DESIGN AND SIMULATION OF REAL-TIME SHORT MESSAGE SERVICE-BASED VOTING SYSTEM

Abstract

Voting is an important aspect of the democratic process in which the electorates select those that will represent them at all levels of government as well as in organizations using various technologies. The efficiency, reliability and security of the technologies involved in such a voting system become of paramount importance. In the bid to curb all the anomalies involved in the traditional voting systems, the design and simulation of a real-time Short Message Service-based voting system in Nigeria was developed. This was achieved by first carrying out a comprehensive review of the already existing e-voting systems to ascertain any limitations associated with them. Inefficiency in preventing electoral fraud and keeping the electorate informed of the real-time results of the ongoing election as well as the result immediately after the election is over were the major drawbacks identified with the existing systems. These were attributed to its architectural design and security algorithm making them unreliable. The inclusion of a real-time Short Message Service in the already existing architecture among others is therefore proposed as a solution to the identified drawbacks. The proposed system was implemented using Hypertext Preprocessor (PHP), Hypertext Markup Language (HTML), Structured Query Language (SQL), SMS enabler, Android studio and Apache Web server technologies. The result showed that the SMS features, security, as well as intelligence incorporated in this work, had zero impact on the success rate of the system. There was an increase in the latency of the existing system by 16.8%, though still has a tolerance of 30.5% to reach saturation point while preventing electoral fraud, since the maximum latency for successful vote casting is 60 seconds. This work confirmed that with this proposed e-voting system with a re-engineered architectural model, electoral fraud can be totally eradicated.

Keywords: Database, HTML, PHP, SMS, SQL

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I. INTRODUCTION

For democracy to survive, to be stable, and to grow, elections are essential. Therefore, the political development and democratic stability of a community are determined by its voting system [1]. The Independent National Electoral Commission (INEC), which was given authority to organize a free and fair election by the 1999 constitution, is the body responsible for organizing and overseeing elections in Nigeria. Nigeria has so far tried five different voting procedures. Open Ballot System (OBS), Modified Open Ballot System (MOBS), Re-modified Open-secret Ballot System (REMOBS), Continuous Accreditation and Voting System (CAVS), and Bimodal Voter Accreditation System (BVAS) are some of them.

The Open Ballot System, commonly known as Option A4, is a voting procedure in which voters publicly select their preferred candidate by standing in line or in another way [1]. These elections were place on June 12, 1993, and in 1979, 1983, and respectively [2]. A modified variant of the well-known open ballot system is known as the Modified Open Ballot System. The difference between the two is that although the open ballot reveals a voter's decision to everyone in the voting booth, the MOBS allows voters to cast a secret ballot. The general elections in 1999, 2003, and 2007 all used this strategy, correspondingly [2]. Additionally, the Re-modified Open-secret Ballot System (REMOBS) was used in the general elections of 2011 and 2015.According to this procedure, voter registration begins simultaneously across the nation, and voting follows registration across the federation [3].

The INEC Commission implemented the Continuous Accreditation and Voting System (CAVS) right after the 2015 general election. This approach enables simultaneous voting and accreditation. The smart card reader (SCR), voter identification using the voter register, and inking the cuticle of a particular fingernail are all parts of the accreditation procedure. Following accreditation, the voter is given a ballot paper to mark his or her choice privately inside the INEC-provided enclosed space, and in front of everyone else in the polling place, the voter places the ballot paper inside the ballot box. This technique was eventually implemented for the 2019 general election and was adopted for all elections held following the 2015 general election.

In the most recent times, INEC has introduced another technique into the e-voting system which is called the Bimodal Voter Accreditation System (BVAS). This procedure eliminates the use of a smart card reader for accreditation and manual searching of voter information from the voter register. In addition, it is used to upload the polling unit results to INEC result viewing portal (IReV) for all stakeholders to view the outcome of the election.

The electronic voter register (EVR), which was used to register potential voters in 2007, was implemented as part of INEC's modernisation plan for the nation's election process. In order to eliminate the majority of the issues related to previous elections and ensure free and fair elections in Nigeria, it involved the use of direct data capture machines (DDCMs) to electronically capture voter information. However, it has since been replaced by another device called the INEC voter enrollment device with an online registration portal in 2021. Although the introduction of the EVR reduced irregularities in the Nigerian voting process by eliminating duplicate names on the register. Research reveals that it was tainted by shoddy logistics and other abnormalities, nevertheless.

A voting method that uses electronic tools to support or assist with the casting and tallying of ballots is known as electronic voting, commonly referred to as e-voting. E-voting may employ standalone electronic voting machines (EVM) or computers linked to the Internet, depending on the specific implementation [3]. It could include a variety of Internet services, from simple results tabulation broadcast to fully functional online voting via widely available connectable home appliances [3]. The level of automation may only involve marking a paper ballot or it may involve a complex system that includes vote input, vote recording, data encryption and transport to servers, consolidation, and tabulation of election results. Most of these activities must be completed by an effective e-voting system, and it must also adhere to a set of regulations and standards.Many of these tasks must be completed by an effective e-voting system in accordance with a set of regulations, and it must be able to meet stringent requirements for security, accuracy, integrity, speed, privacy, audibility, accessibility, cost-effectiveness, scalability, and ecological sustainability.

