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"Tap & Pay"Universal Transport Billing System Using RFID Smart Card

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Abstract: It is the era of technology in which the world is developing. Therefore, people are highly dependent on carrying out their business (money) transactions through internet based services. Most of the fairing/billing systems are now available with online support. Hence to integrate all applications in one system we are introducing Universal Transport Billing System using RF-ID (Radio Frequency Identification) card. In public transportation system at present we use paper tickets which are printed by a small machine with a key pad. In this system we don't know the details of passengers who are using the public transport. The details of the passenger are not taken in the existing system. The system requires user details in order to provide security during identification process. The details are also required in order to provide notifications via sms to the user. In our proposed system automatic ticketing is done with the help of RF-ID card. This card can be used for almost every transport system like buses, cabs, metros, auto-rickshaws and so on. It has details of passengers and it is placed on the RF-ID card reader and the destination is entered with the help of key pad. The amount is deducted from passenger's account according to the distance the passenger as traveled respectively. Thus, users will not have to carry cash and the system becomes more convenient. The main advantage of the system is that the transaction & fare calculation is automated and secured. Disadvantage is the maintenance and the initial cost of installation for the system. The total system mainly acts to bring out the consistency in the public transport system 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.

1. INTRODUCTION

In a megacity, there are various transport services available for public travelling all over the city such as buses, railways, metro, cabs, etc. Among these transportation, most of the transport services use paper based ticketing. This type of services leads to chaos among public, system loss, corruption and most of all traffic jams that is responsible for wastage of time, money and environmental loss. Again having no government authority to take control of keeping an eye on public as well as private transport services, leads to autocratic raise in fairs, corruption are possible or might occur.

The transportation services need some changes for satisfying the general public. These services are either operated by state run authorities or private organizations. Both public and private organizations are not concerned about the detail information of passengers, transportation used by individuals as well as location travelled by the passengers respectively. These all aspects are necessary in order to keep a track on activities performed by individuals.

The Universal Billing Transport System using RF-ID card proposed by us ensures for ticketing system that can be merged to solve above problems. We have proposed this system through RF-ID based tickets for low cost, easy operations, portability, durability, reliability and being much more user friendly. Also the high speed of RF-ID tags and detectors make the tracking system of any transport system merely a child's play.

Public carrying RF-ID based electronic tickets will have access to any transportation system within entire city by only by specifying source and destination location to the system. The data will directly be transferred to the server's main database and the equivalent credit will be stored in the corresponding system account. By using this automated system we will save time, have a higher authoritative inspection and reduce chaos and confusion on roads.

2. Overall Specification

The Software requirement specification ascertains the basic requirements of the system. It not only pinpoints the significant components but also several trivial details which cannot be discounted. It also describes the need for the proposed system over the present conventional system. The following SRS lists outs the major functions of the project, functional as well as non- functional

requirements, databases required , internal and external interfaces associated with hardware and software and the technical environment needed for building the system.

2.1 Project Scope

The project scope includes the website product as well as the hardware product. It also states the abilities of the product that it will accomplish. The scope also defines the activities which would not be performed by the system. Considering all the facts the scope can be stated as:-

The software product is the Tap-&-Pay website. Users register their details through the website. The website will help them get information about the usage of the card, topping up of the card, help services, etc.

The hardware product is the RF-ID Card & Reader. The card will help the commuters in billing purposes while the reader only fetches the data from RF-ID tag.

The system can keep records of transaction and provide it to the user if requested.

The system also does not tend towards tracking of devices nor vehicles through the Global Positioning System.

Also there is no presence of the dynamic scheduling of the devices.

2.2 Intended User Class and Characteristics

The intended user class is the novice user class. There is no specific requirement for the user to be expertise in networking, accounting or management. User simply has to top up the card and just have to tap. Necessity is only the user should possess basic internet knowledge. He/she should be able to top up the card whenever balance in the card falls below appropriate levels through the website (This is only in the case of online top-up).

2.3 General Constraints

The constraints include the limitations observed in the system:-

Only one card can be read at a time.

There should be minimum amount of balance in the card for commencing of transaction.

Until user undergoes website registration, he/she will not be allotted with the RF-ID card.

Until user requests for the transaction records, he/she will not get the records because of the security issues, as fetching of query involves the handling of the databases.

There is a major constraint of continuous internet availability.

Also there must be fully working card readers at every transportation billing points.

Recharge centers should be available within several parts of the city for easy top-up.

