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NFC and AI Integration in Identity Verification: Advances, Applications, and Security Implications.

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Abstract:

Nowadays, the technology of NFC become more advance, and the use of NFC does not limit in putting NFC chip into a card to open a door, the technology of NFC can be mixed with smartphone, a supermarket system and even AI. Hence, in this paper the writer is going to do some research on how to combine the technology of AI with NFC. Hopefully, this paper helps people who are interesting in NFC field and want to combine it with AI to understand basic working principle and information about NFC. This paper firstly introduces what is NFC and some basic information about NFC such as working principle and different modes. Secondly, this paper shows different ways to combine NFC technology with real life and other technologies, such as a mobile phone and a retailing market system. Then, this paper shows some experiments about NFC, such as comparing NFC with Bluetooth and other wireless communication systems, the differences between rectangular device and circle device, and Near field JS&C in narrow-band system. Hence, this paper shows advances, applications, and security implications of NFC and AI integration.

Keywords: NFC, AI, Identity verification, Security.

1. Introduction

NFC represents the near field communication. The detail specifications of NFC can be found in ISO 18092 [1]. The main feature of NFC is it is a wireless communication tool and its effective working distance is about ten centimeters. Also, NFC can work in different mode, an NFC device can send As shown in Table 1:an RF field or gain an RF field from another divice. If a device produce its own RF filed, it can be called an active device, and if a device gain RF field from another device, it can be called passive device. Usually, an active device has its own power supply, while a passive device usually not. When two divices are communicating with each other, there are three different types of combinations. As shown in table 1[2]:

Table 1: Communication Configurations

Device A	Device B	Description
Active	Active	When a device is sending data, it can produce an RF field, and when waiting for the data, this device does not produce an RF field. Hence, an RF field can be produced by both device A and B alternatively.
Active	Passive	Only device A generate the RF field
Passive	Active	Only device B generate the RF field

Those combinations in table 1 are very important, because the way data are transefered depends on the device is in active mode or in passive mode.

In NFC, if the distance between a reader and an NFC tag, this tag can make a response to the activation of the reader, this allows any NFC reader can gain the data in the NFC tag easily. To solve this potential danger of leaking security, NFC safety standard is needed. It regulates the encryption and decryption of the public key, and try to enhance the identification mechanism of NFC for many times. However, the encryption based on public key is not easy to be used in low cost NFC tags, because the chip of NFC tag do not have the calculation ability to deal with the algorithms of public key. Although, some NFC tags can deal with the algorithms of public key, but those attackers can use those weaknesses in stream cipher to read and change those information in NFC chip. Hence, cloning attack is possible.

Due to the fact that NFC is a wireless communication tool, attacking of data is an important issue. The fact is data transefered in passive mode device is much more difficult to attack, but for most of data-transefer sensitive applications, it is not enough to only use passive mode to transfer information.

Because NFC itself cannot provide a effective protection to avoid those attacks during data transfer, to solve this problem, the only way is to build a safe path for transfer information on NFC devices. This method is easy to carry out, because the safe path of NFC transfer is not easy for attackers to attack. Thus, no need to indentify identity to use well-known and easy to provide safe path, this defence method makes NFC technology becomes an ideal way to pair different devices.

