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Enhanced Network Technologies for Secure E-voting Architecture

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Abstract:
Electronic voting comprises many kinds of tasks which include e-voter registration, casting a vote, counting and transmission of votes to a tallying station. Transmission of votes from polling station to a tallying station require a backbone infrastructure or core network build from Fiber optic, 4G system, Wi-Fi technology and Wireless Local Area Network. The purpose of this paper was to establish the network technologies necessary for designing a secure e-voting architecture. E-voting implementation in developing countries is hindered by lack of Internet connectivity and implementation of multi-biometric technologies. An E-voting architecture based on a polling station setup involving Local Area Network using 3G/4G technology for data transfer was developed. This study was undertaken using mixed method design which included survey design, content analysis and Design Science Research. Purposive sampling technique was used to sample sixty-six election coordinators and their deputies and two Information Communication Technology Officers from two Independent Electoral and Boundaries Commission (IEBC) regions of Kakamega and Bungoma. The study found that network technologies necessary for designing a secure e-voting architecture vary in their application. The finding of this study is significant to IEBC and to the government in enhancing use of E-voting to improve transparency.

Keywords: *E-voting architecture, Network Technologies*

1. Introduction

Electronic voting comprise many kinds of voting which includes e-voter registration, casting a vote, counting and transmission of votes to a tallying station. The voter usually chooses the candidates with the aid of a touch-screen display, audio interfaces for voters with visual disabilities, using barcode reader. The basic steps in an election process include; candidate registration, voter registration, ballot composition, vote casting, vote recording, and vote counting (Dimitris, 2002).

The plan of a good voting system, whether, electronic voting, manual voting or using mechanical devices must satisfy a competing criteria. The anonymity of a voter's ballot must be preserved (Cetinkaya & Doganaksoy, 2006) both to guarantee the voter's safety when voting against a malevolent candidate, and to guarantee that voters would not know which candidate they voted for. The voting system must be resistant to tamper in order to thwart a wide range of attacks, including ballot filling by voters and incorrect tallying by insiders. The new E-voting architecture was developed with this in mind where Local Area Network, 3G/4G, Optical Fibers, WI-FI and Wireless Local Area Network technologies were considered for safe data transfer from the polling booth to the polling station server, from the polling station to the constituency tallying station and ultimately to the national tallying station.

According to Riaz &Mahesh, (2009), broadband communications comprises of the technologies and equipment required to distribute packet based digital voice, video, and data services to end users. Broadband gives end users high-speed, always-on access to the Internet while giving service providers the capacity to provide value-added services to grow revenues. Because of the growth of the Internet, there has been an improvement in the speed of inter-city communications links that connect population centers and Internet service providers (ISPs), points of presence (PoPs) around the world. This is build out of the backbone infrastructure or core network that has occurred mainly via optical transport technology. Broadband access technologies are being used to solve the bandwidth bottleneck for the connection of homes and small businesses to this infrastructure. Broadband access to the home allows telecommuting by providing a similar environment where people are physically present in their offices: synchronized telephone and computer access, quick Internet and intranet access for electronic message, file sharing, and access to corporate servers.

The paper is organized as follows. Section 1.2 provides an overview of Fourth and Fifth Generation Mobile Technology. Section 1.3, describes Local Area Network. Section 1.4 Presents Review of Fiber Optic Communication. Section 1.5 describes Wi-Fi technology. Section 1.6.1 presents Internet usage. Section 1.6.2 presents Internet penetration. Section 2.1 provides Problem statement. Section 3.1 presents research Methodology. Section 3.2 presents Study population. Section 3.3 presents Data analysis. Section 4.1 presents the Findings and 5.1presents Discussions and finally the Conclusions and Recommendation are given in section 6.1 and 7.1 respectively.

1.1. Fourth and Fifth Generation Mobile Technology

4G Technology is the extension in the 3G technology offering more bandwidth and services than those of 3G. The important 4G services to user's area application adaptability and high dynamism users' traffic, quality of service, air interfaces and radio environment. Some of the application of 4G technology includes 4G Data intensive interactive user services, 4G Ultra high speed internet access, 4G Location-based services etc. (Priya, Savneet, Ramandeep, Sumeet and Harish, 2014).

