TRACE MODEL FOR CYCLIC BEHAVIOR IN WIRELESS LANS

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ABSTRACT: For the estimation of cycle time in WLANs different parameters were used to analyze the cyclic behavior like packet loss cycle, successful packet cycle and collision cycle. This paper proposes a model to control all the node activities, contention status, including collision probability, successful packet information, packet retransmission, packet loss information, cyclic behavior and throughput with comprehensive consideration of node heterogeneity. The simulation was performed for evaluation of proposed trace model and contention control scheme. The proposed model achieved significant results compared to existing schemes which did not systematically considered node heterogeneity. The results verified that the packet loss rate was 0%, collision probability was 7% and successful packet rate was 100%. The results varied due to the variance of successful sending of MAC Protocol Data Unit (MPDUs), total MPDU losses, total MPDU collision and the cyclic behavior.

Keywords: Collisions, cyclic behavior, DCF behavior, trace mode performance.

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INTRODUCTION

A Wireless LAN (WLAN) provides network connectivity between devices also known as stations, by using radio as the communication medium. Devices that communicate over the WLAN conform to the interfaces and procedures define through the IEEE 802.11b standards. The basic building block of the WLAN network is Basic Service Set (BSS). A BSS defines a coverage area where all stations within the BSS remain fully connected. In some instances WLAN technology is used to save costs and avoid laying cable, while in other cases it is the only option for providing high-speed Internet access to the public. Up to date applications may incorporate any mix of feature, voice and high- speed data rates in a wireless LAN. To improve the transferability of the client give a component to numerous merchants to work at lower costs, the industry has moved to the IEEE 802.11 standard for wireless networks. IEEE 802.11 takes into account numerous balance plans, high information rates and the capacity to give a wireless framework to all parts of the world (Saliga, 2000). The historical background of the wireless telecommunication has begun in 1886-1888 when Heinrich Rudolf Hertz defined the concept of communication. When the Titanic was drowned in 1914, the administration decided to develop a system that controls the ships and shows all the movement of ships on a 24 hour basis. That time the administration tries to work in the field of radio signals and enhance their technology industry. Wireless technology has become more valuable and largely spread when televisions, fax and other wireless devices are available in the market (Ranjini and Yamna, 2011). The demand for wireless connectivity has been tremendously increasing with the emergence of smart mobile devices such as smart phones and tablet PCs. Along with such a trend, the IEEE 802.11 wireless local area network (WLAN) has become very popular and widely deployed. In most WLANs, nodes share medium access opportunities through distributed and contention based medium access control (MAC) called Distributed Coordination Function (DCF). In this paper, the proposed work focuses on to trace the cyclic behavior of nodes in IEEE 802.11b standard for wireless ad hoc networks. For this purpose, a simulator is developed by using IEEE 802.11b standard for ad hoc network. The main purpose of this paperwork is to analyze the cyclic behavior of the nodes in IEEE 802.11 b protocols in an ad hoc wireless LAN. To do this, the behavior of the nodes has been analyzed and results are calculated and compared with the other ones obtained from the input of different parameters. For this purpose the simulator is used to send data through a wireless channel to measure cycle time and its performances. The cycle is an interval of time during which a sequence of a recurring succession of events is completed. In nodes cyclic behavior, the successful packet cycle information, collision cycle information and packet loss cycle information in context of the respective cycles are explored. Successful packet cycle is the cycle in which node successfully transmits packets. To calculate the cycle time simulator store time of end transmission and also store the time when the node was idle and other nodes transmit the data on the medium. In manipulating the network environment, when the node again starts their transmission, then the time of node from end transmission to start transmission is also called the cycle time of the node. The node cycle time variability is due to different factors in network. The goal of the proposed study is to analyze the ideal behavior of the node cycle in a network and then compare them with the results obtained from the proposed simulator. However, to have as less collisions as possible according to proposed algorithm that was implemented in the simulator, communication between nodes and node cycle time was set up. There are two types of WLANs, according to the IEEE 802.11 standard. One is ad hoc network and second is infrastructure network (Chen, 1994). Major focus will be on existing cyclic behavior in WLAN, and their delay procedures and properties. After some time particular node accesses the medium and starts its transmission. The time from end transmission to start transmission is called a cycle of particular node. Wang *et al*. describes the causes of Wi-Fi inefficiency in large audience environments and proposes Carpool to handle the frame aggregation for multiple STAs in the transmission. Carpool is the protocol that is built on lightweight frame structure and integrated into the existing Wi-Fi standards (Wang *et al.*, 2016). New analytical tools are presented in this paper for performance analysis and enhancement of wireless MAC protocols under bursty and correlated multimedia traffic. The proposed analytical models have been used to investigate important QoS performance measures of 802.11 MAC protocol under bursty and correlated traffics (Najjari, 2017).

