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Near Field Communication Technology benefitted for Metro Rides

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Abstract

Near Field Communication, being a new trend in technology has facilitated a wide variety of users by its extensive uses. Near field communication allows contactless communication between devices to exchange information to use it in different applications. The paper elaborates about NFC, its operation and overwhelming usage streams. Afterwards, we have proposed a new framework that can be used as an NFC application to provide comfort to customers who are travelling across the city. The application will make an interface between NFC enabled devices for information communication. It will process the information along with different web servers and databases. The proposed application resembles an easy and efficient use of NFC technology that can ensure comfort to commuters. It will facilitate users by saving their precious time and effort indulged in travel formalities.

Keywords: *Near Field Communication; RFID; Metro Rides; Security.*

1. Introduction

Near Field Communication (NFC) being a new and energetic invention in communication field, has facilitated a wide variety of user with its wide range of applications. Before looking to its extensive usage, the technology must be elaborated and understood properly. Near Field Communication (NFC) has evolved from RFID (Radio frequency Identification). NFC has used concept of RFID technology to facilitate communication between two parties or devices [1]. NFC is a wireless communication, rather it is a form of contactless communication. NFC communication took place without any physical contact between two devices. It uses short-range radio frequency waves for communication. On proprietary terms, Near field communication was earlier developed by Nokia, Sony and Royal Philips Electronics [2]. They bought NFC in industry after its standardization, by developing NFC forum in 2004. ISO 18092 is devised for NFC standard. NFC standard, ISO 18092 is considered similar to ECMA-340 standard. NFC has evolved from RFID, so, it is compatible with RFID and consequently with RFID devices (standard ISO 14443) also [3]. FeliCa and MIFARE are RFID devices, developed respectively by Sony and Philips. They both are compatible with NFC devices and can operate on NFC technology.

As stated earlier, NFC technology is used in various applications. The foremost application of NFC technology is banking. Banking has evolved to a new era by incorporating mobiles applications and consequently, NFC has made brought a new phase to it. Customers can maintain an e-wallet in their mobile phones by using bank's services. They can use e-wallet to make payment at various stores, equipped with installing necessary NFC devices. The

other NFC application is to provide information on movies and food courts to users. NFC can also be used in classroom to share study material. It can also be used as keys to unlock doors and to start vehicles. Moreover, it can also be used in hospitals to facilitate doctor and nurses to observe patient's history and to provide medicines to them [1] [4].

The paper is organized in number of sections. Section 2 explains related work in field of NFC, its operation, interaction between NFC devices. It also mentions researcher's contribution to NFC technology. Section 3 briefly mention about scope of the proposed work. Sector 4 describes proposed NFC application and its operation by outlining block diagram and state chart diagram. The key terms used in application are explained in section 5. Section 6, illustrates a case study with its results, used to verify application's operation. Section 7 mentions some threats of using NFC technology. At end, we have concluded paper with its future scope discussion continued with references list.

2. Related Work

NFC came into existence in last decade, in around 2004. It has evolved rapidly and is a well known technology in today's world. Researcher's extensive effort has evolved NFC to make it available to end users. There are numerous different applications of NFC and the list will exponentially increase in near future. It is estimated that every user will use it sooner or later. Research papers in table 1 reveal the progress of NFC over a decade. Near field communication (NFC) uses the principle of RFID, and gained high popularity as compared to RFID. RFID has been used for various purposes to send and receive contextual information but revealed some problems [4]:

1. RFID's cost is very high.
2. It cannot find out user's position.
3. RFID tags don't have memory space to store information.

2.1 NFC Operation

NFC is a simple and safe communication method between NFC enabled devices. NFC is a wireless technology. It uses 13.56 MHz radio frequency for communication purpose [5]. This frequency is globally available unlicensed ISM band. NFC communication works when two NFC enabled devices are brought into proper radius. Theoretically, radius is around 10cm, but practically, devices must be brought closer to each other within proximity of 4 cm for their operation. The data transfer rate between two NFC enabled devices is around 424Kbps. It also allows communication to take place at data transfer rate of 106 kbps, and 212 kbps [6]. NFC can provide a bandwidth of 2MHz. These facts and figures are summarized in table 2.