The fourth-generation wireless mobile network (4G) an All-IP based Network architecture provides low-cost implementation, high data rates, low latency. The fifth generation wireless mobile network (5G) on the hand makes use of Flat-IP Network architecture does provides very high data rates and increased spectrum efficiency, average cell throughput and supports ubiquitous computing hence supporting applications that require very high data rate and uninterrupted access to the internet(Pratik and Anish, (2014), Mohammed and Zouhair, (2010)).

Cellular generations differ, in four main aspects: radio access, data rates, bandwidth and switching schemes and that 5G (Fifth Generation) network architecture consists of reconfigurable multi-technology core and a single fully reconfigurable terminal able to separately operate in diverse heterogeneous access. The Fifth Generation network is enforced by nanotechnology, cloud computing and based on All IP Platform. In this study,Local Area Network that used 3G and 4G technologies for transferring data to the tallying centres was used. 5G technology when in place will enhance data transfer in the e-voting architecture Anwar, (2012).

1.2. Local Area Network

Local Area Network (LAN) is small networks which allow easy access to the computers or peripherals. The computers in this kind of network can be linked together for different purposes and using a diversity of different cabling types. This leads to smaller amount of wastage of time and hence increased productivity. LAN is described by factor such as Medium Access Control (MAC), Topology, and transmission medium which offer security (Velaga, Immadisetty & Rama, 2012). The voters used Local Area Network to cast their votes in the E-Voting architecture.

Most network technologies are built on wire line solutions. According to Sourangsu, & Rahul, (2012) the introduction of the IEEE 802.11 Wireless LAN technology standards have made a huge influence on the market such that laptops, PCs, printers, cell phones, and VoIP phones, MP3 players in homes, in offices and even in public areas have combined the wireless LAN technology. Wireless broadband technologies currently deliver unrestricted broadband access to users who previously used wire line. The Local Area Network in the polling can be implemented using Wireless or wired network.

1.3. Fiber Optic

Optical fiber has high bandwidth for communication and low attenuation features make it ideal for gigabit transmission. The telecommunications industry has been transformed by Fiber optic. Telecommunications links created using fiber optic cables pans so much greater distances and has enabled much higher data rates to be accommodated. Fiber optics cables transmit data in the form of light signals hence very safe. When compared to copper cables which uses high-voltage electrical transmitter whereas fiber optic has less signals and uses lower power transmitter to send information ultimately reducing cost and maintenance, saving money for customers (Ritesh and Dattatraya, (2013), Prachi,Suraj, Rohit and Mandeep, (2013)). Optical fibers provide huge and unmatched transmission bandwidth with insignificant latency, and are now the transmission medium of high-quality for long distance and high data rate transmission in telecommunication networks (Francis, Dike and Orovwode, (2014)).

1.4. Wi-Fi

Wi-Fi uses radio waves to connect devices wirelessly without the expense of cumbersome cables. Wi-Fi supports variable data rates up to 11 Mbps with a range of approximately 50 meters and allows users to gain convenient wireless internet access. Security due to its high vulnerability is enhanced by Wi-Fi Protected Access, created by the Wi-Fi Alliance which provides a 128-bit encryption of data that is being transmitted and locks on to individual computers and changes the access key frequently (Vandana, 2006).

1.4.1. Internet Users in Kenya

Internet Users in Kenya in 2016 rose to 21,248,977 yielding a share of Kenya Population of 45 % penetration. The total population of 47,251,449 is equivalent to a share of World Internet users at 3,424,971,237 (0.6 %).Table 1 shows internet users in Kenya in the years 2011-2016.

Year	Internet Users**	Penetration (% of Pop)	Total Population	Non-Users (Internetless)	1Y User Change	1Y User Change	Population Change
2016*	**21,248,977**	45 %	47,251,449	26,002,472	3.7 %	763,171	2.61 %
2015*	**20,485,806**	44.5 %	46,050,302	25,564,496	5.2 %	1,015,011	2.65 %
2014	**19,470,795**	43.4 %	44,863,583	25,392,788	14.3 %	2,430,571	2.68 %
2013	**17,040,224**	39 %	43,692,881	26,652,657	24.8 %	3,383,928	2.7 %
2012	**13,656,296**	32.1 %	42,542,978	28,886,682	17.8 %	2,058,709	2.71 %
2011	**11,597,587**	28 %	41,419,954	29,822,367	105.4 %	5,951,623	2.71 %
2010	**5,645,964**	14 %	40,328,313	34,682,349	43.2 %	1,703,257	2.69 %

Table 1: Internet Users in Kenya

Source: adopted from (Internet Live Stats (www.InternetLiveStats.com)

From Table 1 it can be seen that internet users doubled from the year 2010 to 2011 and then from 2011 through 2015 the internet users increased by less than 10%. From 2015 to 2016 there was only an increase of 0.5%. Nevertheless the significant growth of internet users indicates that 3G/4G infrastructure is available for transferring data from polling station to tallying in the e-voting architecture.