2. Methodology and Technical Model Basis

2.1 Operating Modes and Communication Essentials

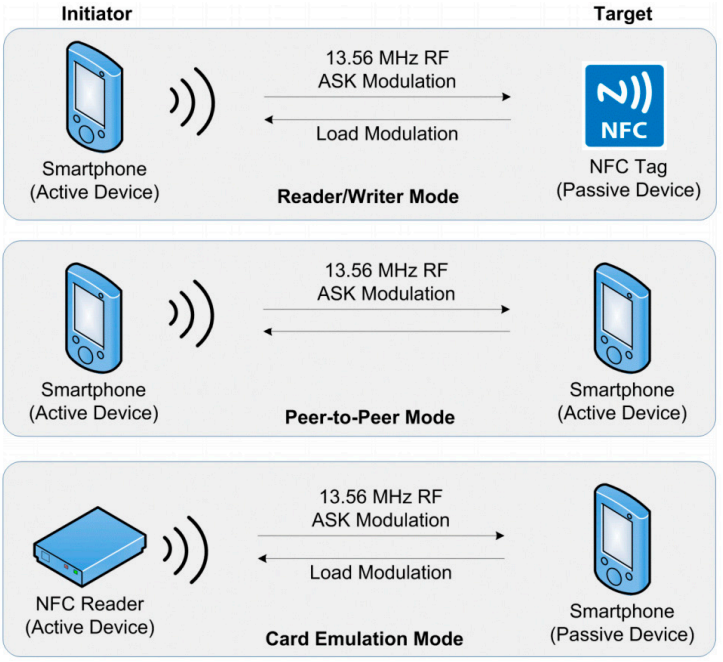

Figure 1. Different operating modes of NFC device

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There are three different types of NFC communications between NFC devices, which are smartphones, NFC tags, and NFC readers. The method of communication between different devices provide three different kinds of operation modes, as shown in figure 1 [3], which are reader or writer mode, one smartphone works as an active device, and an NFC tag works as a passive device; peer-to-peer mode, one smartphone works as an active device, and another smartphone works as an active device; and card emulation mode, an NFC reader works as an active device, and a samrtphone works as a passive device.

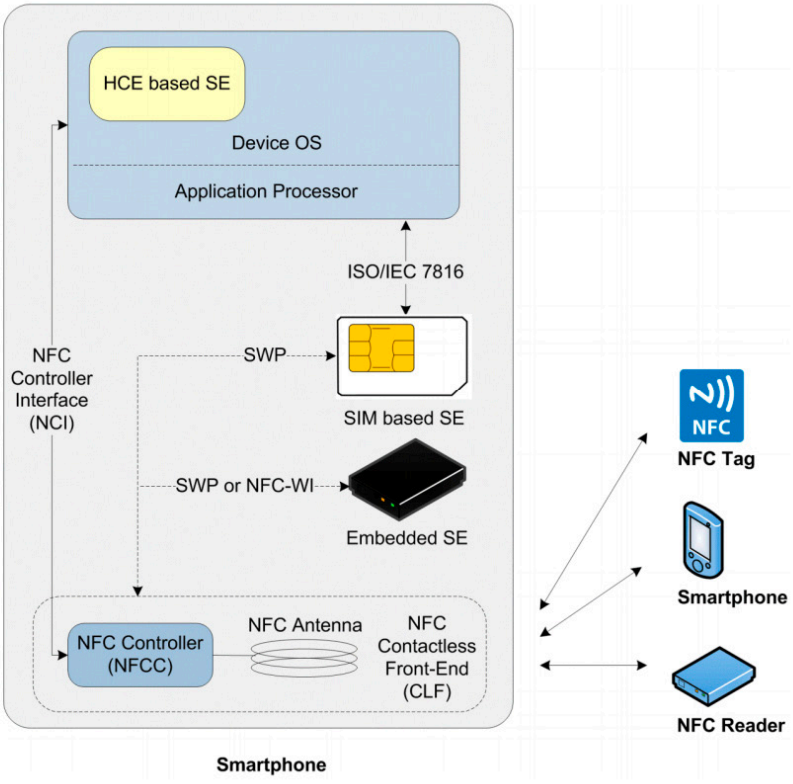

Figure 2. General architecture of an NFC smartphone

An NFC smartphone is a very important part in an NFC communication system, it is usually consisited of many integrated circuits, as shown in figure 2 [3]. An NFC communication module is consisted with a contactless front part, which is called NFC CLF, an NFC antennea, and an integrated chipset, which is known as an NFC controler (NFCC), whose function is to manage the emission and collection of signal and then modulate or demodulate.

