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A Study on Designing the New Near Field Communication Technology-NFC-micro SD Technology

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Abstract: Near Field Communication (NFC) is the popular technology in mobile phones. In recent years, there are several NFC technologies developed and NFC-enabled products launched. No doubt, integrating NFC chip into Micro SD card is the trend, because of the widespread use in Micro SD. However, the challenge is maintaining the size of NFC chip and Micro SD card. Therefore, the research presented a quite innovative processing in NFC field, NFC-Micro SD. It has the unique patent about packaging antenna module. With the patent, only NFC-Micro SD technology doesn't have to change the size of NFC chip and Micro SD card to carry out the convenience of NFC technology. It also has the lower cost than other NFC technologies and could provide the memory for storing the data. The most important is it can apply in all kinds of mobile phones by using the NFC-enabled Micro SD card. The research found NFC-Micro SD technology is prior to other technologies and the mainstream technology in NFC field.

Key words: Near field communication, micro SD, RFID, chip size, NFC-micro SD

INTRODUCTION

With the growth of consumer electronics, Near Field Communication (NFC) is an emerging and compelling technology. It is characterized as a short-range radio communication technology with much potential applications. NFC-enabled devices allow users to communicate with each other by simply touching, waving or putting them close to each other. NFC allows users to exchange the data and service between two NFC-enabled devices by identification passing. It also can apply to payments, retailing, ticketing, electronic key, healthcare and many applications in life.

Most academic literatures considered NFC mobile services as an important application and benefit for the consumers. Most academic literatures focus on the technical issues of NFC-Mobile Phone and considered lack of the key technology to promote the NFC mobile services. Therefore, the research proposes the newly innovative NFC technology, NFC-Micro SD technology. The feature of the new NFC technology can improve the willingness of promotion and using. It is estimated as the leader in NFC field in the future.

NFC RELATED WORK

NFC introduction: Near Field Communication (NFC) is a standard based short-range wireless connection

technology that enabled simple and safe peer-to-peer interconnections between electronic devices (Agrawal and Bhuraria, 2012; ECMA, 2005a). NFC is based on Radio Frequency Identification (RFID) technology and uses the same communication mechanism. RFID uses the magnetic field induction communication between electronic devices as the basic theorem. In RFID systems, there are two components, the transponder (contactless target/simply tag) and the transceiver (read-write device/simply reader or writer). (Falke *et al.*, 2007). RFID is not a symmetric technology because it depends on only the reader/writer to initiate the data transmission (Morak *et al.*, 2007). On the contrary, NFC allows the two-way communication between the two devices.

NFC is based on RFID technology and uses the same communication mechanism. NFC integrates the advantages of RFID and the wireless communication technologies (e.g., Bluetooth, IrDA, WLAN). Farmer *et al.* (2005). The NFC standards (NFC Forum) was proposed in 2003. It operates in the unlicensed frequency band of 13.56 MHz. The data transmission rate of NFC is up to 424 kBit sec⁻¹ between devices over a ten centimeter (4 inches) distance. The transmission module inside can operate as the reader/writer component to access the tags and the contactless smartcards based on proximity-card standard (ISO 14443), like Mifare (included NXP, Graz, Austria) and Felica (included Sony,

Tokyo, Japan) products (Morak *et al.*, 2007). It combines the smartcard interface and the reader in a single device. NFC devices could communicate with the existing smartcards, the contactless reader and support two-way communication between the other NFC-enabled devices in active and passive mode.

Basically, NFC function enables data exchange by taking two NFC-enabled devices close together. For any device with NFC tag built-in it, the device possesses the NFC function. NFC enables the devices to use the tags and connect to them by the antenna. The antenna makes the NFC-enabled devices exchange the data. NFC communication via., the magnetic field induction where the antenna are both located within near field and form an air-core transformer (Agrawal and Bhuraria, 2012). NFC devices are unique, therefore they are capable of changing the mode of operation in accordance with the purpose of usage.

