Mobile Based Elections Results Transmission and Collation System - A Case Study of Nigeria

Steve A. Adeshina, Lukman E. Ismaila, and Adegboyega Ojo

Abstract—Free and fair elections is known to be central to good governance. The interregnum between the time voting is concluded and results declared is often used by mischief makers to manipulate the results of elections. This work presents ways and means of reducing the time between voting activities and results publication to the barest minimum. This is done by automatically transmitting, collating and publishing results from urban and remote places to central servers. Nigeria with its huge population, large mass area, and an extensive difficult terrain without internet access presents us with an appropriate case to study. This method will be applicable to similar electoral constituencies especially in developing countries.A results collation and transmission system was designed and implemented using Nigerian Elections as a case study. Election results are collated from every polling points (about 132,000 locations) sent using a mobile application to a central server. These results are collated using an SQL database. Collated results are subsequently displayed in a result portal using PHP. This process leads to a huge reduction in the time it takes to collate and publish election results and subsequently leading to a free and fair elections. The tests conducted show an 95% effectiveness in the transmitted result and a reduction of Result transmission time from about 3 days to 6 hours.

Index Terms—Polling Units; Electoral Management Body; Short Message Services; Nigerian Elections; Independent National Electoral Commission

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1   INTRODUCTION

A N election is a formal decision making process by which a population chooses an individual to hold public offices. Elections have been the usual mechanism by which modern representative democracy has operated since the 17th century. Elections may fill offices in the legislature, sometimes in the executive and judiciary, and for regional and local government [1]. This process is also used in many other private and business organizations, from clubs to voluntary associations and corporations.

The universal use of elections as a tool for selecting representatives in modern democracies is in contrast with the practice in the democratic archetype, ancient Athens. As the

Elections were considered an oligarchic institution and most political offices were filled using sortation, also known as allotment, by which office holders were chosen by lot.[2]

Electoral reform describes the process of introducing fair electoral systems where they are not in place, or improving the fairness or effectiveness of existing systems. Psephology is the study of results and other statistics relating to elections (especially with a view to predicting future results).[3]

Results transmission is an important part of electronic voting, which consist of other components like such as Electronic Voter Register, Voters' Authentication, Electronic Balloting and Tabulation. This work will be limited to Results' transmission tabulation and publishing.

The motivation for this work arises from the experience of the first author as a major player in the Nigerian Electoral system for many years. Additionally this work also arises from the frustration experienced from previous failed and a few successful elections in Nigeria.

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Nigeria has a land mass of about 1,000 square metres and a population of more than 200 million persons. The country also has very difficult terrains ranging from difficult riverine areas in the south to the arid dessert and mountainous belt in the North. Traditionally election have been controversial in Nigeria. It is needless to mention that the time between the conclusion of elections at polling points and eventual declaration of result provide ample opportunity for the results to be manipulated. Nigeria had experienced this severally in the past. However, starting from the 2011 general elections when Nigeria introduced the Electronic Voters Register (EVR) and Temporary Voters' card (TVC) to the 2015 elections wherein a machine readable Permanent Voters card(PVC) and the so called 'Smart Card Readers'(SCR) were introduced, the story of elections in Nigeria changed for the better. This is to the extent that there was a transfer of power from one political party to another - the first in Nigeria.

The Smart Card reader is an Android based portable device that has integrated fingerprint device. When a voter presents himself the content of the Card is compared with the fingerprint of the holder, if successful the holder is the allowed to vote.

This work is about using the same device that has been used for accreditation for result transmission by developing a mobile application in this regard. The innovative introduction of the SCR, is being extended to perform another sub-division of electronic voting. It thought that this could serve as a template for technology adoption in Sub-sahara Africa, giving that the big bang approach to technology adoption has generally failed across the world.

As it is in most developing countries the Internet penetration is just about 60% while the mobile phone penetration without internet data option is close to 90% in Nigeria. Additionally Nigeria has close to 132,000 polling stations from where result will be transmitted. This work can be used as a stand-alone or can be integrated into an existing system.

