Toll Automation System Using NFC

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***Abstract* — Automated toll Collection framework is considered as a viable technique keeping in mind the end goal to conciliate movement blockage and jams, upgrade the comfort and security of voyagers, and minimize fuel consumption and air pollution for environmental protection need. The paper proposes Architecture for collecting toll using Near Field Communication (NFC) technology. The basic idea is that the client having NFC enabled android mobile taps on NFC enabled toll tab at toll station, which reads the information like NFC Id and automatically sends an acknowledgment to the owner of vehicles and simultaneously the request is forwarded to the server. The system proposed shows a high transparency level in transaction and amount collected. The system is able to develop the auto-generated message as acknowledgment for toll station, client and the server. The automated toll collection system is also able to census traffic flow and audit road maintenance fees. This system is necessary to improve expressway management.**

Keyword: NFC (Near Field Communication), RFID (Radio frequency Identifier), ETC (Electronic Toll Collection).

I. INTRODUCTION

Electronic toll collection (ETC), otherwise called electronic instalment and estimating framework, is one of the significant exploration subjects in wise transportation framework. And so on is an execution of a street estimating idea with a specific end goal to make advantages, for example, decreasing toll paying time, upgrading the comfort and security of explorers, and minimizing air contamination and fuel utilization? As we know normal toll collection takes a lot of time and there is also traffic jams and won't get the transparency in toll amount collection. For this firstly the introduction to RFID was done. RFID is abbreviation of Radio Frequency Identifier which plays vital role in electronic toll collection. RFID is also used for tracing of the vehicles. The drawback of RFID is that it doesn't work properly in the cloudy and unconditional climate. So, to overcome from this drawback we introduced NFC i.e. Near Field Communication. NFC's full-form itself tells that it is a communication protocol that works within 10cm area (near field) for data transfer.

In this Paper we developed Client server protocol. At client side, the client communicates with server through a NFC Android mobile Application which is able to store the information of user and its unique individual NFC ID generated and given by server. For this the user should contain the NFC enabled mobile and registration should be done online.

A. *Goals And Objectives*

i. Reducing traffic at Toll Areas
ii. Transparency in Toll Agent Collection
iii. Enhancing security at toll station

B. *Relevant Mathematics Associated with the system*

i. System Description:
   a) Input: Registration Details, First Recharge and Tapping of NFC Mobile.
   b) Output: Transaction acknowledgment, Proceed as response.
ii. Data Structures: Queue, RDBMS Database.
iii. Functions:
   a) NFC id of client: Transferred on to toll device.
   b) Transfers client's NFC request to server: On Match process client request.
   c) Transaction details from server to toll device: Stores and Transfers to Client through message/ acknowledgement.
   d) Success Conditions: Proper transaction is done.
   e) Failure Conditions: Transaction is declined.

II. LITERATURE SURVEY

In Japan, NFC tags are in built into card popularly named as Felica card which are used to uniquely identify people. In [1] paper the authors tried to make an Attendance management system based on NFC identity cards which when swiped on corresponding smart phone or tab (having Android app) will add attendance into the attendance record present onto the cloud system. Further these attendance records can be viewed and analysed by authorities anytime and anywhere.

In [2] paper the proposed framework first accepts vehicles those are passing toll court and if genuine then charges electronically the records or the sum in the IC card of the enrolled vehicles without interfering with them. Authors tried to develop system having features like automatic challan and reporting methods to registered owner of the vehicles. Also, there was typically excess carriage of NFC IC integrated into a card as burden to the consumer.

In [3] authors have tried to replace DSRC-based technology used in ETC systems by Vehicle position technology. The instrument utilized as a part of this VPS at adjacent toll stations depends on collaboration in the middle of OBU and backend framework through versatile system. [3] paper combines several technologies including vehicle positioning, mobile communication, vehicle detection and classification, and auto license plate recognition. The main advantages of [3] system are the total cost of VPS is much cheaper than DSRC based ETC system, it's easy to setup a new toll area or remove the old ones, transaction time won't be the problem. Detriments incorporates High exactness prerequisite for vehicle situating in ETC

applications, problems associated with GPS signal outages, it is more difficult in the matching process between the debit and enforcement information, so the VPS system needs more post-processing jobs in order to reduce the mismatch failure.

In [3] proposed a good model for toll collection but focuses only on collection and hence lacks in security, to overcome security issues we proposed our model which focuses on transparency and security issues by knowing the person who is going to cross toll station.

