NEAR FIELD COMMUNICATION

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ABSTRACT

Near Filed Communication (NFC) is a close range radio communication protocol which is used for very sensitive applications. It was jointly developed by Sony and Philips. The standard specifies the ways to establish P2P (Peer-to-Peer) communication links for data exchange. After the P2P network has been configured, another wireless communication technology, such as Bluetooth Wi-Fi, can be used for longer range communication or for transferring larger amounts of data. Its development was parallel to RFID (Radio Frequency Identification), but both differ in many ways. NFC offers a very short range as compared to RFID. This is an added advantage in the sense that it requires a very little transmission power and cheap transmitters can be used for the purpose. Hence it is very suitable for Smartcard like applications. It can also work in both active and passive modes. NFC works on a frequency range of 13.56 MHz It offers a baud rate of 106 kbps to 424 kbps. The transmission is made from a frequency of 13.56 MHz inductively; hence it uses a high magnetic field. At a transmission only the two participants can be involved-one transmitter (initiator) and one receiver (target). The transmission can be either in active fashion or passive fashion. Both have their own merits and demerits. The NFC transmission runs helping duplex, i.e. that one of the two devices can send only in each case or receive at a time.

KEYWORDS: Near Field Communication, Bluetooth, WI-Fi, Radio Frequency Identification (RFID), transmitter, receiver, Baud Rate

INTRODUCTION

Near Field Communication (NFC) is a technology for contactless short-range communication. Based on the Radio Frequency Identification (RFID), it uses a magnetic field induction to enable communication between electronic devices. The number of short-range applications for NFC technology is growing continuously, appearing in all areas of life. Especially the use in conjunction with mobile phones offers great opportunities. One of the main goals of NFC technology has been to make the benefits of short-range contactless communications available to consumers globally. The existing radio frequency (RF) technology base has so far been driven by various business needs, such as logistics and item tracking. While the technology behind NFC is found in existing applications, there has been a shift in focus most notably, in how the technology is used and what it offers to the consumers. With just a point or a touch, NFC enables effortless use of the devices and gadgets that we use daily. Here are some of the examples of what a user can do with an NF mobile phone in an NFC-enabled environment. You can download music or a video from a smart poster or you can exchange business cards with any another phone. You can pay a bus or a train fare. You can print an image on a printer [1].

NEAR FIELD AND FAR FIELD

The terms far field and near field describe the fields around an antenna or more generally, any electromagnetic radiation source. The names imply that two regions with a boundary between them exist around an antenna. Actually, as many as three regions and two boundaries move closer to or farther from an antenna, depending on both the radiation frequency and the amount of error an application can tolerate. To talk about these quantities, we need a way to describe these regions and boundaries. The terms apply to the two and three region models [2].

NFC DEVICES:

Essential Specifications:

1. Like ISO 14443, NFC communicates via the magnetic field induction, where the two loop antennas are located within each other's near field, effectively forming an air-core transformer. It operates within the globally available and unlicensed radio frequency ISM band of 13.56 MHz with a bandwidth of almost 2 MHz, with a bandwidth of almost 2MHz.
2. Working distance with compact standard antennas up to 20 cm.
3. The supported data rates are 106 Kbits/sec, 212 Kbits/sec, 424 Kbits/sec.
4. There are two modes:

1. Passive Communication Mode:

The initiator device provides a carrier field and the target device answers by modulating the existing field. In this mode, the target device may draw its operating power from the Initiator provided that the electromagnetic field, thus by making the target device a transponder.

2. Active Communication Mode:

Both the Initiator and Target device communicate by alternately generating their own field. A device deactivates its RF field while it is waiting for the data. In this mode, both the devices typically need to have a power supply.

The different types of communication modes are illustrated along with their data rates:

5. NFC employs two different coding to transfer data. If an active device transfers data at 106 Kbit/s, a modified Miller coding with 100% modulation is used. In all other cases Manchester coding is used with a modulation ratio of 10%. NFC devices are able to receive and transmit the data at the same time. Thus, they can check the radio frequency field and detect a collision if the received signal does not match with the transmitted signal [2].