2.2 Communication between NFC devices

NFC uses electromagnetic wave for communication. These electromagnetic

Table 2. Operating characteristics of NFC

S. No.	Parameter	NFC's device Characteristics
1.	Frequency	Radio frequency at 13.56 MHz
2.	Working distance	4cm
3.	Data transfer rate	106, 212, or 424 kbps
4.	Bandwidth	2 MHz

Table 1: NFC growth over years.

S. No.	Year	Author	Title	Description
1	2014	V. S. Jahagirdar, Naresh Sen, Santosh Kumar Tiwari	Near Field Communication	NFC technology and its potential applications are illustrated along with its barriers and significance.
2	2013	V. Sharma, P. Gusain and P. Kumar.	Near Field Communication	Analysed that NFC technology provides the fastest way of communication between two devices within a fraction of second. Security issues and protective measure are discussed.
3	2013	M. Mareli, S. Rimer, B. S. Paul, K. Ouahada, and A. Pitsillides	Experimental evaluation of NFC reliability between an RFID tag and a Smartphone	Elaborate NFC characteristics and its standards. Also analyses passive NFC tags.
4	2013	J. Shen, X. C. Jiang	A Proposed Architecture for Building NFC Tag Services	Explains architecture for building NFC tag services. Architecture constitutes an application framework and an NFC tag management platform.
5	2013	Hasoo Eun, Hoonjung Lee, Heekuck Oh	Conditional Privacy Preserving Security Protocol	Describes a mechanism for communication between NFC enabled devices which provide advantage by incorporating lower cost consumption.
6	2012	M. U Yaqub and U.A Shaikh	Near Field Communication, its application and implementation in K.S.A.	Explains concept of NFC, history, working, and its application.
7	2012	W. Gong, Y. Ma, Y. Zhang, P. Chen	Research of NFC Technology on Smartphone	An efficient NFC system on smart phones is proposed which gives a global view of NFS system, and analyzes NFC international standards and NFC Forum standards.
8	2010	A. Juntunen, S. Luukkainen,	Deploying NFC technology for mobile ticketing services-	Analyzed NFC technology in smart phones for payment purpose and also its effectiveness on commerce.

		& V. K. Tuunainen	identification of critical business model issues.	
9	2009	Collin Mulliner	Vulnerability Analysis and Attacks on NFC-enabled Mobile Phones	Describes NFC enabled mobile phone's security testing approach to identify unknown vulnerabilities.
10	2008	J. Ondrus and Y. Pigneur	Near field communication: an assessment for future payment systems	NFC is assessed and analyzed in term of payments, realizing a great start for new applications
11	2008	G. Chavira, S. W. Nava, R. Hervás, V. Villarreal, S. Martín, M. Castro.	Services through NFC technology in AmI Environment	The research work uses NFC technology to develop AmI environment. It explores uses of NFC technology in order to get context information and offer services with minimal interactive effort.
12	2008	G. Madlmayr, J. Langer and C. Kantner	NFC Devices: Security and Privacy	NFC use cases and attacker's impact on technology are discussed along with its protective measures.
13	2006	E. Haselsteiner and K. Breitfuß	Security in Near Field Communication Strength and Weaknesses	Paper analyzed security with respect to security. It describes various threats and their respective solutions.

waves are produced by NFC enabled devices, usually considers as NFC tags and NFC readers [2]. NFC device may or may not produce its own RF field. We can distinguish NFC devices through this characteristic. NFC device which produces its own RF field is called Active device and the other which does not produces RF field are called Passive device [6] [7]. Passive devices uses RF field of other device in its proximity radius. Active devices have power supply but in contrast passive devices don't have power supply. Passive devices use or retrieve power from RF field of an active device in range. According to above distinct configuration of NFC devices, there are four types of communication methods between NFC devices [8] which are illustrated in table 3.

