Bandwidth and Resource Allocation for Full Implementation of e-Election in Nigeria

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Abstract

Voting is an act of democracy. Citizens are given the opportunity to voice their opinions by voting. Involving technology will enhance the process by ensuring that every citizen irrespective of his/her abilities or disabilities can exercise such rights. This research work seeks to bring to fore the full benefits of implementing complete e-Election in Nigeria and also using an M/G/S based simulation software predicted the bandwidth as well as resource allocation for an effective conduct of e-voting, which has become more and more glaring with the failure of over 78 years old practice of paper balloting. The study proposed a Public Network Direct Recording Electronic (PNDRE) Voting System which stands out as the ideal option for Nigeria.

Key words: voting system, OMR, direct data capture, PNDRE, bandwidth

1.0 Introduction

In many areas of modern life today, technology dominates. It is believed that technology is progress; progress is good and should, therefore, be embraced. Countries in all the continent of the world are at various stages of piloting or partially using election voting and counting technologies, including the use of Internet voting [1]. There is a wide variety of different voting systems that are based on traditional paper ballots, mechanical devices, or electronic ballots [2]. The advancement of information and telecommunication technology allows for a fully automated online computerize election process in addition to overcoming commonly encountered election pitfalls, electoral vote counts are done in real time, that by the end of election day, the results are automatically out [3],[4]. The protest and election petitions cases in tribunals challenging election results as well as apathy on Election Day in Nigeria are indicators that it is time to change.

This work proposes a method which will best suit Nigeria as a Nation taking into consideration the latest technology and infrastructure available. Public Network Direct- Recording Electronic (PNDRE) voting System, which is a hybrid of the direct- recording electronic (DRE) voting system with various remote voting options via mobile phone, internet and fax, using a public network platform, is the way to go. The work, also using simulation software employing stochastic processes, predicted two very important parameters which if not properly distributed and applied can jeopardize any election process. These are bandwidth and voting machine allocation on Election Day.

1.1 The history of Elections in Nigeria

The history of Elections in Nigeria dates back to the post independence Period, when the Electoral Commission of Nigeria was established in 1964.

Since then the bodies name has been changed to Federal Electoral Commission (FEDECO) in 1978, National Electoral Commission (NEC) in 1987, National Electoral Commission of Nigeria (NECON) 1993 and Independent National Electoral Commission (INEC) in 1998.The present method of voting in Nigeria is the Open Secret Ballot System (OSBS), where ballot paper is used.

In 2002, the Independent National Electoral Commission (INEC), introduced the Electronic Voter Registration (e-Registration). This was to cater for the following problems and limitations: unreliable voter registration data base file, absence of a credible voter identification system and tools, fraudulent electoral system process, and lack of appropriate voting technology which characterized the manual register.

The e-Registration was done using the Optical Mark Recognition (OMR) Technology. It was later abandoned due to errors in the database caused by limited time and poorly trained ad- hoc staff for the registration exercise.

A fresh voter register had to be compiled in 2006, leading to the 2007 polls using the Direct Data Capture (DDC) technology. The DDC incorporated pictures of registrants which was lacking in the OMR.

All efforts to implement e-voting in Nigeria were blocked by the National Assembly in 2006, which only approved the e-Registration aspects of the e-election process proposed by INEC. This was also abandoned, as it also suffered the same fate as the OMR method. Then a fresh registration was conducted in 2010 still using the DDC technology.

1.2 Proposed voting system for Nigeria.

The direct-record electronic (DRE) voting system is the most advanced and user-friendly voting system available today.DRE voting machine can offer many compelling benefits, including good usability and accessibility, multiple languages, and elimination of over voting and unintentional under voting [5]. When combined with transmission of ballots and votes via telephone, private computer network or the internet, it will present the most ideal e-voting by extension e-election Nigeria as the country needs to cater for the various set-backs experienced in time past while conducting election using ballot paper.