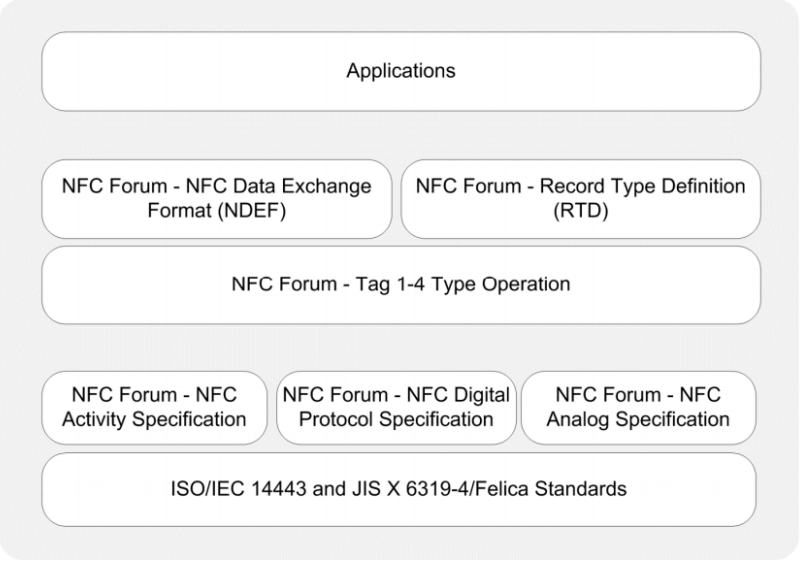

Figure 3. The reader or writer mode communication essentials

This is the essentials of reader or writer mode [3], in reader or writer mode, smartphone works as an active device to start a communication and can read NFC tags, which works as a passive RFID tags. As shown in figure 3, it shows a protocol stack illustration of reader or writer mode communication.

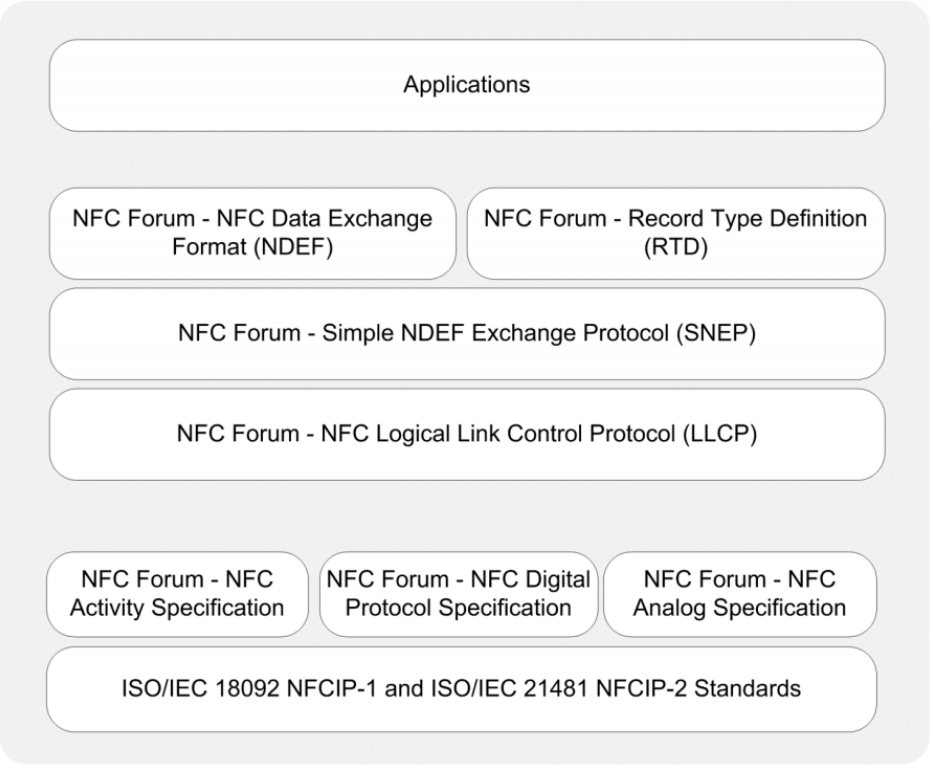

Figure 4. Peer-to-peer mode communication essentials

This is the peer-to-peer mode [3], in peer-to-peer mode two smartphones build a connection that can transfer data in both directions to exchange informations, and those informations can be in any form, such as digital photos, business card, and applications with any use. As shown in figure 4, it shows a protocal stack illustration of peer-to-

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peer mode communication.