MATERIALS AND METHODS

This section elaborated the methodology for the implementation of simulator that was developed by using IEEE 802.11b standard for ad hoc network. The main purpose of this paper work was to analyze the cyclic behavior of the nodes in IEEE 802.11 b protocols in an ad hoc wireless LAN. To do this, the behavior of the nodes was analyzed to calculate the results and compare them with the other ones obtained from the input of different parameters. To achieve the goal, a simulator tool was used that was developed by us to send data through a wireless channel, measure cycle time and its performances. The goal of the proposed study was to analyze the ideal behavior of the node cycle in a network, and then compare them with the results obtained from the simulator. However, to have as less collisions as possible according to our algorithm that was implemented in simulator, so communication between nodes and node cycle time was dedicated to our purposes.

Environment of the simulation development: Environment of the simulation development was the software, hardware and the other system resources that were needed for the development of software. IDE is the combination of computer resources that provides application development interface, deployment, testing, integration and services.

Simulation testing environment: Figure-1 represents the network environment for proposed simulation development and testing. As Figure-1 represent, in network environment for the application development, there was no need of an access point or infrastructure to set up the wireless ad hoc network. The nodes in the ad hoc network accessed the medium using DCF algorithm.

Simulator software component: The simulator software development tools were as follows:

- Microsoft Visual Studio .NET (C#) 2012: Programming tool;
- Print screen: Tool that was used to obtain screen shots;

Simulator design: The main tool for the development of the simulator was Microsoft .Net Compact Framework 2012 in C#. In C#, the application was simulated by using the IEEE 802.11b standard. This application was used to create a node and handle all the transmissions between nodes in giving input time according to DCF algorithm. User datagram protocol (UDP) is chosen to send packets, receive packets, and its size is set to 512 bytes.

