OPTIMIZING THE PERFORMANCE OF IEEE 802.11b WIRELESS LOCAL AREA NETWORK (WLAN) USING DISCRETE EVENT SIMULATION (DES) MODEL

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ABSTRACT

Communication always attracts extensive research interest as it is a core part of modern communication technology. IEEE 802.11b has become common in recent years largely due to the advantage of user mobility, relatively low acquisition cost and ease of implementation making it common for both residential and business Internet access. However, the end user experience has often been less satisfactory than what the technology can offer. IEEE 802.11b wireless local area network (WLAN) is known to achieve relatively small throughput compared to other WLAN standards. The focus of this work is on improving IEEE 802.11b network performance. Quaternary key shifting modulation technique was used with discrete event simulation technique in Riverbed Modeller software to analyse the IEEE 802.11b network model and parameters. Results showed that when data rate was increased from 1Mbps to 11 Mbps which is the optimum value, throughput increased and there was 80% reduction in delay, retransmission attempts also decreased to approximately zero. Results also showed that when buffer size was increased from 1000bits to 12800bits which is also at optimum value, throughput increased by approximately 90% with no data dropped since it will take longer time for the buffer to be filled up and almost zero retransmission attempt was achieved. This work will go a long way in improving the Quality of Service of the IEEE 802.11b network leading to reduced cost of procurement and overhauling of devices in the network.

Keywords: IEEE 802.11b, WLAN, Quality of Service, QoS

1.0 Introduction

The Institute of Electrical and Electronic Engineers (IEEE) 802.11 is a set of standards that govern wireless networking transmission methods. They are used in either IEEE 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac variants to provide wireless connectivity in homes, offices and commercial establishments. Wireless local area networks (WLAN) have permeated every part of the economy over the past decade (Borah *et al.,* 2005). IEEE 802.11b standard expands the original IEEE 802.11 with Direct Sequence Spread Spectrum (DSSS) to operate up to 11 Mbps data rate in the 2.4 GHz unlicensed spectrum using complementary code keying (CCK) modulation technique. The IEEE 802.11b is employed in point to multi point configuration, giving communication access through omnidirectional antenna with mobile clients located within range of the access point and within direct line of sight (Rachana, 2013). Range therefore depends on the output power, audio frequency, environment and sensitivity of the receiver.

The 802.11a and 802.11b technologies operate on different frequencies and the two are incompatible with each other. Due to its high cost, 802.11a is usually found in business networks while 802.11b better serves the home environment. The substantial price reductions led to the rapid acceptance of 802.11b as the definitive wireless LAN technology. The performance of IEEE 802.11b is measured in relation to quality of service which is the description or measurement of the overall performance of a service such as telephone, computer network or cloud

computing services, particularly the performance seen by the users of the network. To quantitatively measure quality of service, several related aspects of the network service are considered such as throughput, packet loss, bit rate, transmission delay, etc. (Doefexi *et al*., 2003).

One major disadvantage of the IEEE 802.11b standard is frequency interference from other wireless/remote controlled devices such as cordless phone, bluetooth devices, microwave ovens and baby monitors. Interference issues and user density problems with the 2.4 GHz band have become a major concern and frustration for users. Also it is important to note that other standards (802.11a, 802.11g, 802.11n and 802.11ac) transmit at faster speed than the 802.11b. Precisely, the current IEEE 802.11b has the slowest operating speed and supports bandwidth of just 5.5 Mbps data rate. To leverage on the wide acceptability of IEEE 802.11b for quality of service, there is need to optimize its performance: Throughput, Fragmentation Threshold, Delay and Retransmission Attempts, in other to achieve maximum yield from the specified standard. To achieve this, the discrete event simulation (DES) model was used:
  i) To determine the best optimisation setting by varying network performance matrices with regards to data rate, buffer size, fragmentation threshold and its effect on the quality of service.
  ii) To effectively use the Riverbed Modeller Software to model a telecommunication network from the base station to the antenna.

