator and other will be the target. While in passive mode, only one device generates the RF field and other uses load modulation to transfer data. In this situation initiator of the communication will generate field and target will use load modulation. During the communication, the initiator starts the communication in a particular mode at a specific speed. Target finds out the current speed and replies back to the initiator. Termination of the communication takes place either when two devices move out of the range or application gives command to terminate it [vii]. During communication either initiator or target generates RF field of level  $H_{\text{min}}$  that does not go beyond the field level of  $H_{\text{max}}$  [viii].

### 2.2.2. Passive Mode

This mode has a key benefit for battery powered devices. For battery powered devices low consumption of battery is the basic priority. Thus NFC allows battery powered devices such as cell phones to operate in passive mode. In this mode RF field is generated on the other side. Thus battery power is saved that was needed to be used for generating RF field. In passive mode target operates continuously between  $H_{\text{min}}$  and  $H_{\text{max}}$  magnetic field strength [ix]. NFC protocol is also compatible with connectionless smart card protocols like Felicia and Mifare. NFC device can work with both smart card and smart card reader. Another benefit of the NFC device is that it can be used as smart card, as well as smart card reader [x].

Devices cannot change mode of communication (Active/Passive) during single transaction unless target is removed or deactivated. Even transfer speed of target to initiator and vice versa may not effect the change in mode [xi].

## 2.3. NFC Stickers

These stickers are the alternative solution to NFC devices and contactless cards as shown in Figure 3. They are self adhesive and smaller in size, can fit on any device, like a cell phone. They are simple to use and have potential of gaining significant business benefits. For production and personalization standard they are following A1 credit card format standard. Although NFC stickers can save start up cost, their production cost is more than simple contactless cards. Only the increase in volume of such stickers can reduce its cost. According to a survey volume of NFC sticker is increased in 2009 and during 2010 and in 2011 it is expected that there will be a significant increase in their volume, reducing its price [xii].



Figure 3: NFC Stickers [xiii]

2.4. *How NFC Works:* There are four ways how NFC works

1. Phone to phone
2. Phone to device
3. Phone to tag
4. Phone to reader

#### 2.4.1. Phone to Phone

In this category two cell phones equipped with NFC communicate with each other. They can transfer music files or pictures by just touching each other.

#### 2.4.2. Phone to Device

Here NFC equipped cell phone can communicate with any device. For example, by just touching phone with NFC equipped printer can print the pictures stored in cell phone. Or by touching payment device can perform payment transaction. The Phone to Phone transaction is shown in Figure 4 and the Phone to Device transaction is shown in the Figure 5 respectively.

#### 2.4.3. Phone to Tag

Tag contains data. Normally tags are embedded on posters for marketing purpose. Cell phone is touched with tag and data from tag is transferred to cell phone. For example, there is a tag on bus terminal which by touching cell phones transfers bus timings and other details.



Figure 4: Phone to Phone NFC Transaction [xiv]

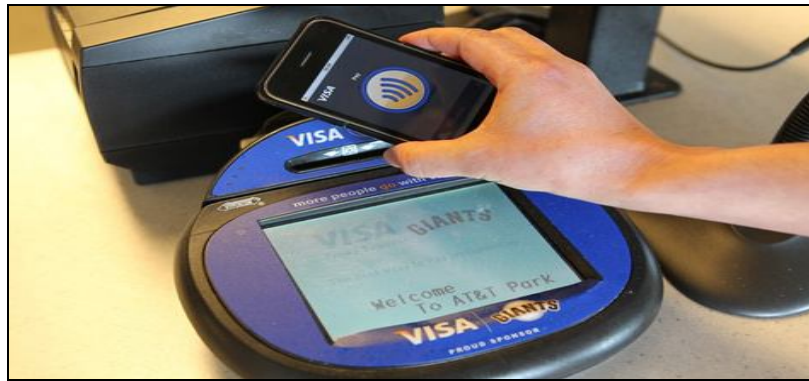


Figure 5: Phone to Device Transaction [<sup>xv</sup>]

#### 2.4.4. Phone to Reader

We can purchase and store electronic tickets on our cell phones. Cell phone can communicate with external reader by just touching it with reader. So one can purchase ticket easily instead of standing and waiting in a long queue

#### 2.5. NFC Applications

NFC fall under three different categories upon its usage in different fields.

