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Evaluation of Traffic Delay and Resources Utilization in Wlan Handover Schemes

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Abstract: *Wireless local area networks (WLAN) have seen rapid growth making it very popular and widely used in data communication. New technologies in WLAN provide high data rates for real time services and also support multimedia applications such as voice over IP and e-conference. Critical to the 802.11 MAC operations, is the handover function which occurs when a mobile node moves its association from one access point (AP) to another. Unreliable and insufficient handover procedure reduces the quality and reliability of the network. Two handover schemes: proactive scanning handover scheme (PAHS) and prevent scanning handover scheme (PRHS) were selected for comparative evaluation. Specifically, the comparison was based on the following quality of service (QoS) indicators: handover delay and resource utilization. Results show that at traffic intensity of 2401615, PRHS and PAHS experienced delays of 1.47e-06 and 1.69e-06 respectively while at traffic intensity of 969470, resource utilization for PRHS and PAHS are 5.74e-02 and 7.01e-02 respectively. PRHS algorithm, therefore, performs a more efficient and seamless handover process in terms of reduced delay while the PAHS offers greater resource utilization at every level of traffic intensity.*

Keywords: *Handover, Local Area Network (WLAN), Delay, Utilization, Traffic Intensity, IEEE 802.11*

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I. Introduction

Wireless local area network (WLAN) has become one of the most popular networking environments as the technology continues to move from wired to wireless. Wireless technology has helped to simplify networking by enabling multiple computer users simultaneously share resources in a home or business without additional or intrusive wiring. The increased demands for mobility and flexibility in our daily life are demands that lead the development [1, 2]. Furthermore, WLAN provides all the features and benefits of traditional Local area Network (LAN) technologies such as Ethernet and Token Ring without the limitations of wires or cables. It usually provides a connection through an Access Point (AP) to the wider internet [3]. This gives users the ability to move around within a local coverage area while still connected to the network.

In order to ensure compatibility in various WLAN technologies and designs, standardization became a key issue. However, the standardization activities concentrated mostly on the unlicensed bands. This standard was created and maintained by the IEEE LAN/MAN Standards Committee (IEEE 802). IEEE 802.11 is a set of standards carrying out wireless local area network (WLAN) computer communication in the 2.4, 3.6 and 5 GHz frequency bands. The 802.11 family includes over-the-air modulation techniques that use the same basic protocol. The most popular are those defined by the 802.11b and 802.11g protocols, which are amendments to the original standard.

The basic building block of IEEE 802.11 network is a basic service set (BSS) consisting of a group of STAs that communicate with each other. During mobility when a STA moves out from the coverage area of its previous AP and going to enter in a new AP's region, it breaks the link with old AP and connects to new one. This process of link transfer is simply called handover [4].Handover procedure is thus very necessary to ensure reliable and smooth handover [5]. The handover procedure in the link layers consist of three different phases [6]. The first is scanning phase which involve searching for free channels available in new APs. STA scans for APs by either sending Probe Request message (Active Scanning) or by listening to Beacon message (Passive Scanning). The second is the authentication phase which takes place after scanning phase. Transfer of credentials of STA occurs from old AP to new AP. By Authentication Request message, the new AP either accepts or rejects the identity of the STA requesting access. The third phase is the Re-association phase. This is the process for transferring association from old AP to new AP. Re-association frame includes information regarding the new association ID and supported data rule and also coordination of the forwarding of data that may still reside in the buffer of the old AP waiting for transmission to the STA. Consequently, there is some latency involved in this process which increases the overall handover Latency. The overall handover delay or latency is the summation of scanning delay, authentication delay and re-association delay. Up to 90% of total handoff delay comes from scanning delay. By reducing scanning delay, we can reduce handoff delay greatly. Unreliable and insufficient handoff procedures reduce the quality and reliability of the WLAN [7].