This project is intended to enhance the election result management system, by ensuring accurate and transparent management of election results from polling units to the final display of result on a webpage. This is because election result is generally faced with a lot of issues arising from poor processing technique, resulting into failure or generally an unsuccessful system. Manipulation of election is often done between voting and the announcement of the results, in the last Nigerian election, this took about 3 days. This is a problem that this work seek to solve.

The full implementation of this problem aim to solve some key issues in election result management.

- To design a result transmission system
- To reduce the cost of using computers to collate results in about 120,000 locations
- To reduce time interval between voting and result announcement
- To reduce manual intervention with election results.

Whereas many existing Elections results transmission systems, most of these assume existence of Internet access at the sending point, this work assume a lack of Internet access for result transmission. This is in line with situation in sub-Sahara Africa, where in broadband penetration is less the 50

The innovation in this work include encouraging a systematic and strategic introduction of technology to ensure it is adopted. Additionally the work also attempt to map the peculiarity of remote environment with appropriate technology in such a way to achieve effectiveness. With careful introduction of this technology result transmission can be reduced from 4 days to less than 6 hours.

2 RELATED WORK

It is obvious that election processes has to be standardize but also jumping into a full electronic voting or full internet voting system suffer lots of problems, user adoption [7][8], just to name a few. Several researchers are more interested in how to perfect electronic voting [8][17]. In this project we intend to reduce intervention to the minimum, and ensure result transmission

method is possible across the country in order to increase result transparency. G. S. Grewal et al [6] address a key issue in internet voting where system trust is distributed in Du-Vote between a simple hardware token issued to the voter, the voter's computer, and a server run by election authorities. Our work adds more value to that of Dichou Karima[15] *et al.* whose work attempted to improved voting system using smart cards. We believe in the establishment made by M. Tarek[19] that e-voting introduces several security challenges and malicious back-door an thereby making e-voting too unreliable and predictable for a country like Nigeria. The closest work to this work is that of Karima *et al.*, whereas their work assumes the existence of Internet access and a computer based voting kiosk, our work require no such devices.

3 SYSTEM METHODOLOGY

3.1 Data

Database of Polling units were obtained from the electoral body. Additionally database of electoral constituencies were also freely available at the Commission's web site. Interviews were conducted. Existing manual results forms were studied to provide an insight to the user's need. Ethnographic studies were also carried out on reports obtained from the Commission's website. All of these provided the ingredients for a detailed requirement analysis.

3.2 System Diagrams

The system has various diagram in other to capture the dynamic behavior of the systems under various situations. Figure 1 above shows the work process diagram. this captures the work flow in a graphical way. The process start when a user at polling point starts the application. he is prompted to fill some authentication details, if successful then he will be given access to fill election result and sent to the collation center. SMS is extracted and sent to database after once its authenticity is confirmed and finally, results are extracted from the database to the web-page.
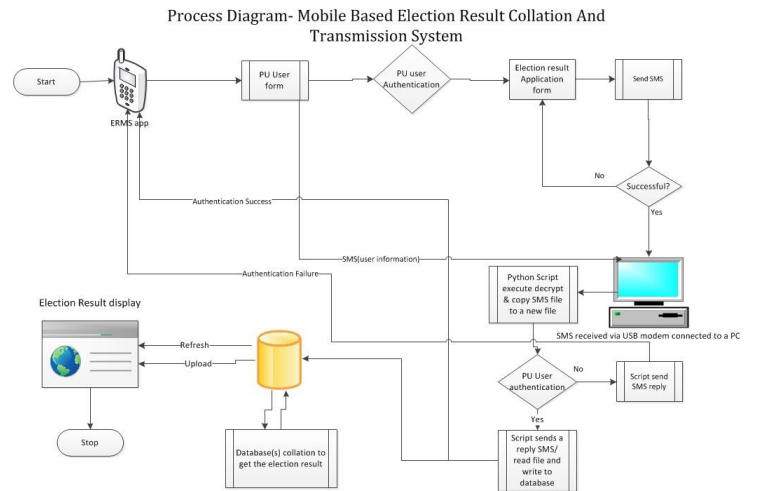

Fig. 1. Systems' Process diagram

The above figure 2 shows a use-case diagram of the work. It describe the interaction between different actors of the system. The Polling point user has direct interaction with the application, and vote count information. A result Manager endorse the final collated result before it is published. PC helps interface with the telerivet application dashboard and run the included script to write result to database system from where it is retrieved to the web-page.