There must be also immediate providing helpline services, in case the card gets misplaced, a certain breakage is observed in RF-ID readers or there is a breakage of the RF-ID card.

2.4 User Documentation

The user documentation includes the documents for the handling the system flawlessly. They may include paper manuals, e-manuals, tutorials, images, presentations and even videos.

The user documentation includes:-

User Help Manual: - Manual for User Smart Card – How to use the card, how to recharge the card, what to do if balance goes low.

Online Help: - E-Manuals to Recharge, Usage of Card via Website, Steps to get details of last ten transactions.

Tutorial - Videos, Presentations about Registration, Usage of Cards.

3. System Features

The system features specifies the functional and nonfunctional requirement. Functional requirements are the requirements which are given by the client. The client expects that all the given requirements are implemented in the system. The client may be an expertise or invoice client or organization. Hence, there are some factors which are to be considered in the system irrespective of the functional requirements. These requirements are given by the development team and they are termed as Non-functional requirements.

3.1 Functional Requirements

Functional requirements are the requirements given by the client (organization) for development of the product. With respect to our system, they can be listed as:-

- **Website.**
  - **Purpose: -** User Registration.
  - **Tool:** - Dreamweaver.
  - **Programming Language Used:** - PHP.
- **Smart Card.**
  - **Purpose: -** Identification.
  - **Technology: -** Radio Frequency Identification.
- **Card Reader.**
  - **Purpose: -** Reading of RFID Tag / fetching the user data for identification.
- **Database of User.**
  - **Purpose: -** Maintain a record of transactions.
- **Fare Calculation.**
  - **Purpose: -** To calculate fare after user travels through transport mean
- **Transaction.**
  - **Purpose: -** To deduce balance from user account after the tap of the card.
  - When transaction is successful message will be displayed as "Transaction Successful…!!!"
- **Notification.**
  - **Purpose:** - To notify the user the status of transaction when it ceases at a particular point (weather it has been successfully processed or halted at any point).
  - **Tool:** - Java Messaging Services.
- **Exception Popup**
  - **Purpose:-** Popup or notify for following exceptions:-
  - Balance falls below appropriate levels.

- Identification unsuccessful.

- **Error Messages.**
  - **Purpose:** -To know the type of error occurred during transactions.
  - **Error Messages:-**
- **"Balance Low….!!!Please Recharge."**
- **"Invalid User!!!"**

3.2. Non Functional Requirement

Non Functional requirements are the requirements specified by the development team irrespective of the requirements submitted by the client. These are the requirements which are supposed to be subjected on the system in order to guarantee other factors which are not considered. They include:-

- **Performance** – Higher performance will be gained if better and efficient readers are installed along with compact databases (at server side) with continuous, fast working internet, as well as user support in timely recharging of the card.

- **Reliability** – Validity of the system will be satisfied at any situation at any time provided the conditions of the system hold good. If the card is misplaced, then user has to first contact and register a complaint about the misplaced card. He/she will then apply for a new card. The balance will be checked for last transaction and the remaining balance will be transferred to the newly applied card, gaining reliability.

- **Availability** – Availability will be achieved if there is availability of the card readers at billing points as well as there is care centers for any kind of help, within vicinity.

- **Security** – Security is required while identification process. If there is a loss of card, damage to the card, the card can be immediately blocked by contacting a care center or calling a help service. For this purpose, a PIN number will be provided. Website security is provided by using appropriate protocols like HTTPS. Also the website programming language plays a major role in which it is developed. Considering this, programming language used will be probably PHP.

- **Maintainability** – Maintaining the system includes proper usage of the card. If the card is damaged beyond limit, then user has to apply for a new card or the transaction will not be processed with the card. Also, continuous help services are necessary to cater with the difficulties of the commuter. The main part of maintainability is to maintain the RFID readers. If any damaged is observed, immediately the reader is to be repaired or a new reader has to be installed in its place with proper configurations.

- **Portability** – Most of the system includes hardware part – RFID smart cards and RFID card readers. The cards and readers are simply mobile and can be easily installed. Also the software part includes the designing of the website, which is OS independent, hence they can be easily accessed from any place, provided there is internet. Hence, portability is easily achieved.

