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Performance and Management of Infrastructure Mode Based Wi-Fi Technology in the State Universities of Zimbabwe

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***Abstract*--** The purpose of the research was to investigate how Wireless Fidelity (Wi-Fi) technology based on infrastructure mode in various universities of Zimbabwe (Wi-Fi) performs as well as how it is being managed. The participants of this research were Information Technology (IT) departmental directors, chief technicians as well as students and staff of various departments of the universities. The results of the research indicated that Wi-Fi users at the various universities of Zimbabwe experience wireless connection problems within the Wi-Fi signal range. The signal can either be very weak or it can simply fail to be accessed by the user terminal. The research revealed that it is more challenging to maintain higher throughput of Wi-Fi network than wired networks. In this document, an evaluation of the performance and management of Wi-Fi technology at some state universities of Zimbabwe is reported. Basing on the responses given about the challenges of the of Wi-Fi performance, it was noted that the Wi-Fi technology has not been implemented to the fullest. This comes through lack of signal strength optimisation and incomplete dissemination of information necessary to users for connecting to Wi-Fi.Basing on the results of the research it was noted that appropriate AP placement is required to obtain greater performance of the Wi-Fi.

Keywords: *Access Point, Wireless Fidelity, Wi-Fi performance Wireless Local Area Networks, Wi-Fi management*

I. INTRODUCTION

Wi-Fi technology is playing an important role in the new paradigm of mobile education influencing student-learning patterns (Zanetti and Warden, 2003). Mobile education is defined as a service or facility that supplies learners with electronic information in the quest to acquire knowledge, regardless of location and time, made possible using wireless technologies (Lehner, Nosekabel and Lehmann (2002) as cited by Rakers, J. (2009). Student's lives and study patterns are changing due to increased availability and use of mobile devices such as Personal Digital Assistants (PDA's), laptop computers and new generation web-enabled mobile phones. Most universities in Zimbabwe have seen the students' need for unlimited internet access to conduct research and prepare for classes; therefore have installed Wi-Fi networks on campuses, a way of providing easy and flexible internet access. Wi-Fi technology has greatly improved student's and staff's access to internet around the universities various campuses.Wi-Fi based networks have to be properly managed in crowded areas so as to achieve the ultimate goal of any wireless connection, which is to provide a high bandwidth and reliable connection for end users anywhere within the signal range and at anytime (Wang, Min, Mellor and Guan, 2004).

II. WI-FI TECHNOLOGY

One of the driving forces behind wireless technology growth was the creation of the working group of Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard of 1997, called Wireless Fidelity and popularly known as Wi-Fi (Bianchi, 2000). IEEE 802.11 access technology is widely considered as the most popular Wi-Fi access technology (Xiong, 2008). According to Xiong (2008) the terms "802.11" and "Wi-Fi" are often used interchangeably, due to the dominant position of the IEEE 802.11 technology in the Wi-Fi equipment market. Devices such as laptop computers and PDAs enabled with Wi-Fi facility can send information to and receive from the internet anywhere within the range of an AP. A typical Wi-Fi system includes one or more APs. Client mobile devices connect to the Wi-Fi system through the APs. When one or more APs are in communication range of a client, the client may select the APs providing the strongest signal for connection. A client may roam through a space covered by multiple APs, switching from one AP to another, for communication with the network.

Wi-Fi provides its users with the liberty of connecting to the Internet from any place within the signal range without the hassles of plugging in the wires. It provides wireless access to applications and data across a radio network (Lee, J. S., Su, Y. W., & Shen, C. C. (2007). Wi-Fi devices are compliant with each other to grant efficient access of information to the user. The geographical area covered by Wi-Fi signals from a single AP is called a hotspot (Ralli, 2006).According to Kyung-hyun (2009) Wi-Fi systems relate generally to WLAN based on one or more of the IEEE 802.11 specifications, and more broadly relate to the wireless interfacing of mobile computing devices for example laptops, handheld computers and cell phones. Wi-Fi systems are being increasingly implemented in society, frequently being available in governmental, corporate, commercial, public "hotspot", and home environments. They enable users of mobile computing devices to communicate with devices coupled to the Local Area Network (LAN) and to communicate over the Internet, without a physical transmission medium.

Wi-Fi transmission characteristics can affect the signal quality thereby hindering the performance of the network. Interference, constantly changing environment, multipath signal propagation and the movement of networking terminals are the characteristics of WLAN, (Vanhatupa. T., 2008).In a highly populated area the mentioned characteristics cause varying bit rates and frequent packet retransmissions and consequently problems for applications requiring high throughput. According to Rysavy (2006) if the most favorable WLAN performance is not attained it will deter effective access to organizational information as well as internet services and cause workers to be less productive. Wi-Fi end users at various Zimbabwe's state universities' campuses experience wireless connection problems within the Wi-Fi signal range. The signal can either be very weak or it can simply fail to be accessed by the user terminal.

