



Smart Electricity Meter System using Near Field Communication (NFC)

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Abstract:

Electricity is one of the most important resources of energy in the whole world. As the resource is limited, a precaution should be taken to minimize misuses and wastage of electricity. In the area of power metering the following trend is obvious these days: Utilities require a more sophisticated payment infrastructure to facilitate the payment process for energy. There is an appreciable trend to transition from a fixed-rate billing to a time-of-use billing. Secure prepaid meters may be used for this purpose. These types of electricity meters give the customer a greater control over their electricity bills. The basic and common principle of prepayment in energy meters is to buy energy credit in advance and to inform the prepaid meter by tapping the NFC card on the meter. This means that customers decide how much energy they need and want to consume. This is the main difference in comparison to traditional power meters (based on fixed-rate billing transactions), where the customer consumes electricity continuously.

Keywords: Android, Contactless Smart Card, Mifare, Near Field Communication (NFC), Prepaid Electricity Meter.

I. INTRODUCTION

Electricity is a prominent resource of energy which is used for domestic, commercial and industrial purpose. Prepaid meters system allow the customers to pay only for the volume of the electricity they will consume and thereby make them aware not to misuse electricity. It will also encourage them to save money and use the electricity for useful purpose. This prepaid system makes the customers aware against wastage and misuse of electricity. This arrangement will eliminate the system loss incurred due to use of electricity in unauthorized access. In current postpaid system, there are many cases where the customers could not trace their bill. Moreover, the domestic customers' have to manually pay bill go to bank and stand in a long queue. Utility has to engage a number of people for disconnection and re-connection of customer's line. Moreover there are always dispute, arbitration etc. between customers and the company. Prepaid metering system will help to remove all the above problems and improve customer service significantly. All the above problems will be totally absent in prepaid metering system. Smart meters are remarkably different from electronic meters. While electronic meters only measure the amount of utility used (electricity, natural gas, water), a smart meter is used to measure the utility and then transmit the reading without any human intervention. Conventional smart meters upload data at least once a day so that a historical trend can be maintained. Smart meters will be used for electricity, natural gas and water. Moving forward, smart meters will help to understand consumption patterns of users and help them save money by keeping close track of their usage [1]. Since the last decades of the past century, scientists and researchers have been worried about energy conservation. People spend much more power than what they actually need and that results in a huge loss of energy. Moreover, the continuous increase in the universal energy prices has resulted in a huge economical loss. Thus we are proposing a prepaid electricity smart card based system so people can buy specific amount of energy to use it only when

they need. The purpose of this project is to reduce the power bill defaulter using smart card technology. Smart card based prepaid electricity is a unique and new concept which saves lot of time and power for electricity department.

II. TECHNOLOGIES USED

A. Near Field Communication

NFC technology was jointly developed by Philips and Sony in late 2002 for contactless communications. it is a wireless short range communication technology that enables easy bidirectional secure exchange of data between two near devices over a distance of approximately 10cm. NFC technology is based on Radio Frequency Identification (RFID) technology. It operates at the 13.56 MHz band with transmission rates up to 464 kbps and has a very low power consumption. An NFC communication between devices is achieved through a dialogue between an initiator device called "Starter" and one or more target device called "Destination". NFC protocol operates according to two distinct modes: active mode and passive mode. In the Active mode of communication both devices generate their own RF field to carry the data. In the Passive mode of communication only the initiator device generates the RF field while the target device uses the induced energy of the active device to transfer its own data. In NFC communications, three kinds of NFC devices can be involved: NFC mobile, NFC tag and NFC reader . Those devices may operate according to three operation modes:

- Peer to peer mode: used for bidirectional communications between NFC devices.
- Card emulation mode: the device behaves as a contactless smart card, and it is not possible for the reader to differentiate between a smart card and the NFC device. This is achieved by meeting with ISO /IEC 14443 standard for contactless smart card.
- NFC read/write mode: allow reading and writing contents in the labels or transponders. This mode is widely used for

customer loyalty and geographic localization by locating NFC labels in some points of the customer path [2].

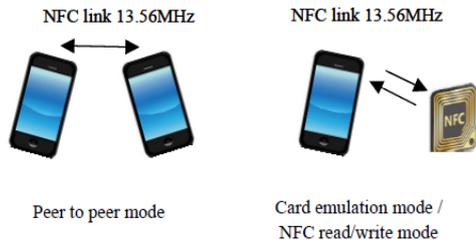


Figure.1. Operation modes of NFC
The NFC operations modes are depicted in figure.

