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IMPROVING RESOURCE RESERVATION CONTROL IN WIRELESS SENSOR NETWORK USING AN SMART CONTROL SCHEME

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Abstract

This paper work is aimed at improving the resource reservation of wireless sensor network. Recently, internet networking has expanded rapidly, with the network stability of bandwidth playing a vital role in transmitting packets. Hence, it was imperative to find solution to the problem of congestion especially in the flow of bandwidth stability. Congestion in computer networking is caused by so many factors. Some of the signs are packet loss, queuing delay resulting from overloading the buffer, faulty hardware devices, intermixing of old and new technologies and unstable flow of bandwidth. A medium access control scheme was developed for both control and queuing theory. The technique ensures that before transmission of signal is enabled, the channel is sensed for congestion at various time slot, if the channel is free, then packet can be transmitted, else it is delayed and then retransmitted once the channel is available. This shows that adopting medium access control protocol reduced congestion by sensing the channels before transmission, monitoring balanced flow of bandwidth, and improved throughput. MATLAB/ Simulink was used to simulate the models and the results generated were analyzed a better throughput performance compared to the characterized system.

Keywords: Wireless Sensor Networks; Congestion; Computer Network; Bandwidth; Smart Control

1. INTRODUCTION

Time sensitivity applications like the conferencing calls and video streaming are challenging to deploy via the internet. This is due to various factors like high bit rate,

delay and losses are not suitable for delay sensitive applications since they are transmitting lots data, leading to long delay. As a result, lots of proposed method has been presented with various opinions. According to Tan (2009), a layered video codes tackles heterogeneity and time varying nature of the internet, adopting bit rates to the available bandwidth. The error resilient codes modified the bit such that the decode video degrade more gracefully in lose environment (Tan, 2009). From channels coding angle, medium access control scheme has been proposed to minimize delay in communication due to retransmission, at the expense of bandwidth expansion (Matthew, 2015).

Another commonly employed method in lose environment is re-transmission which results in a limited bandwidth overhead. It does introduce more latency of a round trip period between the receiver and the sender, thus the transmission delay usually exceeds 150 milliseconds, the tolerance delay limit for many interactive applications like the video conferencing. From protocol perspective, TCP friendly protocols use equations depending on the rate of control to compete fairly with other TCP traffic for bandwidths, while stabilizes throughput and minimizing jitters from multi medium streaming (Floyd, 2010).

From the perspective of networks, telecom organizations use advanced design to get better load balancing, lower latency and higher throughput. Edge architectures reduce latency moving content to the edge of the network in order to minimize the time of round trip and prevent internet congestion.

Majority of the mentioned scheme employs a single fixed path between sender and receiver throughout the process. If network congestion occurs along the propagation path, video streaming suffers high loss rate and jitter.

Based on these facts, it is conceivable to send packets over multi path at the same time as a diversify scheme to fight unpredicted congestion in the network. If the path between a particular receiver and sender experience packet loss as a result of congestion and packet traversed through other paths can be employed to recover packets lost, and an smart control scheme can be used for re-transmission.

Researchers like (Luigi et al., (2017); Ioannis et al., (2008); Harris (2017); Tsao and Lin (2012); Allmanand Paxon (2012) and Zhang et al., (2015)) published works

that attempted to improve on this technology, but despite their success, there is still room for improvements and that is what this paper will address using an smart control scheme.

2. METHODOLOGY

The work employs an medium access control system to improve resource management in a wireless sensor network. The medium access control protocol is a technique that uses random access scheme for both transmitting and carrier sensing to prevent network collision. The approach employed carrier sensing scheme which monitors the spectrum channels during upstream and downstream to ensure that interference do not occur which often leads to congestion of signal. The scheme was implemented with simulation and the performance evaluated

3. MATHEMATICAL MODELING OF THE CONGESTION SCHEME

This work will be modeled using the queuing algorithm presented by (Tan, 2009) the model is adopted to address the challenge of congestion of packet flow in a wireless area network considering the following parameters;

λ= rate of arrival of packets

μ = service rate (rate of transmitting packets)

L_s = Average number of users on the network

L_q = Average number of users requesting for web resources from a router in the network (in the queue).

c = number of routers

ρ = network utilization

P_o = Probability of routers that do not accept packets

$$\boldsymbol{L_s = \sum_{n=1}^{\infty} np_n} \quad 1$$

For a single server model (c =1), there is no limit on the maximum number of users in the network. The model assumes a capacity source. Arrivals occur at rate λuser per unit time. Under these conditions, $\rho < 1$ and $\lambda < \mu$. If arrival rate is higher than the service rate, then the geometric series will not converge and the steady-state probability will not exist. The queue length will continually increase and no steady state will be reached in the network.