In [4], the difference between multilane-free-flow and single-lane systems is overcome with help of millimetre–wave range communication strategy. In multilane-free-flow systems, the vehicle passing through the data-communication region in the ETC plaza may change travel lanes during data transmission between its OBU and the RSU on the previous travel lane. Because of this, the data transmission between the OBU and the RSU on the previous travel lane may very often be incomplete and must be performed consecutively by the RSU mounted on the current travel lane, into which the vehicle has entered. The [4] architecture combines techniques like frequency multiplexing, pulse ranging and fine target-direction determination. Frequency multiplexing illustrates the use of separate emitting antennas for each traffic lane, but only one common receiving antenna for collecting all return signals. The frequency bands utilized in different traffic lanes are distinguishable. Also the system will activate some subsequent enforcement activities against the violating vehicles. The presented model is useful in case for long distance communication between OBU and RSU. [5] It designed the ETC system using RFID technology. It mainly consists of toll-gate, management system of toll station, management centre, and bank and transmission network. The system of toll-gate control mainly is responsible for controlling and managing electronic equipment installed in toll gate and RFID tags installed in vehicles. It identifies and records real-time information of vehicles through RFID tags that are put on vehicles as OBU and sends them to management system of toll station, and management system of toll station will process this information. Management centre is the top manage layer of ETC system. It processes and exchanges charge data. Model uses high level of security as it uses 2-stage security, first is through watermarking for sending signal from OBU and second is usage of robust encryption algorithm to send data from local server to global server. [6] This framework emerges from the expectable interest for versatile applications and NFC innovation to pay bills. The framework proposition breaks the present ideal models, presenting the likelihood of adaptable installment subsequent to causing on tolls. The proposed C2S is constituted by two segments/gadgets, one is ready of the vehicle, named OBU, and another, acts in a versatile application, in an advanced mobile phone with a NFC highlight. It begins with the first segment, the OBU, that is not perceived by the ordinary DSRC tolling framework, when it goes on tollbooths, the authorization framework is activated and the Automatic License Plate Recognition (ALPR) takes a photo and OBU spared the toll and it gives the likelihood to pay in a lawful time period. To gather the toll logs, the client ought to utilize a versatile application, which will get the logs by means of NFC, in this way after the client "touches" the OBU with his Smartphone. At last the versatile application gives a straightforward client interface where the client ought to present all the toll accumulations to the relating toll supplier, by means of Internet association. The proposed system has draw back like user should have compulsory net connection and NFC mobile account. It uses both devices like OBU and NFC enabled device to complete the procedure which is costlier.

III. PROCEDURE

In system NFC is used for storage of the information of the user and each user has an individual NFC ID. For this the user should contain the NFC mobile and registration should be done online. Registration includes First Recharge process that success creation of secured pre-paid account in the database.

After registration there is no need of internet connection for the user mobile at the toll area but if the user wants to be update in accordance with his account as of in database then he will require the internet connection this may be termed as “Synchronization” (Sync-Account). At toll stations the user can use his NFC enabled phone just by tapping his phone on the toll’s NFC device which may be smart phone or tab. On tapping of user’s phone with an opened App, the NFC communication channel is set-up. And users NFC-id stored in app’s local DB is transferred to toll device. After that the toll device converts the user’s NFC-id to http request by adding toll-id and current computed fair and forward this request to the server. The server stores, verifies the data into the database and process further to complete the transaction. On successful verification the requested fair is debited from the user’s pre-paid account and time-stamp of the completed transaction is stored and sent as acknowledgement to the toll device. Then toll device store and sends this information to the user via NFC acknowledgement before closure of communication channel, and then the user proceeds. The toll station are paid monthly on the basis of contract and monthly work-out basis i.e. basically the total amount collected by that particular toll in fix period or a month.

A.Plan of System Execution

i. How we should use NFC?
ii. How should we connect our NFC Mobile to the toll device?
iii. What type of storage should we use?
iv. What type of languages and software should we use at server side?
v. What type of software should be used for making Mobile App?
vi. How should we view our transaction?

Answering such type of question can lead us to the estimated planning strategy,

NFC as we know is a Near Field Communication which plays a vital role in Toll Collection System. We are using NFC Smartphone for this system which requires Registration before using it and can be done by Online Registration. After this user can directly touch his NFC Mobile at the toll’s NFC device which is the easy way of transaction and also helps in the reduction of traffic congestion.

The simplest method used by NFC is just the tapping of Mobile at the toll’s NFC device which helps in automatic transaction

from user's bank account and also helps in the smoothening of the process at the Toll Collection area.
In this Toll Automation System we are using languages such as JavaScript, JSP, AJAX and software such as NetBeans 8.0.2 (IDE).
At the client side for making Mobile App we are using Android Studio Powered by IntelliJ Platform with software as Android SDK for Android device monitors.
On touch is been done by the user with user's NFC device at the toll area, user's NFC id is been accepted by the toll device and forwarded to the server side. Server stores the data in the database and also the transaction process is been done and the details is been transferred back to the toll device. Finally NFC connection is terminated when user receives transaction acknowledgment.