3.3 Android Application

We used android Studio Android Development Toolkit (ADT) for the application development. The design procedure is as follow. Algorithm to create android application (SMS application) with android studio.

- Create an android project in android studio environment
- Edit the layout XML file to design a suitable user Interface for the application
- Switch to the java file and connect your components such as TextView, Button EditText, Spinner on the user interface to the java activity class after making the necessary imports (e.g. android.content.widget.Button), modify the java activity class file to perform the SMS transmission using android SMS manager.
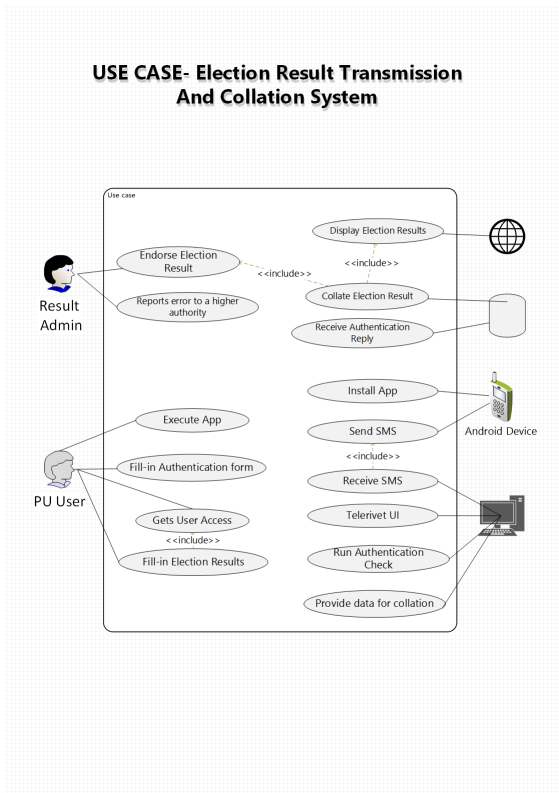
Fig. 2. Use case diagram

PartyName	ElectionType	Vote Count
A	PRESIDENTIAL	84543
AA	PRESIDENTIAL	6546
ACD	PRESIDENTIAL	28454
ACPN	PRESIDENTIAL	11084
AD	PRESIDENTIAL	34655
ADC	PRESIDENTIAL	8744
APA	PRESIDENTIAL	7946
APC	PRESIDENTIAL	255542488
APGA	PRESIDENTIAL	45541
CPP	PRESIDENTIAL	64548
DPP	PRESIDENTIAL	5481
FRESH	PRESIDENTIAL	8188
HDP	PRESIDENTIAL	67545
ID	PRESIDENTIAL	54343

Fig. 3. Proposed webpage for displaying results

- Modify android manifest.xml file to enable necessary permissions your application may be requesting from its users especially android send SMS permission.
- Effective application test should be made to prove its ability to send result through SMS in proper format.

3.4 SMS Retrieval and formatting

This project intends to retrieve transmitted SMS files into database through the use of scripts which will run when an SMS is received and then read SMS content and write result tables to MySQL database in an already created database. Telerivet app is used to auto forward incoming SMS from polling station to collation center. I only requires internet at the receiving end which can be handled. The send does not need internet access to send result but with internet access at the receiving end, incoming sms's are forwarded to online portal (collation dashboard) where all results collated are then managed by scrips which simple extract the SMS content (results) and write to database for further processing. The incoming election results are stored in a result table and collation takes place as results accumulates, The Database has several tables like; PU-Result, PU-User, Party, Election, PU-delimitation, Web-display table for keeping other relevant information that may be needed to validate incoming results, compute final result, registered voters, accredited voters, and other result statistics. Figure 8 below shows the interface of the proposed webpage for displaying results.