NFC communication works on message-reply concept. The concept states some rules:

1. When Device 1 sends message to Device 2, then Device 2 needs to send a reply message to Device 1.
2. If Device 2 is passive and Device 1 has not initiated communication, then Device 2 cannot send any message to Device 1.

According to above rules, NFC device which has initiated the communication i.e. Device 1, is called Initiator. The other NFC

device which remained passive i.e. Device 2 is called Target.

3. Scope

Our proposed work uses Near Field Communication (NFC) technology. NFC communication is applicable between two NFC enabled devices. Devices can be made NFC enabled by easily embedding NFC chip or tag into it [9]. NFC chips and tags are very small in size and light weighted too

Table 3. Communication method between to NFC enabled device.

Device 1	Device 2	Communication Method
Passive	Passive	Both Device 1 and Device 2 are passive. Hence, they both cannot generate RF field for communication. So, no communication will take place in this case.
Passive	Active	Device 1 is passive, resultant it cannot generate RF field while Device 2 is active and can easily generate RF field. In this case, Device 2 can send data to Device 1 for communication.
Active	Passive	Device 1 is active and can easily generate RF field while Device 2 is passive and cannot generate RF field. In this case, Device 1 can send data to Device 2 for communication.
Active	Active	In this case, where both Device 1 and Device 2 are active, both of them can generate RF field and can send data. But when Device 1 sends data, Device 2 does not send data and vice versa. At a particular time, One device will send data and other will wait for the one to finish its transmission. Thus, Device 1 and Device 2 alternatively send data to other device.

NFC chip can also be inserted in mobile phones and reader machines. NFC reader reads information in NFC chips. NFC enabled mobile phones just needs to be swiped to get work done [3]. Similarly, in our framework, users just need to swipe their mobile phones in front of Automatic Fare Collection (AFC) gates, and it will automatically deduct fare amount from credit card connected to mobile phone. The credit card can easily get connected to mobile phone through developed android applications like Google wallet. There are many banks that support this facility, e.g. Citi Bank. So, Google wallet with credit card in NFC enable mobile phone and a swipe, can release commuters' pain taken during completing travel formalities [10]. It obviously saves a good amount of user's time and provides comfortable rides to them.

4. Proposed Application Framework

Our proposed framework will benefit commuters by paying fare for their travel. Commuters need not require making fare payment manually every time they travel. They can travel across city without any money in pocket. Figure 1 shows framework of NFC application used by metro riders for making payment. Commuters use their mobile phones to make payment of fare to retailer by paying at Automatic Fare Collection (AFC) gate. The proposed framework will comfort people who find it hassle to be in queue for purchasing fare

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ticket for travelling [11]. It also saves commuters' time and effort, invested in fulfilling travel formalities.

From user's perspective, he has to swipe his NFC enabled mobile phone at Automatic Fare Collection (AFC) gate. After detecting legitimate information in mobile phone, he must be allowed to enter in station to travel, by passing through Automatic Fare Collection (AFC) gate. At station's exit, person again has to swipe his mobile phone at Automatic Fare Collection (AFC) gate. Automatic Fare Collection (AFC) machine will automatically deduct fare amount based on travel distance and provide a way to exit. For a user, it's just a matter of swiping mobile phone at Automatic Fare Collection

