Framework for Multilingual Mobile E-Voting Service Infrastructure for Democratic Governance

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ABSTRACT
In most developing countries, electoral processes preceding democratic governance is characterized with high rate of fraudulent practices ranging from stolen of ballots, falsification of vote counts or rigging, improper voting and votes lost through invalid ballot marks due to ignorance and inadequate prior awareness and negligence. In this paper, we present the design and generic implementation of a framework of an integrated multilingual voting service infrastructure for conducting credible elections in rural and suburban communities in developing countries. The result of the testing done in Nigeria on the developed voting framework using Hypertext processor Web platform and Google Android mobile platform in the citizens' mother tongue shows promising results. These will ensure high level of citizen participation and conduct of free, fair, transparent, convenient and confidential electoral processes in future elections in these countries.

Keywords: Mobile Voting, Internet Voting, E-registration, Democracy, Governance

1. INTRODUCTION

In every endeavor where democratic leadership structure exists, those in the helm of affairs are usually elected into the office and this is predominantly done by voting. Voting is a method by which a group of people express their opinion over who will lead them for a specific period of time via electoral processes. Usually correctness, robustness to fraudulent behaviors, and coherence are all key requirements for the integrity of an election process [9].

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Others include A wide variety of voting systems exist. These include conventional paper ballots, mechanical systems and electronic ballots.In conventional paper ballots, voters choose their favorite candidate on ballots paper and place them in boxes, which can be sealed and officially opened under special conditions to warrant transparency in the process of casting the vote. The ballots are then counted manually to determine who wins the election among the contending aspirants. The conventional method is not only laborious but it is subject to human error, wastes time, prone to electoral fraud and rigging [13]. In mechanical systems, voters make their choices by pulling down on mechanical levers that correspond to their favorite choice of candidates that will generate vote counts.

In electronic systems, some systems use punch cards where voters punch holes in computer readable ballot, others employed special-purpose computers such as voting machines where voters use touch screens or push buttons to select choices, which are stored and counted or processed by a special program on the same machine [9].

Electoral processes in most developing countries are marred with irregularities. For instance In Nigerian 2007 General Election, there were massive rigging of elections especially in the governorship and state assembly elections in opposition strongholds where many complained of lack of presence of electoral officers in their wards. Some leading party officials were alleged to have taken ballot boxes to private residences to thumb print candidates' names. Many International observers declared that the results of the elections were below the minimum standards and were not true to the wishes of the Nigerian people [3].

Although, the visiting International election observers attest that the Nigerian 2011 general election was relatively free, fair and credible. The chairman of the Independent National Electoral Commission (INEC), Professor Attahiru Jega, agreed that conducting elections that are free, fair, peaceful and credible in a country such as Nigeria, given its size, large population, terrain and ethno-religious diversity, is a very difficult assignment given the circumstances in which the INEC had to conduct the 2011 voter registration and the election itself [11].This crave for the need to provide integrated multilingual electronic voting system to assist and encourage more voters to participate in future electoral processes.

An integrated voting system is a system composed of three major platforms: an e-voting machine; wired internet and mobile internet [14]. A multilingual E-voting system is a presentation of an E-voting system in multiple languages of choice [3]. This system is peculiar because voters have the opportunity of selecting the language they best understand in the voting process. Electronic voting (E-voting) systems include a large variety of system, ranging from hand-held infrared devices, kiosk systems with touch screens machines used in polling stations to remote voting via the internet [3].

E-Voting is the preferred platform for future elections in the developed nations of the world. It is a system that has modernized the electoral processes and electorates are able to cast their votes through an electronic device as against the conventional manual system of voting. The three types of e-Voting include: Polling station, where voters cast their votes electronically on an electronic machine within the polling booth; Kiosk e-Voting, where voters cast their votes at pre-selected stations through ATM-like terminals; and Remote e-Voting, where voters cast their votes anywhere, and anytime, there is Internet access; as well as Voting through mobile devices[5].

In this paper, we present frameworks, models, prototypes and mobile software systems to address above challenges in conducting free, fair, well participated elections in developing nations with emphasis on Nigerian experience.

1.1 Motivation and Justification

Democracy and voting are inseparable because the majority opinion determines the outcome of an election or policy. Voting is by far the most important means in democratic decision-making. Although numerous voting methods have been implemented since the dawn of democracy, a certain degree of trial and error could always be expected according to which voting method was used. For example "Plurality voting" (used in United States, United Kingdom, Canada and Nigeria) is simple plurality, first-past-the-post or winner-takes-all.