Implementation: Distributed coordination function (DCF) algorithm needs a node wincing to transmit the data for a DIFS time. IF channel is engaged for a DIFS time, then the node's communication is different. In network where stations check the medium busy, if the medium is already used then their access time will be changed and maximum number of stations compete for the wireless channel. The basic MAC is a DCF algorithm, which permits automatic medium sharing between physical layer through the utilization of CSMA/CA and random backoff time taking after an occupied medium condition (Hans and Nayyar, 2014). All coordinated traffic utilizes quick, positive acknowledgment (ACK) yet in the event that there is no ACK then the retransmission is planned by the sender. CSMA/CA performed the physical carrier sensing that helped in vanishing collision among different mobile node when try for the medium. The transmission was done when channel was free. A terminal detects the medium, whether free or occupied, for DIFS interval. On the off chance that the medium was occupied for the DIFS interval, the terminal postponed its transmission. Also, if the medium was free, terminal began transmitting. The DCF utilized four way handshake technique RTS, CTS, DATA and ACK. If the channel was free for DIFS interval time, the station was permitted to send RTS. On accepting the RTS, the destination node will delay for a certain time period-short inter frame space (SIFS) and after that send CTS. This showed that destination was prepared to get the information. When SIFS time period ended, then sender send the data. At the end the destination send the ACK to the sender after the SIFS time, to demonstrate that it has effectively received the data. The medium found occupied, the communication would be delayed for the time of busy medium. DCF boosts the virtual carrier sensing through network allocation vector (NAV). NAV predicts length of time for which the channel occupied. RTS as a rule incorporates the length of time for which node will be occupied. So the other node in the region set the NAV. NAV shows that the amount of time must go before checking the medium, that is idle or not and this helps to avoid the collision of other nodes. In an ad hoc wireless network, multiple nodes try to access the channel, numbers of nodes detect the channel and stop their communication for some time, and they will basically at the same time locate the channel being discharge and attempt to get the medium. So to avoid specific collision, nodes should be uprooted in time. Backoff algorithm named as binary exponential backoff that change the nodes location temporally. In binary exponential backoff, when a collision was occurred at random waiting time assigned to the node and such node tried again for the waiting time that was assigned randomly. If the node failed to send their data in the assigned period, then the size of contention window would be multiplied. Binary exponential backoff algorithm utilized the random distributed function to allot the random backoff value to the each node. Backoff time is an arbitrary number of distribution over the interval (0, CW), which was multiple of slot time size. If the medium was busy, any collision may occur, and then back-off values increased exponentially. However, in the event that the medium was free and there was effective transmission, then the backoff value was situated to least CW size. Backoff time was computed as Backoff Time = random ()* Slot Time. DCF algorithm determined the issue of collision, but DCF algorithm did not handle the QoS or the decency issues. Figure 14 shows the DCF flow chart that described the detailed working of our proposed methodology. DCF algorithm utilized the random function in the binary exponential backoff algorithm to produce the values of backoff. If the collision occurs then the backoff value is doubled that time the value reduced to the initial value of the contention window. Low throughput, unfair problem, bandwidth wasting issues is arising due to the high variation in the backoff counter. Contention window's size depends on the magnitude of the transmission (IEEE Computer Society, 1999).Contention window become CW_{min} when the transmission completed successfully which was 7, while collision occurred, it doubled till CW_{max} (1024) was reached. After that BEB created the random number, a station begin checking down, in every slot time (20μs) decrementing the value while listening to the medium. At the point when the station achieved 0 value, it could start transmitting, generally in the event that another node had begun sending frame recently, the value of random number saved, and decrement the random number until the next backoff.

RESULTS AND DISCUSSION

Packets were sent from source to destination. It was observed when contention window size was high, the chances of packet loss rate were low and successful packet rate was high. In a time of 100 seconds, the packet record sent by each node is listed below in Table-1. Successfull packet ratio was 80%, which was better than previous model that described the packets rate (Najjari, 2017).

Collisions: Backoff algorithm named as binary exponential backoff changed the nodes location temporally. In binary exponential backoff, when a collision was occurred at random waiting time assigned to the node and such node tried again for the waiting time that was assigned randomly. If the node didn't send their data in the assigned period, then the size of contention window would be multiplied. Binary exponential backoff algorithm utilized the random distributed function to allot the random backoff value to the each node. Backoff time was an arbitrary number of distribution over the interval (0, CW), which was multiple of slot time. If the medium was busy, during that time collision may occur, then back-off values increased exponentially. However, in the event that the medium was free and there was effective transmission, then the backoff value was situated to least CW size. If the collision occurs then the backoff value was doubled and that time the value reduced to the initial value of the contention window. Contention window's size depends on the magnitude of the transmission (Society, 1999). Contention window become CW_{min} when the transmission completed successfully which is 7, while collision occur, it was doubled till CW_{max} (1024) was reached. Figure 2-5 shows the collision cycle information of the nodes in the network. It was observed that with a large contention window size the chances of collisions were low, successful packet rate was high. The results of collisions that were occurring in the network during the communication of 4 nodes are shown in (Table 2). Carpool was impertinent to narrow channel designs and can be applying only for narrow channel systems. Due to narrow channel, chances of collisions were increased and the efficiency of all the system was affected (Wang *et al.*, 2016). In our proposed trace model, Figure 2-5 represents collision probability which was reduced up to 7% and these results were better than carpool.

Retransmission of packets: In network, if collision occured then the size of the contention window was increased one step. In the network, retransmission rate was affected by the number of nodes and contention window size. In the carpool model collision rate was high, due to this packets retransmission rate was increased. Table 3 shows that the proposed model had a remarkable achievement than the previous approaches given by author which elaborate the packet information (Najjari, 2017).

