Research and Improvement of P2P Protocol in Near Field Communication

Lie Luo, Ning Li

***Abstract*—In order to improve the speed and efficiency of the data transmission between devices in point to point mode in near field communication, a method of connectionless P2P data transmission is proposed on the basis of SNEP.At the link layer,the LLCP protocol is used to provide connectionless transmission link,and the data transmission process which establishes the connection in the connect-oriented transmission link is discarded so that time consumption and error rate are reduced.In the application layer,error detection and serialization services are provided to ensure the reliability and accuracy of data transmission.The experimental results show that the improved protocol has greatly reduced the error rate of P2P data transmission between devices,thereby improving data transmission rate.**

***Index Terms*—Near Field Communication;SNEP protocol; P2P; connectionless transmission; error detection**

I. INTRODUCTION

Near field communication technology is a kind of short distance wireless high frequency data transmission technology, which can be used in the mobile terminal, tag and other devices for contactless data exchange[1][2].With the development of mobile payment and the Internet of things, NFC technology has been rapidly promoted and applied to mobile devices. NFC work in the 13.56MHz band, to be able to establish communication between devices in the range of 10cm, the transmission rate can be 106kbps, 212kbps, 424kbps, and even can be increased to more than 848kbps[3].Compared with the traditional wireless short-range communications, such as Bluetooth, WiFi, ZigBee, The connection speed of NFC get established is very fast, two NFC devices can be close to each other for data transmission. Therefore, the NFC in a small amount of data transmission between devices P2P is an excellent choice.Although the major smartphone manufacturers are configured NFC controller in their phones[4][5], but did not use the NFC point to point transmission function totally.Due to the complexity of the interaction, the traditional point-to-point communication protocol affects the efficiency of point to point communication.This paper presents an improved point to point communication method based on connectionless service.Firstly,use of a connectionless service at the link layer, reduce the connection process time.Then add error detection mechanism in application layer to ensure data transmission reliability.The experimental results show that the improved method has some practical significance to improve the efficiency of point to point communication.

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II. NFC P2P DATA TRANSMISSION

NFC Forum[6] as one of the NFC related standardization organizations, developed a series of standards to regulate the development of NFC technology.Reference [7] shows a two layer protocol specification for NFC P2P communication protocol stack,from bottom to top is NFCIP-1(NFC-DEP) and Logical Link Control Protocol(LLCP).NFCIP-1 is a communication method based on initiator and target.LLCP provides data service for upper layer protocols, including connection oriented service and connectionless service, link activation / deactivation and maintenance functions.Finally, LLCP also provides a MAC mapping mechanism, make the LLC[8] data frame can be mapped to different layers of MAC.

On the basis of the above two protocol standards,NFC Forum also developed an application layer protocol specification--Simple NDEF[9] Exchange Protocol(SNEP),this standard is now widely used.Because NFC-DEP involves digital signal part, this paper does not study the protocol.The main work of this paper is to optimize the LLCP standard in the link layer and the SNEP standard in the application layer.At present, there are few domestic and foreign literature about these protocols. Reference [10] added to the TLS standard based on the LLCP, and the security is improved,there is no further research on point-to-point communication.Therefore, the research of this paper has some guiding significance for NFC point to point communication.

Based on the research of LLCP standard and SNEP standard, this paper summarizes the advantages and disadvantages of LLCP for connection service and connectionless service.In this paper, we propose a SNEP oriented LLCP connectionless service mode, and join the response to ensure the reliability of data transmission on the basis of connectionless service.In this way, the complexity of the transmission is reduced and the reliability is guaranteed, so as to improve the speed of NFC point to point transmission and reduce the transmission error rate caused by external interference.

III. TRADITIONAL SNEP STANDARD

NFC Forum specifies that the SNEP is a request / response protocol for communication, and that SNEP has been defined as a standard P2P transport protocol. Figure 1 is SNEP communication model. The SNEP client sends a request message to the SNEP server, which includes 4 parts: the

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protocol version, the request code, the request message length and the message body. The SNEP server receives a request from the client to respond to the request, and the message content includes the protocol version, the status code, the message length, and the message body.Figure 2 shows the SNEP message format.

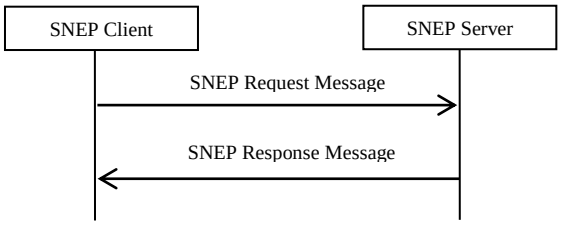

Fig. 1. SNEP communication model

Fig. 2.SNEP message format

A. SNEP Request Message

The SNEP client sends a request message to the SNEP server to communicate with the server, and the request message format is shown in Figure 2. The version number takes up one byte to indicate the protocol version number of the SNEP.Table 1 lists the scope and role of the request code. The request code is used by the SNEP client to request the SNEP server to perform the operation.

