Vehicle Registration and Information Management using Blockchain based Distributed Ledger from Bangladesh Perspective

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***Abstract*—Blockchain (BC) technology has gathered tremendous attention to the academia and industry due to its transparency and security by design without involving the third party. Academia and industry have adapted Blockchain with the future smart network, and they have been utilizing it in several application areas, including crypto-currency, IoT, supply chain management, smart contracts, and other major distributed applications. Alongside the growth of the BC, researchers have recognized distributed ledger as a potential for information management across the shareable platforms. However, most of the organizations still use centralized management systems that are slower and risks-associated. Therefore, to address this issue, we propose a BC-based distributed ledger framework that is capable of maintaining a vehicle registration and information management system across platforms. Our proposed framework addresses the issues in the traditional paper-based management system and ensures the process to be faster and more transparent without the direct involvement of a third party. As the Government must have the supervision capability, we introduce the system with a hybrid architecture that not only makes the user experience better but also transparent at the same time.**

***Index Terms*—Blockchain, Vehicle Registration, Distributed Ledger, Vehicle History Authentication**

I. Introduction

Motor vehicles are required to be registered to establish and maintain a record of the corresponding owner and usually tracked by the *Road Transport Authority* (RTA) in Bangladesh. Usually, there are a number of RTA branches across the country, and the government provides services for vehicle registration by filling out a typical form with identification information required from the owner. The information is used for vehicle authentication, ownership verification, and while changing the ownership. However, the current motor vehicle registration process, the *Bangladesh Road Transport Authority* (BRTA) stores all the registration-related information of a motor vehicle in a central database. Centralized systems have severe security issues, and with the growth of cyber-attacks around the world, single-point failure of a compromised system can lead to a tremendous loss. Besides, the registration takes a long time with a human-involved record entry process and attracts corrupted third parties (e.g., brokers) to intervene.

Blockchain-based distributed ledgers feature decentralization, immutability, and transparency of data and leverage enhanced security. BC has been widely used for diverse technological system deployment in recent years to enforce and enhance through decentralization. Therefore, in this work, we propose a BC-based vehicle registration and information management system that automates the registration process and keep tracks of the ownership information with transparency. The proposed BC system helps to address several issues of the current or traditional paper-based approach of motor vehicle registration, such as delay in processing, lengthy verification process, and no visible transparency. Figure 1 presents the block diagram of our proposed system.

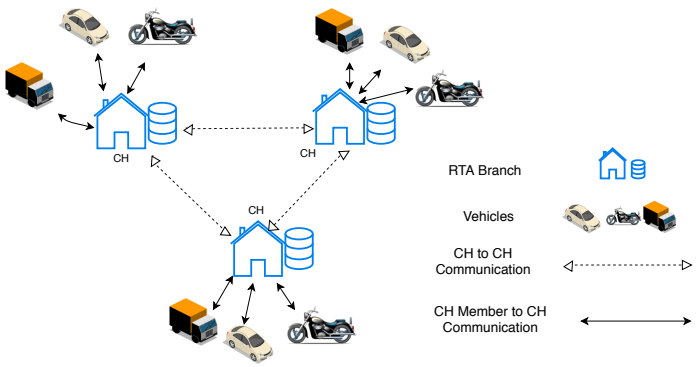

Fig. 1: Proposed BC-based Vehicle Info. Management

Here, we answer the following research questions:

Q1. What are the required data fields to manage a vehicle registration and information management system?

Q2. What is the impact of BC-based distributed ledger in terms of managing vehicle registration?

We answer the first question by providing the list of required data to manage the vehicle registration and information management system (Section II). Regardless of the varieties of data required by authorities, here, we have included and list the most common data fields required by a system.

We answer the second question by differentiating traditional paper-based scenario and our proposed BC-enabled data management scenario (Section III, Section IV). Here, we provide insights into the registration process, authentication, and verification without requiring the manpower involvement. Besides, the autonomous behavior of the framework establishes better performance by providing quick services.

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Paper Organization: The rest of the paper is organized as follows: Section II discusses the vehicle information management process in terms of the required data fields for a conventional vehicle information management system. Then Section III discusses our proposed framework of the information management system. Section IV presents the scenarios of our deployed application. Finally, Section V discusses a few related works followed by a discussion and conclusion.