1.4.2. Africa Population and Internet Penetration Statistics for 2017

Kenya's internet penetration stood at 77.80% in 2017 as shown in Table 2.

	AFRICA 2017 POPULATION AND INTERNET USERS STATISTICS FOR 2017						
	AFRICA	Population (2017 Est.)	Internet Users 31-Dec-00	Internet Users 31-Mar-17	Penetration (% Population)	Africa Internet % Users	Facebook 30-Jun-16
1	Kenya	48,466,928	200,000	37,718,650	77.80%	10.90%	5,500,000
2	Cabo Verd	533,468	8,000	235,183	44.10%	0.10%	210,000
3	Gabon	1,801,232	15,000	670,197	37.20%	0.20%	470,000
4	Algeria	41,063,753	50,000	15,105,000	36.80%	4.40%	15,000,000
5	Egypt	95,215,102	450,000	34,800,000	36.50%	10.10%	32,000,000
6	Botswana	2,343,981	15,000	690,000	29.40%	0.20%	690,000
7	Ghana	28,656,723	30,000	7,958,675	27.80%	2.30%	3,500,000
8	Angola	26,655,513	30,000	5,951,453	22.30%	1.70%	3,500,000
9	Cote d'Ivo	23,815,886	40,000	5,230,000	22.00%	1.50%	2,400,000
10	Equatorial	894,464	500	181,657	20.30%	0.10%	67,000
11	Cameroon	24,513,689	20,000	4,909,178	20.00%	1.40%	2,100,000
12	Gambia	2,120,418	4,000	373,865	17.60%	0.10%	220,000
13	Djibouti	911,382	1,400	150,000	16.50%	0.00%	150,000
14	Burkina Fa	19,173,322	10,000	2,156,498	11.20%	0.60%	600,000
15	Ethiopia	104,344,901	10,000	11,538,000	11.10%	3.30%	4,500,000
16	Benin	11,458,611	15,000	1,232,940	10.80%	0.40%	800,000
17	Congo	4,866,243	500	400,000	8.20%	0.10%	400,000
18	Comoros	825,920	1,500	60,000	7.30%	0.00%	60,000
19	Guinea	13,290,659	8,000	950,000	7.10%	0.30%	950,000
20	Central Af	5,098,826	1,500	246,432	4.80%	0.10%	66,000
21	Burundi	11,936,481	3,000	526,372	4.40%	0.20%	450,000
22	Guinea-Bi	1,932,871	1,500	84,000	4.30%	0.00%	84,000
23	Congo, De	82,242,685	500	3,101,210	3.80%	0.90%	2,100,000
24	Chad	14,965,482	1,000	387,063	2.60%	0.10%	170,000
25	Eritrea	5,481,906	5,000	71,000	1.30%	0.00%	63,000
26	Lesotho	2,185,159	4,000	444,376			

Table 2: Africa population and internet penetration statistics 2017

Source: adopted from (Internet Live Stats www.InternetLiveStats.com)

Kenya has the highest percentage of internet penetration at 70.8% as shown in Table 2.There is a remarkable high penetration in other African countries. The e-voting architecture can be used across African countries due the availability of the network infrastructure. This study was to investigate the existing network technologies for developing a secure E-voting architecture for developing countries.

2. Problem Statement

Most of the E-voting architectures used currently to identify and verify a voter uses single biometric source mainly the fingerprint (Hazzaa & Kadry, 2012). Single biometric source has many problems such as noisy data, intra class disparity, inter class resemblances, not universal, sometimes can be affected by spoofing and at some point can be inaccurate or insecure (Kumari & Jaya, 2014). Multi-biometric sources use multiple source of information for individual authentication (Sanjekar & Patil, 2014) which eliminates irregularities in voter identification, vote casting, and vote counting, vote tallies and auditing. E-voting implementation in developing countries is hindered by lack of Internet connectivity and implementation of multi-biometric technologies. This study suggested the development of an E-voting architecture based on a polling station setup involving Local Area Network using 3G or 4G technology and General Packet Radio Service (GPRS) for data transfer (Olaniyi, Adewumi & Arulogun, 2011). The study considered multi-biometric approach architecture and network technologies based on a polling stationsetup to develop a secure electronic voting architecture. This approach addressed the gap observed in the single biometric approach.

