



# Near Field Communication (NFC) Technology: The Future into Public Transport Infrastructure

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## **Abstract:**

**NFC (Near Field Communication) is a young radio technology which finds special application in the field of mobile consumer electronics. In this paper a scenario for the integration of an electronic ticketing system into an existing public transport system based on NFC is introduced. NFC-enabled phone transactions can be used today with existing transport contactless infrastructure, requiring no additional investment. Improved traveler satisfaction is a major benefit that may be harder to measure but should be considered as a retention factor. The main aim of the proposed ticketing protocol system is to increase the chances of successful travelling in case of the payment done but ticket delivery failure.**

**NFC works with most contactless smart cards and readers, meaning it could easily be integrated into the public transit payment systems in cities that already use a smart card swipe . A key application of Near Field Communication (NFC) can be found in the field of Electronic Fare Management. In the proposed ticketing protocol we are implementing a ticketing system for local trains using the concept of secure (NFC) Near Field Communication.**

## **Index Terms:**

**NFC (near field communication) , RFID (radio frequency identification), RFID tag,Teckiteng System.**

## **I. INTRODUCTION**

Railways and Roadways are the only means of transportation over land. Railways have an advantage over roadways that, they can carry a large number of passengers as well as heavy loads to a long distances. Railways surely play a great role. We are now seeing more advanced versions of railways like metros and monorails in cities. Mumbai's Local Train is The Heart of the City. Tickets for the suburban trains can be purchased at every train station. Travelling without a valid ticket is an offence and if caught can result into penalty. To save time, a Coupon Booklet can be purchased and the coupons can be punched for the designated fare at the Coupon Validating Machines (CVMs) at every station. The ticket fares matrix is pasted above the CVM. As of October 2012, there are approximately 575 CVMs on

Mumbai Suburban Railway stations. The Central Railway network has 350 and the Western Line has 225. There are also Smart Cards available that can be topped up (recharged with some amount) and one can use it to print tickets for themselves from an Automatic Ticket Vending Machine (ATVMs). A Season Ticket can be purchased if one is commuting regularly. One can choose the validity of these tickets from 1-month, 3 months to a year. Season Tickets are the most cost effective and time efficient option for regular commuters.

The protocol, named NFC Ticketing (Near Field Communication Ticketing), is being developed following a user-centered approach, so obtaining a balance between the information reduction required by the user and the increase of application flexibility. In this way, the NFC Ticketing service will not only be less complex and therefore less expensive (keeping low both the cost of development and implementation) but will also be more usable for a broad community of users. The NFC Ticketing application combines latest-generation technologies (such as NFC) with Radio Frequency Identification (RFID). All the architectural components of the application are fully described, detailing both software and hardware features and also the relative communication scheme.

Ease of use was seen as a key potential benefit of M-Ticketing. The use of a mobile phone makes it convenient to buy tickets while on the move or away from a normal purchase point; this helps users to avoid queues and make better use of 'dead' time. M-Ticketing is also seen as a way to reduce 'free riding'. A significant number of free riders are people who turn up late for transportation and do not have the time to buy a regular ticket. M-Ticketing would remove the obstacles that prevent timely post purchase of an appropriate fare.

NFC (Near Field Communication) is a young radio technology which finds special application in the field of mobile consumer electronics. It is designed for bidirectional data transmissions over a distance of up to 10 cm and a maximum data rate of 424 kB/s. Most of the

RF energy is concentrated in the allowed 14 kHz bandwidth range, but the full spectral envelope may be as wide as 1.8 MHz when using ASK modulation [1].

#### **Usages of NFC devices**

NFC can be used in various ways and it is growing continuously. Following figure shows how many ways we can use NFC technology for different purposes. There are basically three main categories.

#### **Card Emulation mode**

In this mode, NFC enabled phones appears to an external reader much the same as a traditional contactless smart card. For example, some confidential data such as Visa card number is written in the secure element of the phone and that data is read by the external reader and send the information for further processing. This enables contactless payments and ticketing by NFC enabled phones without changing the existing infrastructure. Mobile payment, ticketing access control etc are use case of this category.

#### **Peer to Peer mode**

In this mode two NFC enabled devices can exchange data with each other. Both devices take part in the communication. One example could be business card exchange. When we touch two devices with each other both devices can exchange business card. Another example could be pairing Bluetooth headset with the help of NFC enabled phone. Third example could be NFC chat application where two phones can take part in data exchange as specified by NFC forum.