Packet loss: These results show that with a large contention window size the chances of packets loss were little and successful packet rate was extraordinary. Packet loss occured when CW exceeds its CW max limit. The packet loss rate was 0 % in our model. Result for this scenario is shown in following Table 1 which is better than the previous technique results of packets loss (Wang *et al*., 2016).

Network Performance via throughput: Throughput of the node is the amount of bits or data transferred from source to destination in a particular time period. It was observed that with a large contention window size and small node's network increase the network performance. This is the fact that when the number of nodes increased in the ad hoc wireless network, then collisions and packet loss rate become high and successful packet rate decreased. Thus, overall performance of over proposed models was better than previous model which disscussed about the throughput (Wang *et al*., 2016). Figure 6-9 showed the throughput of the nodes in the network. Maximum throughput was the number of bits sent successfully at maximum data rate in a network.

Cycle information: To calculate the cycle time the application store time of end transmission, also store the time when the node was idle and other node transmits the data on the medium. In manipulating the network environment, when the node again started their transmission, then the time of node from end transmission to start transmission was also called the cycle time of the node. In below graphs of success packet cycle, collision cycle and packet loss cycle were shown. Figure numbers 10 to 13 show the success packet cycle information of the nodes in the network. Our graphs show that the proposed model in this paper had an incredible achievement than the previous studies of cycle behavior (Choi *et al*., 2017). From these results, we check how much time is spent by the particular node for the completion of their one cycle. The node cycle time variability depends on the collisions, packet retransmission, network nodes and contention window size.

Another same idea is presented in (Bloessl *et al*, 2017) with complete simulation and experimentation framework for IEEE 802.11. Here a transceiver which is SDR- based gives advantage of providing access to all layers for complete and better communications. This transceiver was visible enough to see the implementation in detail.

In another research article (Blazek *et al.* 2017) authors investigate simple, yet flexible tapped delay line channel model that capture the essential aspects of vehicular communications through asymmetric power spectral densities and well-chosen Doppler and delay spreads. It was demonstrated how to generate such asymmetric fading traces, and use the implementation on a channel emulator to measure packet error probabilities using software defined radios. They analyzed the received packet traces with respect to packet loss and showed the influence of the line of sight obstruction and Doppler frequencies on the packet burst behavior. It thus demonstrates the link of fine-grained packet statistics and underlying physical channels.

Another work (Soo *et al.* 2018) found about the Traffic load in the same protocol infrastructure mode. Here network was typically distributed unevenly between access points (APs), creating hotspots. This was due to innate nature of this protocol, where stations can link to any known AP they want. A condition where underutilized access points may lead to low throughput, long latency, and operation was going below the network potential. To solve this issue, work load should be distributed all access points in WSN making a load balancing. Software-defined networks are enriched with the control integration, management and load-balancing in WLANs

A simulation for wireless network has been used to compute the performance and throughput. An executable mobility model has been proposed where parameters are extracted from real-life mobility and generates scenarios based on the given parameters.

They presented framework to compare any measurements of WLANs, this guides the users to use WLAN mobility model by making mobility scenarios from recording wireless traces.

The model was cross-validated using traces taken by two different methods, during different time frames which proved it to be successful in capturing the mobility characteristics of the real-world with less error rates. It also has a good influence on behaviors of simulated systems (Tuduce. C *et al*. 2005). The parameters used in simulation were as follow:

- Number of nodes=4
- Data transmission rate=11 Mbit/s;
- Simulation Time= 100 seconds
- CW_{min} = 31;
- CW_{max} = 1023;

A comparative analysis of the simulation is given below with the studies in literature.