The use-case diagrams 2 - Please explain the usecase diagram

The webpage result display is the final step of the result management system and this is after necessary validation of the awaited result, in this project, we used wordpress for developing the local website where results are going to be displayed.

3.5 Input Screens

The various user interfaces provided to users for data input that will be used by the system or application in processing output result. The above input screen [?] shows a form to authenticate user and only authenticated users are allowed to fill the result for before sending vote count to remote center.

Fig. 4. a) Login page, b) Result form-page as SMS, and c) election type selection
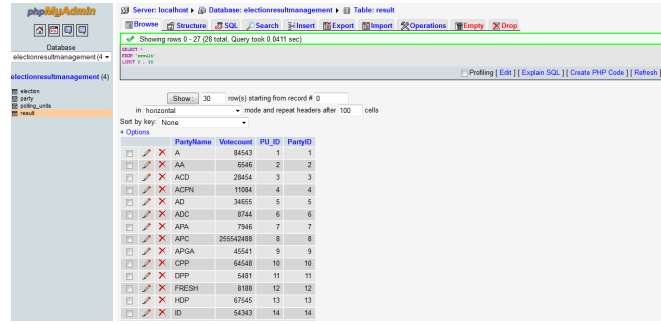

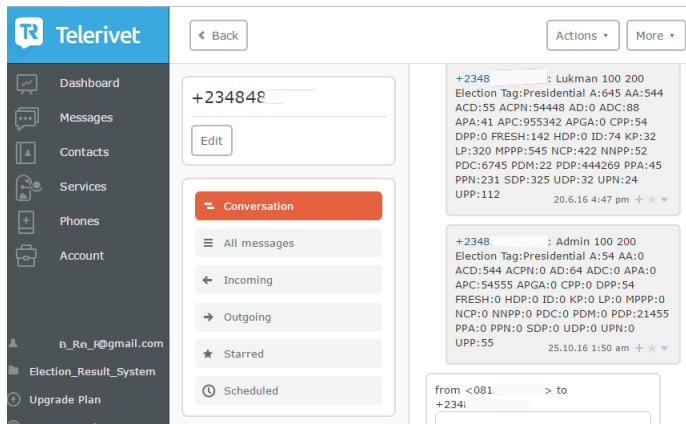Fig. 6. Database tables in phpmyadmin for collating election results sent from polling units.

Fig. 5. Display of Telerivet Interface for receiving incoming SMS from poling units

Fig. 7. Final web display of election results

PartyName	ElectionType	Vote Count
A	PRESIDENTIAL	84543
AA	PRESIDENTIAL	6546
ACD	PRESIDENTIAL	28454
ACPN	PRESIDENTIAL	11084
AD	PRESIDENTIAL	34655
ADC	PRESIDENTIAL	8744
APA	PRESIDENTIAL	7946
APC	PRESIDENTIAL	255542488
APGA	PRESIDENTIAL	45541
CPP	PRESIDENTIAL	64548
DPP	PRESIDENTIAL	5481
FRESH	PRESIDENTIAL	8188
HDP	PRESIDENTIAL	67545
ID	PRESIDENTIAL	54343

3.6 Output Screens

Output screen includes the result display at telerivet dashboard, database interface and web-page display of final election results. The figure 5 below shows Telerivet Dashboard Incoming results from PU

Algorithm for Telerivet Script

- When an SMS is received, check if sender is authentication, and go to step 2 if authenticated
- Read SMS and write to database if properly formatted else alert user.
- Return success alert and exit if database is successfully updated

The user interfaces where processed user inputs are show in form of response or feedback. The figure 5 below shows Telerivet Dashboard Incoming results from PU

4 SYSTEM IMPLEMENTATION

4.1 System Application Development

An Android SMS application was designed for polling unit users to fill votes counted in an interface and then sent SMS at the polling units to a result collation center at the LGA or State collation center. This application is developed on run every android powered device (minimum API of 10

and target API of 21-Lollipop), which means about 95% available devices can use it including the very cheap android phones. Various functionalities were included in this application to ensure accurate result transmission, reduced error possibilities and enhances transparency in election result management.