TABLE I
SNEP REQUEST CODE

Request Code	Name	Description
00h	Continue	Request the server to send the remaining SNEP fragment message
01h	Get	Request the server to return a NDEF message
02h	Put	Request the server to receive a NDEF message
03h~7Eh		Reserved
7Fh	Reject	Request the server stop send the remaining SNEP segment messages
80h~FFh		Reserved

B. SNEP Request Sending Process

The procedure of SNEP client sends a PUT message to the server as follows:

1) Call the LLCP link activation method, initialize the NFC controller as the target, waiting for the connection when the SNEP server is close to the client;

2) When a logical link is established, SNEP server will send a SYMM Protocol Data Unit(PDU), the client extracts the PDU from the MAC layer and detects whether the received SYMM PDU is correct;

3) If the SYMM PDU is correct, client will send the CONNECT PDU to server and waiting for the PDU from server. If the CC PDU is received, means the server receives the connection request; if the DM PDU is received, means the server rejects the connection request;

4) If the server receives a connection request, the client will encapsulate the PUT request message to the SNEP request packet, LLCP packet is encapsulated into the Information PDU, and send out the data packets through the MAC layer mapping, and wait for the server to response a RR (Receive Ready) PDU;

5) When server receives a PDU,and extracts the request code.If the code is PUT,the server will send a RR PDU to client. Then the server determines whether the PUT request is valid, and stores the PUT message if it is valid, finally,sends a SUCCESS PDU to the client.

6) After the client receives the RR PDU, means the PUT request message is sent to the server correctly.Then the client will wait the server send a success status response, so it will wait for the next I PDU to read the corresponding message sent by the server;

7) The client receives the message from the MAC layer, and handed over to LLCP, SNEP client will extract the contents of the I PDU, to determine the corresponding request given by the server;

8) After all the above steps are completed, the client will call the LLCP send disconnect package (DISCONNECT PDU), disconnect the response packet and wait for the server (DM PDU), after receiving DM PDU, shows the link is completed, the entire process of PUT request is finished.

Figure3 shows the PUT request interaction process.

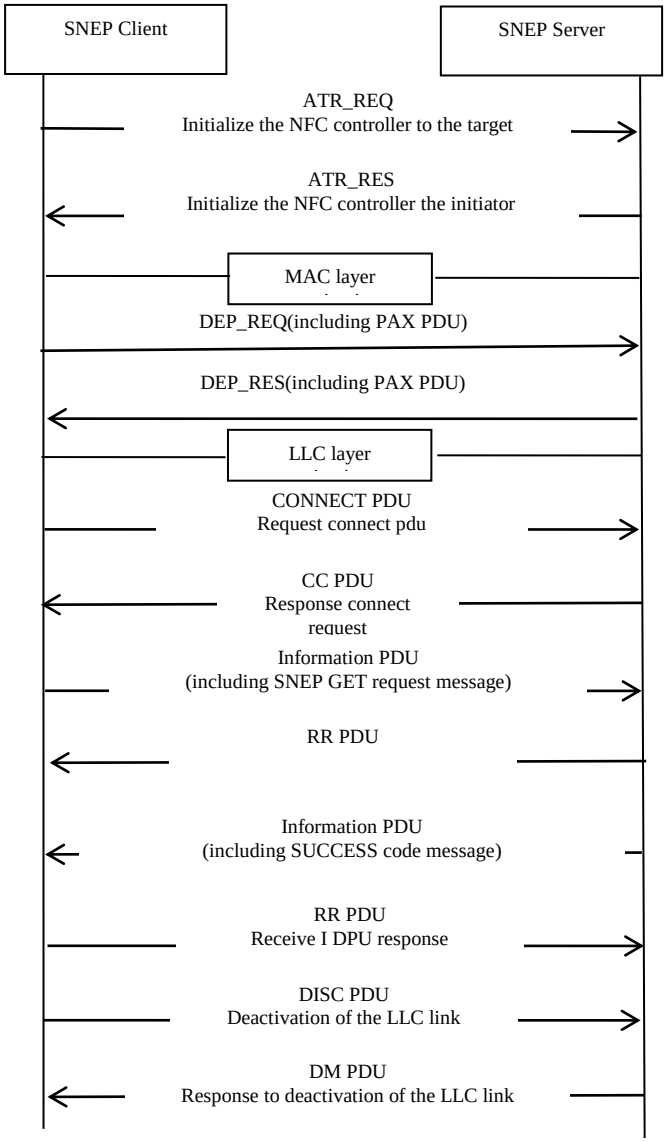

Fig. 3. SNEP PUT request interaction process

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IV. Improvement of SNEP Standard