2.0 Design Model
The RIVERBED MODELLER software is recognized for its high reliability since it provides powerful simulation capability for the study of network architectures and protocols which makes the simulation of real-life networks close to reality. The RIVERBED MODELLER was used to create the network model based on local area network considerations. Figure 1 shows a block representation of the design methodology.

The workflow (i.e. the steps used to model and run the simulations) for the WLAN network centres on the project editor. Using this editor, one can choose the statistics to collect from each network object or from the whole network, execute a simulation and view results. The RIVERBED MODELLER provides Virtual Network Environment that models the behaviour of the entire network, including its routes, switches, protocols, servers, and individual applications. The study characterises and emulates a real life generic WLAN test-bed with metrics such as throughput, delay, bit error rate, fragmentation threshold, retransmission attempts etc. using a Minihop infrastructure. If during every T second time-interval:
- Report traffic + RSS (Received signal strength) to server.
- If network has "sufficiently changed":
- Compute co-channel interference between any two cells.
- Compute channel reassignments to minimize sum interference
- APs change channels. Broadcast change to stations. (1-2 ms)
  To know downloading node for every node in every cell in T seconds:
  $$\text{Load}(L) := \frac{\text{throughput over the past T seconds (T)}}{\text{Data rate (t)}} \qquad (3.1)$$
In the system design, five patterns are followed namely; throughput, delay, packet inter arrival time analysis and packet drop probability. The modulation technique used in this study is Quanternary Phase Shift Keying (QPSK).

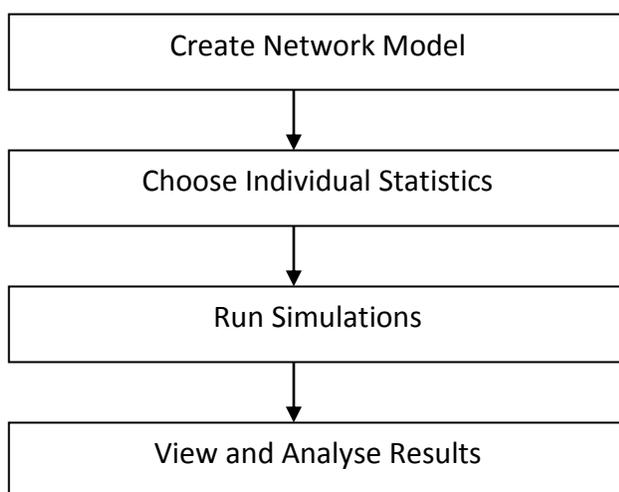The simulation methodology used was Discrete Event Simulation (DES).

Figure 1: Block Representation of the System

3.0 SYSTEM IMPLEMENTATION FOR WIRELESS LAN

The network was set up and represented as shown in Figure 2. It is assumed that the premise of the LAN is within an area of 100m x 100m. Hence the four terminals or nodes are placed within this area. The four terminals were placed within 62.5m x 62.5m.
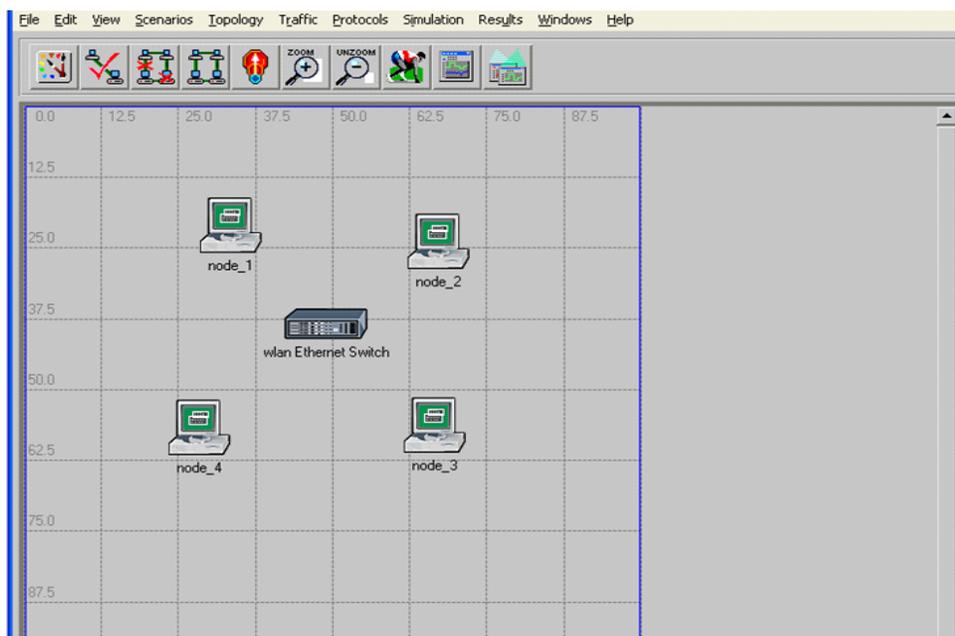