2.2 NFC in a Retailing Market System

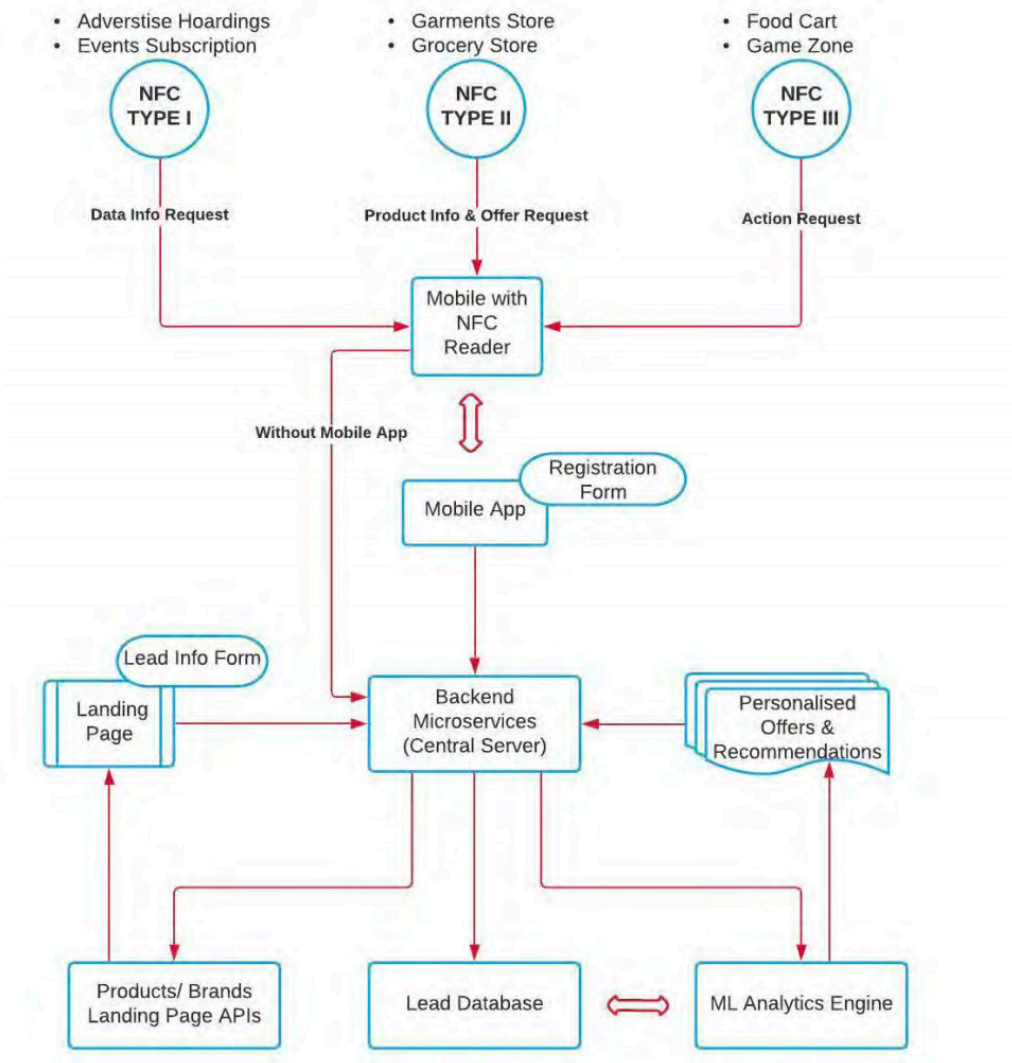

Figure 5. The use of NFC in a retailing market intelligence system

This picture shows a retailing market intelligence system [4].

Firstly, NFC type 1 that represents advertise hoardings and events subscription can send data information request to the mobile with NFC reader, NFC type 2 that represents garments store and grocery store can send production information and offer request to the mobile with NFC reader, and NFC type 3 that represents food cart and game zone can send action request to the mobile with NFC reader.

Secondly, the mobile with NFC reader can interact with mobile app in registration form and send to the backend microservices (central server), or without mobile app send information directly to the backend microservices.

Thirdly, the backend microservices show the lead database, then use products or brands landing page APIs to show landing page in lead information form, and ML analytics engine to show personalized offers and recommendations on backend microservices.

Then, there are explainations of different components in Figure 5 [4].

The smartphone applications mean some applications can use NFC function in the smartphone to interact with NFC tags. The working principle of these applications is quite similar to some business applications, but have supports from NFC technology.