The voting system must also provide adequate protection for voters, votes cast, and other election materials to reduce the likelihood of programming errors, software attacks, system hacks, fake voting sites, and the eventual submission of results that have been electronically altered as a result of computer viruses. Any electronic voting machine used in Nigeria must be capable of real-time transactional monitoring and transmission if it is to deliver credible and transparent elections. Election fraud will be less common if accreditation and results are transmitted quickly away after the vote, especially at collation centers [4].

In a study by [5], it was stated “that the use of mobile phones is a cost effective and secure voting medium through the use of short message service”. With the use of mobile phones at election it is glaring that the use of ballot papers, ballot boxes etc. will be eliminated and the number of manpower needed will drastically reduce thereby increasing cost efficiency. It is also secured as it has been stated by him in the sense that voters can now vote from their privacy without fear of being harassed.

Some of the benefits of SMS based voting system over traditional paper-based voting systems areaccess to democratic processes support, reduction in cost of electoral materials production, distribution and mobility, increase the likelihood of participation for mobile voting, tracks voting progress and collation of result in real time, access to more information regarding voting options, step by step processes help minimize the number of invalid votes, ease and speed,multi-languagesupport and the flexible design allows up-to-the-minute ballot modifications.

[6] claims that despite years of interest, the issue of electronic voting has not yet been fully resolved. Online voting systems include a security flaw that could allow for government fraud or other manipulations that are difficult for other voters to spot. To stop manipulations that could happen during the elections and with the outcomes, a double-layer security model was created and put to the test in their research. It was made sure that the election results could be tallied after the involvement of all parties. The model ensures a voter's privacy, eliminates the need for a central authority, and maintains the recorded votes in a distributed structure. Potential manipulations may be made in this fashion.

[7] used RFID to construct a voting mechanism based on fingerprints. Their suggested plans are excellent for real-time management. The voting mechanism based on fingerprints is

reliable and prevents bogus votes. Because only legitimate candidates are allowed to run for office, this voting method is more reliable and equitable. The voting mechanism is more private thanks to the fingerprint identification algorithms. The buzzer can warn the presiding officer as quickly as possible if somebody who is not authorized attempts to cast a vote. The voting process has been carefully created for 99% of users.

Despite the alleged benefits of e-voting efforts, research on the evaluation of e-voting systems based on Council of Europe recommendations found that acceptance of e-voting mechanisms and implementation procedures is slower than anticipated. The universality and applicability of electronic voting are hampered by several technological, social, and cultural issues. Among these, it is still a significant difficulty to overcome the evaluation and harmonization of e-voting systems given various legal and statutory frameworks. However, this subject hasn't received much attention in the literature [8].

[8] applied a practical evaluation framework to Helios Voting, one of the most popular e-voting tools to date, research aims to advance understanding of the understudied topic. This evaluation framework is heavily based on the technical and security requirements published by the Council of Europe in 2017. Election officials, researchers, and voters can use it as a useful resource to learn about the advantages and disadvantages of Helios Voting, which will help them make better decisions about the kinds and sizes of elections that the system can safely handle. The objective of the research is to provide conceptual and practical support for the protocolized, secure, and progressive deployment of electronic voting.

The SMS Based Voting System uses two mobile phones of which one is the transmitter, and the other phone is the receiver [9]. The receiver mobile is interfaced with the Microcontroller unit while the transmitter mobile is the voter’s mobile. When the voter wants to vote, he will enter the correct voter identification number, and password and then enter the candidate’s identification number in the message to enrol his vote. The sent details to the receiving mobile phone will be matched with the details in the database if it is the same then the vote will be counted for the selected candidate whose identification number came with the vote and is stored in a database where tallying takes place automatically [9].

[10] investigated the design and implementation of a mobile voting system in student union government elections at Lagos State University in which the student must visit the polling booth before they can cast their vote because of the Direct Recording Electronic system of voting in use. To solve the problem of students covering the distance from their hostels, classrooms etc. to the polling booth and wasting quality study time inqueues during student elections the technology of the Remote (e-voting) system comes into existence. Remote electronic voting systems make the casting and counting of votes more convenient and efficient, even making the electoral procedures simple and reducing the mistake of ballot examination [11].

The stressful and gory experiences associated with elections in Nigeria are a pointer to the inevitability of the electronic voting system in Nigeria. Hence, this paper aims at studying the required e-voting system in Nigeria; it is believed that the full implementation of the e-voting system in Nigeria will save the country from the awful experiences of the past as it promises free, fair, transparent, convenient, and confidential elections as well as the speedy processing of results [12].This research work will proffer solutionsto some of the

shortcomings of already existing systems by implementingcomplete electoral automation as well as incorporating short message service feedback.