Figure 2: Wireless LAN Implementation with 4 nodes using Riverbed Modeller Simulator

INTERNATIONAL JOURNAL OF INNOVATIVE ENGINEERING, TECHNOLOGY AND SCIENCE   ISSN: 2533-7365   Vol. -2, No.-2, March – 2019

A Publication of Faculty of Engineering Chukwuemeka Odumegwu Ojukwu University Uli - Nigeria.

3.1 Wireless LAN Simulation Results and Analysis

Data-Rates (Mbps)

Table 1 presents the values for the simulation result of the data-rates used. The graphs of the simulation figures 3 - 5 shows the effects of data-rate on the performance of the wireless LAN. The metrics or qualities of service analysed were: the throughput, delay and retransmission attempts.

Table 1: Table showing the data-rates used for different scenarios

Attributes (Parameters)		Scenario_1	Scenario_2	Scenario_3
Data-rates		1Mbps	5.5Mbps	11Mbps (Optimized)
Parameters		**Metrics**		
Data rates (for 1 Mbps, 5. Mbps and 11 Mbps)	i) Throughput ii) Delay iii) Retransmission attempts			

Throughput

Based on the simulation of the three scenarios, the graph of figure 3 was obtained. It was found that when the data-rate was increased from 1Mbps to 11Mbps, the throughput increased. This is predictable from the theoretical view point that as the data-rate is increased, the number of bits received increases. Thus based on the graphical result, it can be said that when the data-rate increases in a network, the throughput increases, but when the network is overloaded with several stations, that same throughput decreases, since throughput is the number of bits successfully transmitted per second. Stability of a network is what matters in any network design, and that is why this simulation was performed using long duration of 300 seconds in order to get a good performance study.
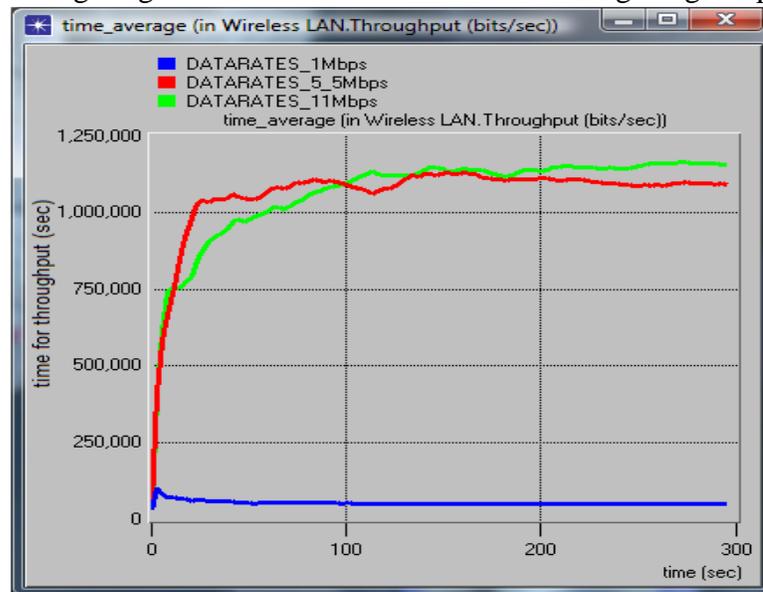