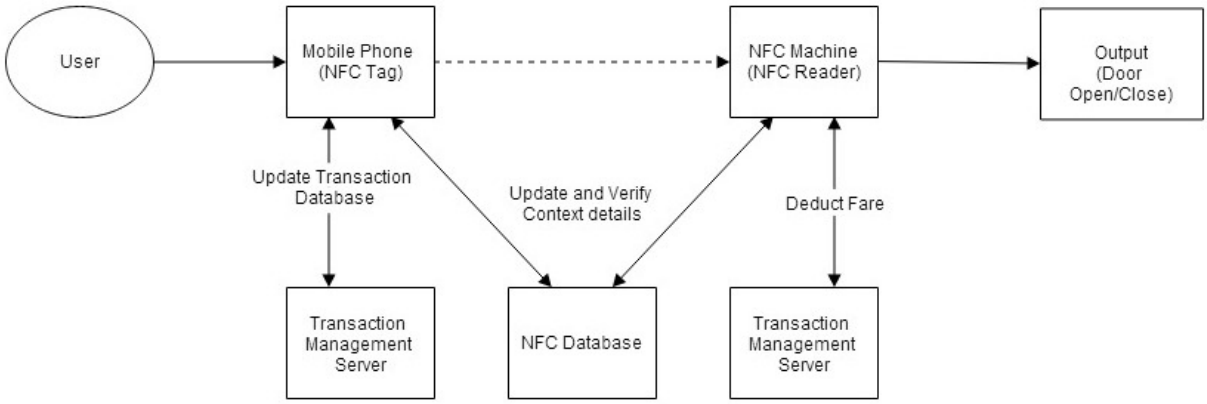

Figure 1. Framework of NFC application for Metro Rider

(AFC) gate.

But developers need to think about the process like this: The mobile phone and Automatic Fare Collection (AFC) gate, both must be NFC enabled devices. The one entity must be initiator that can start process and the other entity must be able to read and receive data from initiator to process it. In our propose application, NFC enabled mobile phone will be an Initiator to start process. NFC enabled mobile phone will be swiped across NFC enabled Automatic Fare Collection (AFC) gate. NFC reader in Automatic Fare Collection (AFC) gate will read context information from NFC enabled mobile phones. The context information may contain mobile phone number, metro tag number, and location of entry in metro station, timing of entry. The acquired context information is processed by NFC server which verifies and adds context information. If user is at entry point then NFC server adds context information in NFC database after its verification. The same context information will get used for verification when user would like to take exit. Context information must be verified every time at entry gate to check if same context information is already in NFC Database. If so, information must not be accepted as same tag is used twice for entry in station without previous exit. Figure 2 illustrates the operation of NFC enabled Metro Rider Application.

At exit gate, user again swipe his NFC enabled mobile phone at Automatic Fare Collection (AFC) gate. NFC reader read context information from NFC enabled mobile phone and verifies its existence against NFC database. After verification,

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Transaction system will calculate fare amount according to travelled locations and deduct it from credit card application. At end, context information must be deleted from NFC database and user takes exit.

5. Key Terms

Our proposed framework incorporates many important entities to accomplish the process. Every entity plays their tasks. The entities are:

5.1 Mobile phone (NFC Tag)

User uses his mobile phones for the application. Mobile phone must be NFC enabled. Upcoming mobile devices, which are android based from Samsung, Apple, etc. has incorporated NFC feature. User can use smart phones to equip them with NFC tag to enjoy contact less communication [9]. Mobile phone acts like an Initiator that initiates the process. Along with mobile