The ideal situation of a best possible Wi-Fi network will be an excellent wireless connection at any place within the Wi-Fi signal range and at anytime. Therefore if the problem is solved value would have been added to the performance and management of Wi-Fi through the hotspots providing much more satisfying and productive experience in terms of wireless

connection. Therefore this research seeks to give an insight into understanding the performance and management of Wi-Fi in universities setups and see if it is providing easy and flexible internet access to the users. It also suggests approaches for optimizing the performance and management of the Wi-Fi technology.

III. WI-FI INFRASTRUCTURE TOPOLOGY

According to Ralli (2006), a Wi-Fi hotspot's basic architecture consists of one or more wireless AP, which is connected to a fixed LAN, normally. In most cases some kind of user authentication is needed before the connection can be established. The AP advertises itself by sending a unique 32-bit identifier called Service Set Identifier (SSID) in a beacon frame. The terminal identifies the home network by using this SSID, AP-specific selection is based on signal strength. While the SSID identifies a wireless network, Basic Service Set Identifier (BSSID) can be used to identify each wireless device uniquely. BSSID is actually the Medium Access Control (MAC) address of each device and can be used by the terminal to select which AP to connect. According to Mapp, G., Shaikh, F., Aiash, M., Vanni, R. P., Augusto, M., & Moreira, E. (2009) a Basic Service Set (BSS) is a collection of Stations (STAs) that are able to communicate with each other within 802.11 WLAN. In this communication mode, the wireless STA must be associated with the AP before communication between devices can occur. The AP may also provide communication of these STAs with devices present in the Distributed System (DS) that is Ethernet networks

IV. RESEARCH QUESTIONS

The study sought to answer the following research questions.
Why does the Wi-Fi network sometimes fail to provide internet access anywhere, within the signal range?
What are the benefits and challenges of Wi-Fi technology?
Are there any special settings or necessary information on how to connect the Wi-Fi that the users must know?
How is the Wi-Fi managed at the state universities in Zimbabwe?

V. RESEARCH METHODOLOGY

The research was based on stratified random sampling. This method would be done by randomly choosing Wi-Fi users from five state universities in Zimbabwe. Convenient sampling was used to select Wi-Fi users because it provides fitting members from target population from which information can be obtained.Data was gathered using questionnaires and a total of 350 questionnaires were distributed to the Information Technology departmental directors, chief technicians as well as students and staff of the various universities.

From the 350 questionnaires which were sent to the target population, only 310 were returned. The reasons for this response were that some respondents said there were too busy to give time to the questionnaires. To surmount these issues interviews were conducted with selected universities' I.T departments' members of staff. The researchers also distributed the questionnaires to the members of staff of other departments other than the I.T department as well as universisties' students. Before the interviews were conducted, an interview checklist was prepared so as to allow the shaping of the questions according to circumstances. Judgemental sampling was used to identify the staff members who participated in the research.

The method allowed the researchers to use own judgement in identifying individuals from the I.T departmental directors, chief technicians, students and staff of the various departments.However, in some instances the sampling method tended to be time consuming since some members approached tended not to have the information required in the research. The interviews gathered data on how Wi-Fi technology is performing, how the various I.T department are managing it as well as the benefits and challenges of implementing it. Also particular issues which were raised from the questionnaires were clarified. The interviews were recorded and later transcribed and analysed using discourse analysis

VI. FINDINGS FROM THE STUDY

A. Performance of Wi-Fi

As regards to the Wi-Fi connection status the majority of Wi-Fi users from the various universities experience a fair connection speed, a fair segment of the users experience good connection speed whilst a small portion experience poor and excellent speeds respectively. This is clear evidence that the Wi-Fi performance is not at its optimal level in terms of providing excellent speed to the users in the state universities. The research showed that 79% of the Wi-Fi users from universities indicated that they experience poor speed when connecting from inside buildings. The 21% outlined that they experience poor connection from both inside buildings and outside buildings.This is clear evidence that the Wi-Fi performance is affected by buildings through obstruction of signals.

The directors of the universities' I.T departments revealed that due to the attenuation nature of Wi-Fi signals the performance would degrade significantly; therefore location of AP has a significant effect on Wi-Fi performance. They further went on to say an appropriate AP placement is required to obtain greater performance of Wi-Fi, since metal door and structural concrete wall have a greater impact on signal attenuation.

B. Management of Wi-Fi

According to the research, the I.T. departments are not disseminating enough and complete information to the Wi-Fi users on how best to locate positions and select the APs with strongest signal strength .The universities' I.T directors through the interviews also confirmed that approximately 255 users can be supported by a single AP effectively. They indicated that exceeding the number can cause the AP to be congested leading to weak signal strength or sudden connection drops.