II. MATERIALS AND METHOD

To realize a highly reliable real-time Short Message Service based voting system, this work adopts a process model called the waterfall reuse model of the System Development Life Cycle which is a combination of both the waterfall and reuse model of the System Development Life Cycle.

1. **The Proposed System:** The proposed model of the real-time Short Message Service-based voting system is shown in Fig. 1. This model comprises two ends: the user end and the server end. The user end is a smart device such as a mobile phone that can communicate with the server end through a wireless means of communication.

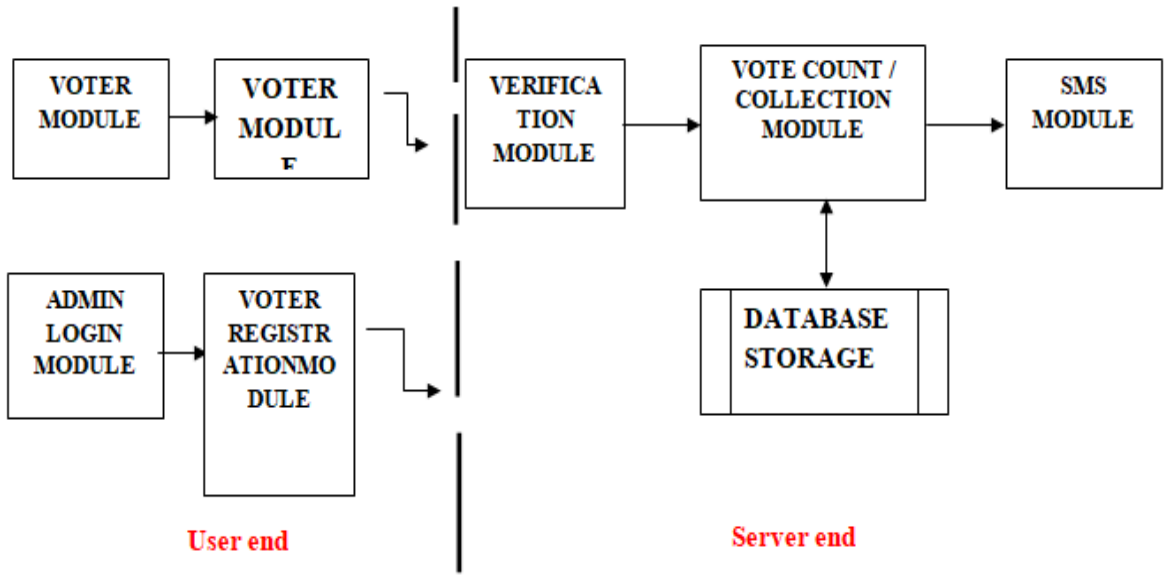


Figure 1: Block Diagram of the Proposed Model of the Real Time Short Message Service Based Voting System**.**

- **Voter Login Module:** This module is responsible for granting or denying the voter access to the application to cast ones vote. This is achieved by this module by accepting the voter's login code and then verifies it to ascertain if the voter is a registered voter or not. If the voter is a registered voter, then the voter will be granted access to the voter module, else denied access.

- **Voter module:** This is the interface used for voting, it aids capturing of the voter's identity, phone number, the party voted for and the time of voting and then transmit the information to the vote count/collection module.

- **Verification Module:** This serves as the receiver, it receives the information from the voter module and checks if the voter has voted before based on the on-going election. If yes, the vote will be invalid and discarded but if the voter has not voted previously, the voter's available information will be transmitted to the vote count/collection module.
- **Vote Count/Collection Module:** This module is responsible for counting and collation of votes cast with respect to the various parties, sending the voters' information to the sms module for instant messaging. It is also responsible for retrieving the total result of votes cast at the end of every election and as well as forwarding it to the SMS module for instant messaging.
- **SMS Module:** This is solely responsible for Sending Instant Messages (SMS) to the various voters.
- **Database Storage:** This functions as a reservoir for holding all the required information of the voters as well as the information of the votes cast for each participating party.
- **Administration Login:** This module allows the admin to login into the admin unit and this is achieved by accepting the admin's login code and then verifies it to ascertain the authenticity of the admin. If the verification is successful, the admin will be granted access to the registration module and to view the progress of the elections at the moment.
- **Registration Module:** This module as the name depicts, allows the admin to carry out the function of registration of eligible voters.

2. **Design Specifications:** Following the block diagram overview of the proposed model of the real time Short Message Service based voting systems shown in Fig. 1, our design will focus on the two layers: access/virtualization layer and logic instance with the server side. In this context, the grid control is the major component in the proposed system SaaS application. The logic instance and the background processes facilitate connection to the server. The model specifications are as follows:

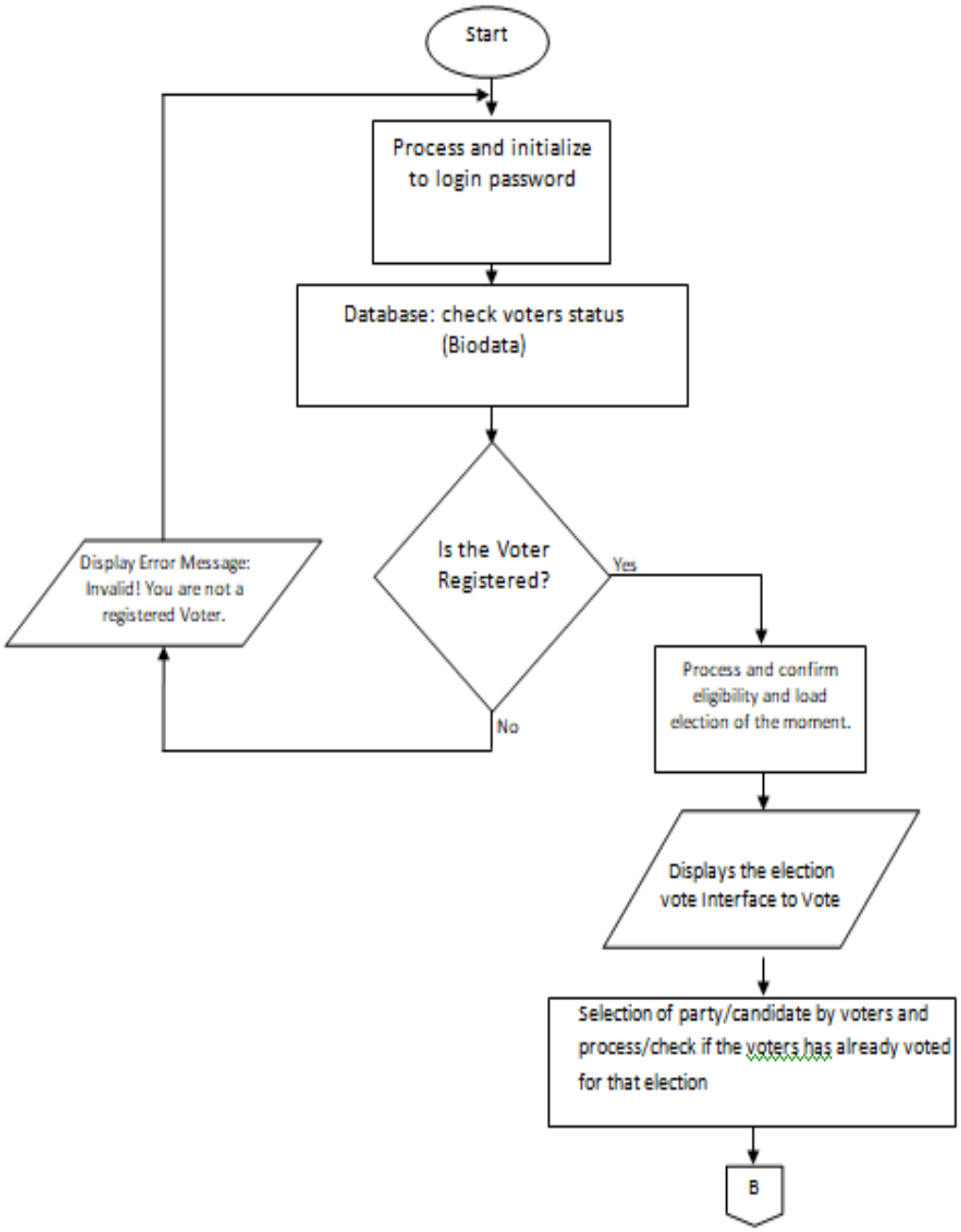
Prototype deployment server system requirements are:

- Memory requirements:
  - 1 GB for the logic instance (grid control)

- Disk space requirements:
  - 1.5 GB of swap space
  - 400 MB of disk space in the /tmp directory
  - Between 1.5 GB and 3.5 GB for the system's software
  - 1.2 GB for the preconfigured database (optional)
  - 2.4 GB for the flash recovery area (optional)

- Operating system requirements
  - Adequate temporary space
  - 64-bit versus 32-bit issues
  - Windows 8/Server 2007 and Linux Redhart
  - OS patch level
  - System packages
  - System and kernel parameters
  - Sufficient swapping
  - Nonempty XAMP htdocs_HOME
  - MySQL database

3. System Flowcharts: In this section, we shall present the respective flowcharts of the proposed model of the real-time Short Message Service-based voting system.