B. Android and Near Field Communication

The usage of NFC can be done through 3 major ways: card emulation, reader mode, peer to peer (P2P) mode. The function of NFC introduced by Google into Android 2.3 (API level 9) device. In Android 2.3, the ability of device is limited in only reading the tag. In Android 2.3.3 (API level 10), data writing and trading ability through mode Peer to Peer (P2P) began to be implemented within android devices. The .nfc android package provides access to NFC function, allows application to read NDEF message (NFC Data Exchange Format) which located at NFC tag. On android.nfc, located several classes which can be used to running NFC function [3].

C. Java Server Pages

Java Server Pages (JSP) is a technology that helps software developers create dynamically generated web pages based on HTML, XML, or other document types. Released in 1999 by Sun Microsystems, JSP is similar to PHP, ASP and React's JSX, but it uses the Java programming language. To deploy and run Java Server Pages, a compatible web server with a servlet container, such as Apache Tomcat or Jetty, is required [4].

III. PROBLEM STATEMENT

Creating a user-friendly system that uses NFC technology for developing a smart electricity prepaid meter system. Using NFC cards the system will authenticate and authorize the user for using the smart meter.

IV. SYSTEM OVERVIEW

The diagram explains, the entire working and collaboration of different entities in the system.

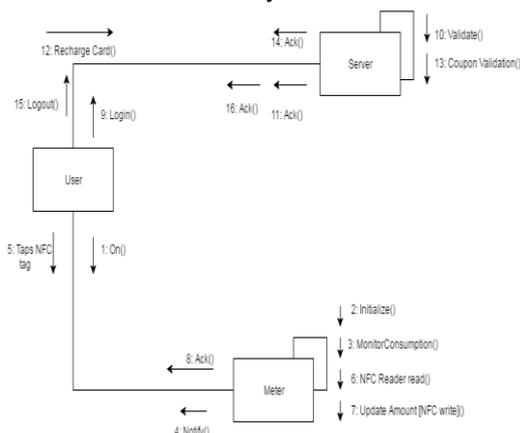


Figure 2: Collaboration Diagram of System

V. PRECISED WORKING

The User who is the consumer registers to the centralized system. On validation of details the system administrator issues NFC cards to the user. The Consumer then recharges the card by paying the amount online. Once recharged the user taps the NFC card on the NFC enabled meter simulated using android mobile application. The meter reads the card data, validates the account details and credits the amount on the meter storage. The meters then functions and supplies the electricity supply via the meter and monitors the supply consumption. As the electricity is consumed the stored amount is deducted as per the charge rules fed in the meter. The meter keeps on monitoring the consumption and when the balance reaches a threshold amount, it notifies the user and displays notification on the meter display. On receiving the notification the user connects the server using the Java Server Pages and can then make the recharge function. The Meter disconnects the electric supply if no sufficient balance is available.

VI. COMPARISON WITH TRADITIONAL METER

Table.1. Comparison between Traditional and Proposed System

| Paramters | Proposed meter system | Traditional meter system |
|--------------------------------|--|--|
| Data Storage | Stores elctricity consumed in oracle using different tables | No storage provided |
| Meter reading | Data is automatically transmitted to the application. | A meter reader physically comes to your home or business to record the information and send it to the metering company. |
| Tracking electricity use | The energy/units consumption can be directly provided to the user through the application in near real time. | Electricity use can only be tracked by either waiting for your quarterly bill or manually reading your household meter yourself. |
| Connections and disconnections | Connections and disconnections are faster as they are managed remotely. | Connections and disconnections must be done manually, slowing down the process when you move house or change energy retailer. |
| Bill generation | Automatically bill gets generated after certain unit consumption. | Monthly bills are generated and sent to the address given by the customer. |

VII. FUTURE SCOPE

Security of online payment can be advanced. Extra features like consumption chart can be provided. More control of electricity usage can be given to the user, like applying threshold values to monitor usage and stop consumption

remotely if required. Instead of using NFC cards, direct tapping of NFC phone to the meter to recharge. Faster and easier energy switching is possible with the help of smart meters.

VIII. CONCLUSION

In this paper the development of a prototype of contactless smart card based prepaid electricity meter are presented. The prototype has been tested successfully. It is more secured and user friendly than the earlier version of prepaid electricity meter. Nowadays NFC standard is becoming popular on cell phones. Many smartphones now include NFC module that can interact with external NFC modules.

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