

Tracking and Monitoring of Vehicles and a Stable and Secure Tolltax Payment Methodology Based on Blockchain Enabled Cryptocurrency E-Wallets

Baby D Dayana, C Sivarama Krishnan, Cimryn Sarah Patrick, Venkateswaran N

Abstract: *The Automatic Toll Gate System is very useful for automatic vehicle tracking, time management and also for the automation of Toll gate. A customer's electronic wallet pays directly to the tolling agency's electronic wallet. Hence back office processing can eliminate payment processing and the transaction fee would not be required. When incorporating blockchain, it becomes a next-generation tolling network for both agency-to-agency national interoperability and cross-border interoperability. This paper describes the implementation of Toll Gate Automation which is a major step towards improving the tracking and monitoring of vehicles travelling in preordained routes and makes secure and stable toll transactions based on blockchain. Blockchain based tolling exploits the Hyperledger Fabric's private, secure channels and encryption. These protect transactions and customer data. This approach also possesses smart characteristics. It uses smart contracts to create digital interoperability rules. A smart contract is the encoding of sets of rules which govern how toll agencies operate and are stored on the blockchain. When known, these rules mean toll agencies can tailor their business approach for each organisation with which they interact: there is no need to conform to one consortium's set of rules. A computerized system automatically identifies an approaching vehicle and records the vehicle number and time it passes. If the vehicle belongs to the authorized person or group, it automatically opens the Toll Gate and a predetermined amount is automatically deducted from its account. This is managed effectively and efficiently by RFID and Blockchain Technology.*
Keywords: *Automatic toll collection, BlockChain, RFID, vehicle theft detection, secure and stable transactions.*

I. INTRODUCTION

Transportation is the foundation of any nation's economy. Improvement in transportation frameworks result into a great lifestyle in which we accomplish phenomenal opportunity for development, enormous exchange fabricated merchandise

and enterprises, just as social versatility. Expanding number of vehicles out and about results into number of issues, for example, congestion and air contamination. Various security issues also occur. The Automated Toll Gate is capable of determining if the vehicle is enlisted or not, and then informing the management center to process violations and debits. For at least the last ten years, the toll industry has tried to solve the problem of interoperability on a national basis. This Blockchain based tolling system allows toll agencies to share status updates for: transponders, license plates and other vehicle identifiers. It also lets toll agencies: send and receive interoperable transactions and handle reconciliation and disputes. In this paper, the blockchain ledger comprises two parts: a 'world state', a database containing the current values of the ledger; a blockchain, the historical journal which holds the record of everything that has ever happened in the system. The combination of these is what makes this toll system more efficient when compared to other systems. It is a permissioned, blockchain network which: enables agencies to communicate with each other; eliminates the need for the more common, and current, hub-based interoperability model and most importantly, is secure.

II. PROPOSED SYSTEM

This paper gives a simplified procedure to passengers to pay toll at toll booths by making them automated and highly secure with the help of blockchain technology. The methods implemented are very efficient. The Benefits of this System include shorter queues at toll plazas, Faster and more efficient service, minimization of fuel wastage and reduced emissions.

Shared, verifiable accounting is one of the main attractions of this paper. A blockchain gives the ironclad, entrenched, transparent accounts of the data kept written in it. This implies 'transaction's' can't vanish, that the past can be re-gathered. Data is encrypted and stored in distributed ledgers. This always enables everyone to possess access to a current copy of the transponder status list. Put another way, this implies the information 'you' are taking a gander at is as similar as to what 'I' am taking a gander at. Better still, this eliminates the need to send giant data-heavy lists back and forth each day. Furthermore the utilization of distributed ledgers makes it simpler for agencies to: send and receive transactions, give an account of what each owes another agency.