4. MATHEMATICAL MODEL

The mathematical model specifies the overall system inputs and the respective responses we will be received based on the inputs given. It also defines several functions which describes the data flow, also the initial and final states of the system, the data which can be determined and the data which will be dynamic. General mathematical model can be stated as:-

{S , e , X , Y , T , F_{main}, DD , NDD, F_{friend}, $Memory_{shared}$, $CPU_{CoreCount}$}

4.1 Overall System Specification.

The specification of the mathematical model with respect to our system can be stated as:-

- **s- The Initial State.**
  The initial state of the system is the user registration. User will register to our system through a website .The registration part will include enrolling the user details along with the payment of basic registration fees, by online or offline services.

- **e – The Final State.**
  The final state of the system is the notification phase. Based on the transaction status the user will receive a notification depicting weather the transaction was successful or transaction was ceased at a particular point, the balance in user account is appropriate or weather it needs to be topped up. Hence, the final phase will be the notification phase.

- **X – Set of Inputs.**
  The set of inputs include the user details, the RF-ID smart card, query for the request of the last ten transaction records, the fare calculated and the online credit card number.
  Initially, the user registers his details via a website to the system.
  After the registration part, the user will be allotted with a unique RF-ID smart card for transaction purposes. The RF-ID card will be the second input to the system i.e. user will tap the RF-ID card on the reader for the identification and later the transaction will be executed.
  The third input to the system will be a database query for retrieving the last ten records of transactions processed of the system.
  The fourth input is the fare calculated i.e. the output of the fare calculation algorithm which will be given as the input for the transaction algorithm.
  The last input is the online credit card number required for the online transaction.

- **Y – Set of Outputs.**
  The set of outputs include the delivery of RF-ID card to the commuter, the fare calculation output along with the transaction. After the registration,

the user receives the RF-ID card that will be the first output of the system. When user will tap the RF-ID on the reader the fare calculation code will be executed which will calculate the fare based on length or time. Also the transaction processed gives an output which includes balance deduction from user database account and notification about the status of transaction.

- **T – Number of Steps.**
  There are total 8 steps included for execution of the system. They include:-
  - Registration→Allotment of RF-ID card to the user→ Fare Calculation→ Tapping of RF-ID card on the reader→ Identification→ Exception (If Low on Balance)→ Transaction →Notification.

- **F_{main} – Main Algorithm.**
  The main algorithm includes the fare calculation and the transaction algorithm. The fare calculation algorithm deals with the fare calculation after the user has travelled for a certain period of time. Based upon distance travelled and the time taken to travel, the fare is calculated.The transaction algorithm is also significant as it deduces the respective balance and notifies the user about the balance left and deduced from user's database.

- **DD – Deterministic Data.**
  Deterministic data is the data that can be correctly predicted or determined. The deterministic data with respect to our system is the data which the user will register to our system. The user will register to our website with details containing name, address, mobile-number, email-address, etc.

- **NDD – Non-Deterministic Data.**
  The data which cannot be determined is termed as the non-deterministic data. In our system, the user top up data is the non-deterministic data. It cannot be determined how much the user will recharge when his balance falls down below appropriate levels. Also, the transaction database is counted under the non-deterministic data.

- **F_{friend}- Functions of the System.**
  Functions of the system can be stated as:-
  - **Registration ()** – Function for registration purposes.
  - **Authentication ()** – Socket Programming Function for connection with server.
  - **Identification ()** – For identification of an authorized user.
  - **Exception ()** – To throw exception if user balance falls below appropriate levels.
  - **Fare Calculation** () – Algorithm for fare calculation.
  - **Transaction (fare output)** – Algorithm for deduction of balance from user account database.
  - **Notification ()** – To notify the user about transaction status as well as if the balance is low.
  - **$Memory_{shared}$- Memory Required**
    The estimated memory requirement is 5 Gigabytes.
  - **$CPU_{CoreCount}$ - Number of CPU's**
    Number of Core – Single, Dual, Multicore.

4.2. State Transition Diagrams

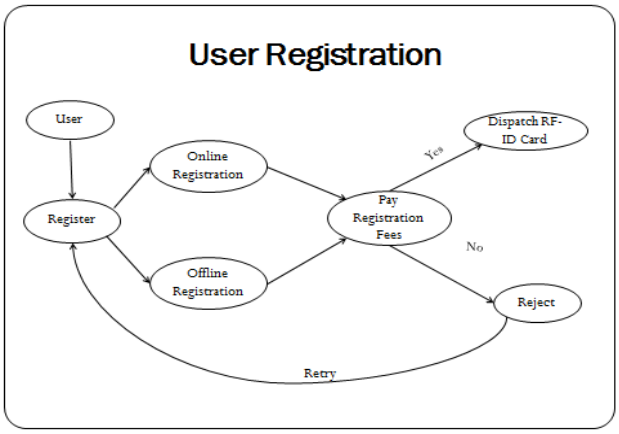

Fig4.2.1. State Transition Diagram –Registration

In fig 4.2.1, user first enters the details in order to register into the system. After registration, the user enters into payment state. After proper payment either by online or offline services, he/she will be allotted with a RFID card or he will be redirected to registration page.