C. Benefits of Wi-Fi

A considerable number of respondents, (94%) from the students and staff of the universities indicated that the Wi-Fi has improved their research and communication at their various campuses. Only 6% of the users pointed out that no communication and research improvement has been brought by Wi-Fi. As regards to installation 84% of the I.T departments directors indicated that Wi-Fi has eliminated the need to pull cables through walls and ceilings making it fast and easy to install. The remaining 26% argued that configuration and installation of Wi-Fi is a cumbersome process as it requires a lot of service planning, defining the requirements for the network before implementing the network. Data gathered from the I.T departments' technicians highlighted that almost all the wireless network devices come with a built in Wi-Fi access, hence the users do not need to incur the extra expenses of Wi-Fi cards.Also 100% of the universities I.T departments directors indicated that access by the users to the network can be at any anytime within the campuses, reducing overcrowding the internet laboratories.

D. Challenges of Wi-Fi

All the universities I.T departments directors and technicians confirmed that although Wi-Fi is playing an increasingly significant role in providing ubiquitous network services their due to its flexibility and cables free usage, it is more challenging to maintain its optimal performance of the than wired network. They indicated that the signal strength and radio propagation are affected by several factors, such as interference, multiple-path propagation, path loss and attenuation.Radio waves used in wireless networks can extend beyond the required perimeter and through buildings and offices thus making Wi-Fi networks difficult.

VII. DISCUSSION

The results revealed that not only Wi-Fi frequency and bandwidth determine the signal strength but also factors such as the distance and the obstruction between the AP and the user device. This characteristic of the radio signal is causing some Wi-Fi users to fail to connect to the network or get weak signals from inside buildings. Many factors could result in attenuation, for example, distance, obstruction, and multiple-path effect. Due to attenuation, receiving devices would not have sufficient signal strength. The performance would degrade significantly. Furthermore the I.T the departments of the various state universities are not effectively disseminating complete information to the Wi-Fi users who seem to be ignorant about the importance of positioning themselves selecting APs. In a highly populated area the Wi-Fi signals can experience interference, multipath signal propagation and these can cause varying bit rates as well as frequent packet retransmissions and consequently problems for applications requiring high throughput The research also confirmed that the Wi-Fi technology has improved research and communication in a great way at the various state universities in Zimbabwe. The Wi-Fi technology is benefiting the Zimbabwe's state universities' through its fast and easy of installation which eliminates the need to pull cables through walls and ceilings and also access by the users to the network can be at any anytime within the campuses, reducing overcrowding the internet laboratories.

On the other hand due to the complexity and unpredictable nature of radio signal propagation, it is has become difficult to the I.T departments to derive real and accurate signal strength and reach an optimal state where the Wi-Fi would be accessed anywhere and at anytime within the signal range. It has been proved that the location of APs have significant effects on Wi-Fi performance. An appropriate AP placement is required to obtain greater performance of Wi-Fi especially from inside buildings. According to the research, the I.T departments of the various state universities are not disseminating enough and complete information to the Wi Fi users on how best to locate positions and select the APs with strongest signal strength .The research, through questionnaire and interview responses confirmed that approximately 255 users can be supported by a single AP effectively. Exceeding the number can cause the AP to congested leading to weak signal strength or sudden connection drops.

VIII. RECOMMENDATIONS

To improve the performance in terms of signal strengths and coverage area of Wi-Fi the universities' I.T. departments should place the APs at strategic locations steering clear of physical obstructions whenever possible. Any barriers along the "line of sight" of the Wi-Fi signals between the AP and the user device will degrade signal strength. Due to the characteristics of radio wave, Wi-Fi provides an open channel for all people to access networks, especially hackers. Future research can focus on the investigation of the impact of security mechanisms on Wi-Fi throughput. It would provide a significant insight into selecting security mechanism for Wi-Fi design and deployment. For generalization of research findings, a simulation approach is suggested for future work. An investigation into the performance of Wi-Fi for ad-hoc infrastructure can also be conducted. The study would help assess Wi-Fi signal strength when they propagate from one Wi-Fi device to another.

CONCLUSION

The question which was addressed at the beginning of the research was to evaluate the performance of Wi-Fi and find out if effectiveness of the Wi-Fi management. The research findings explain that the state universities in Zimbabwe are not optimally utilising the Wi-Fi technology and have not invested much into the network technology. The research also confirmed that the Wi-Fi technology has improved research and communication in a great way at the various state universities in university.According to the research conducted, it can concluded that an appropriate AP placement can improve Wi-Fi performance significantly. Basing on the responses given about the challenges of the of Wi-Fi WLAN performance, it was noted that the Wi-Fi technology has not been implemented to the fullest. This comes through lack of signal strength optimisation and incomplete dissemination of information necessary to users for connecting to Wi-Fi network so the effectiveness of the Wi-Fi is in a way comprised.

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