NFC standard: In 2002, NXP technologies (Philips Semiconductor Operators) and SONY started to develop NFC technologies. NFC is an open platform technology which is standardized in ECMA 340 (ISO/IEC 18092), ECMA 352 (ISO/IEC 21481), ECMA 356 (ISO/IEC 22536), ECMA 362 (ISO/IEC DIS 23917) and ECMA 373 (ECMA, 2005b). ECMA 340 (ISO/IEC 18092) (ECMA, 2004a) itemizes the main protocol, includes modulation schemes, codings, frame format of the RF interfacance, transfer speeds and anti-collision. It also specifies the active and the passive communication modes and data exchange methods for wireless interconnection between the close devices and access to contactless cards operating in the 13.56 MHz environment. NFC technology has three communication modes and the mechanism to detect and select is specified by ECMA 352 (ISO/IEC 21481). (ECMA, 2010) ECMA 356 (ISO/IEC 22536) and ECMA 362 (ISO/IEC DIS 23917) specify RF-test methods for ECMA 340 devices with antennas fitting within the rectangular area of 85 by 54 mm (ECMA, 2004b, 2005a). ECMA 373 specifies the signal wires, binary signals the state diagrams and the bit encodings for three data rates between a transceiver and a front-end (ECMA, 2012).

In 2004, NXP, SONY and NOKIA founded a non-profit NFC Alliance, NFC Forum. It contains more than 150 members included intelligent chip manufacturer, bank, credit card issuers and so on.

NFC IMPLEMENTATION

NFC technology development: NFC technology is considered the mainstream technology of the next generation for mobile phone products. Many

organizations collaborate with the NFC Forum actively (Clark, 2013). The handset manufacturers and network operators all launch the NFC-enabled products to strive for the customers. The competitive condition results in several kinds of the NFC products to apply in mobile phones. There are multiple ways by which the mobile device can be made NFC-enabled as follows:

- **NFC-Tag:** It's a form of sticker. While the sticker is attached to the device, it can be used as the NFC-enabled device. The stickers can be considered read-only, read/write, or need a special tag writer to input the data. The type of stickers is according to the intended use
- **NFC-mobile phone:** The handset manufacturers place NFC chips into the mobile phones in manufacturing process and install the NFC program in advance. The process makes the mobile phone as NFC-enabled device
- **NFC-SIM:** The flexible NFC chip is added on the subscriber's original SIM card which could provide additional NFC services and use the application and services from the third party developers. However, the chip is sensitive to the electromagnetism, especially the battery of the mobile phone. To solve the problem of the electromagnetism, the flexible flat cable has to add on the NFC chip to block the impact of the battery
- **NFC-SWP SD:** The technology integrates NFC chip into Micro SD card. Because the NFC chip integrated is with no antenna module, the integrated Micro SD card must add additional RF contacts on it. The additional RF contacts can communicate with RF antenna in mobile phones to transmit NFC signals
- **NFC-micro SD:** The most important feature is NFC chip packages the antenna module inside in advance and is built-in the Micro SD card. Therefore, NFC-Micro SD technology doesn't have to change the size of NFC chip and Micro SD card and can apply in every kind of phones

NFC Micro SD technology: For the four NFC technologies, the acceptance degrees in the mobile phone market are different. The key to improve the acceptance degree is widely applied in mobile phones. It's also the challenge in NFC field.

Embedding NFC into the mobile phone is the trend in NFC field. The trend of the mobile phone is asked to be slim and light. In the market of mobile phone, the replacement rate is so high and the consumers like the interesting and new mobile phones. NFC-Mobile Phone and NFC-SIM both limit to the special mobile phone

types. It will reduce the using willingness. So the two solutions have the fewer acceptances for the consumers.

Thus, the technology of combining NFC chip and Micro SD card has the less cost and keeps the mobile phone slim and light. While the end users want to replace the mobile phone, they could only swap the SD card with NFC function to the new mobile phone. Then the consumers could choose the favorite mobile phones.

The two technologies, NFC-SWP SD and NFC-Micro SD, both combine the NFC chip with the Micro SD card. The difference is if the antenna module is packaged in the NFC chip. The technology of NFC-SWP SD didn't package the antenna module in the NFC chip. On the chip of NFC-SWP SD, there are two RF contacts on it to do the communication. So it has to depend on the RF function of the mobile phone to do the communication. But not all of the mobile phones have the RF function inside. Besides, it has to additional attaches an antenna outside the chip and then the NFC chip could connect to the RF function by it.