Figure 3: Throughput for data-rates of 1Mbps, 5.5Mbps and 11Mbps

Delay

The simulation graph for the delay is shown in figure 4. When the data-rate was increased from 1Mbps to 5 Mbps between times 0.0000 to approximately 0.0125 (existing system) it was observed that there was approximately 75% reduction in delay. When the system was then optimized (11Mbps), there was further reduction in delay by

INTERNATIONAL JOURNAL OF INNOVATIVE ENGINEERING, TECHNOLOGY AND SCIENCE   ISSN: 2533-7365   Vol. -2, No.-2, March – 2019

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35%. Delay can therefore be minimized by increasing the data-rate or increasing the rate at which each node accepts or transmits data.
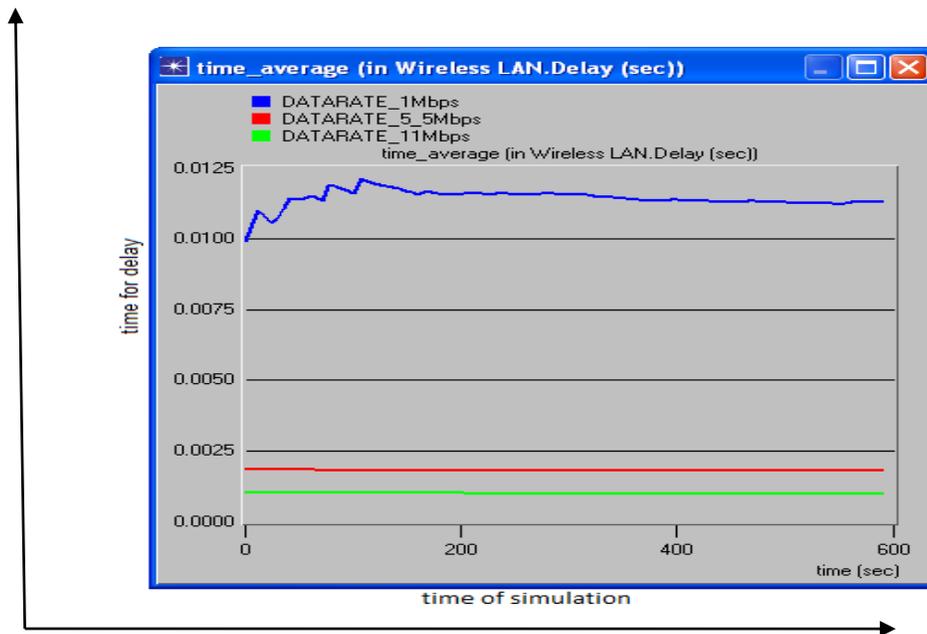

Figure 4: Delay for Data-rates of 1Mbps, 5.5Mbps and 11Mbps

Retransmission Attempts

From figure 4, it was observed that as data-rate increased from 1 Mbps to 11 Mbps, retransmission attempts was decrease to approximately zero. Though from the graph it was observed that at the optimized value of 11 Mbps, in the first 100seconds, there was a slight peak as compared to retransmission attempt at 5.5Mbps (current system) (figure 5) but as time increased retransmission decreased to approximately zero, this is so because if data rate is increased, packets are delivered more accurately, hence less need for retransmission.
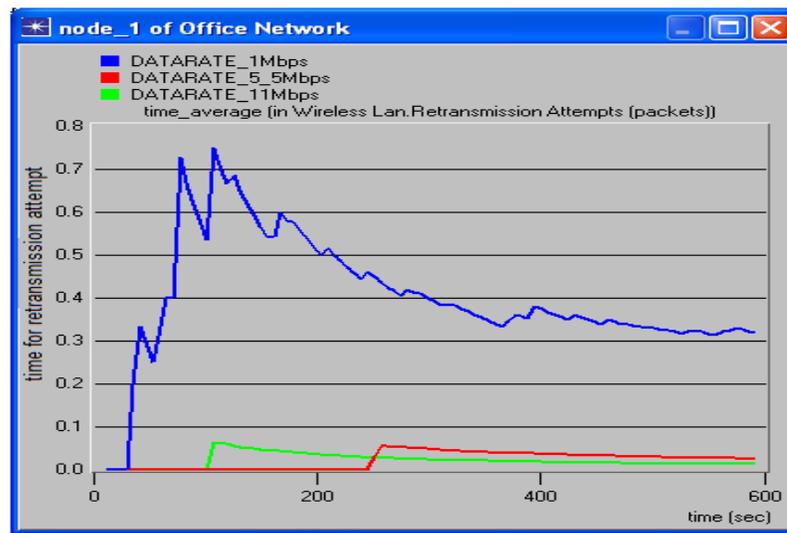