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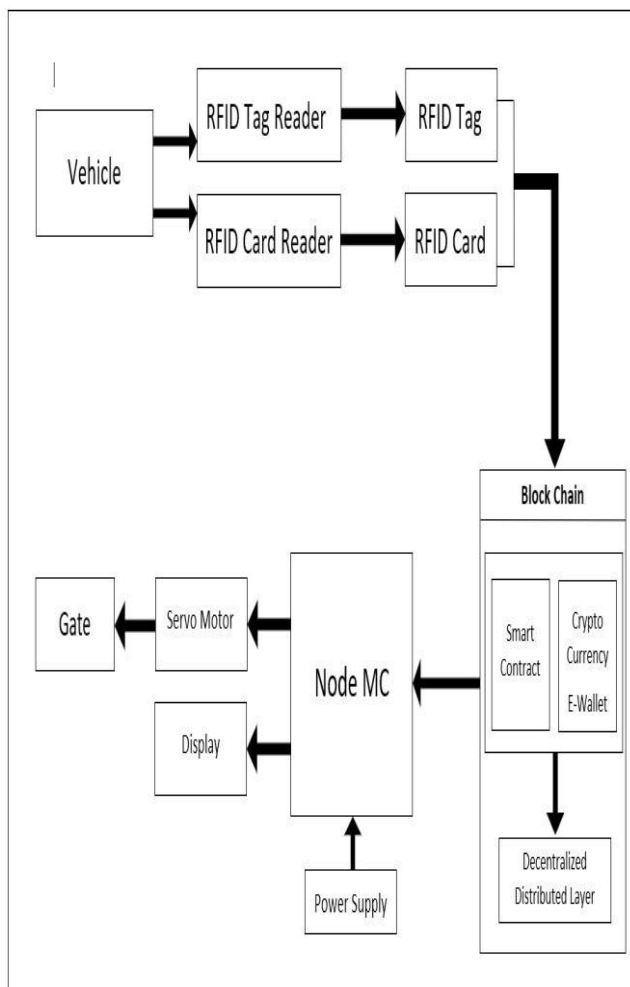
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Along with the Crypto currency E-Wallets, Vehicle theft detection, Signal breaking avoidance, tracking over speed vehicles and vehicles that carry illegal goods are the features that makes this paper unique. By eliminating delays on highways and roadways, the system ensures that toll payment is made automatically in a hassle-free manner. The system of automatic identification of vehicle is composed on board unit, road side unit, a decentralized distributed ledger and other components. And the central control system is the blockchain which comprises the smart contract, database and ledgers containing the information and transaction processes of enrolled vehicles and users.

When vehicle passes the toll station sensor detects the vehicle, sends out the signal and the reader responds thus establishing two-way communication and data exchange. Center control system fetches and identifies vehicle information like car's ID and car's module and compares the information to the database. The payment is then done automatically through a cryptocurrency E-Wallet.

III. SYSTEM ARCHITECTURE



IV. COMPONENTS USED

A. SERVO MOTOR

A servomotor is a revolving actuator or straight actuator that is used for exact control of angular or linear position, speed and acceleration. It consists of a suitable motor coupled to a

sensor for position feedback. It is used for the opening and closing of toll gates.

B. NODE MCU

NodeUSB is an open IoT platform, the size of a standard USB stick. It was intended to use NodeMCU for simple programming and has the additional component of USB capacity. It is perfect for Plug-n-Play arrangements, permitting simple prototyping for developers.

C. RFID TAGS AND READER

The RFID reader is a Radio frequency device that operates at 125 KHz. It reads the data from the passive RFID tag placed in the vehicle and converts the data into digital Weigand format. The Weigand format data can be read using the Microcontroller program and sent to the PC via the RS232 port. A RFID tag is a microchip combined with an antenna in a minimized package; this is organized to permit the RFID tag to be attached to an object to be tracked.