Letting $\rho = \frac{\lambda}{\mu}$, the expression for Pn in the generalized model then reduced to

$P_n = \rho^n p_o$, n = 0, 1, 2, -------, n 2

To determine the value of p_o we use the identity

$p_o = (1 + \rho + \rho^2 + \text{-----} \rho^n) = 1$ 3

3.1 Propagation channel Model

The approach considers propagation models with two separate parts consisting of the random and deterministic (or non-random) components of signal propagation. The deterministic component is represented by some path-loss function that uses the distance propagated by the signal (from its source) for modeling the power decay of electromagnetic signals. The distance-dependent path-loss function is a fast-decaying exponential function to define the propagation path as shown in equation 1. Wang et al (2006)

$$\iota(|x-y|) = |x-y|^{\alpha} \qquad 4$$

Where the path-loss exponent $\alpha > 2$, and $|x-y|$ denotes the distance between point y and the signal source at point x.

3.2 Model of the Network positions

A number of point processes have been suggested to model the positioning of wireless network nodes. Among these, the most frequently used is the Poisson process, which gives a Poisson network model. The Poisson process in general is commonly used as a mathematical model across numerous disciplines due to its highly tractable and well-studied nature. It is often assumed that the Poisson process is homogeneous (implying it is a stationary process) with some constant node density λ. For a Poisson process in the plane, this implies that the probability of having n points or nodes in a bounded region **B** is given by Manadu and Teruya (2013).

$$P(n)\frac{(\lambda|B|)^n}{n!}e^{-\lambda|B|} \qquad 5$$

Where $|B|$ is the area of B and $n!$ denotes n factorial. The above equation quickly extends to the $\mathbf{R}^3$ case by replacing the area term with a volume term.

The mathematical tractability or ease of working with Poisson models is mostly because of its 'complete independence', which essentially says that two (or more) disjoint (or non-overlapping) bounded regions respectively contain two (or more) a Poisson number of points that are independent to each other.

3.3 Implementing the Access Control

This section will present the implementation design of the access control scheme, guided by the congestion model represented in the previous section. The implementation will be done using communication toolbox, signal processing toolbox, optimization toolbox and Simulink.

This model simulates data switched network with three (nodes) computers and a shared channel operated at 10 Mbps as shown in (figure 2). Each node is designed with a PHY/MAC transceiver (receiver and transmitter). MAC controller The MAC Controller block implements the random-access control protocol. The model is comprising of three major sections which are;

i. The wireless area network model with various nodes with a transceiver
ii. The media access controller section which controls the computer use of the channel
iii. Access point that connects the computer network

Implementing the random-access control Protocol Standard data switched network use carrier sensing multi access or collision detection protocol to manage the network. Each node controller physically monitors the traffic on the channels before transmission. The transmission is enabled only when the channel is sensed idle else a collision is occurred.

Inside the MAC Controller subsystem, a transmission buffer holds packets waiting for transmission. When the carrier-sensing component indicates that the channel is ready, a gate opens and the packet advances to the subsystem's TX output port. This output port permits the packet to advance to the access point. During this process, the signal also passes through a Replicate block that makes a copy of the packet. The subsystem uses this copy to observe the channel's state and to implement CSMA/CD. In particular, the subsystem tracks the packets that use the channel, determines when the channel is not busy, and determines when the channel experiences a collision between two packets. For packets that experience a collision, the Back-off Controller subsystem determines whether and when a packet reattempts transmission.