#### **Reader/Writer mode**

In this use case, NFC enabled device (for example mobile phones) can read or write data to NFC tag (see later section of this document). NFC enabled smart poster is one example. Inside the poster there is embedded NFC tag where more information is written about the product. Device and read and act accordingly what is written in the tag. Another use case is electronic product code. [6]

#### **Advantages of NFC Ticketing**

Operators can see both financial and operational benefits from adopting NFC. Billions of mobile phones are already in use, making them convenient devices for travelers. Mobile phones are network-connected and have easy-to-use sound interfaces. They provide anytime-anywhere access to information and applications are easy to download over the air and manage on the phone. When these features are combined with NFC, travelers can experience a host of new, intuitive, and rewarding experiences on their mobile phones. We can divide benefits from two points of view.

Advantages over other communication technologies:

From the traveler's perspective,

- NFC-enabled phones have great benefits over paper tickets. Tickets stored virtually in phones

are inherently more durable, less likely to be lost, and are perceived to be more environmentally friendly than paper versions.

- They are even more convenient than plastic cards, with no fumbling in a wallet for the right card.
- NFC enabled phones can hold multiple payment applications, allowing the traveler to select which method to use—credit, debit, travel passes, or prepaid tickets.
- A mobile device allows the operator to provide additional services such as language settings, advertising and promotional opportunities, tourism information, loyalty schemes, and direct marketing.
- Risk management can also be improved through the use of NFC-enabled phones for over-the-air blocking and updates to prevent fraud, know-your-customer protections, and general management information.
- The speed of over-the-air updates is a major benefit compared to delays that can occur when blocking contactless cards.
- A simple tap also provides fast access to Internet services and rich information.

From the Transport Operator perspective,

- Transport operators can also benefit from reduced operating and maintenance costs by cutting down on the use of paper tickets, ticket machines, ticket sellers, and even ticket collectors.
- Paper tickets require production, storage, and distribution.
- Pure NFC communication enables lower pricing, since NFC is technically less complex than other technology.

Due to its shorter range and near field coupling, NFC is more immune to intentional or unintentional interferences

## **II. LITERATURE SURVEY**

NFC is a descendant or an evolved form of Radio Frequency Identification (RFID). Before studying NFC, certain features and specifications of RFID must be studied. RFID involves tracking or identifying objects by a 'reader' through information stored on electronic 'tags' using special RFID software called middleware. For communication, RFID technology uses frequencies in the radio range of the Electromagnetic (EM) spectrum; which are in the range of 3 kHz – 300 GHz. RFID can trace its roots back to World War II where a Russian inventor developed a covert audio spying device for the Soviet army in 1945. However, it wasn't until 1970's that the

first true RFID device was invented which was a radio transponder with memory. From 1973 and onwards, real competition developed for research in the field of RFID. The term RFID was first used in a patent that was awarded to Charles Walton in 1983 for a "Portable radio frequency emitting identifier". From then on, many applications have been found for RFID. [7] [8].

The work on NFC was started by Phillips and Sony in 2002 and they complemented it by developing the first NFC forum along with Nokia. Since then, the NFC forum has more than 150 members and research is being conducted by many companies and academic organizations in this field. NFC can also be called the 2nd generation or '2G' RFID. A lot of NFC-enabled phones now exist in the market and many applications have been or are being developed. [9]. In 2005 the German transport association RMV (Rhein-Main-Verkehrsverbund) started a pilot project, where customers could use their NFC enabled mobile phone to purchase tickets. Based on a best-price-policy passengers only had to check in/out at a terminal in the bus when they entered or left, in order to receive the cheapest ticket for the route. [10]

Today there are already some well-established transport applications for chip cards in big cities using EFM, such as the Octopus Card in Hongkong, Oyster Card in London, ezlink Card in Singapore and the Super Urban Intelligent Card (Suica) in Tokio [11].

The ticketing system is the translation of fares into concrete means of payment (for the passenger) and fare collection (for the operator). Several types of tickets are used in public transport systems such as Bus, Train, Airplane etc.

Md. Foisal Mahedi Hasan, Golam Tangim, Md. Kafiul Islam, Md. Rezwanul Haque Khandokar, Arif Ul Alam have proposed RFID-based ticketing for public transport system for megacity Dhaka. The total system mainly acts to bring out the consistency among various bus agencies that will conclude in uniform access of passengers in daily rides through an automated server being updated every single time the passengers travel by carrying the RFID based tickets [12].

Finzgar, L.Trebar, M describes the implementation of a system, which enables the use of phones for acquiring electronic public transport ticket. QR codes and RFID tags are used for registering passenger at the beginning and at the end of their journeys. Use of NFC and QR code identification in an electronic ticket system for public transport [13].

The range of ways in which we can make and receive payments is growing at a steady pace. Where we used to rely on just cash and cheques, we now have a wide variety of options. These include credit and debit cards, automated payments like Direct Debit, and other ways to make payments such as those using phone and internet banking.

Chen, W. Hancke, G.P. ; Mayes, K.E. ; Lien, Y. ; Chiu, J.-H. Describes a mobile payment system for merchant micropayments, which can be built on existing GSM and NFC architecture components. Many mobile payment methods have been proposed, although such methods are intended for peer-to-peer transactions rather than a conventional merchant payment environment [14].