3. Research Methodology

This study undertook a mixed method research design which included survey design and content analysis. Purposive sampling technique was used to sample sixty six election coordinators and their deputies and two Information Communication Technology Officers from two Independent Electoral and Boundaries Commission (IEBC) regions of Kakamega and Bungoma. This study focused on the opinion of the IEBC Regional ICT officers and constituency election coordinators on ways and means in which a secure E-voting architecture can be developed.

3.1. Study Population

The population that was used for inclusion in this study was the IEBC constituency election coordinators and their deputies as well as IEBC Regional ICT officers as shown in Table 1.

Participants	**Kakamega County**	**Bungoma County**	**Total**
Election Coordinators	34	32	66
ICT Staff	1	1	2
Total	**35**	**33**	**68**

Table 3: Study population

Table 3 shows that the study population comprised 34 election coordinators from Kakamega and 32 election coordinators from Bungoma, two Regional ICT officers one each from Kakamega and Bungoma IEBC regions giving a total of 68 respondents.

3.2. Data Analysis

The research adopted survey strategy; information was collected from a sample of the respondents by administering structured questionnaires. Descriptive and inferential statistics were used for the data Spearman's Rank correlation coefficient was performed to measure the relationship between variables.

4. Findings and Discussions

The findings of this study were based on Fibre Optic System, Optical Fibres Transmission Bandwidth, 4G systems, WIFI Technology and Wireless Local Area Network as Network Technologies for E-voting Architecture.

4.1. Fibre Optic System

The study sought to establish that fibre optic system is appropriate to Local Area Network and long distance communication as shown in Table 4

Fibre optic system is appropriate to Local Area Network and long distance communication		Region		Total
		Kakamega	Bungoma	
strongly Disagree	Count	1	2	3
	% within The complexity of a fibre optic	33.3%	66.7%	100.0%
	% within Region	3.2%	8.0%	5.4%
Undecided	Count	8	2	10
	% within The complexity of a fibre optic system	80.0%	20.0%	100.0%
	% within Region	25.8%	8.0%	17.9%
Agree	Count	18	10	28
	% within The complexity of a fibre optic system	64.3%	35.7%	100.0%
	% within Region	58.1%	40.0%	50.0%
Strongly Agree	Count	4	11	15
	% within The complexity of a fibre optic system	26.7%	73.3%	100.0%
	% within Region	12.9%	44.0%	26.8%
Total	Count	31	25	56
	% within The complexity of a fibre optic system	55.4%	44.6%	100.0%
	% within Region	100.0%	100.0%	100.0%

Table 4: Fibre Optic System

From the findings majority of the respondents 76.8% agreed or strongly agreed that Fibre optic system is appropriate to Local Area Network and long distance communication, 17.9% of the respondents remained undecided, 5.4% respondents strongly disagreed.

4.2. Optical Fibre Transmission Bandwidth

When asked whether optical fibres provide enormous and unsurpassed transmission bandwidth with negligible latency, and are now the transmission media of choice for long distance and high data range transmission in telecommunication networks the respondent responses are as indicated Table 5.

Optical fibres provide enormous and unsurpassed transmission bandwidth with negligible latency		Region		Total
		Kakamega	Bungoma	
Disagree	Count	1	2	3
	% within Optical fibres Transmission	33.3%	66.7%	100.0%
	% within Region	3.2%	8.0%	5.4%
Undecided	Count	7	4	11
	% within Optical fibres Transmission	63.6%	36.4%	100.0%
	% within Region	22.6%	16.0%	19.6%
Agree	Count	20	11	31
	% within Optical fibres Transmission	64.5%	35.5%	100.0%
	% within Region	64.5%	44.0%	55.4%
Strongly Agree	Count	3	8	11
	% within Optical fibres Transmission	27.3%	72.7%	100.0%
	% within Region	9.7%	32.0%	19.6%
Total	Count	31	25	56
	% within Optical fibres Transmission	55.4%	44.6%	100.0%
	% within Region	100.0%	100.0%	100.0%

Table 5: Optical Fibres Transmission Bandwidth

From the findings 75% of the respondents agreed or strongly agreed thatOptical fibres provide enormous and unsurpassed transmission bandwidth with negligible latency, 19.6% remained undecided, 5.4% disagreed. The optical fibre can be used as a medium for telecommunication and networking because it is flexible and can be bundled as cables. Fibres, like waveguides, can have various transmission modes. The fibres used for long-distance communication are known as single mode fibres, as they have only one strong propagation mode.

