A Proposed Mobile Voting Framework Utilizing Blockchain Technology and Multi-Factor Authentication

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Abstract-
Voting is fundamental to any consensus-based society and is one of the most critical functions of democracy. Mobile voting (m-voting) was utilized as a means for voters to easily and conveniently cast their votes using their mobile devices which have been the most adopted means of communication but has a major problem which is safely securing the casted votes and avoiding any form of tampering. In this paper, we propose an m-voting framework that utilizes blockchain technology to securely store the casted votes and multi-factor authentication to authenticate the voters before they cast their votes while also providing an easily accessible, secure and transparent m-voting system.

Key words: Blockchain, M-Voting, Mobile Devices, Multi-factor Authentication, Voting

1. Introduction

Voting is a significant process in different countries around the world and is fundamental to any consensus-based society [1]. History has shown that most elections were manipulated in order to influence the outcomes and results were announced without any voting process taking place which has been credited to a poor and terrible electoral system [2]. To overcome this, M-voting (mobile voting) was introduced as a fitting method to make casting a ballot more convenient and promises to increase the citizen's engagement in elections while also improving the exactness of the results and bringing down the expenses of running elections [3]. Mobile voting (m-voting) can be defined as a mobile application which is secured that eases the voting procedure for voters since they just require an internet-connected mobile device to take part in the electoral procedure [4]. Mobile devices have been the most utilized means of communication in developing and developed countries with over two billion users worldwide and its penetration outshining other electronic devices [5]. Thus, it can be considered a good candidate for the voting platform the world over and are been applied in different areas/fields like banking, e-health, engineering, agriculture, etc. [6].

One of the most problematic phases in m-voting is the managing of the votes which is the process of ensuring that casted votes cannot be altered or tampered with while also ensuring transparency in order to provide assurance not only to the citizens but the Election Management Body (EMB) as well [7]. A centralized database was utilized to store the votes but is susceptible to DDoS attacks and since its being managed by an administrator, the stored votes could be changed by the admin or by a malicious insider [8]. Blockchain technology which is a distributed ledger that manages an ever-increasing list of records protected from any form of revision or tampering was proposed as a means to mitigate these issues. It is de-centralized so as to avoid a single point of failure with the group working together to confirm legitimate new transactions [9]. The blockchain serves as a public ledger of transactions which cannot be reversed. Deleting or changing data in a blockchain is computationally improbable [10]. Since mobile devices don't have enough resources to be a miner/node on the blockchain network, another means was needed for mobile devices to be able to send their transaction or votes to the blockchain pool to be stored. In order for

their transactions to be sent, they have to be eligible to do so and one of the means of verifying their eligibility is through the use of authentication [11], [12]. Authentication is the process of proving who you claim to be which usually requires a mechanism for identification that can verify one's identity prior to granting them access and some of this includes PIN, Password, Smart Card, Security Tokens, etc. [13]. One major issue noted was that previous m-voting techniques made use of a centralized database that tends to be susceptible to DDoS attacks and tampering by a malicious insider or the admins themselves. Blockchain technology was proposed as a means to mitigate this issue but was being used with the concept of bitcoin in mind which was a lot more tasking on the mobile devices due to the fact that they do not have enough computing resources to support it and would also require a very powerful system(s) to run the nodes of the blockchain.

In order to combat this, cloud computing was introduced which offers beneficial services [14]. One such service is Blockchain as a Service (BaaS) which enabled clients to create, host and utilize their own blockchain applications on the cloud-based infrastructure while the cloud service provider deals with all the essential undertakings to keep the infrastructure active and operational [15]. The use of these resources would seem very expensive but cloud computing offers a PAY-AS-YOU-GO or pay-as-you-use which is a payment method that charges dependent on utilization, diminishing the expense of setting up the blockchain infrastructure. A blockchain database makes use of blockchain technology to build a permanent record that could contain any data such as time/date, ownership, and transaction details which are permanently stored in the record [16]. Blockchains can be utilized to record anything of considerable importance such as deeds, marriage licenses, birth and death certificates, votes, titles of ownership, etc. [17]. A blockchain database ostensibly is similar to a centralized database but it is completely decentralized. It can store data that can be added to or accessed by anybody with the approval to do so and the data on the chain can't be hacked or adjusted as the different nodes in the blockchain network involved with the database will oppose any unapproved changes [18].

In this paper, we propose our mobile voting framework that utilizes blockchain technology and multi-factor authentication to provide an easily accessible, secure and transparent m-voting system. We organize the rest of the paper as follows. Related work is discussed in Section 2. In Section 3, we present the Methodology while Section 4 provides a brief discussion and Section 5 concludes the paper.