The authors (Choi *et al*., 2017) developed a performance analysis model that enables analytic estimation on the contention status, including the collision, probability, collision time, back-off time and throughput with comprehensive consideration of node heterogeneity. Based on the newly developed model, however, in this study the theoretical ideal contention status in an average sense have been derived. The authors (Savkin and Matveev, 1999), in their study, set up network communication without any central device where area was used as a control variable in server. However, the results show that even exceptionally straightforward exchanged frameworks of request can display a disorderly sporadic random behavior A novel synchronization plan in view of the cyclic shifted presented by the authors (Zhao and Lim, 2006). In their study, with many synchronization strategies, they proposed a plan that provides precise estimation and fundamentally enhanced execution when a sensible SNR considered. In another method (Riera-Palou and Femenias, 2007), term MC-CDM-CDD, cyclic delay diversity and multicarrier code division multiplex had been offered as appropriate option for coming era of WLANs. The authors (Inan *et al*., 2007) introduced an accurate cycle time approach for anticipating the enhanced distributed channel access immersion execution diagnostically. The model records for AIFS and CW separation components of EDCA. They utilize a basic normal collision computation with respect to AIFS and CW separation method of EDCA. Rather than nonspecific time analysis, the AC-specific cycle time as the replenishment cycle had been utilized. In another paper, the authors (Khodaverdian, 2014) studied the output synchronization issue for straight heterogeneous multi-operators frameworks, under cycle free correspondence networks. A disseminated static state input law was introduced that ensures synchronization under gentle presumptions. In another research work, the authors (GONG *et al*., 2011) introduces a Cycling Specific Timing System application for observing and examining timing information in cycling routine preparing and race. The authors, (Chiou *et al.*, 2007) presented a simulation technique and constructs a test system utilizing that technique that has more alluring properties than are typically found in a solitary test system. In another study, (Tarkov, 2013) demonstrated that the neural system calculation utilizing the half aggregates is not sub-par compared to the known stage techniques in time of the cycle development. The change calculations don't oblige drifting point processor and the decision of parameters. (Lee *et al.*, 2013) explore the essential structure and algorithm of Sully. We empowered Sully to make chart by applying limit inside way scope with a specific end goal to reproduce the path between solicitations characterized in the session enough. The cycle time synchronization is basic to exchange information on the isochronous mode (PARK *et al.*, 2008). The beacon contains the cycle time of all slaves that transmitted by wireless coordinator. In a method suggested by (Yu *et al.*, 2006), slaves can discover time float among spared process duration and recently got cycle duration despite the fact that the slaves not able to get two continuous beacon. The author (Mich, 1991) managed the application of theory of constraints (TOC) and simulation cycle time decrease at production process. Since development, custom technologies have developed fab, procurement was made in the study to incorporate differed item blend, reentrants streams, streamlined WIP.