4.3. 4G System

The study sought to establish that 4G or 3G system, in addition to usual voice and other services of previous generations, provides mobile broadband internet access. The results are shown in

4G system with usual voice and other services of previous generations, provides mobile broadband Internet access		Region		Total
		Kakamega	Bungoma	
Disagree	Count	1	0	1
	% within 4G system with	100.0%	0.0%	100%
	% within Region	3.2%	0.0%	1.8%
Undecided	Count	7	5	12
	% within 4G system	58.3%	41.7%	100%
	% within Region	22.6%	20.0%	21.4%
Agree	Count	12	9	21
	% within 4G system with	57.1%	42.9%	100%
	% within Region	38.7%	36.0%	37.5%
Strongly Agree	Count	11	11	22
	% within 4G system with	50.0%	50.0%	100%
	% within Region	35.5%	44.0%	39.3%
Total	Count	31	25	56
	% within 4G system with	55.4%	44.6%	100%
	% within Region	100.0%	100.0%	100%

Table 6: 4G System

From the findings 76.8% of the respondents agreed or strongly agreed that4G system with usual voice and other services of previous generations, provides mobile broadband Internet access. 21.4% of the respondents remained undecided, 1.8% of the respondents disagreed. 4G system with usual voice and other services of previous generations, provides mobile broadband Internet access to laptops with wireless modems, to smart phones and other mobile devices and renders for the users very efficient and lighting speed, amulti access way of communication services.

4.4. Wi-Fi Technology

The study sought to find out if Wi-Fi is widely used to deploy high speed wireless technology. Theresults of the respondentsare as indicated in Table 7.

Wi-Fi is widely used to deploy high speed wireless technology		Region		Total
		Kakamega	Bungoma	
Disagree	Count	2	0	2
	% within WiFi	100.0%	0.0%	100.0%
	% within Region	6.5%	0.0%	3.6%
Undecided	Count	1	6	7
	% within WiFi	14.3%	85.7%	100.0%
	% within Region	3.2%	24.0%	12.5%
Agree	Count	13	9	22
	% within WiFi	59.1%	40.9%	100.0%
	% within Region	41.9%	36.0%	39.3%
Strongly Agree	Count	15	10	25
	% within WiFi	60.0%	40.0%	100.0%
	% within Region	48.4%	40.0%	44.6%
Total	Count	31	25	56
	% within WiFi	55.4%	44.6%	100.0%
	% within Region	100.0%	100.0%	100.0%

Table 7: Wi-Fi Technology

From the findings 83.9% of the respondents agreed or strongly agreed Wi-Fi is widely used to deploy high speed wireless technology. 12.5% of the respondents remained undecided, 3.6% of the respondents disagreed. Wi-Fi has a wide range of applications in networks at home, office, and in growing number of cafes, hotels, and airports. Wi-Fi allows users to stay connected in a multitude of different places including the office, home, coffee shop down the street, or hotel on the other side of the country. Unlike cell phones, it can connect to a network anywhere in the world with a Wi-Fi enabled device, allowing for widespread coverage.

4.5. Wireless Local Area Network

The study sought to find out if Wireless Local Area Network (WLAN) devices, allow users to move their laptops from place to place and still stay in connection as shown in Table 8

			Region		Total
			Kakamega	Bungoma	
	strongly Disagree	Count	0	4	4
		% within Wireless	0.0%	100.0%	100.0%
		% within Region	0.0%	16.0%	7.1%
	Disagree	Count	0	2	2
		% within Wireless	0.0%	100.0%	100.0%
		% within Region	0.0%	8.0%	3.6%
	Undecided	Count	4	4	8
		% within Wireless	50.0%	50.0%	100.0%
		% within Region	12.9%	16.0%	14.3%
	Agree	Count	11	11	22
		% within Wireless	50.0%	50.0%	100.0%
		% within Region	35.5%	44.0%	39.3%
	Strongly Agree	Count	16	4	20
		% within Wireless	80.0%	20.0%	100.0%
		% within Region	51.6%	16.0%	35.7%
Total		Count	31	25	56
		% within Wireless	55.4%	44.6%	100.0%
		% within Region	100.0%	100.0%	100.0%

