A BLOCKCHAIN IMPLEMENTATION MODEL FOR ELECTRONIC VOTING SYSTEM

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) IN MANAGEMENT INFORMATION SYSTEM IN THE DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES, COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY, OTA, OGUN STATE, NIGERIA

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ACCEPTANCE

This is to attest that this thesis is accepted in partial fulfillment of the requirements of the award of the degree of Doctor of Philosophy (Ph.D) in Management Information Science in the Department of Computer and Information **Sciences**, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria.

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DECLARATION

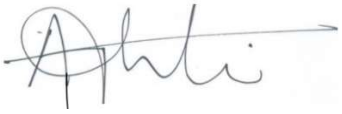
I, **APEH, JONATHAN APEH (15PCH01171),** declare that this research was carried out by me under the supervision of Professor Charles K. Ayo of the Department of Computer Science, Trinity University, Yaba, Nigeria, and Professor Ayodele A. Adebiyi of the Department of Computer Science, Landmark University, Omu-Arun, Nigeria. I attest that the thesis has not been presented either wholly or partly for the award of any degree elsewhere. All sources of data and scholarly information used in this thesis are duly acknowledged.

APEH, JONATHAN APEH

Signature and Date

CERTIFICATION

We certify that the thesis titled **"A BLOCKCHAIN IMPLEMENTATION MODEL FOR ELECTRONIC VOTING SYSTEM"** is an original research work carried out by **APEH, JONATHAN APEH (15PCH01171),** in the Department of Computer and Information Sciences, Covenant University, Ota, Ogun State, Nigeria, under the supervision of Professor Charles K. Ayo and Professor Ayodele A. Adebiyi. We have examined and found the work acceptable as part of the requirements for the award of Doctor of Philosophy (Ph.D) degree in Management Information System.



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DEDICATION

I dedicate this thesis to my Heavenly Father – the source of wisdom and in whom is no variation or shadow of turning. I also dedicate it to my wife Mrs. Eunice Apeh and my daughters Jewel and GodsHeir; my dad Elder Matthew E. Apeh, my mum Mrs. Joy M. Apeh, and my brother Charles E. Apeh.

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LIST OF ABBREVIATIONS AND SYMBOLS

ACRONYMS	FULL MEANINGS
AES	Advanced Encryption Standard
ATM	Automated Teller Machine
BEL	Bharat Electronics Limited
BG	Byzantine Generals
BEV	Blockchain Electronic Voting
BTC	Bitcoin
BIP	Bitcoin Improvement Plan
CDH	Computational Diffie-Hellman Problem
DDCMs	Direct Data Capture Machine
DLT	Distributed Ledger Technology
DRE	Direct Recording Electronic
DiFi	Distributed Finance
DPoS	Delegated proof of stake
DDoS	Distributed Denial of Service
Dapp	Decentralized application
ECDSA	Elliptic Curve Digital Signature Algorithm
EOA	Externally Owned Account
EVM	Election Virtual Machine
ES&S	Electronic System and Software
INEC	Independent National Electoral Commission
PIN	Personal Identification Number
PoW	Proof of Work
PoS	Proof of Stake

PBFT	Practical Byzantine Fault Tolerance
JSON	JavaScript Object Notation
LTC	Litecoin
LCD	Liquid Crystal Display
LLL	Low-level Lisp-like Language
RSQ	Random Security Question
RSA	Rivest, Shamir, Adleman
RPC	Remote Protocol Call
OTP	One Time Password
PVC	Permanent Voters Card
PU	Polling Unit
SLA	Service Level Agreements
SPV	Simplified Payment Verification
SCR	Smart Card Reader
SIM	Subscriber Identification Module
SUS	System Usability Scale
TXID	Transaction Identity
TCP	Transmission Control Protocol
IoT	Internet of Things
TPS	Transactions per second
UPS	Uninterrupted Power Supply
VVPAT	Voter Verifiable Paper Audit Trail

ABSTRACT

The rate of Blockchain technology adoption is on the increase as seen in the cryptocurrency and Distributed Finance (DiFi) domain. The technology is also attracting lots of attention in many other application areas including the electronic voting(e-voting) system. The electronic voting system is an interesting use case for blockchain technology because critical problems within that space, specifically, the integrity of voting data, the secrecy of the ballot, and a single point of failure can be tackled with the technology. However, the scalability and latency of the blockchain network are two major challenges. This research, therefore, evolves a scalable, latency-improved blockchain implementation model for a Nation-Wide Electronic Voting System. The model is validated by a series of procedures: firstly, data collection, which involves observations, interviews, and the use of secondary data sources. The interview involved five Independent National Electoral Commission (INEC) personnel from the voters' education department and the Information and Communication Technology unit. Secondly, the model was designed using a combination of algorithm, software tools, and design decisions. The design decisions were built on the result of the analysis of four major blockchain networks (Bitcoin, Ethereum, Litecoin, and Dogecoin). Thirdly, the model implementation which is made of the steps taken to develop the proposed model. The implementation method includes setting up the node, creating a private blockchain network, creating a distributed application (DAPP) and the smart contract deployment. The Ethereum Virtual Machine, Solidity, and MongoDB were used to implement the model. The fourth procedure is the evaluation of the model performance from scalability, latency, and usability standpoints. The result from the latency evaluation showed a 99.36 percent improvement on the existing blockchain-based e-voting system; the scalability result shows the proposed model takes an average of 2.6 minutes to spin up a new node; the System Usability Scale (SUS) result shows a usability perception of 76 percent which is above average. The model therefore serves as a novel contribution to the application of blockchain technology to large scale e-voting like national election.

Keywords: Blockchain, Election Results Integrity. Electronic Voting System, INEC, Latency, Scalability.