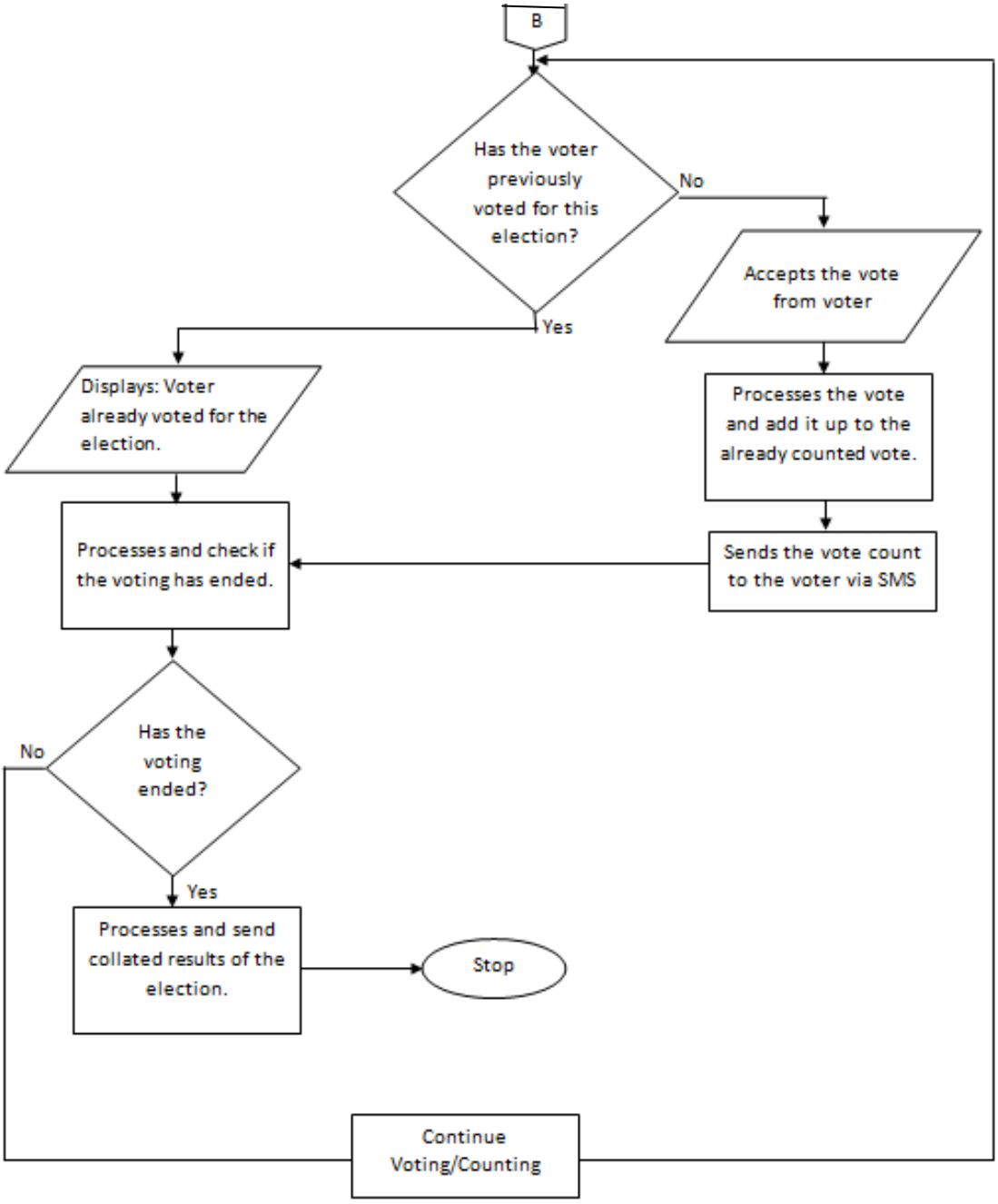


Figure 2: Flowcharts of the Proposed Model of the Real Time Short Message Service Based Voting System

Figure 2 shows the flow chat design for the proposed model of the real time Short Message Service based voting system. In this model, to gain access to the application so as to vote, the user must provide the user login code which was made available to the user during registration. This is the only condition for accessing the platform for voting; afterwards the system will verify the voter's status (voted or not voted) based on the election taking place. If the voter has not voted, the voter will be allowed to vote for the party of his/her choice, else access will be denied to the voter. When a voter has voted, he/she will immediately receive

an SMS as feedback stating its vote status and at the end of the polls the voter will also gets the collated result of the election through an SMS.

4. **System Database Design:** A system of this magnitude often has to do with content management, which often supports qualitative content using metadata values. These metadata values cover technical information like the name of the user, date of birth, occupation, phone number, state of origin, Local Government Area, registration area etc. Here, the database was designed to efficiently hold such metadata values in database objects called tables.The following design parameters were put in place while designing the database.
   - The database size
   - Access time of the database

In designing this database, the first thing done was to understand the process of the proposed system. Table 1 to Table 4 shows the database design for the Voter table, Election table, voting table and result table.