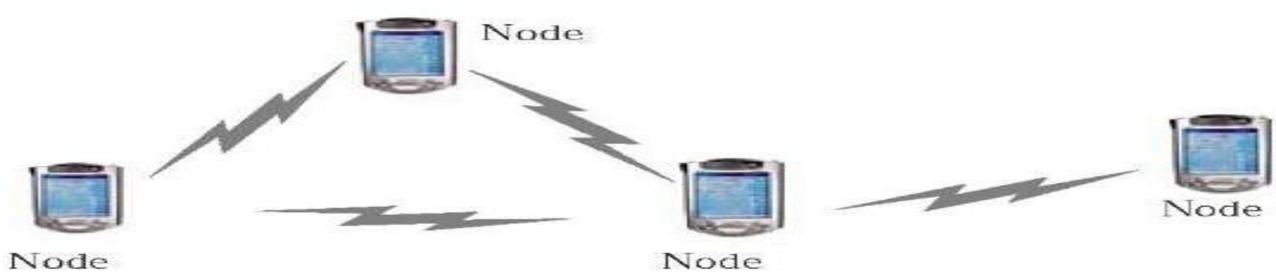

Figure-1: **Simulation testing environment for the application development**

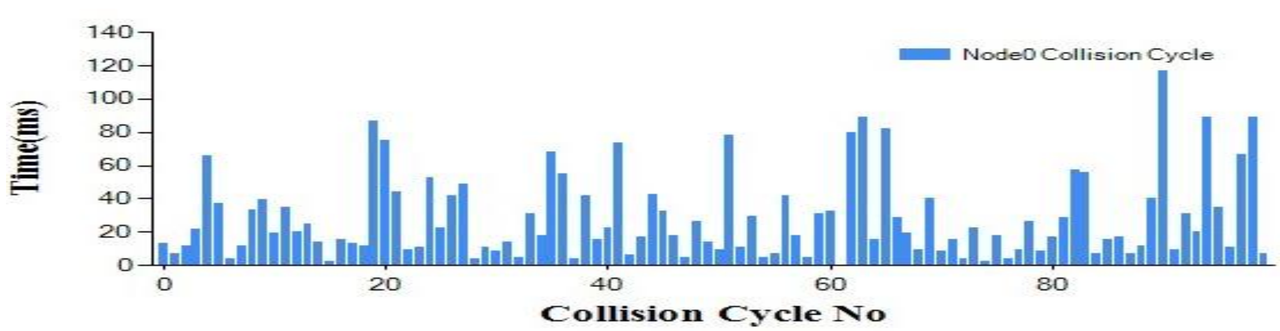

Figure-2: Collision cycle node 0

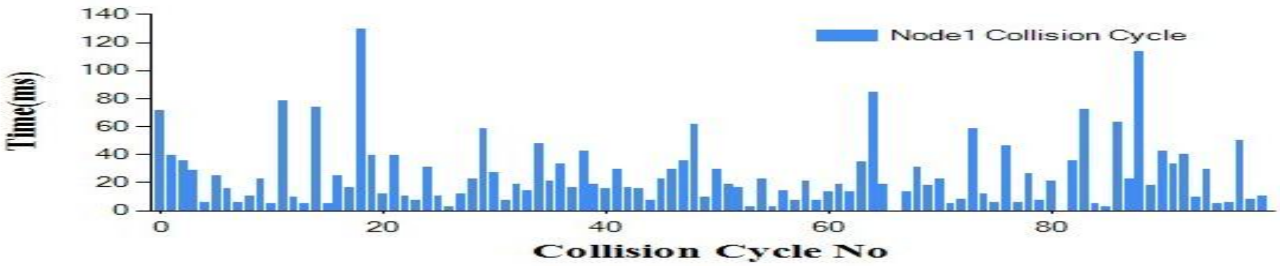

Figure-3: Collision cycle node 1

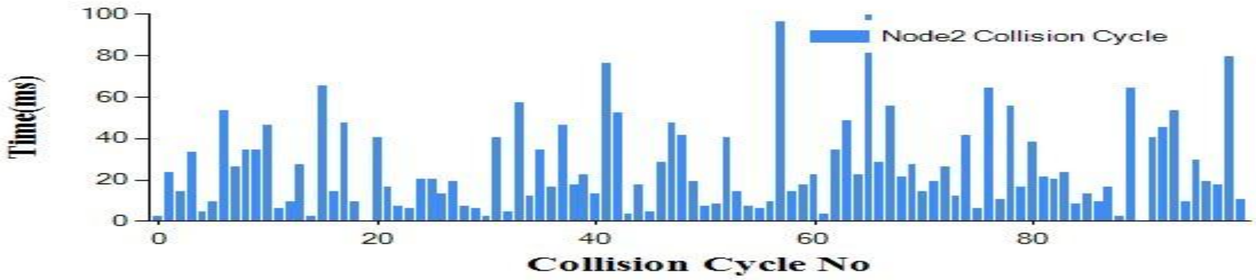