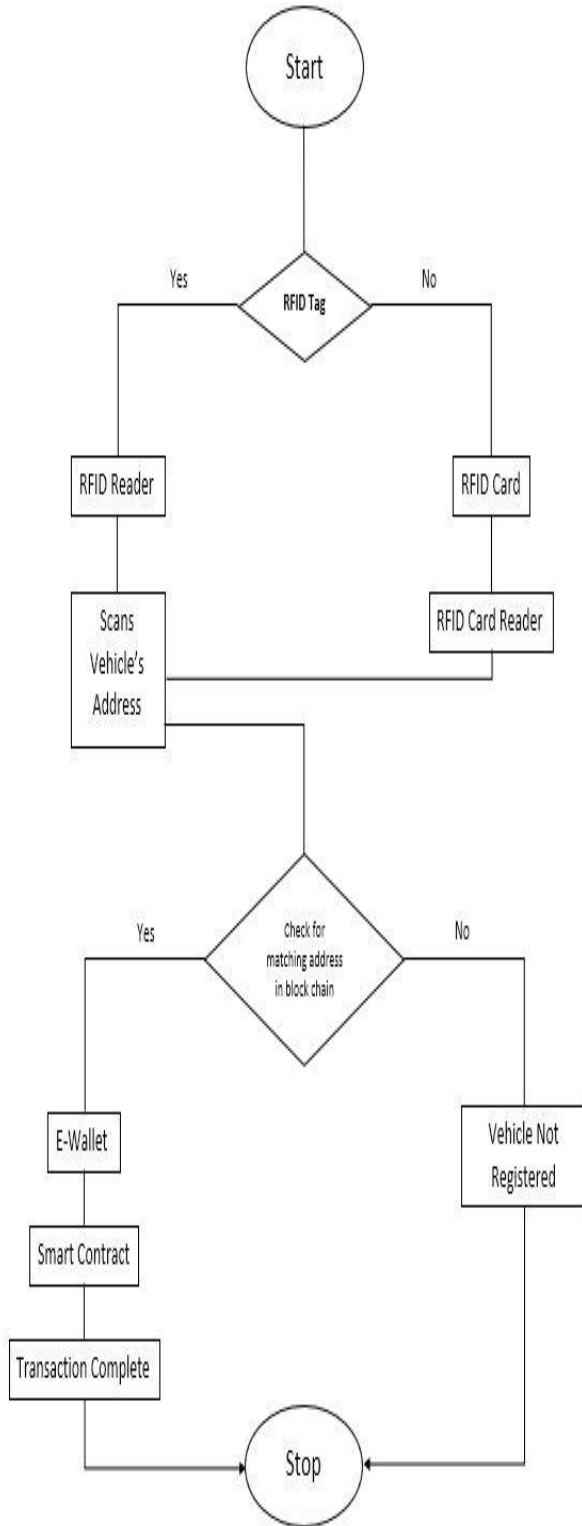
D. SMART CONTRACT

A smart contract is an agreement actualized, deployed and executed inside Ethereum environment. Smart contracts are digitization of the legitimate contracts. Smart contracts are sent, recorded and executed inside the Ethereum Virtual machine. They store information. The information stored can be utilized to record data, facts, affiliations, transactions, balances and some other data expected to actualize rationale for genuine contracts. Smart contracts are fundamentally the same as Object situated classes. One smart contract can call another smart contract simply like an Object-oriented object to make and utilize objects of another class.

E. CRYPTOCURRENCY E-WALLET

The "Cryptocurrency E-Wallet" is basically an electronic wallet with a Wallet Address based on a so-called "smart contract". The owner of the vehicle can add credit to this wallet with cryptocurrencies such as Ether. Physically, i.e. on the hardware side, the "Cryptocurrency E-Wallet" consists of mobile Ethan BIoT© Computer with an in-built cellular 4G modem for mobile communication, a Near Field Communication Reader which authenticates a truck driver's identity and validates his driving license and a special RFID Tag for reading and identifying the Wallet Address by the automated toll system.

V. FLOW DIAGRAM



VI. MODULES

The modules implemented in this paper are as follows:

- A. RFID Tag Reader
- B. RFID Card Reader
- C. Blockchain Based Toll Payment

A. RFID TAG READER: The RFID reader is a Radio frequency device . It reads the data from the passive RFID tag placed in the vehicle and converts the data into digital format. This data can be read using the Microcontroller program and sent to the PC. An RFID tag is a microchip with an antenna in a compact package; the packaging is structured to allow the RFID tag to be attached to an object to be tracked. If in case the RFID tag has been lost the process moves on to RFID card reader.