Table 1: Voter Database

Serial	Column/Field Name	Data Type	Size	Description
1	Sn	Int	10	Assigns unique serial number to individual records
2	Voter id	varchar	15	Holds the id of the voter
3	Voter name	Varchar	200	Holds the name of the voter
4	Ward	Varchar	100	Holds the ward of the voter
	Phone no	Int	11	Holds the phone number of the voter
5	Lga	Varchar	100	Holds the local government of the voter
6	State	Varchar	50	Holds the state of the voter
7	status	Int	2	Holds the status of the voter

Table 2: Election Table Database

Serial	Field	Type	Size	Description
1	Sn	Int	10	Assigns unique serial number to individual records
2	Election_type	Varchar	50	Holds the election type (presidential, gubernatorial etc)
3	Election_date	datetime		Holds the election date
4	Number_of_candidates	Int	3	Holds the number of the candidates
5	Election_status	Int	2	Holds the election status (Done or still on)

Table 3: Voting Table Database

Serial	Field	Type	Size	Description
1	Sn	Int	10	Assigns unique serial number to individual records
2	Voter_id	Varchar	15	Holds the id of the voter
3	Candidate_voted	Varchar	50	Holds the candidate voted for
4	Election_type	Varchar	50	Holds the election type
5	Election_date	Datetime	10	Holds the election date

Table 4: Result Table Database

Serial	Field	Type	Size	Description
1	Sn	Int	10	Assigns unique serial number to individual records
2	Election_type	Varchar	50	Holds the election type
3	Total_vote_count	Int	10	Holds the total vote count
4	Election_date	Datetime		Holds the election date

In the implementation of this system, the following administration tools were used:

- Adobe Dreamweaver
- SMS enabler
- MySQL Server
- Apache Web Server
- Android Studio
- SMS gateway

5. **Development Platforms:** The proposed model of the real time short message service based voting system is written with PHP and HTML programming language in Adobe Dreamweaver and as such can run on any system. The platform offers reusable services common to cloud computing applications, allowing developers to focus on the logic specific to their application.

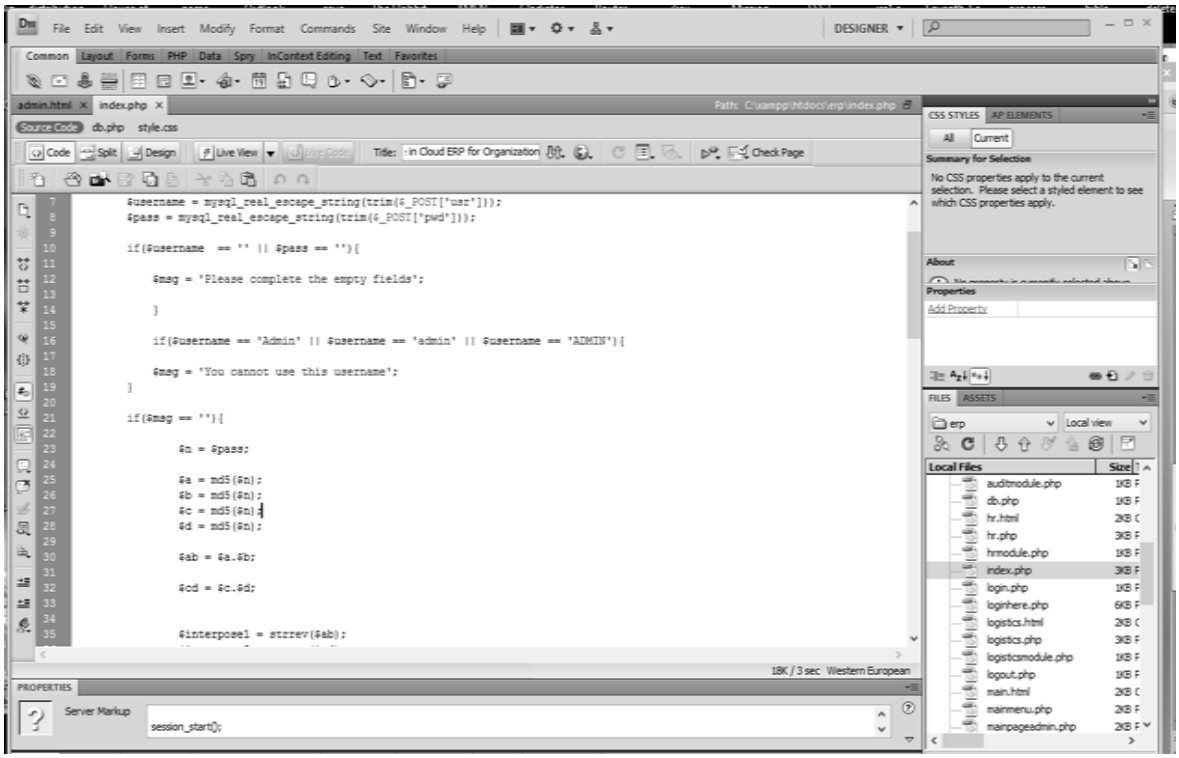


Figure 3: System's Coding Pages

III. RESULTS AND DISCUSSION

The figures below show the snapshots of the interfaces of the real time Short Message Service based voting system. These interfaces make voting possible. Figure 4shows the snapshot of the voter Registration and Login Interface.