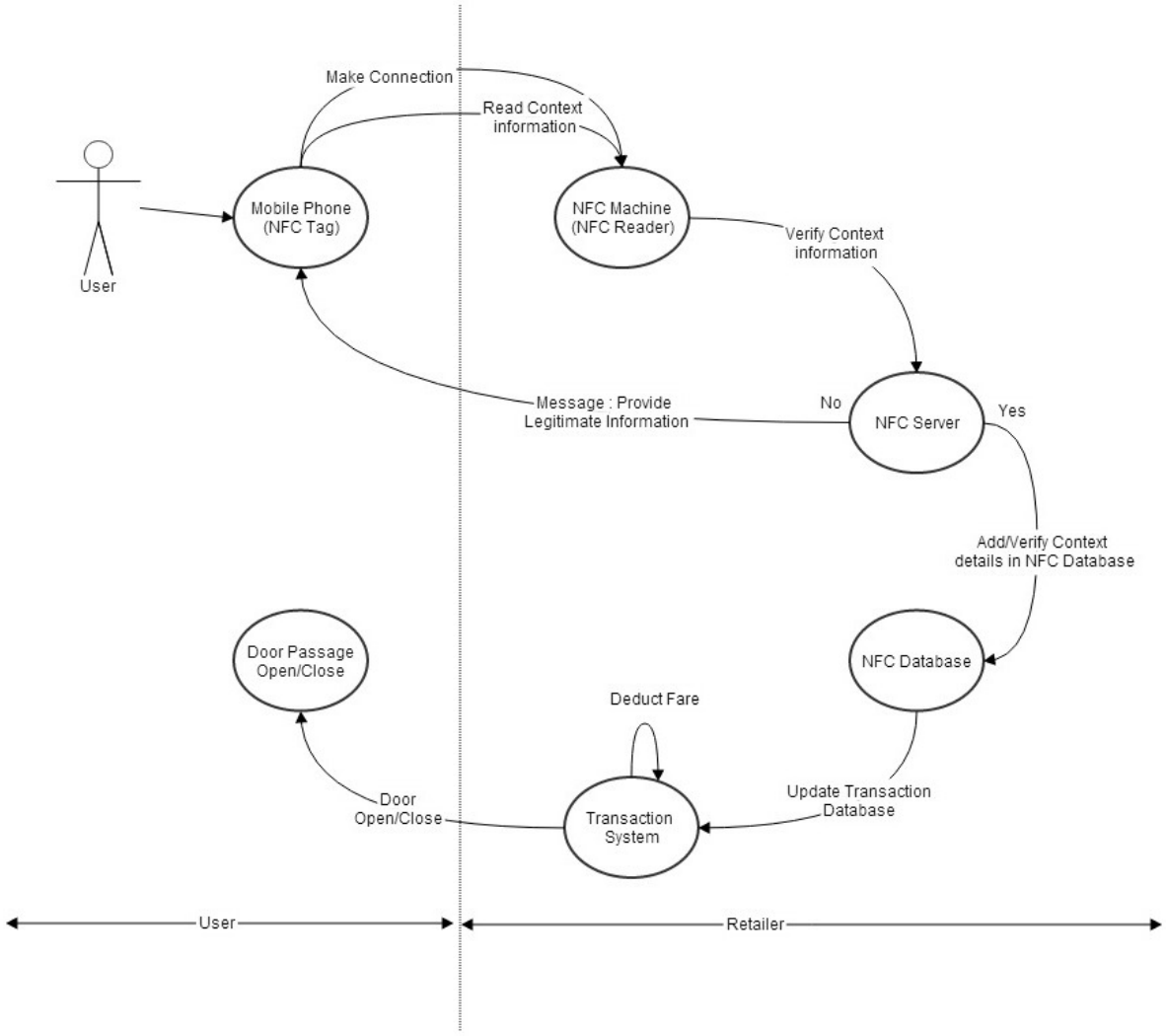

Figure 2. Operation of NFC enabled Metro Rider Application.

phone, proposed framework requires an application to make payment. There are numbers of banking applications available that facilitates their customers to make payment. User must install and use application like Google Wallet to make payment through coupled credit cards [11].

5.2 NFC Machine (NFC Reader)

NFC Machine in proposed framework would be Automatic Fare Collection (AFC) gate. NFC machine must have an installed NFC reader that can access, verify and add context information to NFC database through NFC server. NFC Reader is also called Target machine.

5.3 NFC Server

NFC Server plays an important role in framework. It manages context information from NFC tags or initiator. It will verify, add and delete context information to/from NFC database.