In this voting system, the single winner is the person with the most votes; there is no requirement that the winner gain an absolute majority of votes. Plurality voting is used for local and/or national elections in 43 of the 191 countries of the United Nations [16]. Other voting methods include Preferential systems (Condorcet methods, Bucklin voting, Coomb's method) [17], Block voting (Plurality-at-large, Preferential block voting, General ticket) [18].The biggest problem with the current conventional voting method is in the most significant loss in terms of manpower, time, and money. In addition, there is usually a great deal of dispute as to the validity of the votes cast and also the manual counting of ballots is usually time-consuming.

For instance in Nigeria, in the 2003 presidential election, there were 2,538,246 invalid votes recorded, representing 6.04% of the total votes [19]. This is substantial, hence an outright elimination of the traditional manual process is recommended. Elections have become a reason for war in some developing countries, therefore to make the world a better and safer place there is a need to put in place a credible voting system across different platforms in languages most citizens are familiar with.

2. REVIEW OF RELATED WORKS

A number of related works exist in literature in the area of electronic and mobile voting systems and democratic governance. In [1], authors emphasized the success factors in implementing an electronic voting system in Nigeria, reviewed the e-registration exercise by the Nigerian electoral body as a springboard for future e-voting implementation in Nigeria and proposed solutions to common problems associated with countries that vote electronically. The authors proposed system have the potential to eliminate the common electoral malpractices associated with the manual voting system; reduce the duration of the election which will directly lead to reduced overall costs. Some principles of voting have to be established for the proper functioning of elections. According to [12] the following principles are established a)

Correctness of the Results: Only eligible users can vote only once and all votes counted are valid votes and all valid notes are counted,

b) **Verifiability of results by involved parties**: Researchers have argued for 'Voter verified audit trails', which means that the voter's choice is printed on a paper, which can be inspected (behind glass) and is automatically dropped in a ballot box afterwards. This enables manual recounts, if there are any doubts about the results and

c) **Secrecy of Votes**: Forced voting is prevented by making sure no one is able to derive a relation between the vote cast and the involved voter also sale of votes is prevented by making sure the voter is not able to prove the vote he casts.

An account of what a good electronic voting system's result should look like was proposed in [5]. E-voting is a type of voting system that allows voters to vote and record secret ballot electronically and its implementation has been a major interest of countries including Nigeria. The authors emphasize the flaws of using electronic voting ranging from rigging to fraud, not allowing recounting of votes and monitoring the system is almost impossible hence the probability of rigging is intolerably high and unacceptable.

Although the fact that the amount of dataset involved in e-voting is usually large based on the population and the distribution of the area in question, [5] attempted to solve these problems by using a Tree Map based visualization technique to monitor the distributed balloting and voting processes in real time. However with this technique, events in the balloting process can be monitored which will act as a form of getting the overall information through the whole balloting process in real time and secured electronic voting that ensures faults and fraud can be noticed. Some problems of the proposed system include: The tree map is not adequate for large trees because the traditional nodes and link diagrams cannot be drawn adequately in a limited display space. Also, the map lacks content information because each node cannot have additional information due to the fact that it takes most of the display space therefore only a simple text is used as the label.

In [4], an algorithm for displaying the results of seven elections (Presidential, Gubernatorial, senatorial, Representatives, Chairmanship, Assembly and Council) held simultaneously by thirty six political parties in Nigeria was developed. This algorithm was implemented along the principle of one-man one vote on an embedded direct recoding electronic voting machine system. With the system, a voter is permitted to press button corresponding to candidates or parties of their choice. The results for each candidate and for each election stored in particular elections locations of Electrically Erasable Programmable Read Only Memory (EEPROM) of a PIC18F2685 based Microcontroller are displayed on two 40x4 character LCD display modules.

Although the developed system ensures electoral process that enhances transparency of the elections as the result display is initiated by pressing a button on the voting machine, the insecurity of life and properties in most developing countries particularly in Nigeria during the election period and epileptic power supply to energize the developed system might defeat the principle of one man and one vote along which the system was developed and above all, the system was developed along the lingual franca of English language which might deny illiterates from exercising their franchise right in selecting candidates of their choice.

In [6], author proposed an integrated electronic voting through the internet and mobile platforms tested and used for over two years for six elections in Canton Zurich, Switzerland. This electronic voting system was achieved by modular and service oriented architecture (SOA) which allows easy integration of all platforms for electronic voting (via internet, mobile phone, television sets and any other digital technology) and existing software solutions without interfering with the high security standard set. The system has a service oriented structure which enables it to cover a wide range of voting concepts needed.