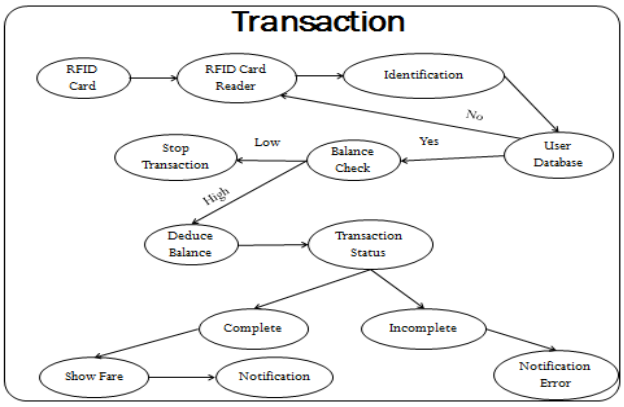

Fig4.2.2. State Transition Diagram – Transaction

In fig 4.2.2, user will tap the card on the reader. The state of system is till ideal. After the tap, the RFID card is recognized and client - server communication is processed. After the communication, the identification with the database is done. If this succeeds then further processing will be done or the user is requested to tap again or a notification is popped as "Invalid User". Further processing after successful identification will be fare calculation. Here the user account's balance is checked. If the balance is greater than the minimum amount required, then the fare is deducted and details of transaction are notified to the user. Hence this is the final state of the system.

5. SYSTEM DESIGN

5.1. System Architecture

The system architecture includes the architecture of the system which is stated by functional block diagram and ER system architecture diagram. These can be stated as in Basic Functional Diagram.

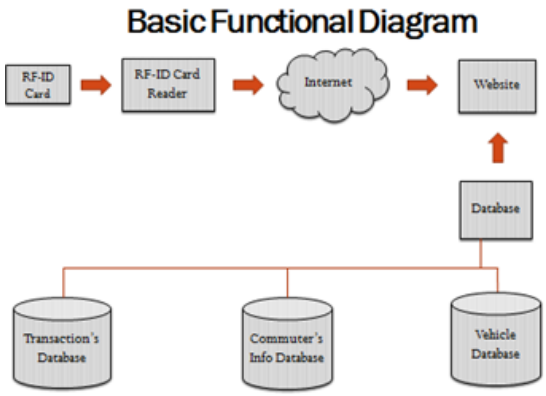

Fig5.1.1. Basic Functional Block Diagram of the System

The fig 5.1.1 explains the several entities that will be active as the user places the RFD card on the reader. The reader will then contact the server through internet and then it will be checked for user identification. The relationship between entities is shown by E-R diagram. The E-R diagram specifies several levels of relationships between the entities and their response and behavior with each other.

5.2. UML Diagrams

The UML diagrams showcases the data flow of the system, the response for a particular input, the behavior of the system and the structure of the system through which the development phase will undergo. Tool used for designing of the system are: - IBM Rational Architect & KDE UmbrelloUML modeling software. The UML diagrams can be stated as in **Use Case Diagrams.**

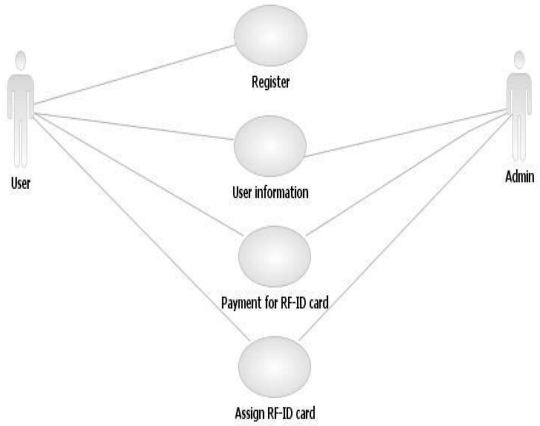

Fig5.2.1. Use Case – Registration

In fig 5.2.1, the registration process is specified. The user will first enroll through the website by providing basic information and by paying the registration fees in an online or offline manner. If the fee is paid, then user will receive the RFID card or he will have to again register through the website.

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