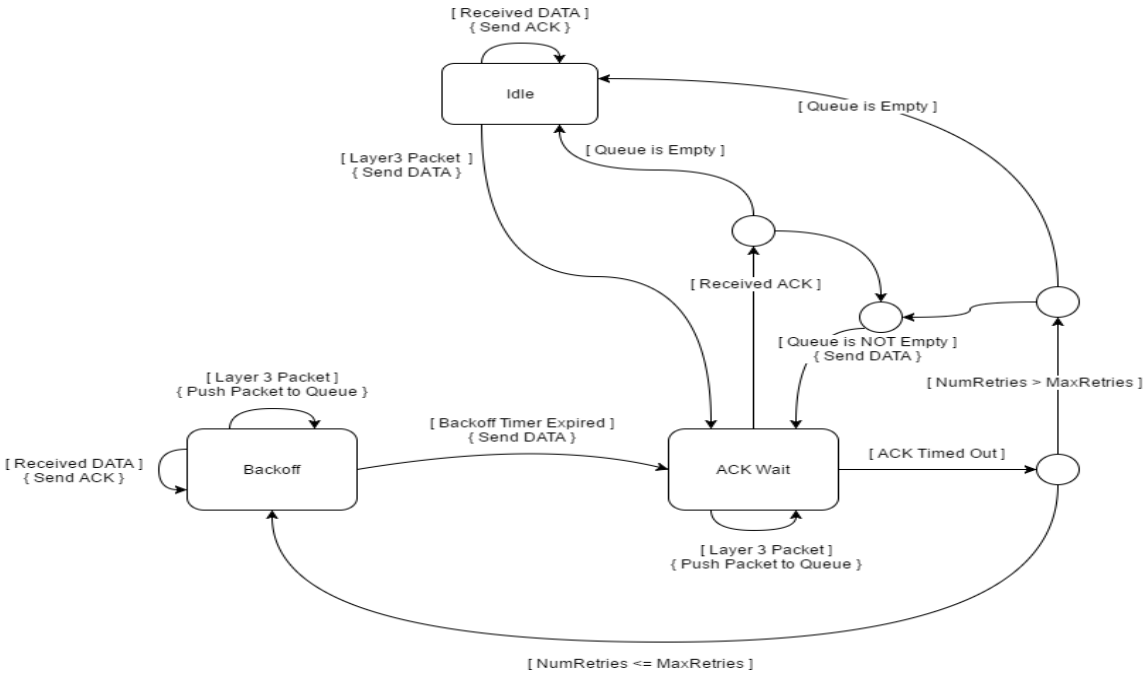

Figure 2: Modeling diagram of the access control scheme

3.4 Simulation Parameter

MATLAB was employed for the system simulation using the IEEE 802.11b standard as MAC layer protocol. It has the functionality to sense the network about congestion or break link in the communication channel and enable transmission if the network is idle. The simulation parameters are presented in table 2:

Table 2: Parameters for the simulation

Parameter	**Value**
Traffic Source	CBR
Minimum Packet Size	64 bytes
Maximum Packet Size	1500 bytes
Network Speed	10 m/s
Rate of packet generation	100pakets/s
Area	500X500 m
MAC	Mac/802_11
Simulation Time Interval	20 sec
Bit rate (Gb/s)	10

4. RESULTS AND DISCUSSION

This section will present the simulation result of the designed Simulink model, the result will present the back-off performance analysis of the respective nodes, how the wireless sensor network is controlled using the MAC scheme, the average throughput per second, the packet loss analysis and then evaluate the result.

Figure 3 presents the network traffic at node 1; showing the transmitted signal at various

interval when the channel is idle; the back off graph below is to monitor and sense the channel ensuring that free path for propagation is available or not that is when there is communication between node 3 and node 2.

Figure 3: network traffic at node 1

Figure 4is the result of the other transmitted node 2 and the back off pattern, the back off was initiated if the carrier sensor detects communication between node 1 and node 3. Figure 4 presents the network traffic at node 2, revealing the back off interval when there is communication between node 3 and node 2 respectively. Figure 6 presents a unified simulation model to help the researcher properly investigate the result of the simulation properly, showing the variance in the back off chart to prevent congestion in the wireless sensor network.