Also in [7], authors proposed secure mobile voting system based on GSM Mobile technology. By this, secure mobile authentication mechanisms are used which provides voter authentication and mobility. The system is developed using a GSM mobile voting scheme based on a blind signature voting scheme, other schemes used are digital signature and bit-commitment mechanisms. In [2], author presents the security considerations for remote electronic voting in public elections. The importance of security in elections cannot be overstated. The future of countries rests on public confidence that the people have the power to elect their own government.

Our proposition is premised along the provision of multilingual mobile e- voting service infrastructure for developing countries using major tribes in Nigeria-Yoruba, Igbo and Hausa as well as the National Lingua Franca as a vehicle of providing simple, cheaper, convenient, faster and credible electoral process in future democratic elections.

The proposed service infrastructure is capable of providing a platform that will that will give a free, fair, transparent, convenient and confidential electoral processes in future election. The infrastructure will provide platform for three major Nigerian languages (Igbo, Yoruba and Hausa) including the official English language to provide confidential result as well as speedy processing of the result and the capability to display instant result almost immediately after elections [21].

2.1 Analysis of Problems of Existing Voting System in Nigeria

The current voting system Nigeria is based on modified open ballot voting system in which voters carry out voting in an open booth. This manual voting system is based on the following processes:

a) Pre-registration of privileged voters.
b) Voters must queue up for proper accreditation using their registration cards.
c) The different parties' symbols or pictures of contesting candidates are displayed.
d) Voters are directed by the Electoral Officials to queue up for the candidates or parties of their choice.
e) Voters are counted openly and loudly and the number of people in each queue recorded on result sheet.
f) The result is announced to all present at the polling station.

Most citizens do not vote appropriately during 2011 election because of loss of confidence in previous leadership, inadequate awareness about proper voting measures and ignorance. Some other problems of the existing system are: a.) **Stuffing of ballot box with ballot papers**- This is a common practice where there are no genuine securities and election monitors to guard the process; b.) **Absconding with ballot boxes**-There are instances where some overzealous voters snatch and make away with ballot boxes. This is usually the case where they feel that their supporters are losing; 3) **Mutilation of election result sheets and falsification of election results**: This means tampering with the election result by way of tearing it or trying to change the figures already recorded.

3. MATERIALS AND METHODS

The following scientific approaches were used to achieve the central idea of this work. They are:
Requirement Definition and Infrastructural Modeling

3.1 Requirement Definition of the Proposed Service Infrastructure

i. Voters' Management Requirement

This requirement follows from the assumption that in order to have a free, fair, transparent, convenient and confidential electoral processes; the system should: a) **Be Unique and Secure**: A voter should be of acceptable age range and should not be able to vote more than one time; b) **Accurate:** After the election, the system should record the votes correctly; c) **Integrity**: Votes casted should not be able to be modified, forged, or deleted without detection; d) **Secrecy and Non-Forcibility**: Voters should not be able to determine how any individual voted, and voters should not be forced to vote for any candidate or party; e) **Convenience**: Voters should be able to cast votes quickly with minimal equipment or skills; f) **Verifiability**: Election systems should be testable so that election officials have confidence that they meet the necessary criteria and **Transparency: V**oters should be able to possess a general knowledge and understanding of the voting process.

ii. Service Provision Requirement

The infrastructure should allow mobile voters to find registered voting services i.e. Presidential, Gubernatorial, senatorial, Representatives, Chairmanship, Assembly and Council voting service from recognized mobile service providers. The services delivered should be as required by the voter.

3.2 Infrastructural Model and Architect:

i. Overall System Architecture

The architecture used for the proposed infrastructure is based on the Three-tier architecture which consists of the front end, middle tier and back end as shown in Figure 3.1.The web browser (and/or Wireless Application Protocol for mobile devices) constitutes the first tier, a middleware engine using some dynamic web content technology such as: common gateway interface (CGI), Hypertext preprocessor (PHP), Java servlets or Java server page (JSP), Active Server Pages (ASP) constitute the middle-tier and the database end is the third tier. The middle-tier may be multi-tiered. That is, it can be composed of several other servers with designated responsibilities, hence the over-all architecture is said to be N-tier. A fundamental rule in 3-tier architecture is that the client has no direct line of communication with the data tier. All communications are routed through the middleware tier. The n-tier architecture allows for better utilization of resources, **tiering** generally involves placing code modules on different machines in a distributed server environment, tiers make it easy to secure internal systems and ensure security; firewalls are set up to filter all network traffic moving in and out of the enterprise.