The traditional SNEP standard needs reliable message transfer protocol. In the NFC Forum protocol architecture, SNEP is based on LLCP protocol, LLCP provides connection oriented transport service to ensure the reliable transmission of SNEP messages. Through the analysis of the previous section,before data transmission, need a activation process ,and also have a deactivation process after data transmission finished. However, due to the use of the magnetic field of the physical link is not reliable and vulnerable to external interference, so the above processes will increase the complexity of data transmission and increase the failure rate. In view of the above situation, this paper puts forward 2 improvements:

1) Add a parameter in the SNEP application layer interface,or add a interface to provide connectless transmission. Application developers can choose a reasonable transmission plan from these two ways. For example, before the function interface for int8_t SNEP:: write (const uint8_t *buf, uint8_t len, uint16_t timeout), can be changed to int8_t SNEP: write (const uint8_t *buf, uint8_t len, uint16_t timeout, int way), by adding the way parameter to decide which kind of transmission mode. When way is equal to 0, select a connectionless server,way is equal to 1,select a connection oriented server.Or split the SNEP:write into two functions, one for the connection oriented service, and the other for the connectionless service.

2) On the basis of the connectionless transmission of LLCP, a receiving response mechanism is added, which simplifies the connection oriented transmission process and ensures the reliability of data transmission. In the process of sending and receiving the serialized data, by judging whether the data sequence in the UI PDU is consistent to judge whether the data is sent and received successfully or not. When receiving or transmitting over time, the system performs retransmission operations as needed. According to the characteristics of NFC communication, the general timeout time can be set to 500ms, if the setting of the timeout is too long to cause data to send slowly, if too short may cause the loss of data.

The improved protocol steps are described as follows:

1）If parameter of way is equal to 1, the transmission is described in the preceding section. If parameter of way is equal to 0,go to step2).

2) After the MAC layer setup a connect,LLCP will package the SNEP client PUT request message to LLC UI (Unnumbered Information) PDU directly. UI PDU is a data packet unit specifically designed for connectionless transport services in LLC.

3) SNEP server extract UI PDU from the LLCP frame, then still be like the connection to the transmission process is given a RR PDU, to tell each other the message has been received.

4) If the SNEP client does not receive the RR PRU response given by the SNEP server for a period of time after the UI PDU is sent, the UI PDU will be sent again to ensure the reliability of data transmission.

Figure 4 shows the improved PUT request interaction process based on connectionless server:

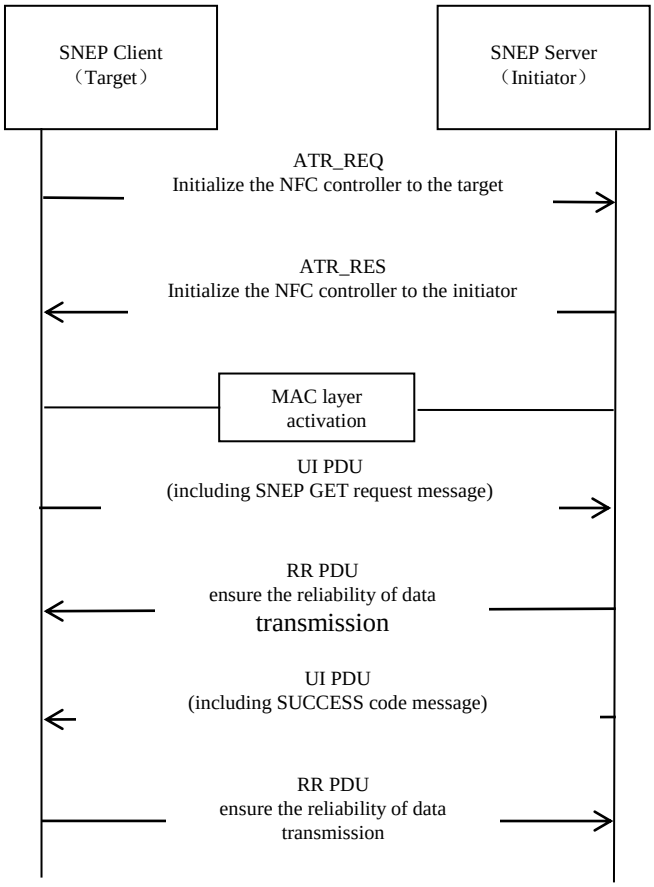

Fig. 4. Improved PUT request interaction process based on connectionless server

The above 4 steps can be summarized as the following 2 main processes:

1)Activation and connection of the MAC link

2) Send and receive packets

Through the above process can be seen in the use of UI PDU in the transmission of information, the traditional LLCP protocol is not RR PDU response, and in order to ensure the reliability of data transmission also need RR PDU to ensure the reliability of data transmission, so we can see that the improved SNEP protocol reduces the connection process, reduce the transmission time ,At the same time,also ensure the reliability of data transmission.