4.2 Major Challenges and solutions

- Android SMS Message char size- solve

using Multi-part SMS to group message part into 160 characters

- USB Modem SMS retrival- Solved using Telerivet application, which makes sms at receiving end readable
- CSV file Import to database- Original CSV file (database of polling units) acquired from google fusion table was too large to be imported directly into the database. This was solved by editing PHP configuration file (increase max size import).

4.3 System Maintenance

This project has been designed to trill in diverse environmental condition and this is only achieved through effective maintenance of the system. Software update to the android application will be made if any software bug is discovered after the test, as it is impossible to make exhaustive test. This will be same for other aspects of the system. More importantly, this system is subject to test before use for election result management, this can be done by sending results from different locations in Nigeria in order to ensure that the system will be effective during the time of actual use.

5 SYSTEM EVALUATION AND EFFECTIVENESS ANALYSIS

	Usability Test	
	OBJECTIVE	DEGREE
1	Public accessibility	80%
2	error prevention	98%
3	SMS destination control	98%
4	SMS format	95%
5	Increase Speed	90%

Additionally we conducted a User acceptance test, where-in the product was deployed to a mountainous Local Government in Kogi state. The Internet penetration is less than 30% but Mobile phone penetration is 90%. 352 Users sent SMS for collation for a state constituency elections. The final result was obtained and tallied with 2 hours of conclusion of the elections. The parallel manual compilation took 48 hours.

Election Result Transmission and Collation System

Usability Test For android application to be used for election Result transmission through SMS

	Party Name(Acronym)	Vote Count
1	A	2918
2	AA	535
3	ACD	464
4	ACPN	944
5	AD	323
6	ADC	5634
7	APA	321
8	APC	987842
9	APGA	13
10	CPP	224
11	DPP	
12	FRESH	3345
13	HDP	
14	ID	2432443
15	KP	
16	LP	113
17	MPPP	77
18	NCP	434
19	NNPP	786
20	PDC	431
21	PDM	217
22	PDP	877543
23	PPA	
24	PPN	
25	SDP	
26	UDP	4454
27	UPN	
28	UPP	4666

Fig. 8. Android App Usability Test

6 DISCUSSIONS AND CONCLUSIONS

6.1 Conclusion

Good governance has being a commodity that has consistently troubled under developing countries. Dictatorial governments have also consistently rigged elections by manipulating results. This project aim to eliminate result manipulation by reducing manual intervention to the minimum, in addition the time between voting and declaration of results will be reduced to the minimum, it is during this time that rigging takes place. This project, if fully implemented successfully, will significantly promote transparency and accuracy of election results.

We believed Nigeria as a country present us with a comprehensive model of what a developing country can be and will experience, we hope to implement this work amongst other initiatives of the Electoral Commission. This is terms of spread, terrain and volume. Consequently we commend this work to organization who are concerned about good governance. Several countries in the sub-sahara Africa can benefit from this work and initiative.

It it is not surprising that, to the best of our ability we are unable to find a similar work to directly compare with this work, this is because

Internet access and penetration is rarely not a problem in most consistencies.

The design system is not limited to a specific type of election. In its maturity, it can also be used by organizations to carry out election with little modification of same underline system. This system can easily be integrated with a full voting system (electronic voting system) where by voting and result management (transmission and collation) are been managed by one system.

6.2   Further Research Work

This project aimed to reduce manual intervention with election result to the minimum, Telerivet web application makes sms retrieval possible but other software could not retrieve sms. The slight introduction of manual intervention at this stage needs to be worked on. This system needs to be automated to use script to read SMS and write to database directly. The effectiveness of this project depends greatly on efficient record keeping and this is only possible with database. Therefore the database design of this project has to be more sophisticated in order to suit variations in elections as well as allow results display to be more informative rather than just showing a single table.

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