The landing pages mean after scaning NFC tags, customers is usually leaded into a landing page that helps increas-

ing their shopping experience. This landing page is also a good place for reltailers to show their advertisements.
The backended microservices, which is also known as a central server, is a cenrtralized component. It combines all of things into a single system, backended microservices handle all the requirements from customers who scan the NFC tags. This central server use essential function through carrying out services, and send back prompts to customers by using applications.
The lead database is a place storing customers' informations, such as personal informations, purchasing history, services, special offers, and past online activities.
The mechine learning (ML) analytics engine is one of the most important part in the system, because it supports retailers design their their services and products based on customers' needs, and helps understanding all data stored.

3. Experiment and Model Evaluation

Table 2: Differences among different wireless communication systems

Feature	NFC	Bluetooth	UHF RFID	Chipless RFID
Reader cost	Low, smartphone	Low, smartphone	High, $1000-$2000	High, not commercial
Read range	1-2cm for proximity cards with energy harvesting, 0.5m for vicinity cards	10-100m	Up to 15m with 2dBm read IC sensitivity. Up to 3m UHF sensors (with -9dBm read IC sensitivity). Up to 30m BAP.	<50 cm frequency coded 2-3m, time-coded UWB
Universal Frequency regulation	Yes, ISM	Yes, ISM	No, by regions	No, often used UWB
ID rewritable	Yes	Yes	Yes	No
Energy harvesting	Approximately 10mW	No	Few μW	No
Tag price	Low	High	Low	Moderate
Memory capacity	<64 kilobits	Several kilobytes depending on the microcontroller	96 bits EPC, typically 512 bits for users (<64 Kilobytes)	<40 bits

As shown in table 2, by comparing four different kinds of wireless communication technologies, which are NFC, Bluetooth, UHF RFID and Chipless RFID, in seven different aspects, which are reader cost, read range, universal, frequency regulation, ID rewritable, energy harvesting, tag price and memory capacity [5].
Firstly, the read cost of NFC is lower than two different kinds of RFID, which are UHF RFID and chipless RFID, this is because the UHF reader is very expensive about $1000-$2000, and chipless RFID doesn't have a commercial standard and needs a dedicated reader to interrogate the tag, thus it needs many efforts to develop chipless RFID [6].
Secondly, the energy harvesting ability of NFC is much greater than others, this is because in passive mode the NFC can gain energy from the readers to power up the external electronics. Also, in the market many sensitive NFC IC has the ability of harvesting energy and can stimulate the development of low cost and green energy wearable devices.
Thirdly, the read range of NFC is about 1-2cm [7], but the read range for Bluetooth is much greater than NFC, which is 10-100m because Bluetooth technology has a battery to power. Also, chipless RFID has a very small read range for the frequency codes, which is about one to two centimeters, but the read range for the time-domain-code tags is about two to three meters. Also, UHF RFID, which is known as ultrahigh frequency RFID, and passive RFID have much longer operation distance than low-frequency RFID tags.