B.Motivation of the System
This system motivates us to solve the problem of citizens by having a transparency in Toll Collection System. It directly or indirectly helps in time consumption and traffic congestion too. In this way the Toll Automation using NFC is going to be used in a vital way.

C. System Architecture
The block diagram mainly consists of four components those are user NFC device, Toll NFC device, Server and presented web Application. The web application is hosted for purpose so that initially user can register his details and make android app available in his device may be tab or smart-phone which supports NFC communication protocols.
During the registration process, client/user will be provided with the NFC-Id that will be unique as per user's filled details. The whole required details will be saved into user's respective account database (Server). The web Application can be serviced from PC Desktop, tab, smart-phones.

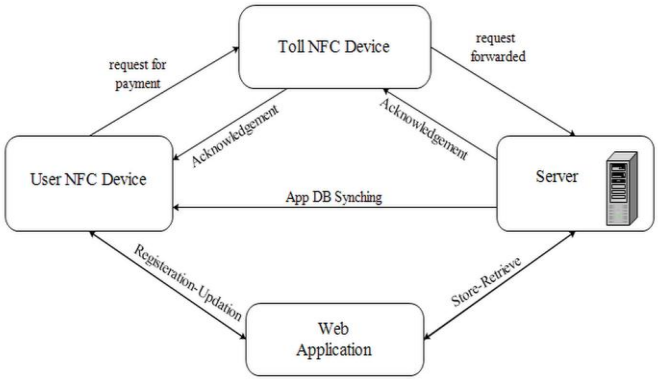

***Fig 1:* System Architecture diagram**

User NFC Device can be tab, smart-phone. It is used to share the user's NFC-Id with the toll device which is represented by the user request for payment at toll booth. The request passes through toll device and hits to server for payment processing. The Server then validates and process the request further while making usage of information stored in database.
Toll NFC device is a bridge that fills up the communication gap between user's NFC device and the server. The toll NFC device accepts the request from user which is invoked on tap/contact of these two devices. The request is then dispatched from toll device for server for requested payment processing. All the transaction history is maintained in user's account. The Server returns an acknowledgement which is the response of the processing. The acknowledgement is saved and send to both toll and user device.
On connection establishment of server with user NFC smart device, local Database of NFC Android Application get synchronized with the account present in the server database. Hence with these the user App account is always updated.

IV. SYSTEM REQUIREMENTS

Due to this architecture design there will be an idea about the software contents used in this system.
The first block represents Android OS which contain NFC App users and toll station.
The second block is of web application which contains all web containers for user interfacing like html, jsp files. The last block represents Windows OS used which contains server and database. Server has java, .class, web.xml, lib, .jar files which is logical and back end tier of client server model and web app.

V. SYSTEM FEATURES

A. Interface for App Download
Description and Priority: - This feature will allow the user to allow for registering to the NFC App. The system shall display the required fields that are available for registration. The system shall allow the user to select the number cars and their types. The system shall notify the user about the User-Id and Password.

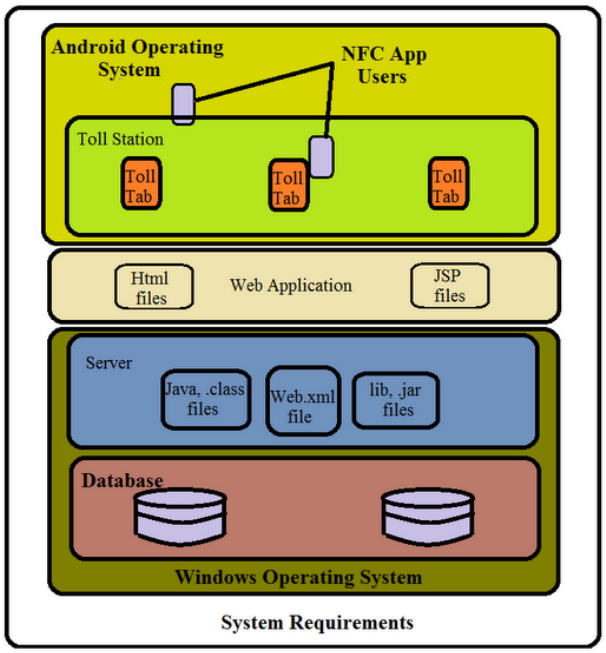

Fig 2: **System Requirements**

B. Stimulus/Response Sequences

It will consist of many basic fields. Personnel Details, Number of cars and Type of cars, Update and Pre-paid Payment process.

C. NFC App Interfacing

Description and Priority: - This feature will provide the user an access to the NFC App where the user can do toll transactions with the help of NFC enabled smart phone. It has various buttons to view user's transaction details, account balance and update.

Stimulus/Response Sequence:-It will consist about 3-4 main tabs to know your current account balance, transaction history, to update your personnel information etc. Each tab/button will trigger an action whenever the user will bring his/her palm over the tab/button which is shown on the screen.