II. Vehicle Information Management Process

In this section, first we discuss the required information for vehicle registration process. Then we discuss traditional paper-based workflow and how Blockchain can outperform previous management systems.

A. Vehicle Registration

Vehicle registration requires several documents, including the proof of ownership, change of ownership, previous histories, and owner's information. Therefore, in the process of motor vehicle registration, the *road transport authority* (RTA) requires the vehicle owner to submit several documents mentioning required data records. Then RTA verifies the information and documents for further inputs before it is finally recorded as an entry in the government database.

1) Personal Information: RTA requires different information from the vehicle owner, such as the name of the owner, father/husband's name, address, sex, phone/mobile number, nationality, guardian's name, and Date of birth.

2) Vehicle Price: Every motor vehicle has a particular price. While registering the motor vehicle through RTA, vehicle owner is required to provide the price of that particular vehicle. As proof, an invoice is required to be submitted by the new owner of the vehicle.

3) Color(cabin/body): As a part of the process of vehicle registration, the new owner is bound to provide the visual aspect (color) of that vehicle. Details are important for different parts of the vehicle, for example, the color of the cabin and the body of that particular vehicle.

4) Judicial and Non-Judicial Stamp: The RTA requires judicial and non-judicial Stamp throughout the registration process. In case of changing, ownership buyers must provide non-judicial Stamp with pictures and additional proof of the owner's affidavit.

5) Tax: Every registered motor vehicle have to pay a certain amount of tax to RTA per year. The rate of the tax depends on the type of the motor vehicles. Not only types but also size,weight,seat number,etc.

6) Insurance Information: In vehicle registration process RTA required some information about insurance. Such as: Policy number, Type of policy, Insurers name and address, Date of expiry, etc. ,

7) Signature: Throughout the process, RTA requires several specimen signature. Signature is required in almost all documents, e.g., new registration, changing ownership.

B. Traditional Paper based Process

In a traditional paper-based system, an owner needs to download the registration form from the RTA website or RTA office. After collecting the registration form, an applicant needs to download the application(changing ownership) form from the RTA website or RTA office. After providing the required information on a particular form, the applicant needs to provide mandatory documents required by the RTA. Then RTA verifies the applicant's form and provided documents. If everything is OK, then the RTA accepts the request.

In this modern era, it is one kind of inconvenience for the vehicle owner to collect the form, fill it up, and submit thereby. Besides, in the traditional paper-based system, there is a lot of scope of corruption and other unauthentic processes.

C. BlockChain and It's Impact

Blockchain(BC) is a distributed ledger technology that has brought an enormous revolution in modern technology in recent years. In this process, BC works with blocks. In BC, a block is nothing but a collection of data. Different fields of data being added to a single block, connecting one after another in chronological order, ensure the authenticity and immutability of data. The very initial/first block in the BC is known as Genesis Block.

A distributed ledger in BC refers to a ledger that is shared across the network among all peers/blocks in the network, and each peer/block holds a copy of the complete ledger of that BC. A simple BC-based data structure or ledger is presented in Figure 2.

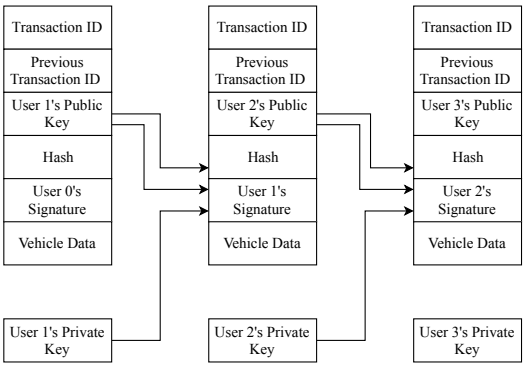

Fig. 2: Example Transaction Block

BC has some key attributes [1] that proves that Blockchain is better than traditional systems. These attributes have some key benefits[2]. Key attributes of BC e.g., *peer-to-peer* communication, *distributed* nature, *cryptographically* secured, *immutability*, and *consensus* are crucial for the RTA to solve the issues of traditional paper based system and can ensure a smart Vehicle information management system.

III. Vehicle Registration Management using BlockChain

In our proposed system architecture, each RTA branch will be considered as a node in the chain. They will be considered

as Cluster Head(CH). And every vehicle will be considered as block under any RTA branch(CH). BC among the RTA's will be consortium BC and managed by all the RTA's. Our proposed System architecture shown in Figure 3. And the flowchart of our proposed system shown in Figure 4.