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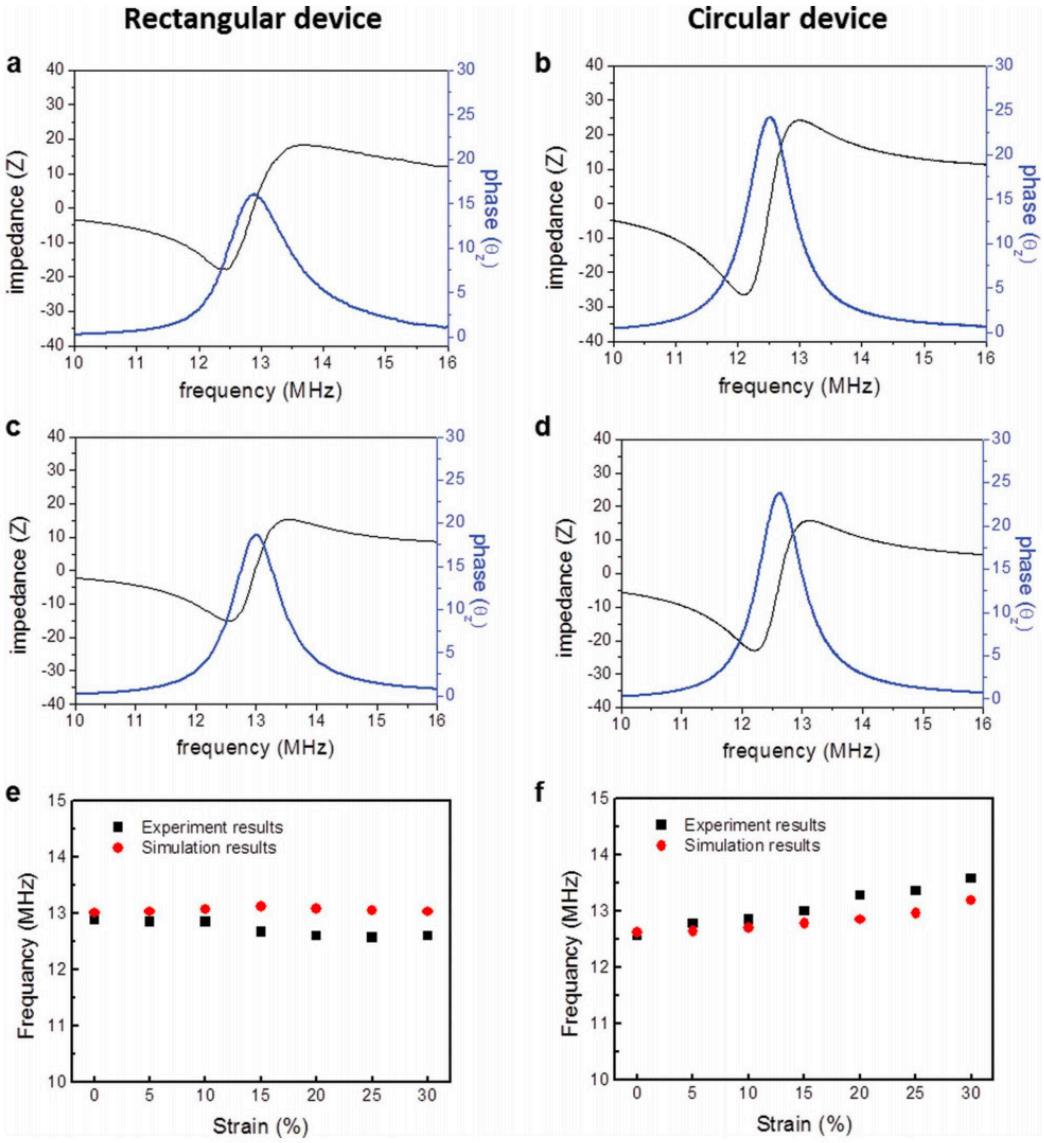

Figure 6. Experimental and modeling results of the NFC devices

As shown in figure 6, the experimental and modeling results of NFC devices [8]. Picture a and b show the frequency dependent impedance and phase responses for rectangular device and circular device, picture c and d show the corresponding electromagnetic modeling results for rectangular device and circular device, and picture e and f show the resonant frequency changes with uniaxial strain and corresponding modeling result of each device.

Firstly, in graph a the impedance first decreases and increases then decreases, the minimum point is about (12.5, -18) and the maximum point is about (13.5, 15), the phase first increases and decreases, the maximum point is about (12.9, 5). Then, in graph b, the impedance first decreases and increases then decreases in a greater amplitude, the minimum point is about (12.2, -27) and the maximum point is about (13.3, 25), the phase first increases and decreases in a greater amplitude too, the maximum point is about (12.5, 25).

Secondly, in graph c the impedance first decreases and increases then decreases, the minimum point is about (12.5, -15) and the maximum point is about (13.5, 15), the phase first increases and decreases, the maximum point is about (13, 10). The significant difference between graph a and c is, the maximum magnitude of phase changes from 5 to 15. Then, in graph b, the impedance first decreases and increases then decreases in a samller amplitude, the minimum point is about (12.2, -23) and the maximum point is about (13.3, 15), the phase first increases and decreases in a greater amplitude too, the maximum point is about (12.5, 25). The significant difference between graph b and d is,

the amplitude of impedance decreases from b to d.

Thirdly, in graph e the experiment results show the relationship between strain and frequency is first increasing and then decreasing, and the simulation results show the relationship between strain and frequency is first increasing and then decreasing too. However, the magnitudes of frequency in experiment results are all smaller than simulation results and the gap increases as magnitudes of strain increases. In graph f the experiment results show the relationship between strain and frequency is increasing, and the simulation results show the relationship between strain and frequency is increasing too. However, the magnitudes of frequency in experiment results are first smaller but then greater than simulation results and the gap increases as magnitudes of strain increases.