The architecture is divided into three phases: the pre-election which is the front end, election and post-election phase which is the back end. The pre-election phase involves the registration of all necessary bodies needed for the election to take place they include: the administrator, citizens (voters), candidates, parties, posts, and languages. The election phase is where the actual voting takes place. The registration number given at the pre-election stage is needed to login and cast the desired vote. All the votes cast by each voter is sent to the database through the middle tier layer of the architecture. The post-election phase is where the results are being processed after the election is over. After a result has been collected the stated result goes through auditing (the votes are recounted) and the final result is shown on the "display result" page on the web. All information here is stored in the centralized server and can be used for future reference. The architecture is represented in the figure 3.

ii. Application framework Overview

Figure 2 gives the platform aware application framework of the proposed voting infrastructure. The architecture is based on client proxy server mobile computing model which uses existing 2G, 2.5G, 3G and emerging mobile wireless networks to provide different services using service oriented architecture(SOA).

iii. Requirement Specification

From the architecture, three main components are required for the development and implementation of the architecture:

a) **Voting devices:** The voting application resides on the voting terminal devices which can be mobile devices, Laptop and Computer with internet access.

b) **Mobile operator:** The mobile operator provides Mobile Web Services through 3G and 4G technology as well as General Packet Radio Service (GPRS) required by voting devices to transfer data.

c) **Application Server:** The application server ensures that the assumption stated in voters' Management Requirement above is met, authorizes and authenticates privilege voters, ensure one-man-vote mechanism, responds to context of communication etc.

iv. Application System Modelling

The model is premised along the system requirement specifications and the architecture. The server is responsible for the voter authentication, authorization, data transfer and message switching. The application system model is divided into three tiers. These are the Presentation Tier, Web Services Tier and Application server Tier.

Presentation Tier

This is the top most level of the application. The presentation tier displays information related to the clients which consists of Computers, laptops, mobile devices and the network operator. It communicates with other tiers by outputting results from the browser/client tier to the Application Server tier using the services provided by the web services tier.

Application Server Tier

The Application Server consists of the backend Application component of Voting System Application which is responsible for execution of requests from the voters using any of the devices at the client end, processing it and sending response back to the client tier.

Web Services Tier

The web services tier consists of the service registry which controls the voters' information as well as the specific election service (presidential, gubernatorial, house of representative and local council) in the database for authentication and authorization.