Over the past 10 years, researchers have been proposing various handover techniques for WLAN [8, 9]. However, this work aims to evaluate two handover schemes that reduce scanning phase delay which contribute more than 90% of the overall handover delay: proactive scanning handover scheme (PAHS) and prevent scanning handover scheme (PRHS). Specifically, the comparison was based on the following quality of service (QoS) indicators: handover delay and resource utilization. MATLAB 2014 will be used for the simulation of the models based on the developed flow charts.

II. Proactive Scanning Handover Scheme (PAHS)

The proactive scanning handover scheme takes place during normal connectivity. Here, the STA continues to monitor the signal strength and at the same time, scan neighboring APs in the range every 2 seconds. The handover algorithm and its associated terminology are shown in the flowchart of Figure 1 below [10, 11].

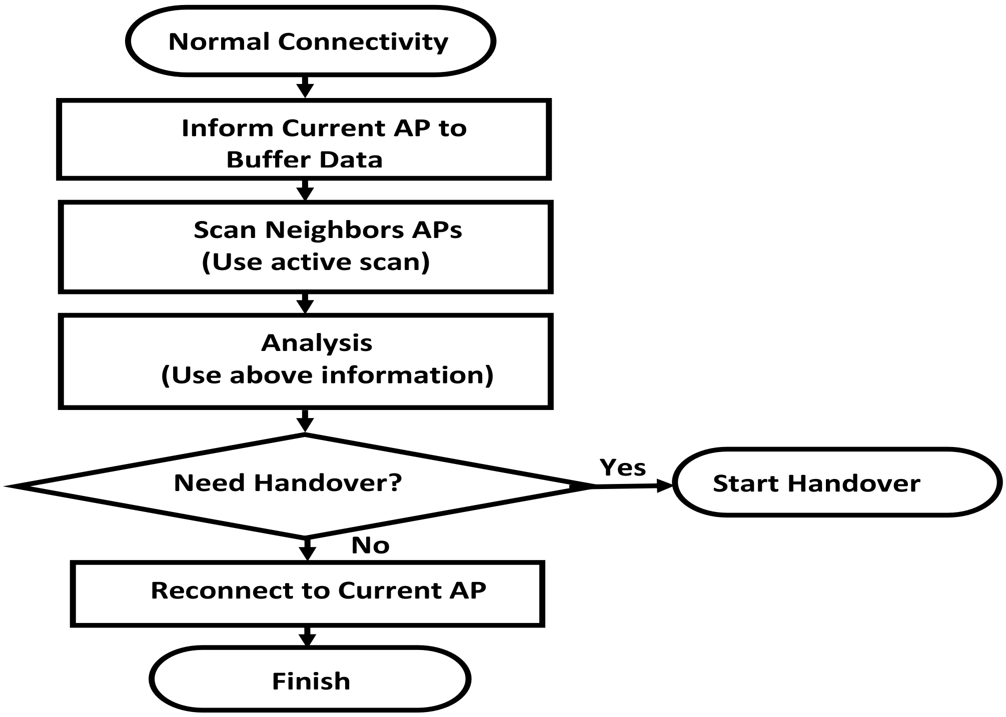

Figure 1: Proactive Scanning Phase Flowchart

III. Preventive Scanning Handover Scheme (PRHS)

This scheme is aimed at preventing scanning phase which contributes a greater percentage of handoff delay in the system [10, 12, 13]. The Prevent scanning procedure is illustrated in Figure 3. Prevent scanning process uses passive scan mode where the STA must listen to the wireless medium for beacons frames. This beacon frames provide the STA with timing and advertising information [14]. During passive scanning, the STA listens to each channel of the physical medium one by one, in an attempt to locate the potential APs using the probe channel. Current APs have a default beacon interval of 100ms [15].