Jan Ondrus, Yves Pigneur evaluate in a systematic manner the potential of NFC as an upcoming technology for mobile payments. In order to ensure the rigor of our research, we used a formal and structured approach based on multi-actor multi-criteria methods [15]. Pasquet, Marc Reynaud, J. ; Rosenberger, C. describes on the security analysis which can occur in a NFC mobile phone payment [16].

Beside mobile payment another large segment capable for NFC applications is mobile ticketing. In certain cases, both mobile ticketing and payment could even be combined into powerful and innovative appliances with great usability.

#### 1. DB Touch and Travel:

In Germany, a similar system is gradually attracting attention. The project "Touch and Travel" run by Deutsche Bahn (DB) is also based on a best-price principle using check-in and check-out points at train stations which the users have to touch in order to trace their journey. These are equipped with NFC tags storing location information. In order to use this system, customers are required to register their NFC phone and to install an application that is available for Android and iOS. At the beginning and end of their journey they tap the Touch point with their NFC phone.

#### 2. Oyster Card:

One of the most popular systems for RFID based mobile ticketing is operating in London. The so-called Oyster Card works as contactless smartcard for prepaid mobile ticketing and can be used on all public transport services within the London area. In cooperation with Telefonica O2, Nokia, Barclaycard, Visa Europe and others, a six months trial for NFC based travel capabilities embedded in mobile phones has finished in 2008 with great success and positive user feedback [17,18].

#### 3. Movie, Concert and Hotel Ticketing:

The use of Near Field Communication does not only make sense for ticketing in public transport systems but also in various other areas that apply ticket reservation, ticket selling and admission control. In the introduction chapter an example for combining NFC with concert ticketing was already described: a user waves his NFC handset over a tagged advertisement poster and is redirected to a website where he can buy a ticket online. The ticket is cryptographically stored on the mobile phone and guarantees access on-site by being verified by a staff member with a NFC reading device or by an automatic entry barrier.

The same procedure is applicable for movie tickets, conference entrance cards or hotel reservation. In the latter scenario NFC readers could for example be installed at the entrance of each hotel room. The NFC phones of the hotel guest could then operate as room keys providing access only to the booked rooms.

### **Why NFC for ticketing for local trains?**

Thus from the study, we came to know that the current ticketing methods are good but need some improvements. As traditional paper tickets, you lose them, you're in trouble. Coupon Validating Machines (CVMs) were introduced to decongest the booking counter. Here, passengers have to purchase a booklet (worth a maximum of Rs. 50) from the counter consisting of various denominations (Rs. 1, Rs. 2, Rs. 3, etc.) of coupons which have to be validated by inserting into the machine. Again for purchase of coupon booklet will be queue process and passenger will have to check for fair amount from charts will take time. Malfunctioning CVM is again major issue. To add more trouble to this facility, commuters of Central Railway say that you get coupons which have denominations such as Rs. 3 and Rs. 5, whereas the tariff for most stations are on the lines of Rs. 4, Rs. 6, Rs. 12, etc. In short, you end up spending more just because they don't give right currencies. According to a circular dated April 1, 2012, passengers will now have to wait in line for purchasing the booklets.

ATVM machines, currently there is Smart Card operating Machine. ATVM (Automatic Ticket Vending Machine), currently there is Smart Card operating Machine. This card will cost and initial amount of Rs.100, from which the first time usable amount will be Rs.52 to get tickets from ATVM machine and some Rs.30 to balance amount is kept by Railway as one time security deposit (Refundable). At any given time you can cancel and return the smart card which will cost you Rs.10 as cancellation charges. Recharge of ATVM smart cards can be done on any ticket booking counters, currently there is no online recharge facilities for same. ATVM machines did not have that much of response as expected because not all commuters found it easy to operate, the touch screen getting little touch insensitive with time and understanding the START and END route was initially not easy. Basically the user interface can be made easier. Smart Cards once lost can be used by any person, so adding on full recharge of Rs.500 can sometime be risky.

We need more reliable, secure, easy to use, suitable for the mass population with more successful travelling guarantee protocol.

### **III. PROBLEM DEFINITION**

Motivation:

The existing ticketing systems in metro city have a drawback of long and time consuming queues. The present ticketing systems either electronic or manual provide paper based tickets which may get lost as compared to electronic tickets in NFC. These all lead to motivation about study based on NFC embedded in phone. In addition, the study also focused on the customers' perspectives with Near Field Communication ticketing in terms of its reliability, security and convenience. With this proposed protocol our aim is to decrease the unavailability of service.

Problem Definition:

Proposed Ticketing Protocol is used to Collect passengers' time and location based data and communicating that to a central back-end system perfectly. Token (Partial or encrypted ticket) will be given to customer with the fare amount. If the fare is deducted from customer's side and the delivery of the ticket is failed due to some reason :

Such as Connection failure, Device problem (mobile phone) etc.