Figure 5: Retransmission attempts occurring at node 1 for data-rates of 1Mbps, 5.5Mbps, and 11Mbps

INTERNATIONAL **J**OURNAL OF **I**NNOVATIVE **E**NGINEERING, **T**ECHNOLOGY AND **S**CIENCE **ISSN: 2533-7365   Vol. -2, No.-2, March – 2019**

A Publication of Faculty of Engineering Chukwuemeka Odumegwu Ojukwu University Uli - Nigeria.

Buffer Size (bits)

Buffer size is the amount of time allotted for processing incoming data/information in a network. It acts like a holding place. It exists not necessarily to accelerate the speed of an activity but to support the coordination of separate activities. The values for different scenarios between the existing system values and the optimized system values are is listed in table 2:

Table 2: Buffer Sizes Used

Attributes (Parameters)	Scenario_1	Scenario_2	Scenario_3
Buffer Sizes	1000bits	6400bits	12800bits (Optimized)
Parameters	**Metrics**		
Buffer sizes (for 1000 bits, 6400 bits and 12800 bits)	i) Throughput ii) Data dropped		

Here throughput and data dropped as metrics or the qualities of service are analyized.

Throughput

The graphs of figure 6 shows that when the size of the buffer was increased from 1000bits to 6400bits (existing system values), throughput (the rate of successful data delivery over a communication channel) was increased by approximately 17%, but when further increased to 12800 bits (optimized) throughput further increased by approximately 90% hence for a very small size of buffer, the throughput reduces to zero, meaning that packets are dropped or discarded because the buffer has no space to accommodate more packets.
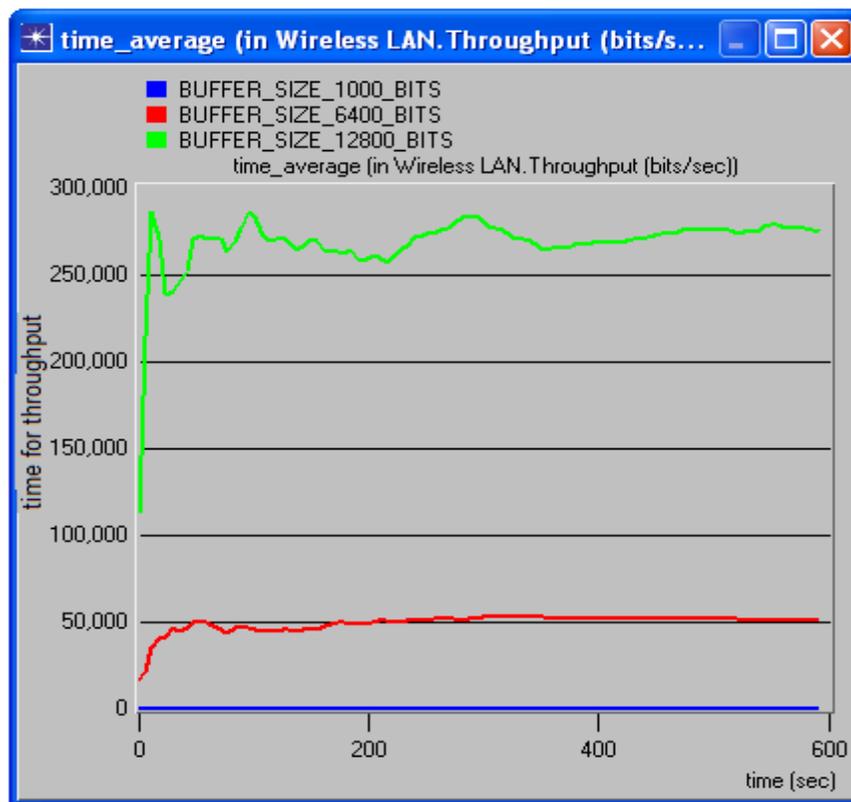
INTERNATIONAL JOURNAL OF INNOVATIVE ENGINEERING, TECHNOLOGY AND SCIENCE   ISSN: 2533-7365   Vol. -2, No.-2, March – 2019