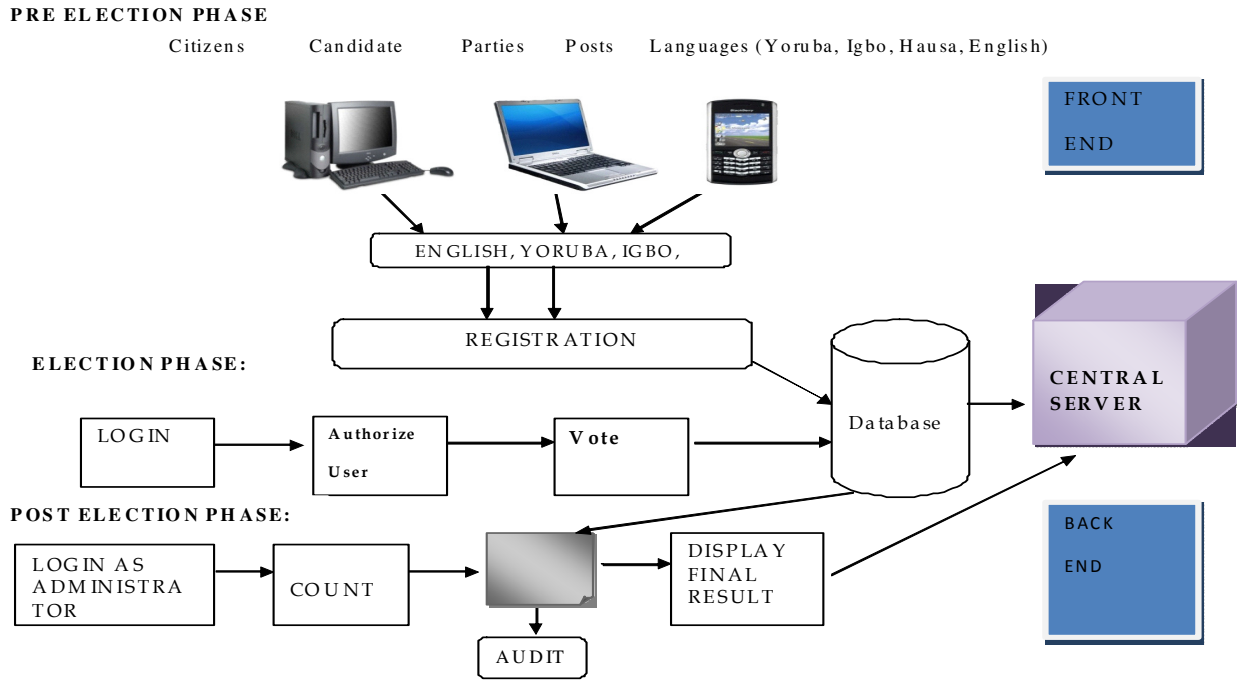


Figure 1: **Model of the Proposed Service Oriented Mobile E-Voting Framework**

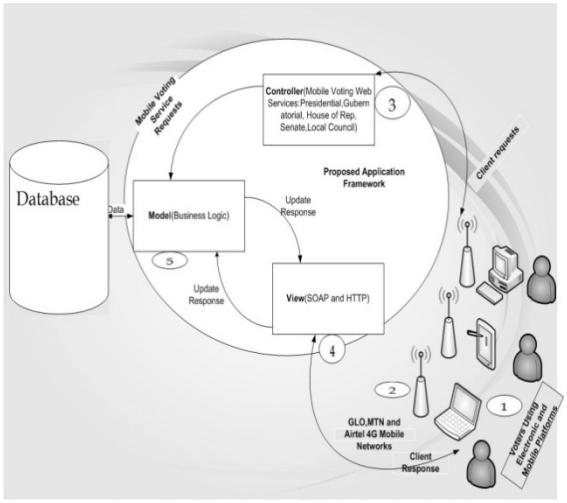


Figure 2: Overview of the Proposed Service Infrastructure Application Framework (Adapted from [20] and [8])

v. The Analysis of the Model

The structure of the proposed model can be analyzed using the Use-Case diagram, Class diagrams and the behavioral/sequence diagram. The use case scenario of the infrastructure is shown in figure 3 showing the interaction of the Voters, Administrator and Electoral commissioner on each tier of the model.

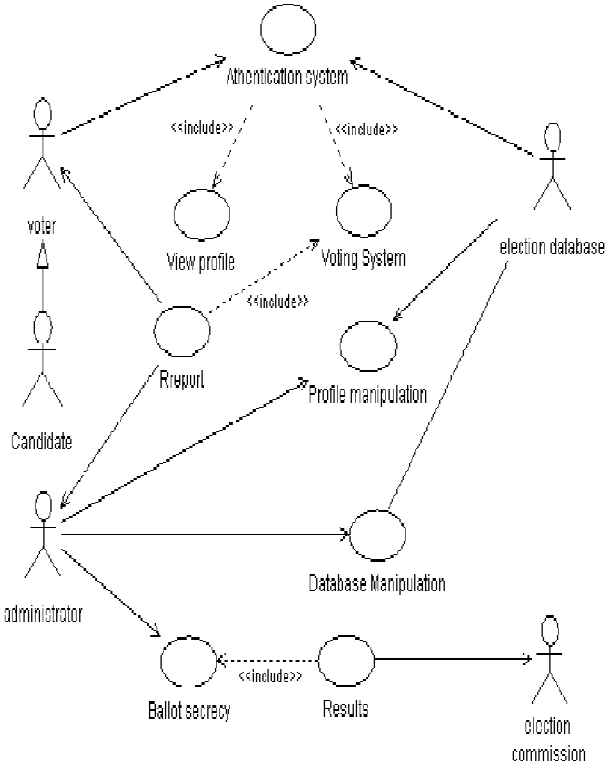


Figure 3 Use Case Diagram for E-Voting Service Infrastructure for Democratic Governance in Nigeria

In figure 3, there are three main actors: the Voter, the system Administrator and the Electoral commissioner. The registered voter login into the desired voting service, get authenticated and cast vote. At the end of the election period the results are processed, audited by the Election commissioner and the final result is shown on the "display result" page on the web. All information here is stored in the centralized server and can be used for future reference.