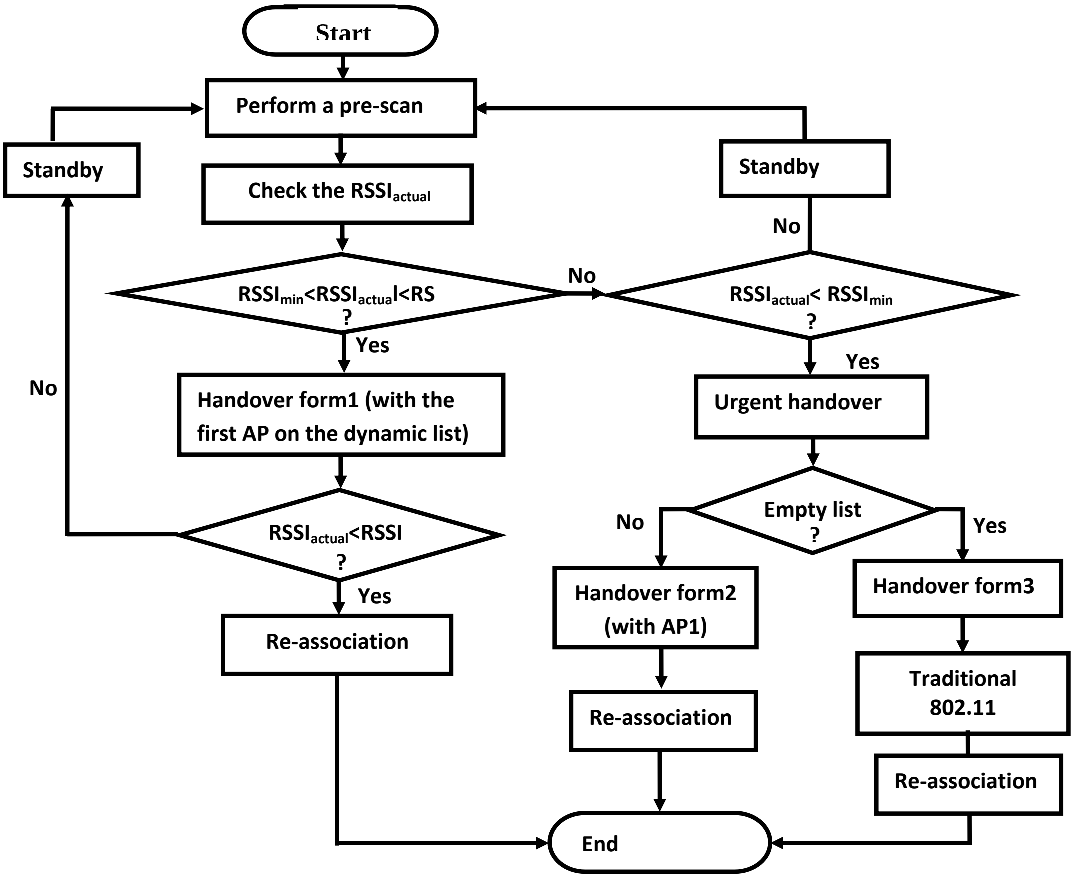

Figure 3: Prevent Scanning Process Flowchart

IV. Simulation of PAHS and PRHS Models

For the present study, the models for the two handover schemes (PAHS and PRHS) will be simulated using blocks from MATLAB/Simulink Simevent library. The specific objective of the simulation is to evaluate and compare the Handover Delay and Resource Utilization. The simulation parameters are listed in Table 1 below.

Table 1: Simulation Parameters

Parameter	Value
No of mobile stations (STA)	2
No of access points (AP)	3
Number of Channels	11
Simulation Time	100 seconds
Generation type	Exponential
Type of queue	FIFO
Threshold for AP1	-36.5dB
Threshold for AP2	-40dB
Threshold for AP3	-44dB

In performing the simulations, the received signal strength indicator value is based on the distance between an STA and its AP (RSSI-based positioning) as shown in [16]. The relationship between the distance, d separating an STA and its AP and the received signal strength Pr, is shown in equation (1).