Table 8: Wireless Local Area Network

From the findings 75% of the respondents agreed that Wireless Local Area Network (WLAN) devices, allow users to move their laptops from place to place and still stay in connection. 14.3% of the respondents remained undecided 10.7% of the respondents disagreed. Wireless Local Area Network (WLAN) devices, allow users to move their laptops from place to place and still connected. Wireless increases accessibility within the coverage area or locality of the access point device. Users accessing the e-voting system can increase without necessarily expanding the network infrastructure as compared to wired approach.

4.6. Spearman's Rank Correlation Coefficient

In statistics, Spearman's rank correlation coefficient or Spearman's rho or $r_s$is a nonparametric measure of rank correlation, statistical dependence between the rankings of two variables.

Spearman's rank correlation coefficient r_s or rho is a reliable and fairly simple method of testing both the strength and direction which can be positive or negative of any correlation between two variables. The values of r_s must be between -1 and +1 [-1 < rs < 1]. Spearman's Rank Order Correlation Coefficient formula as proposed by (Crawshaw and Chambers, (2001),Norman and Martin, (2012))

$$\boldsymbol{r_s = 1 - 6\frac{\sum d^2}{n(n^2-1)}}$$

Where $r_s$is Spearman's Rank Order Correlation Coefficient, d = difference between ranks and d2 = difference squared, df = N – 2, where N = number of pairwise cases, p= p Value.

Table 9 shows the results of performing a Two-Tailed test of significance on five network technologies deemed fit for e-voting architecture.

Indicator	Measure	H1	H2	H3	H4	H5
H1	Spearman's Correlation	1.000	.615**	.509**	.460**	.247
	Significance	.	.000	.000	.000	.067
H2	Spearman's Correlation	.615**	1.000	.476**	.627**	.407**
	Significance	.000	.	.000	.000	.002
H3	Spearman's Correlation	.509**	.476**	1.000	.616**	.412**
	Significance	.000	.000	.	.000	.002
H4	Spearman's Correlation	.460**	.627**	.616**	1.000	.645**
	Significance	.000	.000	.000	.	.000
H5	Spearman's Correlation	.247	.407**	.412**	.645**	1.000
	Significance	.067	.002	.002	.000	.

Table 9: Correlation between Network Technologies variables for E-voting Architectures
***. Correlation is significant at the 0.01 level (2-tailed)*

H1: Fibre optic system
H2: Optical fibre bandwidth
H3: Wi-Fi Technology
H4: 4G system
H5: Wireless Local Area Network (WLAN)

Spearman rank-order correlations were conducted in order to determine if there were any relationships between:

a) The Fiber optic system correlated with four network technologies namely; Optical fiber bandwidth, Wi-Fi Technology, 4G system and Wireless Local Area Network (WLAN). A two-tailed test of significance indicated that there was a significant positive relationship between the Fiber optic system with Optical fiber bandwidth $r_s(56) = .615$, $p< .05$., Wi-Fi Technology $r_s(56) = .509$, $p< .05$., 4G system $r_s(56) = .460$, $p< .05$. However, a similar two tailed test of significance indicated that the Fiber optic system was unrelated to Wireless Local Area Network (WLAN) $r_s(56) = .247$, $p > .05$.
b) The Optical fiber bandwidth correlated with four network technologies namely; Fiber optic system, Wi-Fi Technology, 4G system and Wireless Local Area Network (WLAN). A two-tailed test of significance indicated that the there was a significant positive relationship between the Optical fiber bandwidth with Fiber optic system $r_s(56) = .615$, $p< .05$., Wi-Fi Technology $r_s(56) = .476$, $p< .05$., 4G system $r_s(56) = .627$, $p< .05$., Wireless Local Area Network (WLAN) $r_s(56) = .407$, $p < .05$.
c) The Wi-Fi Technology correlated with four network technologies namely; Fiber optic system, Optical fiber bandwidth, 4G system and Wireless Local Area Network (WLAN). A two-tailed test of significance indicated there was a significant positive relationship between the Wi-Fi Technology with Fiber optic system $r_s(56) = .509$, $p< .05$., Optical fiber bandwidth $r_s(56) = .476$, $p< .05$., 4G system $r_s(56) = .616$, $p< .05$., Wireless Local Area Network (WLAN) $r_s(56) = .412$, $p < .05$.
d) The 4G system correlated with four network technologies namely; Fiber optic system, Optical fiber bandwidth, Wi-Fi Technology and Wireless Local Area Network (WLAN). A two-tailed test of significance indicated there was a significant positive relationship between the 4G system with Fiber optic system $r_s(56) = .460$, $p< .05$., Optical fiber bandwidth $r_s(56) = .627$, $p< .05$., 4G system $r_s(56) = .616$, $p< .05$., Wireless Local Area Network (WLAN) $r_s(56) = .645$, $p < .05$.
e) The Wireless Local Area Network (WLAN) correlated with four network technologies namely; Fiber optic system, Optical fiber bandwidth, Wi-Fi Technology and: 4G system. A two-tailed test of significance indicated there was a significant positive relationship between the Wireless Local Area Network (WLAN) with Optical fiber bandwidth $r_s(56) = .407$, $p< .05$, Wi-Fi Technology $r_s(56) = .412$, $p< .05$., 4G system $r_s(56) = .645$, $p< .05$. Indicating that Wireless Local Area Network (WLAN). However, a similar two tailed test of significance indicated that the Wireless Local Area Network (WLAN) was unrelated to Fiber optic system $r_s(56) = .247$, $p>.05$.