Standards and Compatibility:

The Near Field Communication is an open platform technology, which is developed by Philips and Sony. NFC, which is described by NFCIP-1 (Near Field Communication Interface and Protocol 1), is standardized in ISO 18092, ECMA 340 as well as in ETSI TS 102190. These standards specify the basic capabilities, such as the transfer speeds, the bit encoding schemes, modulation, the frame architecture and the transport protocol. Furthermore, the active and passive NFC modes are described and the condition that are required to prevent the collisions during the initialization. The NFC devices not only implement the NFCIP-1, but also NGCIP-2, which is defined in ISO 21481, ECMA 352 and ETSI TS 102312. The NFCIP-2 allows for the selection of one of the three operating modes. The NFC data transfer (NFCIP-1), proximity coupling device (OCD), which is defined in ISO 14443 and vicinity coupling device (VCD), which is defined in ISO 15693. The NFC devices have to provide these three functions in order to be compatible with the main international standards for smartcard interoperability, ISO 14443 (proximity cards, e.g. Philip's Mifare), ISO 15693 (Vicinity cards) and to Sony's Felicia contactless smart card system. Hence, as a combination of smartcard and contactless interconnection technologies, NFC is compatible with today's field proven RFID technology. That means, it is providing compatibility with the millions of contactless smartcards and scanners that already exist worldwide [2].

Technological Overview:

NFC operates in the standard, globally available 13.56 MHz frequency band. The possible supported data transfer rates are 106 kbps, 212 kbps and 424 kbps and there is potential for higher data rates. The technology has been designed for communication up to a distance of 20 cm, but typically it is used within less than 10 cm. This short range is not a disadvantage, since it aggravates the eavesdropping.

Communication Modes: Active and Passive

The NFC interface can operate in two different modes: active and passive. An active device generates its own radio frequency (RF) field, whereas a device in passive mode has to use inductive coupling to transmit the data. For battery-powered devices, like mobile phones, it is better to act in a passive mode. In contrast to the active mode, no internal power source is required. In passive mode, a device can be powered by the RF field of an active NFC device and transfers the data using load modulation. Hence, the protocol allows for card emulation, e.g. the card which is used for ticketing applications, even when the mobile phone is turned off. This yields to a two possible cases, which are described in the table which is given below. The communication between two active devices case is called the active communication mode, whereas the communication between an active and a passive device is called as the passive communication mode. In general, at most two devices communicate with each other at the same time. However, in passive mode the initiator is able to communicate with the multiple targets. This is realized by a time slot method, which is used to perform a Single Device Detection (SDD). The maximal number of time slots is limited to 16. A target responds in a random chosen time slot that may lead to a collision with the response of another target. In order to reduce the collisions, a target may ignore a poling request set out by the initiator. If the initiator receives no response, then it has to send the polling request again [3].

Coding and Modulation:

The distinction between an active and a passive device specifies the way the data is being transmitted. Passive devices encode the data always with a Manchester coding and a 10% ASK. Instead, for active devices one can distinguish between the modified Miller coding with 100% modulation if the data rate is 106 kbps, and the Manchester coding by using a modulation ratio of 10% if the data rate is greater than 106 kbps. The modulation ratio by using the modified Miller coding is of high importance for the security of the NFC data transfer.

Manchester Code:

The Manchester coding depends on two possible transitions at the midpoint of a period. A low-to-high transition expresses a 0 bit, whereas a high-to-low transition stands for a 1 bit. Consequently, in the middle of each bit period there is always a transition. The transitions at the start of a period are not considered.

Modified Miller Code:

This line code is characterized by pauses which are occurring in the carrier at the different positions of a period. Depending on the information to be transmitted, bits are coded as shown in the figure. While a 1 is always encoded in the same way, the coding of a 0 is determined on the basis of the preceded bit.