$$Pr = P0 - 20\log10 \frac{4\pi d}{\lambda} \text{ [dB]} \quad (1)$$

Where P_0=transmitting power, d= distance and λ is the wavelength

$$\lambda = c/f \quad (2)$$

Where c = velocity of light (3×10^8) and f = transmission frequency (8×106). Transmitting power P0 (200mW)

V. Analysis of Simulation Results

Comparison was done based on Network access delay against traffic intensity and Access point resource utilization against traffic intensity.

a. Network Access delay against Traffic Intensity

Here, the two schemes are investigated with respect to access delay experienced by traffic in seeking access to the network. It is observed from Figure 4 that, for both schemes, the AP delay against traffic intensity follow an almost linear and constant pattern for both schemes under review at low traffic intensities but for each instant of traffic intensity, the PAHS experiences more access delay relative to the PRHS. As traffic intensity increases, there is a sharp rise in delay for both schemes with the PAHS still showing more access delay at each instant of traffic intensity. This observed behaviour is attributable to the fact that in the PAHS, decision on the choice of AP to support a particular traffic is taken at the interface between the AP and the network, thus adding to the delay experienced by traffic. In the case of the PRHS, the choice of the AP to support a particular traffic has already been made by the STA and this information is stored in the traffic being transmitted. Based on this, traffic getting to an AP does so because it is meant to be supported by that AP. Thus reducing the delay experienced by traffic in gaining access into the network and also error due to traffic getting to the wrong AP.

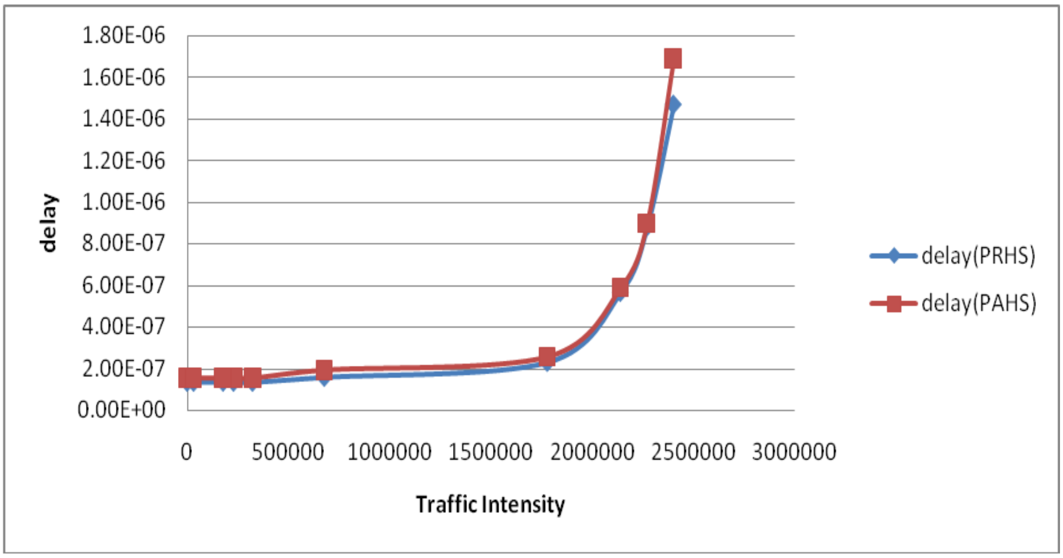

Figure 4: Network access delay against traffic intensity

b. Access Point Resource Utilization against Traffic Intensity

In this case, the utilization of the different access point by traffic that gets into the network is compared. This is basically done with intention of determining which scheme best utilizes the AP at different traffic intensity. From Figure 5, it can be seen that there is a linear relationship between AP utilization and traffic intensity. The linear relationship is attributable to the fact that as the traffic intensity increases, more traffic contends for the access point and as such increasing the utilization of the access point.

With respect to the two schemes under investigation, it is observed that the PAHS experiences more utilization of the AP when compared with the PRHS. This is as a result of the complexity of the system at mobile station since decisions are taken at the STA.