Combining DRE with other forms of voting produces two types of e-voting opportunities;

- **(i) E-voting which is physically supervised by Election Management Board (EMB)- DRE machine**
- **(ii) Remote e-voting where voting is performed within the voter's sole influence, and is not supervised by the EMB (INEC), example voting from PC, mobile-phone television, via the internet (i-voting) .This combination is called Public Network DRE (PNDRE).**

A public network DRE (PNDRE) voting system is an election system that uses electronic ballots and transmits vote data from the polling place to another location over a public network. The PNDRE voting system can utilize either precinct count or central count method.

1.3 Components of PNDRE

The components that make up the proposed PNDRE voting system are: a laptop, scanner, printer, USB hub, camera, power packs, and network MODEM, user interface MODEM, voting device for disable (machine) persons, voting machine. Fig.1 shows the interconnection of the components fig. 2 Shows interconnections for remote voting capability as well as real time result computation devices which includes mobile phone, PC with internet connection, servers, public network (backbone). Figs 3-5 show the interconnection of servers (WAN) at Local Government, State and National levels.

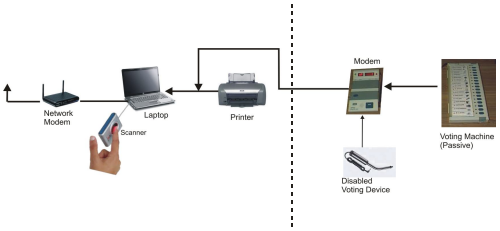

Fig. 1: Design of DRE using the existing DDC machines connected via a modem to a voting Machin

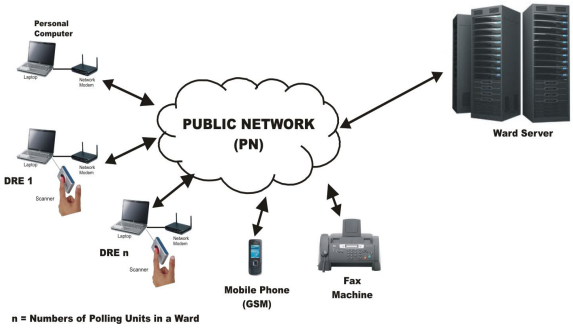

Fig. 2: A typical Ward Wide Area Network (WAN) for actualizing PNDRE voting system

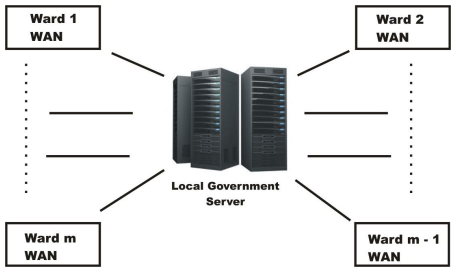

Fig. 3: Local Government WAN System for Real Time Results Transmission

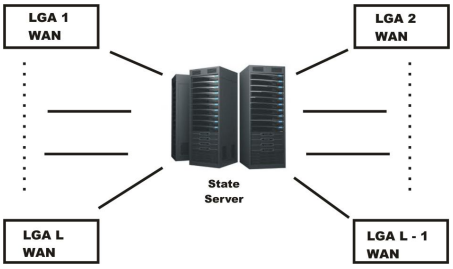

Fig. 4: State WAN for real time transmission of results

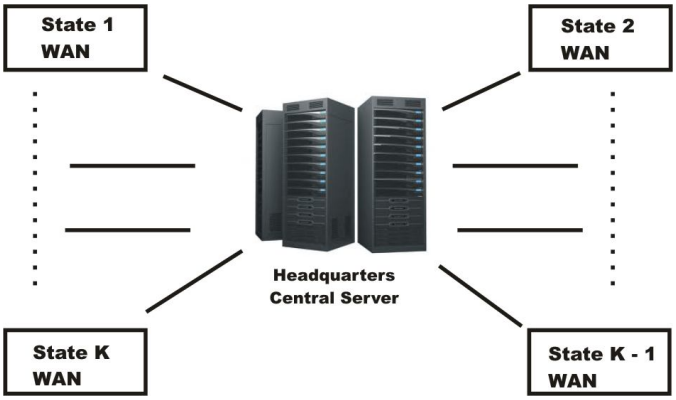

Fig. 5: National WAN for Real Time Transmission of Results

The DRE has a laptop as the main active device, with software to interpret effectively the signals from the various passive devices connected to it. It is expected to:

- **Process data from scanner during voter authentication (accreditation) and produce a voter list from the voter register in it.**
- **Receive, send and process signal from the public network.**
- **Have security against hacking and virus attack.**
- **Form the operator terminal where permission to vote is activated for each voter in turn.**
- **Process data from user interface MODEM of the two voting machines connected to it namely, the voting machine and disable voting device.**

The DRE is made of two sections; the operator device and the user device connected by a 5m cable. (See Fig. 1).The voting machines are basically passive devices and their signals can only be processed by the laptop. The voting machine has pictorial looks, like a typical ballot with buttons beside each party for voters to press in, while making their choices.

The disabled voting devices can employ voice technology for blind voters or maybe a device known as sip and puff for those with little or no mobility and other such devices as will be needed by the disables. It is expected that a special centre, one in each local government should provide for such needs.

The printer prints the voter list for eligible voters after accreditation, a receipt for voter after voting , the final result after polls , and the audit trail of activities that the computer was engaged in a period so desired.

Through the public network and internet MODEM, the DRE and the various remote voting devices are inter connected to the various severs at the ward levels, local government levels, State and National levels for collation of result. This mesh structure is important for Nigerian political structure which supports collation at the various levels so mentioned. (See Figs 2, 3, 4 &5).

When PNDRE system is employed in election, the advantages include; no risk of exhausting the supply of ballots; it removes the need for printing of paper ballots which is a significant reduction in cost; it can be programmed to provide ballots in multiple languages for a single machine; this attribute is unique to electronic voting. Electronic voting machines can be made fully accessible for persons with disabilities. It can use headphones, sip and puff, foot pedals, joysticks and other adaptive technology to provide the necessary accessibility for the various forms of disabilities etc. Remote voting is facilitated by internet, phones, personal Computer and even via fax and email, making it possible for Astronauts in orbit to vote.

2.0 Materials and Method

The simulation environment is made up of one central server and ten laptops representing ten

voting stations. Using a simulation model that is a generalised (M/S/G) queuing model system where voters randomly arrive according to a Poisson random process. The inter-arrival rate is controlled by the mean time between successive arrivals all governed by an exponential distribution and introducing a random delay to compensate for inter-net transfer time, since both central DB server and local voting machine are located within the same network segment for this experiment. The effect execution of e-–election (e-voting) is predicated on two very important parameters which are: bandwidth of network and resource allocation e.g. voting machine. The transfer time is a function of bandwidth and message size.

The metric used by the simulator are

i. The voting (simulation) time
ii. Average queue length of voters
iii. Waiting time of voter
iv. Voting machine requirement at each ward

3.0 Results

There are three bandwidth sizes in this work;

a. A I Mbps is a conservative bandwidth.
b. A smaller bandwidth 128kbps
c. A bigger bandwidth 10mbps for a more developed network.

3.1 Bandwidth Requiremen

BW	Average Services time											
	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
128KB	9.8	10.2	10.5	9.8	10	10.1	9.6	10.2	9.8	10.4	10	9.4
IMB	7.5	8.0	8.2	7.6	7.8	7.9	7.5	7.9	7.4	8.1	7.5	7.3
10MB	7.3	7.8	8.0	7.4	7.6	7.7	7.3	7.7	7.2	7.9	7.3	7.1

Table1. Average service time (minute)

The type WAN bandwidth applied has an impact on the model performance table (1) shows the average service time for the three different bandwidth values (128wp5, 1mbp5 ad 10 Mbp5). Which show results various station. It can be seen that beyond 1Mbps marginal utility become negative, as any pronounced improvement in the bandwidth size will begin to diminish.

BW	Average queue lenght											
	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
128KB	550	480	410	350	380	380	390	380	460	405	345	407
1MB	150	110	115	120	150	160	110	105	150	115	105	150
10MB	80	85	100	90	85	50	48	52	55	60	70	75

Table 2, on the other hand shows the average queue length for different bandwidths. The average queue length for a 128 kps bandwidth can be 3 times as big as a that of 1Mbps queue length. It can be seen that the performance improvement beyond Mbp5 is rather insignificant.