5.4 NFC Database

NFC database is a database management system. It would maintain record for each NFC card along with its entry and exit information on various location and time period. It would also maintain fare deducted from the tag, every time a commuter travels.

5.5 Transaction System

Transaction system is an important entity in framework. It calculates fare to be deducted according to distance travelled. It also allows users to make payment through mobile phone by deducting fare from user's credit card.

5.6 Door Passage

Door passage in our framework would be at Automatic Fare Collection (AFC) gate. The Automatic Fare Collection (AFC) gate deducts fare amount from credit card through transaction system and allows user to take exit from station.

6. Experimental Results

We have devices some case studies to validate framework. After extensive testing, it would be easy to implement framework through Near Field Communication (NFC) technology. The pre-requisite for the framework is: if a user has made entry to station through NFC tag, then he has to take exit first before using it again for travel.

6.1 Case Studies of Metro ride

6.1.1 User enters station, taking entry.

User enters station through Automatic Fare Collection (AFC) gate. At AFC gate, he has to wave or swipe his NFC enabled mobile phone near NFC reader. NFC reader will read context information like mobile tag number, entry location and time, mobile phone number, etc. NFC reader, with help of NFC server, verifies and adds context information to NFC database to use it later at exit point.

6.1.2 User exits station.

User after travelling takes exit through Automatic Fare Collection (AFC) gate. For this user has to wave or swipe his NFC enabled mobile phone near NFC reader. NFC reader will read context information like mobile tag number, entry location and time, mobile phone number, etc. Now,

Transaction system will calculate fare amount according to entry and exit station. It would deduct fare amount from credit card coupled within mobile phone. At end, NFC server will delete current entry of NFC tag from NFC database. It will also add usage information of NFC tag to NFC database for maintaining logs.

6.1.3 User cannot take exit if credit card got expired.

User wants to exit station. Upon swiping NFC enabled mobile phone at Automatic Fare Collection (AFC) gate, transaction system found that credit card information read from NFC tag through NFC reader is not authentic. Credit card information got expired or blocked. Due to non-authentic information, payment cannot be made. Hence, transaction failed. As a solution to the problem, user has to make payment through some other mode of payment.

6.1.4 User cannot take exit if credit card payment limit has extended to credit limit.

User wants to exit station. Upon swiping NFC enabled mobile phone at Automatic Fare Collection (AFC) gate, transaction system read NFC tag through NFC reader and found that credit card payment limit has extended up to its credit limit. User would not be able to make payment to vendor and user will have to make payment through some other mode of payment.

6.2 Results

Above mentioned case studies show that the user is allowed to travel with NFC enabled mobile phone. User just need to swipe his mobile phone across NFC enabled reader and further processing would get completed in few seconds, that a user can not even imagine. User will enter the station and travel and similarly, exits at Automatic Fare Collection (AFC) gate in a short eye-blink, with payment processing at backend, putting burden on credit card for payment. The framework will make user relax about travel formalities. The proposed framework will be very effective if it can be used for every kind of transportation.

7. Threats

NFC technology is a new technology and growing day by day. It provides its benefits in many applications to facilitate users. Besides many uses of NFC technology like travelling, it may produce some common problem to users, which are [5] [12] [8]:

7.1 Hardware and software failure

It would be a great problem to mankind if software and hardware fails for NFC tag and reader. If mobile phone and its installed applications are not working properly, then it will results in rush at station. It can also lead to Denial of Service attack [13].

7.2 Hacking of user account

For using mobile phones for making payment, user needs to register itself with applications. If user account on application gets hacked, then user will face losses. It can also lead to monetary losses as mobile phone stores credit card information.

7.3 Stealing of personal information

If user loses mobile phone, then his personal information can be compromised and can cause risk.

7.4 Costly

As Near field communication (NFC) is a new technology and people are very keen to understand it, but not every range of people are using it. Moreover, it is costly to use.