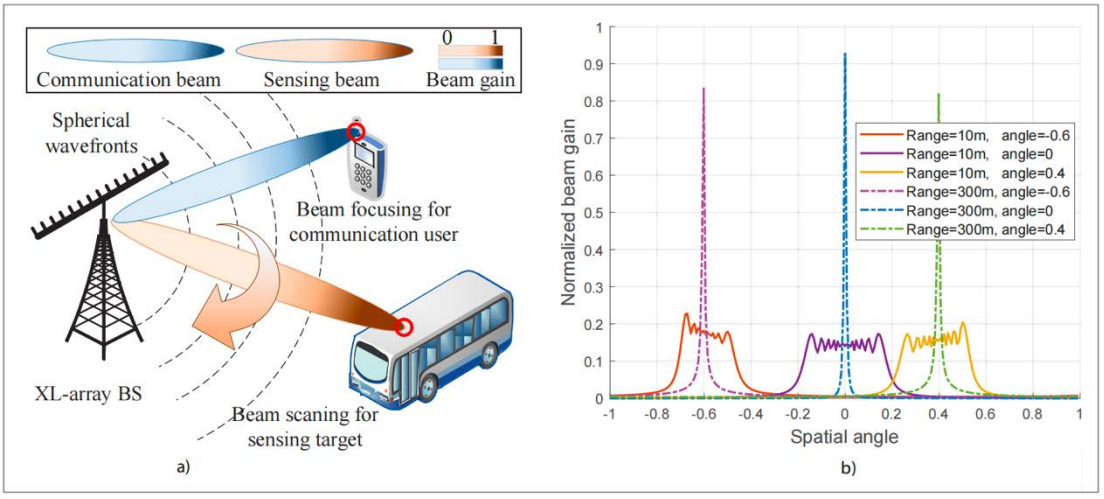

Figure 7. Near field JS&C in narrow-band system

Firstly, as shown in figure 7 in graph a, the XL-array BS transfer spherical wavefronts to beam focusing for communication user and beam scanning for sensing target through communication beam and sensing beam respectively [9]. The color depth shows 0 and 1, and the beam transfer from XL-array BS is 0 and the beam gain by communication user and sensing target is 1[10].

Secondly, graph b shows the relationship between spatial angle and normalized beam gain. For orange color, the range is 10 meters and the spatial angle equals -0.6, for purple color, the range is 10 meters and the spatial angle equals 0, for yellow color, the range is 10 meters and the spatial angle equals 0.4, for pink color in dotted line, the range is 300 meters and the spatial angle equals -0.6, for blue color in dotted line, the range is 300 meters and the spatial angle equals 0, and for green color in dotted line, the range is 300 meters and the spatial angle equals 0.4. Although the range for dotted line and regular line has huge difference in magnitude, which are 300m and 10m respectively, the spatial angle are actually same respectively, they are all -0.6, 0, and 0.4.

4. Conclusion

Firstly, this paper introduces the basic information about NFC, such as different combinations between active and passive devices and different working principles. After knowing the work principle of NFC, this paper shows how do NFC increase the security in identity identification Then, this paper starts to discuss different ways to combine NFC technology with other technologies. Firstly, there are three operating modes of NFC device, which are reader/writer mode, peer-to-peer mode, and card emulation mode, these modes include different situations in people's daily life. Secondly, this paper shows a general structure of an NFC smartphone, which explains how do an NFC device communicate with an NFC tag, a smartphone, or an NFC reader. Thirdly, to ensure the communication between devices through NFC is safe, there are communication essentials, which are the writer/reader mode communication essentials and peer-to-peer mode communication essentials. At last, this paper shows the combination of NFC technology with a retailing market intelligence system to show the possibilities of combining NFC technology in different ways of life.

Thirdly, this paper shows some experiment results and evaluations of some models. The first part is about differences among different wireless communication systems such as read cost, read range, and energy harvesting. Then, this paper compares experimental and modelling results of rectangular device and circular device in NFC. At last, a near field JS&C in narrow-band system is introduced.

The writer wants to use this paper to share basic informa-

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tion of NFC to those people who want to learn something about NFC and do some research on it. Then, some examples of combination of NFC technology with other technologies is used to give readers' inspirations to combine AI with NFC. At last, those experiment and model in this paper are used to share some data about different NFC in different situations, which can help readers to classify NFC in different circumstances.

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