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Figure 6: Analysis of throughput for different buffer sizes

Data Dropped

In figure 7, it was observed that at 6400 bits (existing system values), there was approximately 66% data dropped while at 12800 bits (optimised) there was approximately no data dropped because it would take a longer time for the buffer to be filled up.
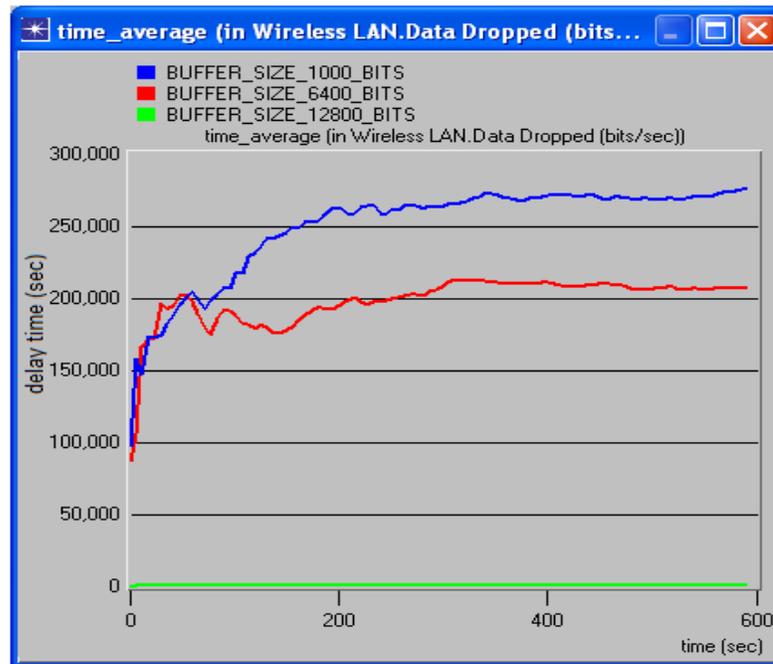

Figure 7: Data dropped for different buffer sizes

CONCLUSION

The simulation results showed that when data rate was optimized from 1Mbps to 11Mbps, throughput performed much better and there is 80% reduction in delay and also about zero retransmission attempts was achieved, this implies that packets are delivered successfully in less time and accurately. This improvement can also be seen when buffer size is increased from 1000bits to 12800bits, throughput increased by approximately 90% and there was no data dropped since it will take longer time for the buffer to be filled up. The proposed model provided has, through simulation, been proven viable. The next step would be to implement it in hardware for testing.

REFERENCES

Borah, D. K., Daga, A., Lovelace, G. R., and Deleon, P. (2005), *Performance Evaluation of the IEEE 802.11a and b WLAN Physical Layer on the Maritain Surface*, Proceedings of IEEE Aerospace Conference.

Rachana, K. (2013), *Performance Comparison Analysis between IEEE 802.11a/b/g/a Standards*, International Journal of Computer Applications, Vol. 78, Issue 1, pp. 13-20.

Doefexi, A., Armour, S., Lee, B. S., Nix, A. and Bull, D. (2003), *An Evaluation of the Performance of IEEE 802.11a and 802.11g Wireless Local Area Networks in a Corporate Office Environment*, IEEE International Conference on Communications, pp. 1196-1200.