Initiator and Target:

Furthermore, it is important to observe the role allocation of the initiator and target. The initiator is the one who wishes to communicate and starts the communication. The target receives the initiator's communication request and sends back a reply. This concept prevents the target from sending any data without first receiving a message. Regarding the passive communication mode, the passive device acts always as the NFC target. Here the active device is the initiator, which is responsible for generating the radio field. In the case of an active configuration in which the RF field is alternately generated, the roles of initiator and the target are strictly assigned by the one who starts the communication. By default, all devices are NFC targets, and only act as NFC initiator device if it is required by the application. In the case of two passive devices communication is not possible.

Collision Avoidance:

Usually misunderstandings are rather rare, since the devices have to be placed in direct proximity. The protocol proceeds from the principle, listen before talk. If the initiator wants to communicate, first, it has to make sure that there is no external RF field, in order not to disturb any other NFC communication. It has to wait silently as long as another RF field is detected, before it can start the communication, after an accurately defined guard-time. If the case occurs that two or more targets answer at exactly the same time, a collision will be detected by the initiator.

General Protocol Flow:

As shown in the Figure, the general protocol flow can be divided into the initialization and transport protocol. The initialization comprises the collision avoidance and selection of targets, where the initiator determines the communication mode (active or passive) and chooses the transfer speed. The transport protocol is divided into three parts:

1. Activation of the protocol, which includes the Request for attributes and the parameter selection.
2. The data exchange protocol.
3. The deactivation of the protocol including the Deselecting and the Release. During one transaction, the mode (active and passive) and the role (initiator and target) does not change until the communication is finished. Though, the data transfer speed may be changed by a parameter change procedure [3].

Unique Features:

What makes the communication between the devices so easy is that the NFC protocol provides some features not found in other general-purpose protocols. First of all, it is a very short-range protocol. It supports communication at distances measured in centimetres. The devices have to be literally almost touched to establish the link between them. This has two important consequences:

[1] The devices can rely on the protocol to be inherently secured. Since the devices must be placed very close to each other. It is easy to control whether the two devices communicate by simply placing them next to each other or keeping them apart.

[2] The procedure of establishing the protocol is inherently familiar to people you want something to communicate touch it.

This allows for the establishment of the network connection between the devices to be completely automated and happen in a transparent manner. The whole process feels then like if devices recognize each other by touch and connect to each other once touched. This is very important for the battery devices since they have to place conservation of the energy as the first priority. The protocol allows such a device, like a mobile phone, to operate in a power saving mode the passive mode of NFC communication. This mode does not require both the devices to generate the RF field and allows the complete communication to be powered from one side only. Of course, the device itself will still need to be powered internally but it does not have to waste the battery on powering the RF communication interface. Also, the protocol can be used easily in conjunction with the other protocols to select the devices and automate the connection set-up. As was demonstrated in the examples of use above, the parameters of other wireless protocols can be exchanged allowing for the automated set-up of the other, longer range, connections. The difficulty in using the long-range protocols like Bluetooth or Wireless Ethernet is in selecting the correct device out of the multitude of devices in the range and providing the right parameters to the connection by using NFC the whole procedure is simplified to a mere touch of one device to another [3].

Operating Modes of NFC:
NFC is a proximity coupling technology closely linked to the standard of the proximity smart cards as specified in ISO 14443. NFC devices are capable of three different operating modes.
Peer-To-Peer Mode (NFC):
This mode is the classic NFC mode, allowing the data connection for up to 424 Kbit/sec. The electromagnetic properties and the protocol (NFCIP-1) is standardized in ISO 18092 and ECMA 320/340 [1]
Reader/Writer Mode (PCD):
NFC devices can be used as a reader/writer for tags and smart cards. In this case the NFC device acts as an initiator and the passive tag is the target. In reader/writer mode the data rates of 106 Kbit/Sec are possible.
Tag Emulation Mode (PICC):
In this mode, the NFC device emulates an ISO 14443 smart card or a smart card chip integrated in the mobile devices is connected to the antenna of the NFC module. A legacy reader can't distinguish a mobile phone operating in tag emulation mode from an ordinary smart card. This is an advantage of NFC technology as already existing reader infrastructures do not need to be replaced. The smart card chip used for tag emulation is also referred to as the secure element [3].