2. Related Work

[19] proposed the use of mobile phones be utilized by the citizens to efficiently, securely and easily partake in the voting process. They noted that mobile devices being utilized in the voting process cannot only save time but cost as well and could be used as a secure method for casting their ballots or votes. In a study by [20], a mobile voting application was designed that enables voter's to easily cast their vote using their mobile devices. The voter would download the application and cast their votes which would be stored on a centralized database. This meant that the votes were being managed by an administrator and the stored votes could be changed by a malicious insider or the admin. Since it is a centralized database, it is susceptible to DDoS attacks. [21] also noted the same problem in their proposed mobile voting system which also made use of a centralized database to store the vote. [9] stated that blockchain serves as a public ledger of transactions which cannot be reversed and can be used to store the casted votes but the cost in setting up powerful nodes for the distributed blockchain system was too high. A novel electronic voting system based on blockchain was proposed by [9] that aimed to improves security while also reducing the expense of carrying out an election. Their proposed system would require a powerful dedicated system situated at each polling unit meaning that voters still have to queue to cast their votes and the cost of implementing this would be high.

An Auditable Blockchain Voting System (ABVS) was designed by [9] which would enable easy audit and verification of the voting process using distributed blockchain technology. They also noted that powerful systems would have to be implemented at the voting polls which meant that citizens would still need to leave their homes or places of residence to cast their votes while also consume a lot of electrical energy increasing the setup cost compared to a paper-based voting system. [22] noted that voting is significant and it's still being engaged in by physically going to voting booths which is susceptible to tampering and does not guarantee security. They developed an online voting application using Ethereum blockchain to combat these issues, however, a voter would need a pretty powerful system to partake in the voting process and sometime their system could be utilized as a node to aid in the mining process. Each of the research work introduced different means to provide an easily accessible and secured m-voting system with or without the utilization of blockchain technology.

3. Methodology

In this study, we propose the use of blockchain technology as a database used to securely store casted votes while preventing any form of tampering and multi-factor authentication to verify the eligibility while granting the voters permission/access to cast their votes. A framework would also be proposed which would enable eligible voters to easily and securely cast their votes using their mobile devices from any location while also increasing voters trust towards the voting process and offer better transparency during the voting process.

3.1 Existing Framework

The adapted framework is by [23] titled "Model of the proposed service-oriented mobile e-voting framework". Their framework depicts a multilingual mobile e-voting service infrastructure for developing countries using major tribes in Nigeria-Yoruba, Igbo and Hausa. Their framework shows the processes carried out during the pre-election, election and post-election phases and this enables voters to cast their votes using mobile devices while also utilizing a database and a means to audit or tally the votes. An image of the existing framework is presented in figure 1.

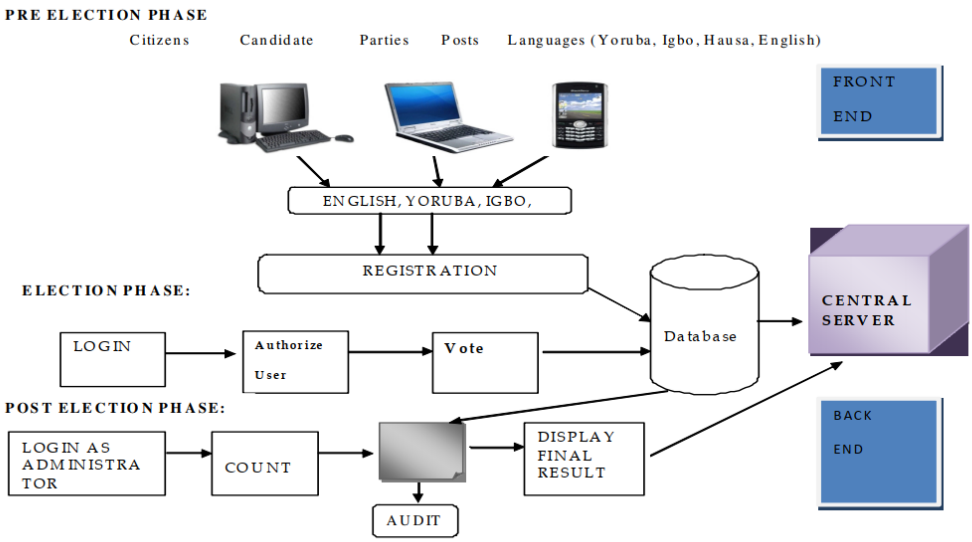

Figure 1: Adapted Framework [23]

3.2 Improved/Proposed Framework

The proposed framework is adapted from [23]. Their proposed framework made use of a centralized server that houses the database which makes it be a simple point of failure that

could bring down the whole system. The proposed model utilized the three (3) phases from the adapted framework by [23] and utilize a database that held ever voter's identification number (VIN) alongside their phone number and other important data. The proposed system made use of a distributed blockchain database instead of a single centralized database and also made use of multi-factor authentication to verify the voters which include their voter's identification number (VIN), PIN and one-time password (OTP). The proposed framework is presented in Figure 2.