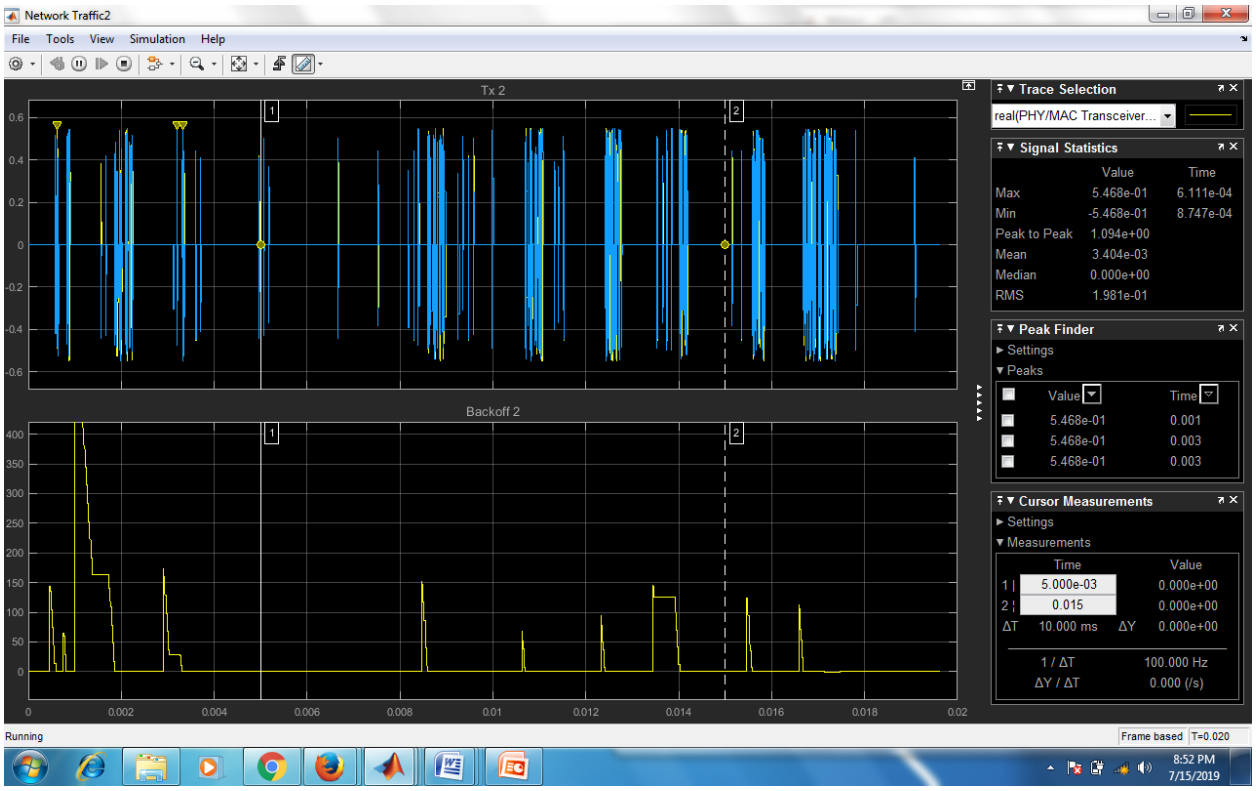

Figure 4: network traffic at node 2

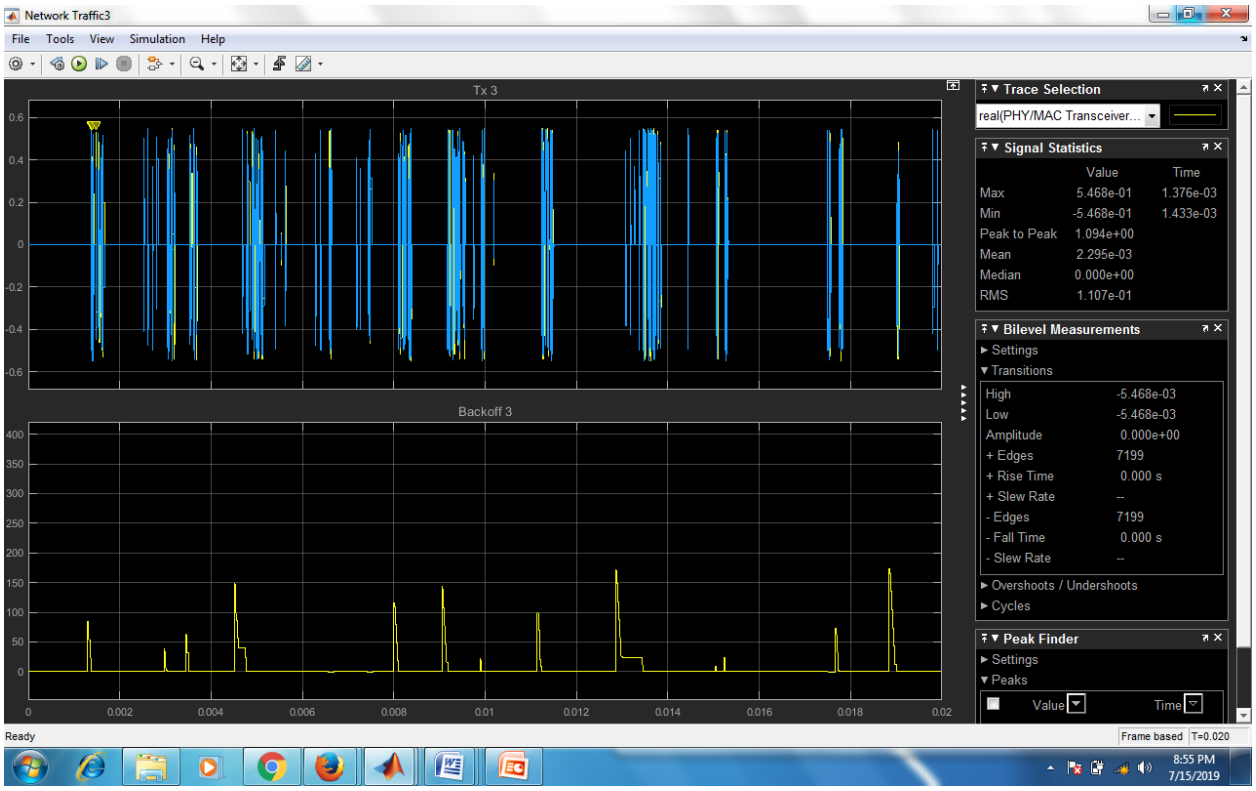

Figure 5: network traffic at node 3

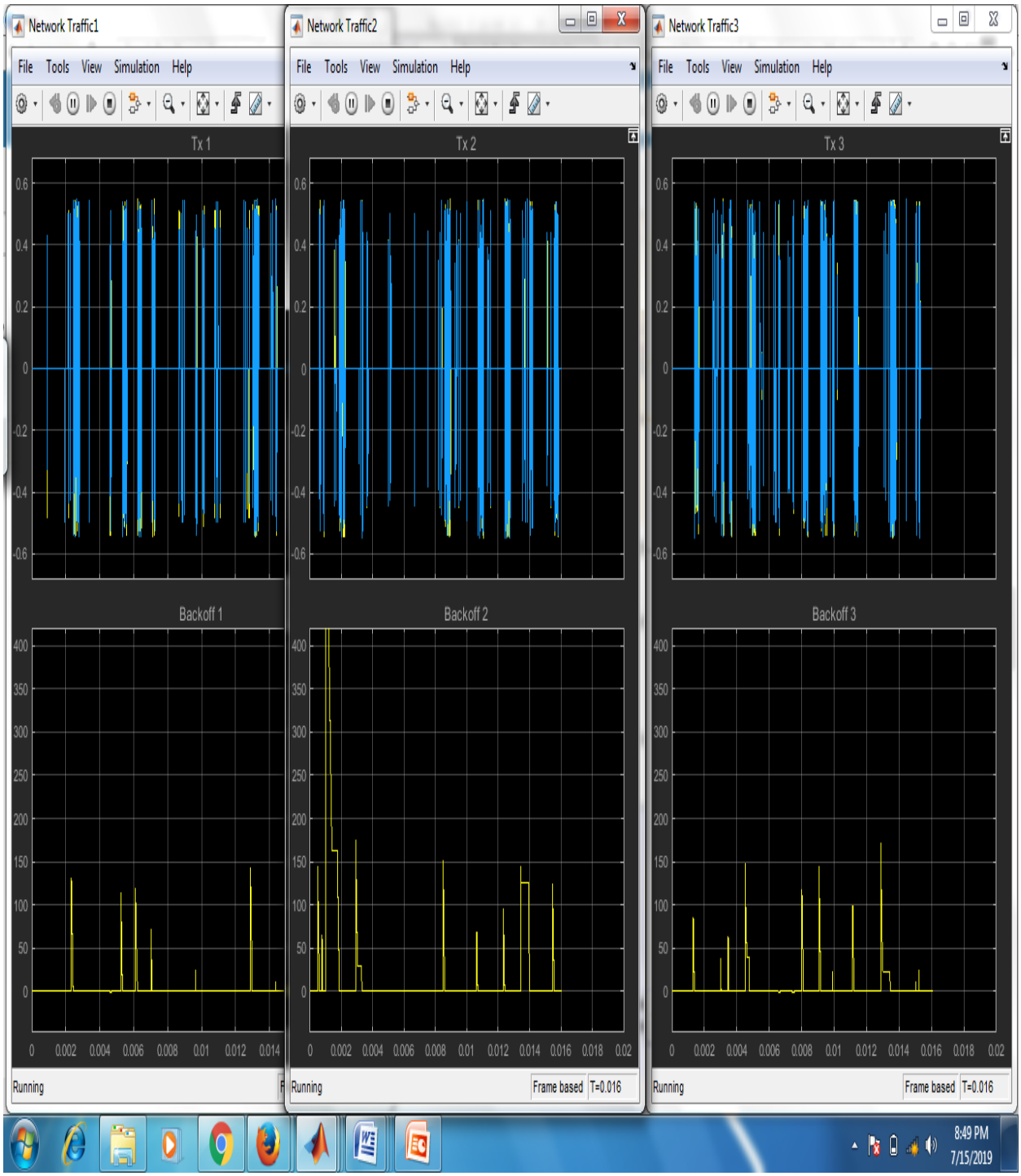

Figure 6: throughput result for the multi sensor network

4.1 DISCUSSIONS

In network communication architectures, every packet data start its route of transmission from a specified location towards a specified node destination with a varying network simulation time which

affects the speed relative to the node. Node mobility in a network and traffic schemes which are employed using protocols to get quality of service output based on the simulation results presented so far from figure 4.8; the throughput value of the network varies from 1546 bit in 100secs to 565bit, showing that the switched network without MAC control model. It can't provide good quality of service throughput in a congested environment where as on the result of table 4.9 the throughput value of the network in various time initially was higher as 1856bit but reduced to 1632 as the simulation time decreases to 100sec which shows the MAC control model based switched network is good network throughput was achieved.