8. Conclusion

Near field communication technology has evolved communication field to a new era. It facilitates communication between two NFC enabled devices without any physical interaction. NFC provides an innovative and powerful futuristic computing environment. It facilitates users by saving their precious time and effort. NFC technology embedded in mobile phones, facilitates a wide range of applications. In this paper, Near field communication technology, concepts and specification are described. Procedure of communication (or operation) between NFC enabled devices has been explained for better understanding. Further, we have proposed an application of Near Field Communication Technology for Metro riders. It facilitates commuters to make payment through their phone and its application. The application's framework and procedure is illustrated through suitable diagrams. We have also verified the framework through case study which shows appropriate results. At last, we have mentioned some threats to NFC technology that can manipulate its operation and can cause great losses to users.

Moving forward, the paper would be very helpful for new learners, who can learn and understand about NFC technology, and its evolution and operation. It would also encourage researchers to implement proposed application to provide a world class facility to daily commuters by eliminating their efforts for making fare payment. Moreover, the paper may also inspire researcher to use NFC in other applications too.

References

[1] *V. S. Jahagirdar, Naresh Sen, Santosh Kumar Tiwari, "Near Field Communication", 2014, Available at URI: http://hdl.handle.net/123456789/658.*

[2] M. U Yaqub and U.A Shaikh,"Near Field Communication, its application and implementation in K.S.A" 2012.

[3] W. Gong, Y. Ma, Y. Zhang, P. Chen, "Research of NFC Technology on Smartphone", International Journal of Advancements in Computing Technology (IJACT), Vol. 4, No. 18, 2012.

[4] G. Chavira, S. W. Nava, R. Hervás, V. Villarreal, S. Martín, M. Castro., "Services through NFC technology in AmI Environment", Proceeding of: iiWAS'2008 - The Tenth International Conference on Information Integration and Web-based Applications Services, ERPAS, 2008.

[5] H. Eun, H. Lee, H. Oh, "Conditional Privacy Preserving Security Protocol for NFC Applications", Consumer Electronics, IEEE Transactions on Consumer Electronics, Vol. 59, Issue. 1, pp. 153-160, 2013.

[6] M. Mareli, S. Rimer, B. S. Paul, K. Ouahada, and A. Pitsillides, "Experimental evaluation of NFC reliability between an RFID tag and a Smartphone", IEEE AFRICON, 2013, pp. 1-5.

[7] V. Sharma, P. Gusain and P. Kumar, "Near Field Communication", Proceeding of the Conference on Advances in Communication and Control Systems, 2013.

[8] E. Haselsteiner and K. Breitfuß, "Security in Near Field Communication, Strength and Weaknesses", Workshop on RFID Security 2006.

[9] J. Shen and X. C. Jiang, "A Proposed Architecture for Building NFC Tag Services", IEEE Sixth International Symposium on Computational Intelligence and Design (ISCID), Vol. 2, pp. 48 – 52, 2013.

[10] A. Juntunen, S. Luukkainen, & V. K. Tuunainen, "Deploying NFC technology for

mobile ticketing services-identification of critical business model issues", Proceedings of ninth international conference on mobile business and 2010 ninth global mobility roundtable, pp. 82–90, 2010.

[11] J. Ondrus and Y. Pigneur, "Near Field Communication: An Assessment for Future Payment Systems", Information Systems and E-Business Management, Vol. 7, No. 3, pp. 347-361, 2009.

[12] G. Madlmayr, J. Langer and C. Kantner, "NFC devices: Security and Privacy", Proceedings of Third International Conference on Availability, Reliability and Security, pp. 642–647, 2008.

[13] C. Mulliner, "Vulnerability Analysis and Attacks on NFC-enabled Mobile Phones", International Conference on Availability, Reliability and Security, IEEE Computer Society, Proceedings of the 1st International Workshop on Sensor Security (IWSS), 2009.

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