The characteristic of NFC-Micro SD is packaging the antenna module in the NFC chip. It's the patent. With the patent, NFC-Micro SD solution doesn't need the additional antenna attaches outside the chip to communicate with RF function of the mobile phone. On the contrary, the NFC-Micro SD could transit the message by the built-in antenna. Thus, the NFC-Micro SD card could use in all kinds of the mobile phones. As Fig. 1 shown, the users could only place the NFC-Micro SD card into the smart phone and choose the apps to activate the NFC function.

Every NFC chip contains four blocks on the substrate, included Die 1, Die 2, Die 3 and Antenna module, as shown in Fig. 2.

The first block (Die 1) is the memory, standard NAND Flash. It processes the reading and the storing of the data. The second block (Die 2) is Memory Card Controller with OTA (Over-the-Air) Support. It controls the data flow. The third block (Die 3) is the SmartCard Controller. It operates encryption, decryption and transmit the corresponding payment ways. The fourth one is the miniature Antenna module and it transmits the signals.

To package the antenna in the chip, NFC-Micro SD uses the miniature 13.56MHz Antenna Coil. Then it can solve the problem of the limited space. While the signal is received by Antenna module, it transmits to the SmartCard Controller by ISO 14443. After SmartCard Controller executes the encryption and decryption, it makes the preprocedure of the data. If the data is about NFC, SmartCard Controller would choose the corresponding payment way and do the identification

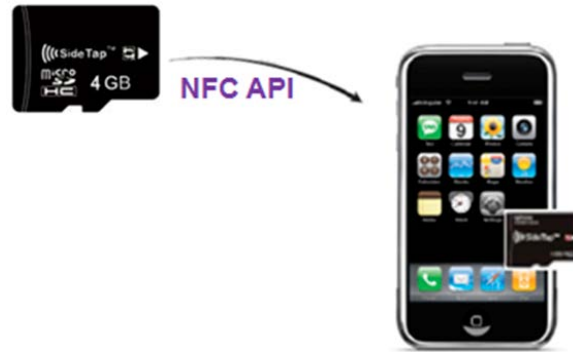


Fig. 1: NFC combines with smart phone

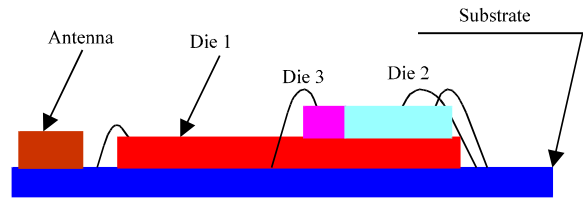


Fig. 2: NFC-Micro SD card structure

directly and transmit the signal by Antenna module. Then it can block the private personal data away the normal data.

The SmartCard Controller communicates with Memory Card Controller on the basis of ISO 7816. To access the ISO 7816 SmartCard functions in a memory card slot needs Memory Card Controller to process the data flow. It's supported by OTA, without need for SDIO or McEX. Memory Card Controller communicates with the electronic devices by SD Bus and communicates with NAND Flash by the Memory Bus. The NAND Flash is the main storing center.

To upgrade the security, NFC-Micro SD Card has the additional hardware OTP. The OTP is generated by the card and the server. If the OTP generated by the card is the same as OTP generated by the server, then it's valid. And the transactions can be continued. The OTP is generated based on the chip serial number and follows the sequence based approach. Therefore, NFC-Micro SD technology could realize NFC goals without changing the size of the Micro SD card and the mobile phones.

CONCLUSION

As people know, NFC technology is a popular wireless communication technology. Many companies invest in the development of NFC field. With the mobile phone market growing, there are several NFC technologies developed.

In the comparison of NFC technologies, NFC-Micro SD technology is apparent that it's better than other NFC technologies. With the unique patent of packaging the antenna module, NFC-Micro SD technology can maintain the size of the Micro SD card and enhance the efficiency. The most important thing is NFC-Micro SD can apply in every type of mobile phone. Users can make every mobile phone they prefer as NFC-enabled device by using the NFC-Micro SD. By NFC-Micro SD technology, it estimated to make the more applications realized. Therefore, NFC-Micro SD technology will be the mainstream technology in NFC field.

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