4.0 DEVELOPMENT/EXPERIMENTAL SYSTEM IMPLEMENTATION

The Google Android Emulator is used to simulate the mobile version of the e-voting system while the hypertext processor (PHP) embedded in HTML is used for the electronic web platform. The result of experimental interactive Client Proxy Server (CPS) mobile e-voting system deployed on our proposed framework is presented here. Starting the application depends on the choice of the user and the mobile version depends on the model of the mobile phone. The screen shot of the Web and Mobile interface for the e-voting system shown in figure 4, 5 and 6as follows:

Login Interface

This interface welcomes the prospective voters to the system. It gives an overview of what the system should look like. It also gives the users opportunity to choose their preferred language (Igbo, Yoruba and Hausa including the official English language).

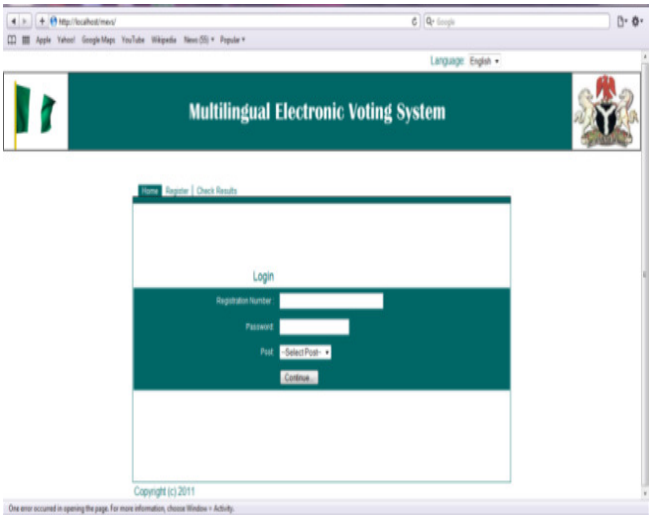


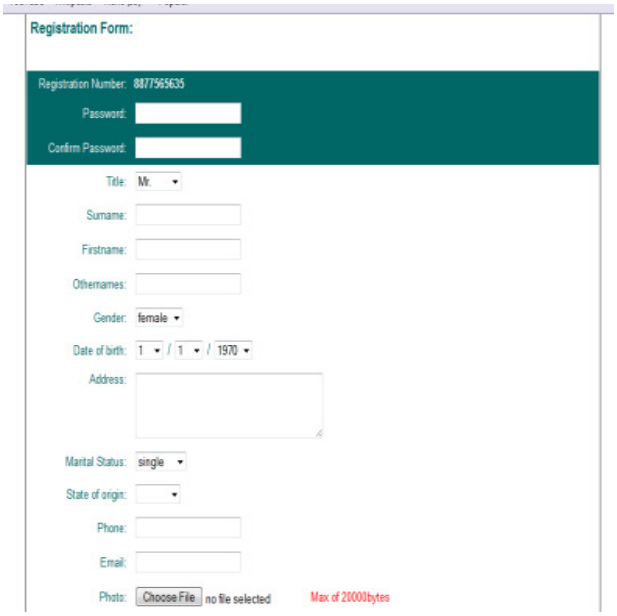
Figure 4.0. **Login Page/ Language Select Page in English**

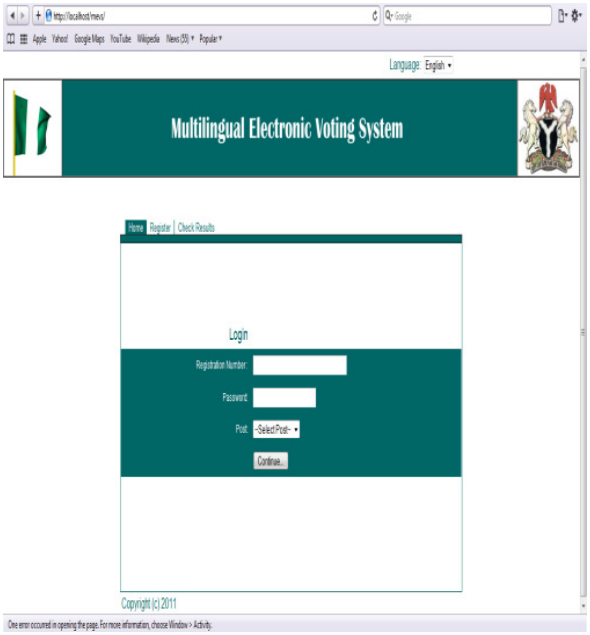
Figure 5.0 **Voters Registration Interface Vote Login Page**

Registration Interface

On Figure 5.0 interface, the prospective voter is expected to supply his personal information; the voter gets the pass word and registration number needed for login into the voting page from this page.