The simulation results as shown in figure 4.4, the packet delivery ratio without MAC Control Model was low. Whereas, the packet delivery ratio of MAC Control Model based network in different simulation time can provide good packet delivery.

Based on simulation results as shown in figure table 4.7, the packets loss of network is more without MAC Control Model. Whereas MAC Control Model based network in different simulation time recorded less packet loss.

5. CONCLUSION

This study is aimed at improving the resource reservation of wireless sensor network. Recently, internet networking has expanded rapidly, with the network stability of bandwidth playing a vital role in transmitting packets. Hence, it was imperative to find solution to the problem of congestion especially in the flow of bandwidth stability. Congestion in computer networking is caused by so many factors. Some of the signs are packet loss, queuing delay resulting from overloading the buffer, faulty hardware devices, intermixing of old and new technologies and unstable flow of bandwidth. A medium access control scheme was developed for both control and queuing theory. The technique ensures that before transmission of signal is enabled, the channel is sensed for congestion at various time slot, if the channel is free, then packet can be transmitted, else it is delayed and then retransmitted once the channel is available. This shows that adopting medium access control protocol reduced congestion by sensing the channels before transmission, monitoring balanced flow of bandwidth, and improved throughput. MATLAB/ Simulink was used to simulate the models and the results generated were analyzed a better

throughput performance compared to the characterized system

This work has successfully developed an smart wireless sensing technique for effective communication process. The work will help minimize interference and congestion challenges experienced during daily communication process. The wireless sensor network was developed using the MAC technique that adopts a random-access control protocol to smartly sense propagation path before communication.

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