B. RFID CARD READER: RFID card reader is a device that is placed in the tollgate. The driver can swipe the RFID prepaid card to pass the tollgate. RFID transponders are present in smart cards and RFID tags. It is a special kind of radio transmitter and receiver and gets activated when it receives a signal.

C. BLOCKCHAIN BASED TOLLING: Blockchain based tolling ensures security and stability for toll agencies as it uses Hyperledger Fabric for toll operations. The system is also known as a permissioned blockchain network which offers the agencies to interact with the other directly. It uses smart contracts to design and inculcate rules digitally. Road tolling systems, tend to exist more in isolation than with interoperation. In this paper, blockchain becomes the common or shared point for interoperability. Blockchain helps primarily in four different ways :

1. Trust—Blockchain helps in making applications that are decentralized and collectively claimed by numerous individuals. Nobody can change or erase past transactions. Regardless of whether somebody endeavors to do as such, it won't be acknowledged by other stakeholders.
2. Autonomy—There is no single owner for Blockchain based applications. Nobody controls the blockchain, yet everybody plays a part in its activities. This aides in making arrangements that can't be controlled or instigate defilement.
3. Integrity—The past and current transactions are secured using various cryptographic algorithms and cannot be tampered with easily.
4. Intermediaries— Generally, there is a central body for Vehicle registration, license issuing etc who acts as registrar for registering vehicles as well as issuing driver licenses. Blockchain based applications can help remove these intermediaries.

Assuming a country uses RFID devices for road toll. The way it works is:

All vehicles will have a RFID device installed when the vehicle is first purchased. The RFID ID is linked to a car plate in the regulator's central database. Driver tops up a cash card and inserts the card into the device when driving. When the vehicle passes the toll, the card value is automatically deducted based on some business rules decided by the Toll. If the card does not have enough credit when passing the toll, the vehicle owner will be penalized. Driver is usually not aware of actual toll charges as regulation keeps changing. Topping up cash card can be troublesome. Cash card can be misplaced or stolen. Driver does not know if toll is charging correctly. Driver has to trust the regulator as there is currently no way for the driver to access his own toll ledger.



The solution to this would be: A permission less blockchain to track all transactions for all vehicles passing through the toll. Driver deposits credit to his own account inside a smart contract. Once the vehicle passes the toll, driver's account is automatically debited inside the contract. It works very much like the cash card but without the card and cannot be stolen. The smart contract allows user to check any toll fee at any point in time. The smart contract can also allow users to pre-book a journey early. Driver pays a small fee and locks in the date/time of travel. This will allow better traffic distribution throughout the day.

An Example

A new car is manufactured. The regulator registers the car in the Smart Toll Contract. Let's say the car is given a unique vehicle address called 1xNUHSUSH. This address is embedded into the rfid device of the truck. Together with this address, details of the truck such as manufactured date, type, model...etc is stored in an off-chain system. Alex bought the car and is now the owner of the new car. His sensitive details such as name, date of birth, license number, contact number and address is kept off-chain. The regulator creates a new account address in the blockchain and associates it to the off-chain account. Let's say Alex's unique on-chain account address is 1xALEX. In the smart contract, the regulator associates 1xALEX to be the rightful owner of vehicle 1xNUHSUSH. Alex tops up his account in the blockchain. Alex starts driving. When the car passes through the toll, his account "1xALEX" is auto debited. All this is done in a cryptocurrency E-Wallet.

With this Cryptocurrency E-Wallet the following is possible: The Wallet can pay autonomously for services such as toll fees. The Cryptocurrency E-Wallet captures important data such as the truck driver's "driving time and rest periods" and stores this data into the blockchain via smart contract. The Cryptocurrency E-Wallet keeps track of the validity of the truck driver's driving license by way of his Blockchain Identity Card. If the Cryptocurrency E-Wallet runs out of money while the truck is on the highway, the driver gets a notification to recharge the wallet.