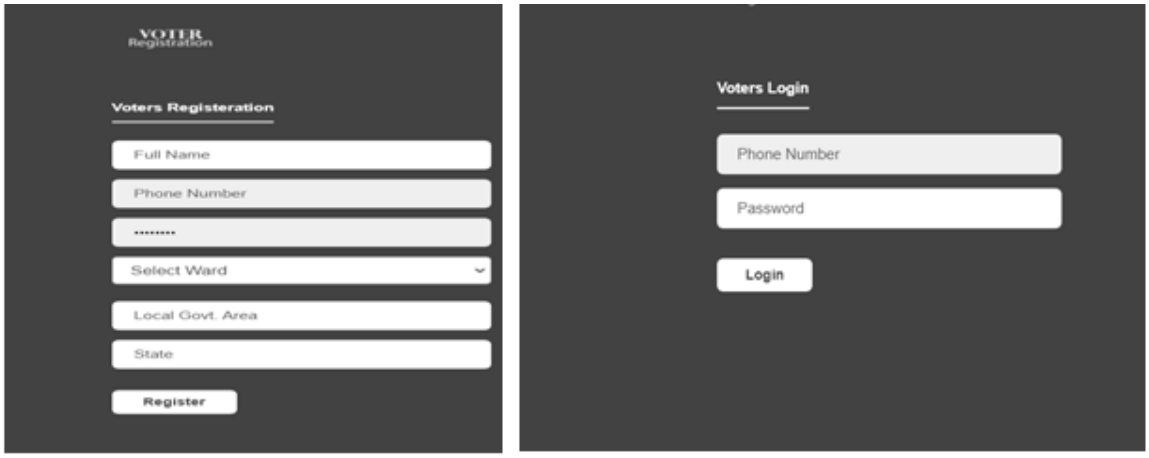


Figure 4: Voter Registration and Login Interface (Web and Mobile Respectively)

This interface enables a voter to be registered by an electoral officer before the voter can be allowed to cast his or her vote. This is done online by the electoral officer. Then on a successful registration the voter is given a unique code, which serves as his login code.

Through the login interface, the voter is either granted or denied access to the voting interface.

Figure 5: Sample Voting Interface and Feedback

Figure 5 shows the snapshot of the Voting Interface and feedback. This interface allows the selection of the election type e.g. presidential, gubernatorial, senatorial etc. A feedback message gotten for each successful vote casting.Figure 6 shows the snapshot of the admin interface for the election vote count and summary. With this platform, the election summary can now be sent to the voters at the end of the election.

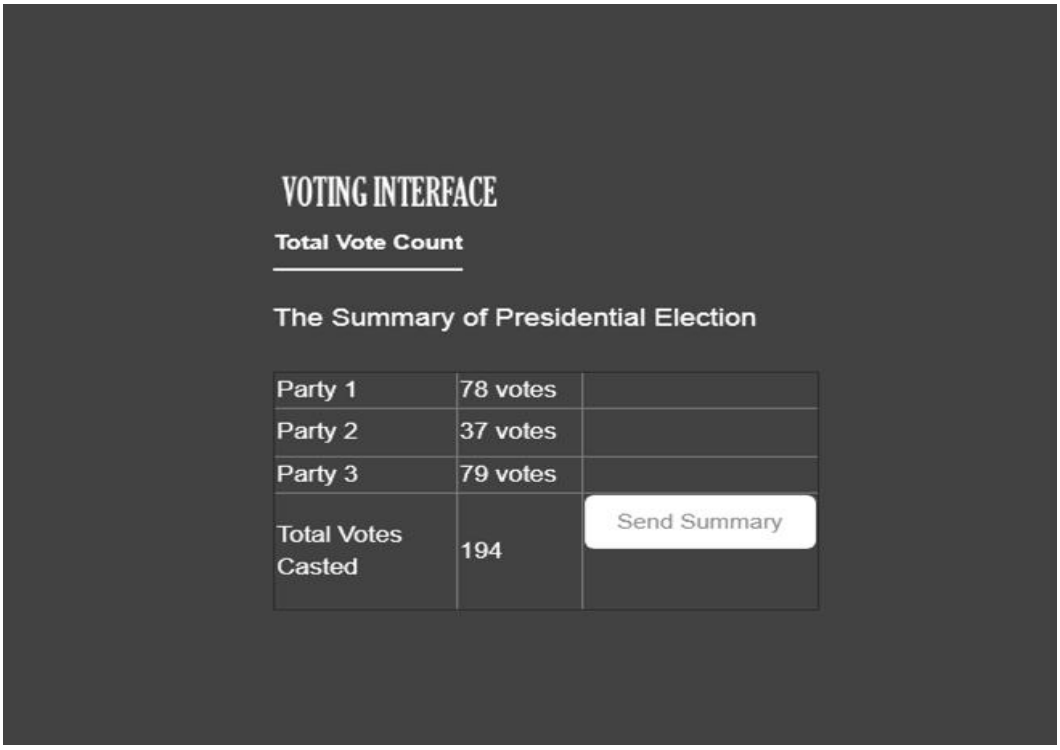


Figure 6: Sample of Admin interface for Election Vote Count and Summary

Table 5 shows the latency for each successful vote cast for both the existing e-voting system and that of the real time Short Message Service based e-voting system respectively.