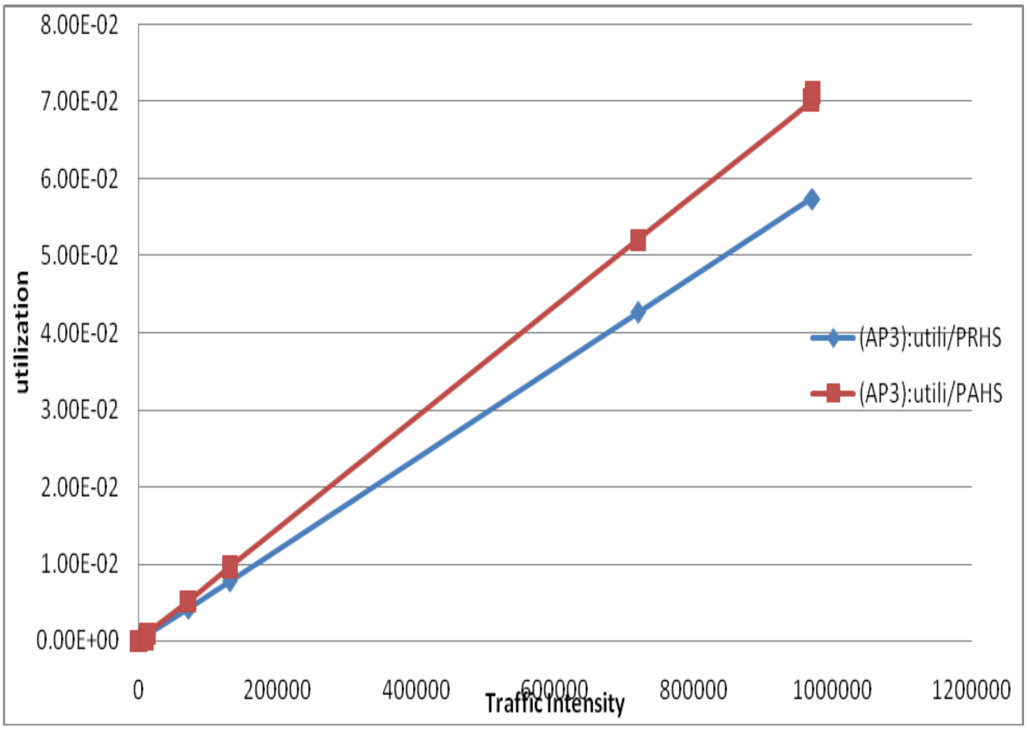

Figure 5: Access point utilization against traffic intensity

VI. Conclusion

This paper has presented a comparison of the two handover schemes in WLAN based network. The two handover scheme algorithms under evaluation were simulated in MATLAB Simulink Simevent environment and data obtained were analysis in Microsoft Excel. The QoS parameters used for comparison are: handover delay and resource utilization.

The PRHS has a significant advantage over PAHS by minimizing the time during which an STA remains out of contact with its AP and allowing handover to be made earlier and with more confidence and this brings 95% reduction of handover latency compared to PAHS. At traffic intensity of 2401615, PRHS and PAHS experienced delays of 1.47e-06 and 1.69e-06 respectively. At traffic intensity of 969470, resource utilization for PRHS and PAHS are 5.74e-02 and 7.01e-02 respectively. The results clearly show that the PRHS is superior to PAHS in terms of reduction in delay while the PAHS offered better utilisation of network resources.

From the results of the comparison, it is observed that the PRHS algorithm performs a more effective and seamless handover process in terms of reduced delay and is, therefore, recommended. Its inferior utilization of network resources can be a trade-off considering the adverse effect of excessive delay during the scanning phase in conventional handover schemes. These are the obvious advantages of the PRHS.

In conclusion, therefore, it is pertinent to reiterate that the overall performance of a scheme is based on the capability of the scheme to provide reliable and high quality service. The PRHS has been demonstrated to offer more efficient and reliable handover in WLAN and is therefore presented for vendor implementation.

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