This gives a registered citizen access into the voting page by the issuance of the registration number and password as authentication. The voter also selects the post he wants to vote for presidential, gubernatorial, and local council as shown in figure 7.0.





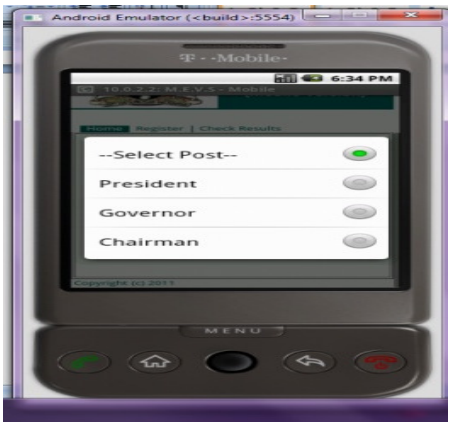


Figure 6.0. **Voters Registration Interface**
Ballot Submission Interface

The voter casts vote on this page for the preferred candidate of the preferred political party.

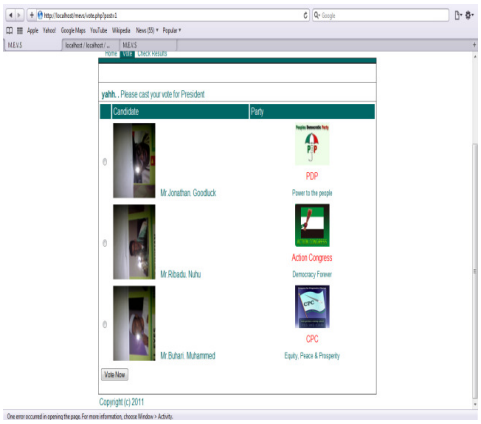


Figure 7.0 **Electronic Voting on the Web and Mobile Device**

End User Awareness
To enable the effective use of the proposed system, end users should be trained appropriately. Orientation, prior media advertorials on TV and Radio, Handbills and user manual would help in ensuring that the voters/users receive adequate training on how to use the software along different platforms. Also, electoral commissions' official may conduct seminars on how to use the system in villages.

Security Concern
Security is a vital aspect of the electronic voting system that may dissuade electorates from patronizing it. The objective of the security is to protect valuable or sensitive electronic voting information while making it readily available. Attackers trying to harm a system or disrupt normal voting processes exploit vulnerabilities in a computer system, security policy and controls by using various techniques, methods, and tools. Parties involved in the proposed voting system are the voter, the wireless mobile service provider and the electoral commission's secure infrastructure. The traffic among the parties is wireless between the mobile voter, the mobile operator and wired from the mobile operator to the electoral commission's secure infrastructure. Although, the security of vote can be guaranteed through a trusted third party involving the mobile operator and the electoral commission, future research direction should look into provision security of vote over open wireless channel of communication.

5. CONCLUSION

A framework for mobile e-voting service infrastructure for developing countries along the experience of its giant, Nigeria has been presented in this research. Some experimental web and mobile applications have been developed based on the framework. The integrated mobile e-voting system would give voters the opportunity of casting votes using the most convenient medium, thus increasing the level of participation and ensure a free, fair, transparent, convenient and confidential electoral processes in future election. The infrastructure provides platform for three major Nigerian languages (Igbo, Yoruba and Hausa) including the official English language to provide confidential result.

This can also speed-up the processing of the result and the capability to display instant result almost immediately after elections. This research will provide a cutting-edge solution to electoral voting services for rural communities where mobile wireless services exists as the mobile devices are more affordable than the PC technology to an average Nigerian citizen [8]. It is, therefore, recommended that electoral bodies in developing countries should take competitive advantages of deploying the proposed mobile e-voting service infrastructure into the conduct of future elections thereby involving mobile wireless providers into their current voting systems. Other areas of future research, therefore, include:

- Quantitative performance metrics of the proposed software model in availability, reliability, response time, speed, throughput, etc.

- Extension of the model to provide Quality of Service (QoS) support and management

Note:
This Manuscript is a revised draft of [21] presented at , 6th International Conference on ICT Applications, Application of ICT to Teaching, Research, and Administration (AICTTRA 2011), 11th -15th September 2011,Obafemi Awolowo University,Ile-Ife, Osun State, Nigeria.