V. The Experimental Results And Analysis

This experiment used STM32F103 as main control chip and NXP company's PN532 as NFC controller, build a SNEP client environment, using Duali company's NFC controller tablets as a SNEP server . Experiment of data transmission between these two devices.Figure 5 shows the experimental platform.

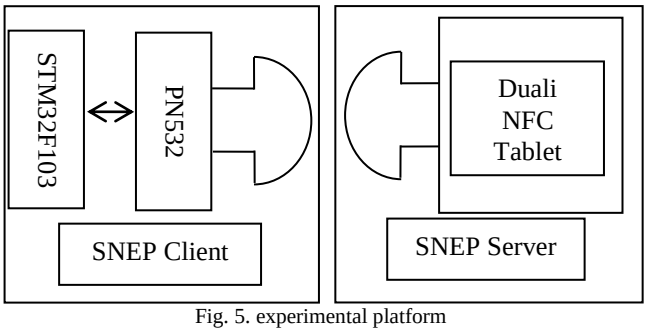

Fig. 5. experimental platform

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The experiment uses open source SNEP protocol as a contrast. In order to verify the validity of the improved protocol, the experiment selected four groups of different sizes of representative data for the PUT and GET request operation. Each experiment of them are selected 424kbps rate of communication and the communication distance are kept within 0 ~ 3 cm. Each group of data size experiment respectively, 100 times the number of records sent successfully the count, and the average time S. The number of successful count record of variables are kept by the program, the average time spent were calculated using the following formula:

$$S = \frac{\sum_{i=1}^{n} Si}{n} \quad (1)$$

The Si shows the time when sending is successful, n indicates successful number.

GET operation success number's different show in Table II;the average time spent shows in Table III. PUT operation success number's different shows in Table IV ; the average time shows in Table V.

TABLE II
COMPARISON OF THE NUMBER OF SUCCESSFUL GET OPERATION BEFORE AND AFTER IMPROVEMENT

Data Length(Byte)	1	100	10K	50K
Count before improvement	54	56	43	36
Count after improvement	80	85	81	76

TABLE III
COMPARISON OF AVERAGE TIME SPENT ON GET OPERATION BEFORE AND AFTER IMPROVEMENT

Data Length(Byte)	1	100	10K	50K
Count before improvement	78	88	65	36
Count after improvement	95	93	87	83

TABLE IV
COMPARISON OF THE NUMBER OF SUCCESSFUL PUT OPERATION BEFORE AND AFTER IMPROVEMENT

Data Length(Byte)	1	100	10K	50K
Average time spent before improvement (s)	0.22	0.43	1.26	4.34
Average time spent after improvement (s)	0.13	0.22	0.65	3.57

TABLE V
COMPARISON OF AVERAGE TIME SPENT ON PUT OPERATION BEFORE AND AFTER IMPROVEMENT

Data Length(Byte)	1	100	10K	50K
Average time spent before improvement (s)	0.43	0.66	1.26	4.63
Average time spent after improvement (s)	0.20	0.32	0.98	3.77

Through comparative analysis of the four tables above, it can be found that in a small data transmission, success number has much increased than before when it did not be improved due to reduced data interaction when connected. The average transmission speed has also been increased.Due to the large data block transmission, a connection transmission can be transported in many times. It also can be seen that the larger data sending speed is not improved obviously when compared with small amount of data sending through the experiment. GET operation improvement effect is better than the PUT operation improvement effect. This is because the GET operation omits more steps than the PUT operation when improved.By transplanting the improved protocol into the embedded platform and using Android platform for experiment ,it can also show that the improved protocol is suitable for embedded platform and Android.

VI. CONCLUSION

In order to reduce the failure of NFC in the process of point to point transmission due to the instability of the link and the interference of the outside world. In this paper, we propose a SNEP based LLCP connectionless service method to reduce the interaction process in the connection process, and on the basis of the LLCP connectionless service to increase the responding confirmation process to guarantee the reliability of data transmission. So that we can reduce the failure rate at the same time ensure the reliability, this paper has been proved the validity of the proposed improvements by the experiment.

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