Functional Requirements: - The most important function is to only grant those users who are registered and authenticated to pass the toll plaza with successful transaction entry at user, toll plaza and at server station.

VI. PROJECT SCOPE

In this project, the main aim is to demonstrate secure toll transaction with better interaction features in transaction through website and Android App which can improve the availability of toll collection amount directly to government without any corruption.

With help of this project, transparency will be maintained towards all customers, toll agents and the government.

Customers can view their amount deducted, all toll transactions operated successfully with their corresponding toll location referencing through their id, and remaining balance on their respective accounts.

The toll agents will be paid a certain salary as per decided amount by the government on the basis of individual toll collection of the month.

VII. DATA MODEL AND DESCRIPTION

A. Data Description

A DFD is frequently utilized as a preparatory stride to make an outline of the framework, which can later be expounded. DFDs can likewise be utilized for the representation of information handling (organized configuration).

B. Data objects and Relationships

The DFD diagram show in fig 4, contains the flow of data from to client, server and the toll device. The data flow from client to server is through a web application and stored in database. On client request for processing the data is sent to a server through a toll device which is then matched with database and further processing takes place at server.

C. The activities done by each task is shown in below flowchart

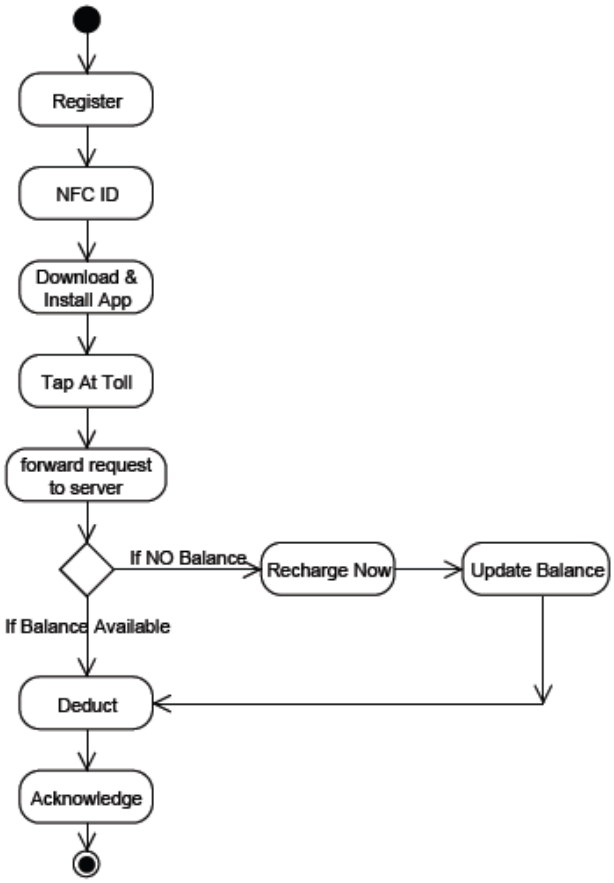

Fig 3: **Flow chart of System**

D. Data Flow Diagram

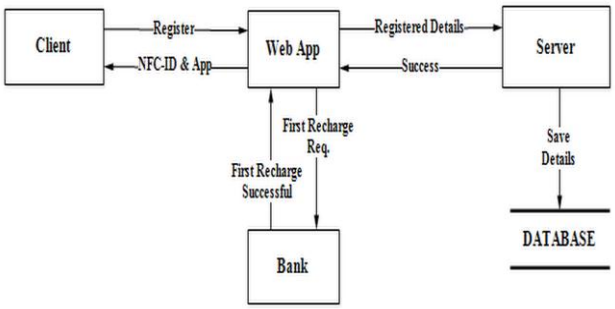

Fig 4: **Data Flow Diagram**

VIII. ADVANTAGES

i. Car documents can be checked in once.
ii. Standardizations and transparency at Toll fair collection and its utilization.
iii. Security is enhanced as both the centralized server and toll device knows who is crossing the toll.
iv. Need for manual toll based system is completely reduced.

IX. CONCLUSION

The focal points for the customer and the diminishment of operational costs for toll associations our structure, answer to the necessities of current issue that we are going up against. Our proposed structure also answers the need of those a couple of customers, for instance, rent an auto costumers, auto offering customers and remote drivers to enhanced security highlights. The motorized toll system will allow any road customer to pay viably the brought on tolls in a genial customer interface.

For the present, the check of-thought model is done up, with the essential system squares, interfaces and as of late exhibited correspondence propels, joining the compact application and the server in a gathering game plan.

Finally, to complete up the confirmation of thought, it is required to test this game plan in certifiable circumstances, over a couple of countries in unmistakable systems.

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