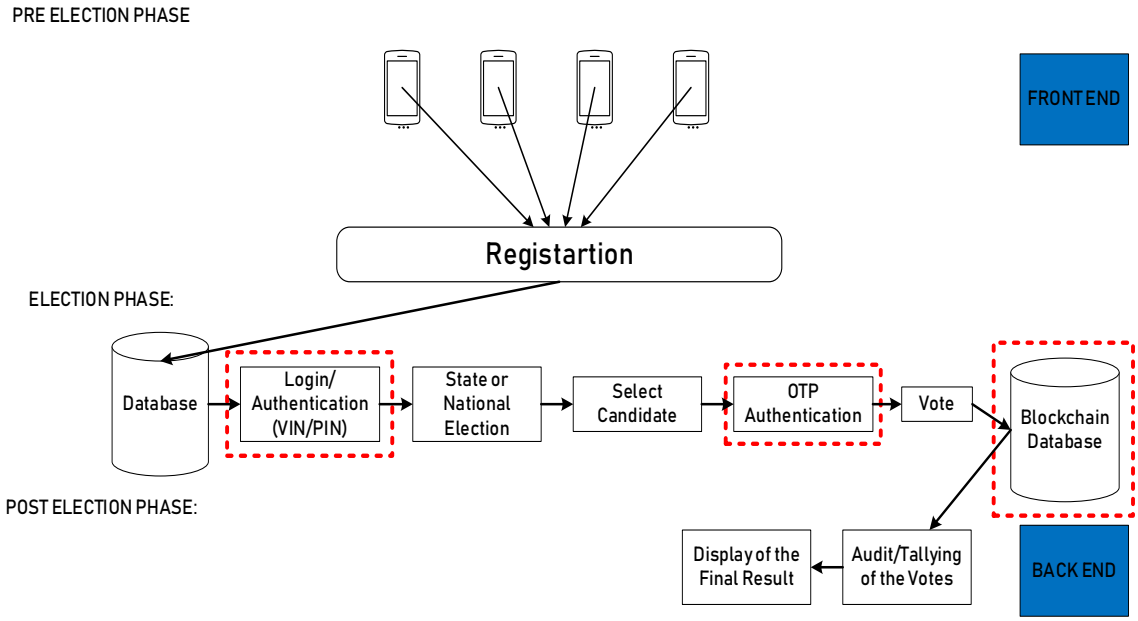

Figure 2: Improved Framework

The proposed framework as seen in Figure 2 is divided into two (2) layers which are the front end and back end that was also adapted.

1. **Front End Layer:** This layer is categorized into two (2) phases which are the pre-election phase (can be utilized by the voters to register themselves and is stored in the voter's database) and the election phase (voters using their mobile devices can cast their votes).
2. **Back End Layer:** This layer deals with the blockchain database that can be viewed and monitored by the EMBs which is carried out at the post-election phase. Here, the casted votes are stored in the blockchain distributed database and once the election phase is over, the votes would be tallied and the final result would also be presented or shown.

This proposed framework would provide a tool for increasing the overall efficiency of the electoral process advancing democracy, adding credibility to election results, and building trust in electoral management. It would achieve all of this using a three (3) stage process which is explained in Figure 3 below.