COMPARISON WITH OTHER TECHNOLOGIES:

NFC AND RFID:
The heritage of earlier standards gives the NFC compatibility benefits with the existing RFID applications, such as access control or public transport ticketing- it is often possible to operate with the old infrastructure, even if the RFID card is replaced with an NFC enabled mobile phone, for example. This is possible because of NFC's capability to emulate RFID tags (card interface mode). NFC hardware can include a secure element for improved security in critical applications such as payments. For example, a credit card could be integrated into a mobile phone and used over NFC. NFCIP-1 is an NFC specific communication mode, which is defined in the ECMA-340 standard. This mode is intended for peer-to-peer data communication between the devices. In this mode, the NFC is comparable to other short-range communication technologies such as IrDA, although the physical data transfer mechanism is different. Basically, the technologies Radio Frequency Identification and Near Field Communication use the same working standards. However the essential extension of RFID is the communication mode between two active devices. In addition to contactless smart cards (ISO 14443), which only support communication between powered devices and

passive tags, NFC also provides peer-to-peer communication. Thus, NFC combines the feature to read out and emulate RFID tags, and furthermore, to share data between electronic devices that both have active power. NFCIP-1 is an NFC-specific communication mode, defined in the ECMA-340 standard. This mode is intended for peer-to-peer data communication between the devices. In this mode, NFC is comparable to other short-range communication technologies such as IrDA, although the physical data transfer mechanism is different. The NFCIP-1 mode is divided into two variants: Active mode and Passive mode. In active mode, both the participants generate their own carrier during communications, and the target device uses the load modulation when communicating back to the initiator, in a way similar to the passive RFID tag behaviour. This makes it possible to save power in the target device, which is a useful feature if the target device has a very restricted energy source, such as a small battery [2].

APPLICATIONS

The NFC technology which is used currently aimed mainly at being used with the mobile phones. There are three main use cases for NFC:
[1] Card Emulation: The NFC device behaves like an existing contactless card.
[2] Reader Mode: The NFC device is active and can read a passive RFID tag.
[3] P2P Mode: The two NFC devices are communicating together and exchanging the information.
There are a plenty of applications which can be possible such as:
[1] Mobile Ticketing in Public Transport: An extension of the existing contactless infrastructure.
[2] Mobile Payment: The device acts as a debit/credit payment card.
[3] Smart Poster: The mobile phone is used to read the RFID tags on the outdoor billboards in order to get the information on the move.
[4] Bluetooth Pairing: In the future, pairing of the Bluetooth 2.1 devices with NFC support will be as easy as bringing them close together and accepting the pairing. The process of activating the Bluetooth on the sides, searching, waiting, pairing and authorization will be replaced by a simple “touch” of the mobile phone.

CONCLUSION AND FUTURE SCOPE

Near Field Communication is an efficient technology for communication with short ranges. It offers an intuitive and simple way to transfer the data between electronic devices. A significant advantage of this technique is the compatibility with existing RFID infrastructures. Additionally, it would bring benefits to the set up of longer range wireless technologies, such as the Bluetooth, Wi-Fi. The NFC is based on the existing contactless infrastructure around the world that is already in use by millions of people’s lives easier which means easier to pay for goods and services, easier to use the public transport and easier to share the data in between the devices. The future work includes some of the following themes which are described as below:

[1] Electronic Ticketing: Airline tickets, Concert/Event tickets and others
[2] Electronic Money
[3] Travel Cards
[4] Identity Documents

[5] Mobile Commerce
[6] Electronic Keys such as the car keys, house/office keys, hotel room keys etc.
[7] NFC can be used to configure and initiate other wireless network connections such as the Bluetooth, Wi-Fi or Ultra-Wideband
[8] NFC for Health Monitoring in our daily life

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