1. Service initiation category
2. Peer-to-Peer category
3. Payment and Ticketing category

- Service initiation: In this scenario functioning of NFC is the same as of RFID. NFC device reads some data from a tag and uses this information in several different ways. In this case tag serves as transponder, it could be a turned off cell phone. NFC device can read the data even if the cell phone is powered off. Example of such scenario can be the advertisement or information poster [<sup>xvi</sup>]. In this application NFC tag is fixed near information desk, user touches its NFC device with tag and retrieves the information. Suppose this tag is placed in university for guidance regarding study schedule of students. Whenever student wants to know his course schedule, he brings his NFC device close to NFC course tag and retrieves the information of his course schedule
- Peer-to-Peer: In this application direct link between two devices is set up to transfer data. Amount of data may not be too large. If user wants to transfer large amount of data, Wi-Fi or Bluetooth connection can be set up, but that is invisible to user. For example, food packing, flight schedule, street signs, signs on bus stops, sign on posters, airline information, advertisement information, hotel charges, train timings and much more As a result of adding NFC tags on magazines, posters and other advertisement panels user can get existing cell phone services like SMS and Internet based services using their NFC cell phones.

Touch to Pay With the help of NFC users can keep contactless cards and tickets in their cell phones. Instead of keeping tickets and debit/credit cards separately, user can store all the cards and tickets in their NFC equipped cell phone. NFC mobile wallet facilitates by showing current balance, last ten transactions, and works on all contactless readers.

#### 2.6. NFC Usage Models

##### 2.6.1. Touch to Connect

NFC allows us to retrieve information from our environment. NFC allows cell phones to collect information stored on daily life objects in the form of NFC tags.

##### 2.6.2. Touch to get Parking Information

NFC parking application facilitates user to collect parking information on his/her NFC cell phone by just touching cell phone to NFC tag that gives you the parking service information i.e. location to park your vehicle, parking duration, parking rent. It saves user's lot of time and decreases the queue time in parking lots. You can install this application by SMS and can pay the parking fee through the GSM operator.

Touch for Entertainment Accessing web site, transferring/copying data, getting movie advertisements, initiating phone call or sending SMS by single touch, purchasing tickets of concerts, club or cinema, making hotel reservations, storing discount coupons on NFC cell phones and using them later are all part of NFC entertainment. We can buy any entertainment service using M-Wallet on NFC cell phone.

##### 2.6.3. Payment and Ticketing

In this scenario cell phone is used as electronic wallet. Nowadays we are using cards only for payments. But with NFC equipped device, multiple functions could be collected under the same platform. Virtual money can be loaded in the cell phone that can be used to pay travelling tickets or parking fee [16].

#### 2.6.4. Touch for Kiosk Services

Kiosk service facilitates user to get different NFC-based services and applications at a single point. Tag services includes SMS services, call services (Emergency numbers), entertainment activities, train/bus/flight schedule, location information (for visitors) etc.

#### 2.6.5. Touch to Shop

NFC shopping application provides you the facility to manage your shopping cart by using NFC cell phone. By bringing your NFC phone closer to the product tag you can get product information (size, color, manufacturing date, expiry date, price and weight). NFC access control application facility provides entry to any access control point like parking gates, tunnels, university entrance, and staff entrance to organization. This application can be used at any exit control point. NFC phone can also act as terminal for current RFID contactless cards. However it has the ability to integrate with Misfire technology [<sup>xvii</sup>]. Figure 6 illustrates a day in the life of NFC.



Figure 9: NFC Application Scenarios [<sup>xviii</sup>]

### 3. Conclusion

Compared with other wireless technologies some of the threats have a low impact on the NFC, such as eavesdropping, which is difficult to achieve through the transaction due to the distance in less communication between devices and the denial of the attack, which will only affect the normal operation for some time. The data modification, data corruption, and the attack of the sequential devices are the threats to NFC. There is a threat of downloading malicious software on the mobile phone and then this software can be used to eavesdrop on the data entered on the keyboard or attempt to access sensitive data, which threatens the security of other applications. Encryption gives us better way to secure communications. The question is which encryption method to use here, either symmetric or asymmetric. Symmetric encryption has its own issues, like key distribution and trust, etc. Asymmetric encryption technique increases transaction time and more utilization of battery power which is not suitable in terms of low powered devices. Advanced encryption techniques like ECC (Elliptic Curve Cryptography) can be used to solve such issues. Using an appropriate encryption technique depends on the use case. In sensitive environments, where more security is required, asymmetric cryptography should be used despite of its increased transaction time property. Using NFC devices will affect personal privacy by tractability. Possibly someone could read UID of a NFC tag from a distance and see that the same phone passes at a later time. Having GPS in the cell phone will help attacker to pin point your location. Cell phone affected by malware can collect all of the information stored in the cell phone or the information typed by the keyboard and can send it back to the attacker.

No doubt NFC technology will ease our life. Its touch and go facility will be fun for the people. But, this technology is not mature yet and has lots of security and privacy issues. Using NFC devices for entertainment will be fun, but this technology is not yet ready for business use since there are privacy threats faced by NFC.

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