5. Discussion

The main objective of this paper was to investigate existing network technologies necessary for designing a secure E-voting architecture. The study established that Fiber optic system provides enormous and unsurpassed transmission bandwidth with negligible latency, and is now the transmission media of choice as supported by 76.8% of the respondents.

The optical fiber can be used as a medium for telecommunication and networking because it is flexible and can be bundled as cables and have various transmission modes an idea supported by 75% of the respondents.

4G systems with usual voice and other services of previous generations, provides mobile broadband Internet access to laptops with wireless modems, to smart phones and other mobile devices and renders for the users very efficient and lighting speed, a multi access way of communication services as agreed by 76.8% of the respondents.

Wi-Fi is widely used to deploy high speed wireless technology. Wi-Fi has a wide range of applications in networks at home, office, and in growing number of cafes, hotels, and airports. Wi-Fi allows users to stay connected in a multitude of different places including the office, home and hotel. Unlike cell phones, it can connect to a network anywhere in the world with a Wi-Fi enabled device, allowing for widespread coverage as agreed by 83.9% of the respondents.

Wireless Local Area Network (WLAN) devices, allow users to move their laptops from place to place and still connected. Wireless increases accessibility within the coverage area or locality of the access point device. Users accessing the e-voting system can increase without necessarily expanding the network infrastructure as compared to wired approach supported by 82.1% of the respondents.

A two-tailed test of significance indicated there was a significant positive relationship between the Optical fiber bandwidth, Fiber optic system, Wi-Fi Technology, 4G system and Wireless Local Area Network (WLAN) at $rs(56) = .615$, $p< .05$., Wi-Fi Technology $rs(56) = .476$, $p< .05$., 4G system $rs(56) = .627$, $p< .05$., Wireless Local Area Network (WLAN) $rs(56) = .407$, $p < .05$. However, a similar two tailed test of significance indicated that the Fiber optic system was unrelated to Wireless Local Area Network (WLAN) at $rs(56) = .247$, $p > .05$.

This study shows that the network technologies considered in the study are indeed the main contributors for designing a secure e-voting architecture.

6. Conclusion

This study investigated existing network technologies necessary for designing a secure E-voting architecture. The study as shown that Fiber optic system, optical fiber, Wi-Fi technology, 4th Generation system and Wireless Local Area Network (WLAN) are the network technologies that can influence the design of an e-voting architecture. Network technologies necessary for designing a secure e-voting architecture vary in their application and strength. The application and strength enforced in an e-voting environment can provide enhanced secure e-voting architecture.

7. Recommendation

This study recommends that Fiber optic system, optical fiber, Wi-Fi technology, 4G systems and Wireless Local Area Network (WLAN) be used to create a secure e-voting architecture.

Future research should focus on ways in which 4G and 5G can provide higher mobile broadband Internet access and make it more secure for data transmission. Fiber optics suffers from insufficient transmitting power and excessive signal loss due to cable span that is too long. These issues need to be addressed.

8. References

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