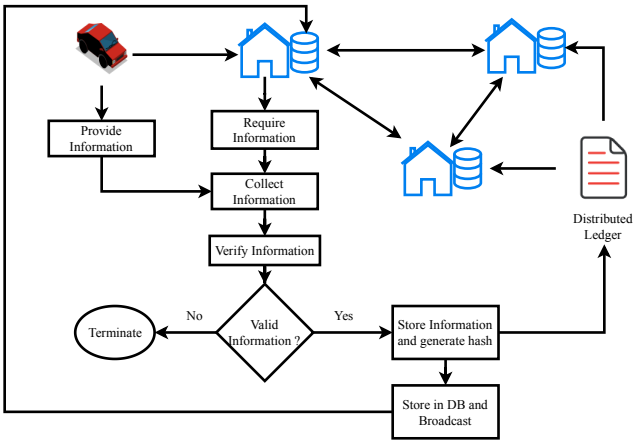

Fig. 3: System Architecture

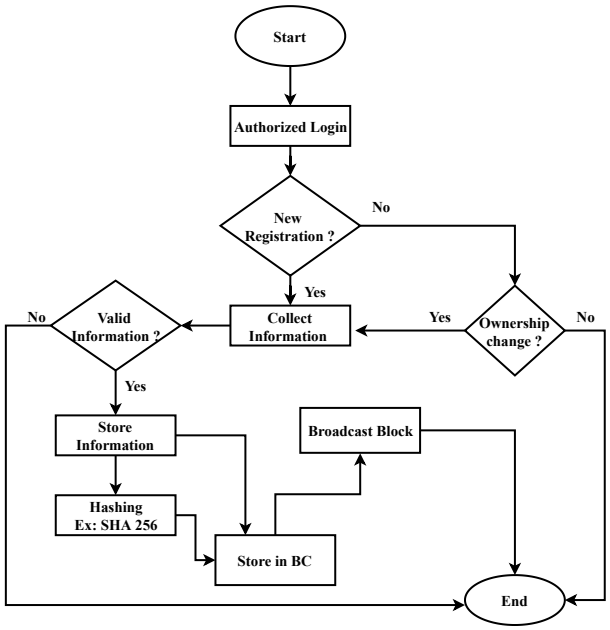

Fig. 4: Proposed Flowchart for Vehicle Registration

A. System Components

Throughout the whole process, our proposed system requires an interactive web application, user inputs, a BC-based distributed ledger, and smart contracts.

1) Interactive Web Application: An interactive web application consists of two operation module: one for the vehicle registration process, another one is for ownership verification.

a) Vehicle Registration Module: With the help of this module, the user can request the registration process. In the provided form, the vehicle owner needs to submit mandatory information discussed in section II.

b) Ownership Verification Module: This module is for vehicle ownership verification and requires user proof.

2) BC based Distributed Ledger: BC-based distributed ledger helps to store and distribute the data among other blocks in the chain. It uses every individual node in BC to store, share, and synchronize every transaction in their respective electronic ledgers (instead of keeping data centralized as in a traditional ledger). Blockchain stores data into several blocks, which are chained together in an append-only mode.

3) Smart Contracts: Smart Contracts are added more values in Blockchain Technology. It is nothing but a piece of code that exists in the network of BC. And it automatically executes when the predetermined terms and conditions match. With the help of smart contracts, BCT can achieve some benefits such as speed and accuracy, trust, security, and Savings.

4) Blocks of Data: An example of data block is shown in Figure 5. Every block in BCT holds data for some attributes such as hash, previous block hash, Merkle root, no. of transactions, timestamp, nonce, height, size, meta data, etc.

Hashes	
Hash	00006908400d0c122e4403b7b0d8a06e91a124b3e6266313c5f33d39fac8ecb6
Prev. Block	0000c3ea3bf2bc0fffee0ddcf4c51a3f2da2d0d7a0eb40408187de80cb849696
Merkle Root	600d183101769875b2107ffc24ef289b33c9e3c056181e21813f6cd7b1b9e252

Summary	
Number of Transaction	173
Timestamp	2019-08-02 17:27:53
Height	16
Size	1
Nonce	94689

Fig. 5: An Example Block

B. System Processes

When the owner of a motor vehicle wants to register his/her vehicle in RTA, they have to follow the steps :

1) User Authentication: Verifying the user authenticity is important when it requires the human-to-machine transfer of credentials, which is the first step of the registration process in our system architecture. As we all know, in case of security purposes, user authentication is one of the important issues.