RESOURCES ALLOCATION (VOTING MACHINE)

When the number of voters for a ward is relatively large can/or the arrival of voters is high, the parameter which can easily be tuned is the allotting or addition of more machine as required[6]. This is a very important parameter as it is within the control of an EMB. For a distributed network system the impact is appreciable, as the load is distributed locally without a significant impact on the main server. Unlike the centralize DB network approach where addition of voting machine may not improve the results significantly, as the machine supply shift the overload from the local station on the main (central) server.

Table3 shows the number of voting machine required to complete all election transactions within 8 hours for different population of different wards.

Assuming

i. A 1Mbps bandwidth and
ii. A cluster policy in a distributed architecture.

No of Machines	No of Voters
7	4000
9	8000
22	12,000
26	16,000
38	20,000

Table3 Voting Machine Allocation for different voting strength

SUMMARY

The role of technology in conducting elections across the globe cannot be over emphasized. The availability of Public network backbone almost everywhere in Nigeria in form of internet connectivity and GSM (mobile phone) has even made it easier and cheaper to

implement and reap full benefit of its introduction which are reliability, fraud free and cheap elections..

This research work looked the most ideal voting system, a hybrid of the DRE and other form of the remote voting options like internet voting, mobile phone voting etc., through a Public network backbone, this system is called Public Network Direct Recording Electronic (PNDRE) voting system. This system has distinguishing features that makes it stand out, these features are as follows:

- Ability for those with disabilities to vote
- Accuracy in computation of result
- Real time computation of result
- Provision of paper auditing and so on.

This work looked at how best to deploy two main parameter that are very important to a successful e-voting process, Using an M/G/ S based simulation software, predictions were made as to how many voting machines are required for each ward and the ideal bandwidth for effective transmission of data during election.

RECOMMENDATIONS

For PNDRE voting system to perform well and bring the best output, it is important the following be put in place:

I. Improved Network (Public and Private) system be deployed across the country.

II. Pilot scheme be run in at least three states, Lagos, Kano, and Abuja in 2015 general elections while other states use the usual ballot paper voting system with electronic accreditation using the e-authentication device.

III. Proper development of man power in all relevant areas of need should start now for persons to be engaged in the future. This can be achieved if the IT training in higher institution includes those areas of handling minor faults and operating of such devices. The National Youth Service Corps(NYSC) orientation camp is another place for such training.

IV. Development of a national data bank with all citizen having personal identification number (PIN) that can serve as Voter Identification Number (VIN) for election purposes, should be seriously considered. It is vital tool for achieving remote voting capabilities.

CONCLUSION

The introduction of computer and computer networking in the election activities in Nigeria will in no small measure improve the way the business of election management and indeed governance in general is handled. Electronic election (e-Election) in Nigeria will eliminate the infelicities that have characterized previous elections in the following ways:

- Introduction of voter authentication through biometrics (finger prints and Iris of the eye)
- Instantaneous transmission of results from polling station to collation centre making falsification impossible.
- Ballot box stuffing will be eliminated.
- It delivers a higher degree of accuracy of both the voting method and the transmission of results.
- It offers a better election result management since result can be calculated and published in good time.

- **Paper trail will be printed from the polling station reflecting the summary/calculation of result at each polling station, avoiding the alteration at any stage.**

- **This system will lend itself to easy use by the barely literate (user-friendly).**

- **It will also be powered by solar system charged batteries.**

- **Disables will be given the opportunity to vote**

- **It will in the long run reduce the cost of holding an election, as it will greatly reduced human and economical resources, not to talk of the tons of paper used previously that will be eliminated almost entirely.**

The complete implementation of this work will be all inclusive, with the Direct Recording Electronics (DRE) voting system, internet voting system, and voting by fax and mobile phones being part of it. This will increase the voting points and solve the major problems of apathy and other problems associated with polling unit voting. It will also incorporate real time result transmission that will ensure all results are gotten 2 hours after close of polls. Most importantly this work will help electoral official to effectively deploy resources during election

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