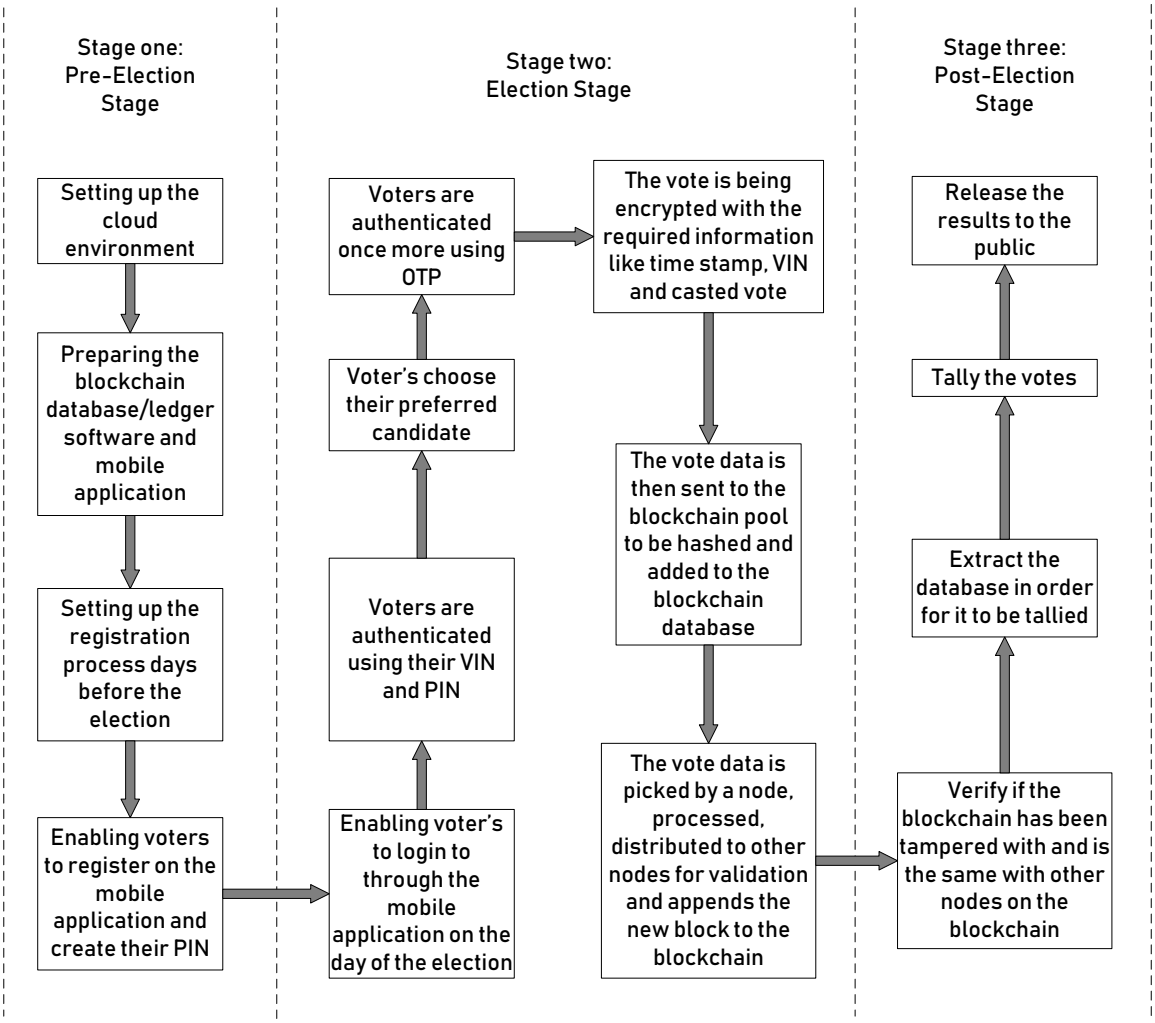

Figure 3: Schema of the proposed framework

4. Results and discussion

This study presents a mobile voting framework that utilized both blockchain technology and multifactor authentication to provide an easily accessible voting system while also securely protecting the casted votes and verifying the voter's eligibility to cast their votes. The implementation of this proposed framework can offer multiple benefits in the electoral sector and some of these benefits are:

- A polling station doesn't need to be set up due to the fact that the voters can make use of their mobile device to partake in the voting procedure which helps to reduce the high cost that is required in setting up polling stations.
- On the day of the election, eligible voters would be given access to cast their votes between a period of time and thanks to this, the government won't experience any losses since they did not declare a public holiday or the day wasn't called off.
- Voters are not required to leave their homes or palace of work in order to cast their votes.
- Multiple means of authentications would be utilized in order to enable the eligible voters to cast their voters and prevent illegible voters from casting theirs.
- Problems associated with the double casting of votes can be mitigated.

- This could also provide easier accessibility of the voting procedure to multiple individuals including the elderlies and those with disabilities.
- The casted votes would be safely and securely stored in the blockchain database which would mitigate any form of manipulation or tampering like the deletion of legitimate votes or the addition of illegitimate votes.
- The casting of votes and tallying of the votes would be a lot quicker while also providing better transparency and accuracy.
- There will be a progressive increment in the number of youths taking part in the voting procedure.

This study presents a new case study report of the application of an m-voting system which utilizes blockchain technology and multi-factor authentication that adds to the existing body of knowledge in the voting sector.

5. Conclusion

In conclusion, the harmonization of mobile devices, blockchain technology, and multi-factor authentication can greatly enhance and simplify the voting process in Nigeria while also providing better transparency that can regain voters trust and also increase voter's turnouts during elections.

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