2) Registration Request: The user sends request to the RTA and needs to provide details required by the process.

3) Information Verification: The RTA branch verifies the information provided by the user.

4) Hashing: Once the information provided by the user is verified, it is converted to a generated unique hash using the *SHA-256* algorithm.

5) Store and Broadcast: After completing the verification and hashing process, a new block is generated, and related data is stored in the database. Now, the new block is broadcasted to the network and is shared among the peers.

IV. Implementation

We implement a simple distributed ledger that contains the chain of blocks keeping records of a paper form. We use a *REST API* for communication with our system that uses HTTP requests (GET, POST, PUT, PATCH) to obtain, and update our blocks. Here is a simple JSON containing an example block while we request block information using a GET request.

```
\resizebox{.45\textwidth}{!}{
{"nonce": 94689,
"hash": "00006908400d0c122e4403b7b0d8a06e91a
    124b3e6266313c5f33d39fac8ecb6",
"previousHash": "0000c3ea3bf2bc0fffee0ddcf4c
    51a3f2da2d0d7a0eb40408187de80cb849696",
"version": "JSEcoin Server v1.1",
"startTime": 1501529567202,
"size": 1,
"server": "192.168.1.1",
"block": 1,
"data": "[{
\"first_name\":\"Jon\",
\"last_name\":\"Doe\",
\"father\":\"Mr. Doe Sr.\",
\"addr_line_1\":\"6011 riverside st.\",
\"addr_line_2\":\"Riverside, Dhaka\",
\"nationality\":\"Bangladeshi\",
\"sex\":\"Male\",
\"date_of_birth\":\"21/09/1990\",
\"mobile\":\"+8801111111111\",
\"email\":\"test@test.com\",
}]"}}
```

Here, we present a comparison between existing system and our proposed system in Table I.

TABLE I: Comparison between existing and proposed system

Category	Existing Systems	BC-based System
Data Management	Paper-based alongside Online central Database	Distributed ledger
Data Security	Requires strong measurements	Secure by design
Processing Speed	At least 7-30 business days	Within a day
Verification	Weak	Strong
Transparency	No visible transparency	Transparent by design
Automation	Requires manpower for processing and verification	Almost completely automated

V. Related Work

BC-based distributed ledgers can contribute to better service provision and several applications have been deployed to-date. Here, we discuss a few of these works.

Sharma et al. have proposed an architecture for vehicle network based on blockchain technology in the smart city [3]. They have been considering a new network system of vehicles, Block-VN, above them. In addition, They have test how the network of vehicles evolves with paradigms focused on networking and vehicular information.

Alexopoulos et al. provides a thorough analysis of e-Government pilot applications of Blockchain Technology (BCT) in a European level [4]. Also discusses the key benefits and main barriers coming from the application of this technology in different domains with BCT experts.

McGhin et al. have surveyed some applications include smart contracts, fraud detection, and identity verifications and addressed vulnerabilities of Blockchain technology [5].

Saberi et al. have examined blockchain technology and smart contracts are critically with potential application to supply chain management [6]. They have also proposed future research propositions and directions that can provide insights into overcoming barriers and adoption of Blockchain technology for supply chain management.

So far we see, researchers and developers across academia, industry, and Government have utilized the features of BC in modern applications and management systems. Therefore, we understand the open opportunities of BC-based applications in Govt. service sectors.

VI. Discussion and Conclusion

Our proposed architecture of the vehicle registration, and information management system using a distributed ledger can solve the problems of the traditional lacking and shortcomings of the traditional paper-based system. Table I validates our claim of deploying a BC-based system that ensures smart and secure information management without involving lots of slower working procedures. In this work, we provide the base framework with simple implementation. However, in future, we aim to employ Ethereum-based smart contracts to manage all procedures including driver's license information management. Blockchain-based distributed ledgers continue to attract Governments to deploy smart applications and information management systems towards it's citizens and we validate the factor with this vehicular information management system.

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