Table 5: Latency for each successful vote cast for existing e-voting system and the real time Short Message Service based e-voting system

Number of trial (N)	Existing e-voting system (sec)	Real Time Short Message Service based e-voting system (sec)
1	32.01	42.02
2	31.40	41.42
3	31.51	41.50
4	32.00	42.00
5	32.01	42.01
6	31.42	42.02
7	31.44	41.55
8	31.50	41.51
9	31.45	41.56
10	31.47	41.50
Total average	**31.62**	**41.71**

Performance Evaluation of the Real Time Short Message Service Based E-Voting System

The developed real time short message service based e-voting system was evaluated by comparing its availability on demand with that of the existing e-voting system. The real time short message service based e-voting system success rate which is a function of the system's availability is the same as the existing system. This means that the SMS feedback features incorporated in the real time short message service based e-voting system had zero (0) impact on success rate.

On the other hand figure7 shows the latency of both systems, it can be seen that the real-time short message service-based e-voting system introduced an average delay of 41.71 seconds into the e-voting system.

Transparency and availability are key performance indicators for evaluating an e-voting system with transparency being of more critical importance. Most e-voting systems can tolerate a maximum latency of 60seconds for each successive vote cast. It can be seen that the latency of the existing e-voting system on a scale of 60seconds is 52.7% giving a tolerance of 47.3%. The latency of the new system is 69.5% giving a tolerance of 30.5% and with a difference of 16.8% (introduced latency by the new system), when compared with the existing system. Since 16.8% is less than 47.3%, this means that the introduced latency as a result of the SMS features of the real-time short message service-based e-voting system still falls within the tolerance region of the existing e-voting system.

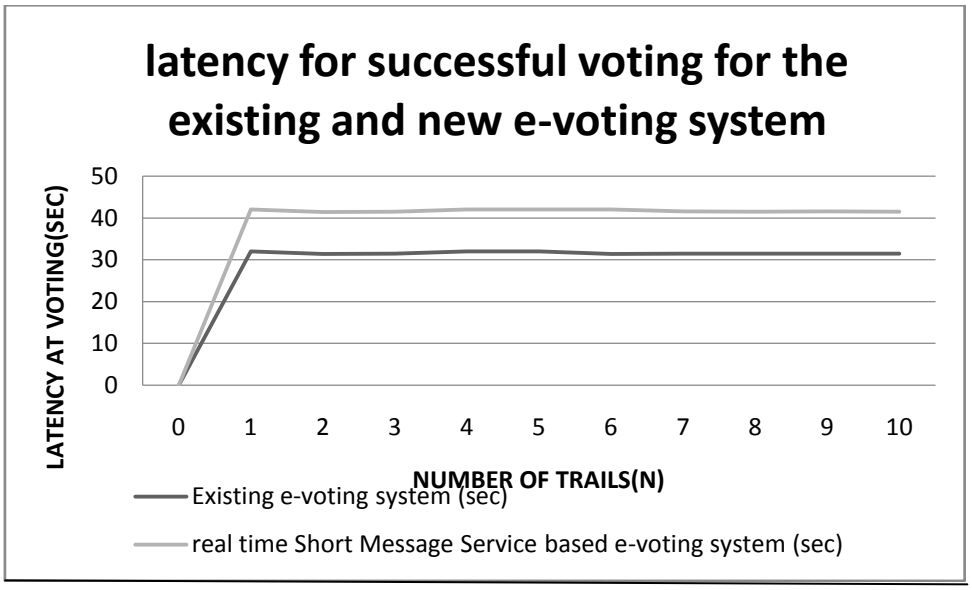


Figure 7: Comparison of Latency for Successful Voting for the Existing and New E-Voting System

IV. CONCLUSION

This research work has designed and simulated a real time short message service based e-voting system. Hypertext Preprocessor (PHP), Hypertext Markup Language (HTML), Structured Query Language (SQL) were used in the coding, while the running of the application was done using the Apache Web server. With this re-engineered architecture and inbuilt SMS features, this system can perfectly bring election malpractice to an end as well as making electoral processes transparent, free and fair.

Cloud computing technology is still relatively new in terms of maturity and adoption. The expectation is that it will undergo several changes in the future, in terms of resources, issues, risks, and ultimately best practices and standards. However, there are some great advantages offered by cloud computing to e-voting. Again, this developed system is an application developed for better and effective election monitoring and management, which is designed to curb electoral fraud that is on the increase. The system when accepted and deployed will end the era of electoral fraud and will give way for a constant and consistent free, fair and transparent election in Nigeria and the world at large. This paper having understudied cloud computing types and delivery models and various limitations of existing e-voting systems, now concludes that a robust e-votingarchitecture with SMS incorporation will be optimized e-voting systems.

The following were the contributions made in this work:

1. Development of a real-time short message service (SMS) based e-voting system for efficient and transparent electoral processes.
2. Incorporation of strong security measures in the system to prevent electoral fraud.
3. Developing a more effective e-voting system by leveraging Android technology.

The work presented in this paper indicates that there are more areas that can be improved for further study such as facial recognition authentication, improved scalability and fault tolerance, online viewing and optimized TCP.

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