With the token provided and the transaction detail for the ticket the customer will be able to travel. Further validation of the ticket can be done with token and transaction detail by Railway authorities.

PROPOSED SYSTEM

The basic model of the proposed NFC based M-ticketing for Public Transport is as below:

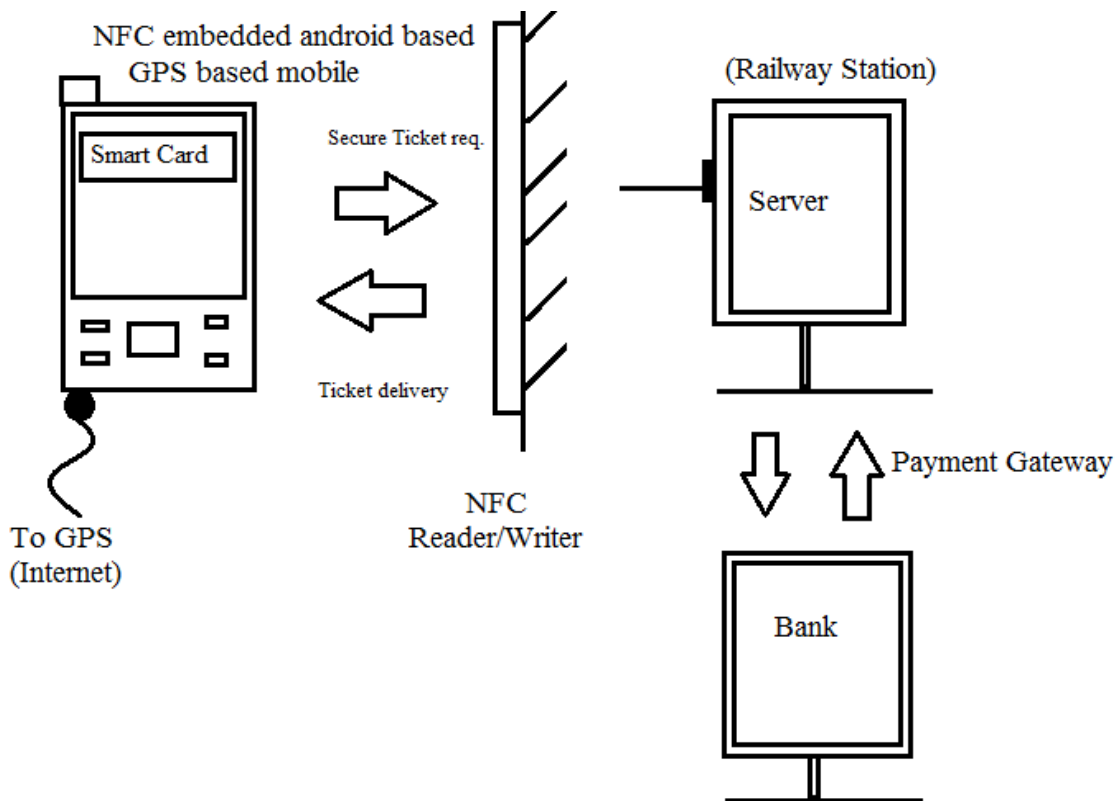


Fig: Proposed Model of the NFC based Ticketing Protocol For Public Transport

Ticketing Protocol Using NFC embedded mobile phone contains following modules :

[1] Mobile phone- accepting the user input as User name, Password, no of tickets etc.

[2] NFC Reader/Writer -To communicate with Railway Server by reading and writing mobile ,

[3] Railway Server - Authentication of device and user will be done by railway server, ticket generation , Payment Clearance and Ticket delivery.

Working of the proposed system will follow these steps:

1. NFC embedded phone has Ticking application .He/she will open the application and fill form .Form contains User name , Password, No of tickets, To, From (taken from railway station with GPS).

2. Submit form.

3. Show the mobile to NFC reader/writer mounted on Railway station wall .

4. Authentication of user and Device authentication by the railway server.

5. After the authentication railway server will generate fair.

6. Mobile has a Smart card for payment of fair generated , railway server will send the fair amount and the partial ticket to customer and the smartcard will pay the money .

7. After the payment done railway server will send the complete ticket and the transaction process will be completed.

#### CONCLUSION

NFC provides all the features which make it a valid technology for mass public transport ticketing: contactless transactions at high speed, stability, security and simplicity. They include proposed solutions based on combinations of standards and technologies using current contactless infrastructures. An important contribution of proposed protocol is security and the increase in chances of travelling in case of ticket delivery failure and payment done. Obtaining a ticket is much more convenient. Using their NFC-enabled phones, consumers can manage their cards and tickets anywhere at any time.

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