But why should a vehicle need to have a "Cryptocurrency E-Wallet"?

Currently, logistics companies need to manage a great deal of pointless regulatory guidelines and procedures which are a waste of time, money and resources. If a vehicle is fitted with a Cryptocurrency E-Wallet, the whole payment and validation process for toll fees and the like becomes streamlined, more efficient and comes at less of a cost. To keep track of and capture the important data of a truck driver's "driving time and rest periods", which is required by the regulations and laws of government and which ensures road safety, is a complicated and complex undertaking for both drivers and logistics companies; they also have to keep this data up to date and safe from tampering, human error or otherwise. From one viewpoint, the "Cryptocurrency E-Wallet" goes about as the central innovation for giving the vehicle a chance to perform explicit tasks, for example, the programmed, self-governing installment of toll expenses, and then again to capture crucial information, for example, "driving time and rest periods" and to store it into the blockchain.

VII. RESULT ANALYSIS

The tollgate operation was done using the following lines of code.

```
#include <SPI.h>

#include <deprecated.h>

#include <MFRC522.h>

#include <MFRC522Debug.h>

#include <MFRC522Extended.h>

#include <MFRC522Hack.h>

#include <require_cpp11.h>

#include <Servo.h>

#define SS_PIN 2 //D4

#define RST_PIN 0 //D3

MFRC522 mfrc522(SS_PIN, RST_PIN); // Create MFRC522 instance.

Servo servo;

const int button = 16;

int temp = 0;

void setup() {

  Serial.begin(9600);

  pinMode(button, INPUT);

  SPI.begin();

  mfrc522.PCD_Init(); // Initiate MFRC522

  mfrc522.PCD_SetAntennaGain(mfrc522.RxGain_max);

  servo.attach(4); //D2

  servo.write(0);

  delay(1000);

}

void loop() {

  if(!mfrc522.PICC_IsNewCardPresent())

  {
```

```

delay(50);

servo.write(0);

delay(1000);

Serial.println(" Pay to Open Toll ");

return;
}

if ( ! mfrc522.PICC_ReadCardSerial() ) {

delay(50);

servo.write(0);

delay(1000);

Serial.println(" Pay to Open Toll ");

return;
}

mfrc522.PICC_HaltA();

servo.write(90);

Serial.println(" Toll Opened Proceed ");

delay(3000);

/*temp = mfrc522.PICC_IsNewCardPresent();

Serial.print("in loop");

if (temp == true) {

servo.write(90);

Serial.println(" Toll Opened Proceed ");

delay(20000);
}

else {

servo.write(0);

delay(1000);

Serial.println(" Pay to Open Toll ");
} */
}

```

VIII. CONCLUSION

In this paper, solutions to the Blockchain based toll collection system and vehicle theft system have been designed. This system is capable of eliminating congestion in toll plazas, especially during those seasons when traffic seems to be higher than normal. In addition we are not only helping the vehicle owners and system administrators, the police department is also benefitted as vehicle theft detection and tracking of over speeding vehicles are done with ease. This is a permissioned, blockchain network which: enables agencies to communicate with each other; eliminates the need for the more common, and current, hub-based interoperability model and most importantly, is secure. It not only improves the technology level, but also the passage ability of expressway.

IX. FUTURE WORKS

A. To Incorporate parking and fuel facilities: With the help of E-Wallets, the vehicle could simply pay small amounts of fuel and parking charges. Credit is exchanged directly between the seller and the buyer without the help of intermediaries such as banks or credit card companies. The payment is made immediately and it does not take an amount of days or even weeks for the money to appear on the account.

B. To Incorporate accidental benefits: Incorporation of benefits like the reduction in incidents at the toll plaza due to the ETC implementation would give a more comprehensive benefit model.

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