REFERENCES

[1]Ayo C.K, Adebiyi A.A, and Sofoluwe A.B, E-voting implementation in Nigeria: The Success Factors , Journal of Computer Science and its Application, 15 (2), 2008, 91-10.

[2] Avi Rubin (2004):"Security Considerations for Remote Electronic Voting over the Internet", AT&T Labs – Research Florham Park, NJ.

[3] Bashorun M.A. (2011),"Development of a Multilingual Voting System for Developing Countries: The Nigeria Experience", B. Tech Dissertation, Bells University of Technology, Ota, Ogun State,Nigeria.

[4] Enokela, J.A. and C.C. Osuagwu.,An Algorithm for the Display of Results of Multiple Elections involving Multiple Candidates using a Microcontroller and Character LCD Display Modules", Pacific Journal of Science and Technology, 11(2), 2010,278-282.

[5] Folorunso, O; Ogunseye, O.S; Okesola, J.O and Olaniyan, O.M, Visualizing E-voting Results, Journal of Theoretical and Applied Information Technology, 16 (1),2010, 57-69

[6] Giampiero E.G. (2007):"E-Voting through the Internet and with Mobile Phones", Statistical Office Canton Zurich, Switzerland

[7] Manish K, Suresh K.T, Hanumanthappa. M, Evangelin G. D:"Secure Mobile Based Voting System", Retrived online at http:// www.iceg.net/2008/books/2/35_324_350.pdf

[8] Oladosu J.B,Emuoyinbarfe. O.J,Ojo S.O and Adigun O.M (2009), Framework for a Content-Aware Mobile E-health Service discovery infrastructure for Rural/Suburban health care ", Journal of Theoretical and Applied Information Technology, .16 (1), 2009 , 81-91.

[9] Mohammad M., Mohammed K., and Omar Al-Jarrah, " Modelling and Simulation of a Robust E-voting System", Communication of Information Management Association (IBIMA) Journal, Volume 8,2009, pp 198-206.

[10] National Science Foundation. Report on the National Workshop on Internet Voting: Issues and Research Agenda, Mar. 2001. http://news.findlaw.com/cnn/docs/voting/nsfe-voterprt.pdf

[11] Olurotimi A.(2011),"Jega Admits flaws and irregularities in 2011 Elections", Retrieved at http://africanheraldexpress.com/blog7/2011/05/11/jega-admits-flaws-and -irregularites-in-2011-elections/on 21st June 2011.

[12] Pieters.W; Becker M.J (2005):"Ethics of e-voting: An essay on requirements and values in Internet elections", Institute for computing and information sciences Radboud University Nijmegen

[13] Selker, T. 2004. "Fixing the Vote". Scientific American. 90-97. http://www.sciam.com.

[14] Tom Forest (1995), Politics and Economic Development in Nigeria, Oxford View Press, Retrieved at http://www.jstor.org/stable/221131/ (15th June 2011)

[15]Iyayi F, (2004), The Conduct of Elections and electoral Practices in Nigeria, [online], http://nigerianbar.com/papers3.htm (17h June 2011)
[16]Wikipedia(2011),Plurality voting system, Retrieved online , http://wikipedia.org/wiki/plurality_voting_system (17h June 2011)

[17]Wikipedia (2011) Preferential voting system, [online], http://wikipedia.org/wiki/Preferential_voting (17th June 2011)

[18] Wikipedia (2011) Plurality-at-large voting [online], http://wikipedia.org/wiki/Plurality-at-large_voting (19th June 2011)

[19] Sanni Tunde (2007), Police Dock INEC Officials and others. This Day [Online] Jan.2007

[20] Olaniyi O.M., Ajose S. O., Adegoke A.M., Development of Mobile Airline Reservation and Payment System", International Journal of Electronic Finance (IJEF), Vol.4 (4), 2010, pp 372-389.

[21] Olaniyi, O.M, Adewumi D.O, Oluwatosin E.A, Arulogun, O. T., Bashorun M.A **(2011),** " Framework for a Multilingual Mobile E-Voting Service Infrastructure for Democratic Governance in Nigeria",pp118-130, 6th International Conference on ICT Applications, Application of ICT to Teaching, Research, and Administration (AICTTRA 2011), 11th -15th September 2011, Obafemi Awolowo University,Ile-Ife, Osun State, Nigeria.