Figure-4: Collision cycle node 2

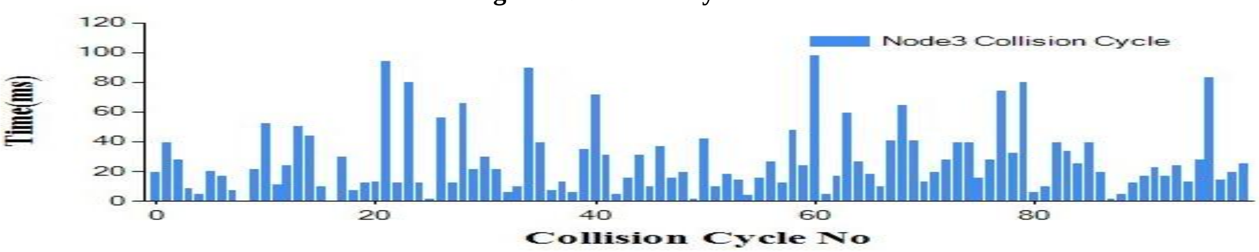

Figure-5: Collision cycle node 3

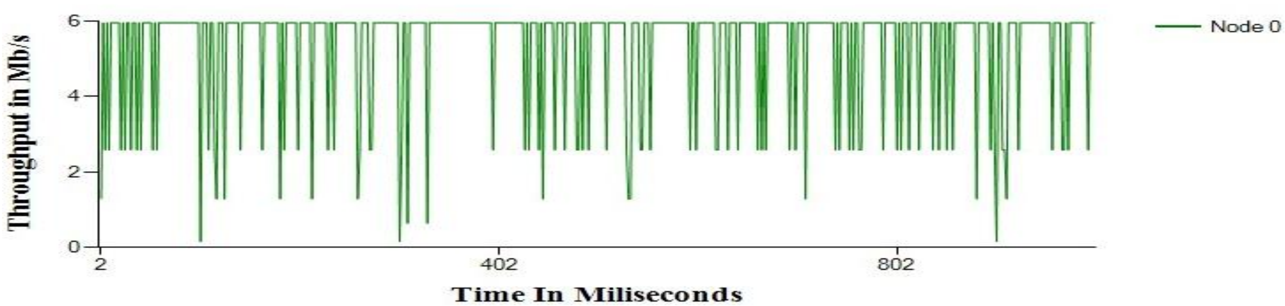

Figure-6: Throughput graph node 0

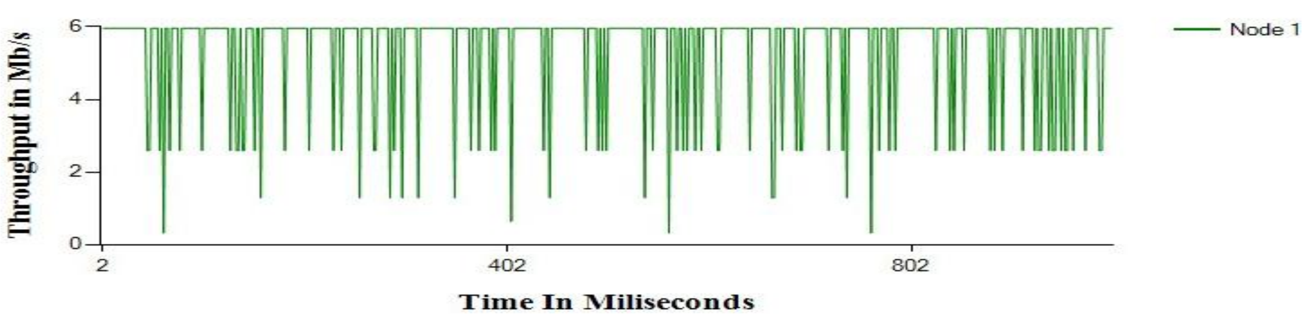

Figure-7: Throughput graph node 1

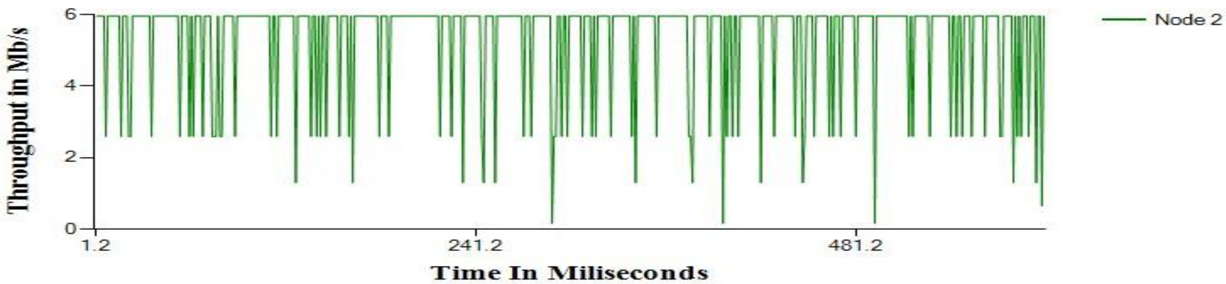

Figure-8: Throughput graph node 2

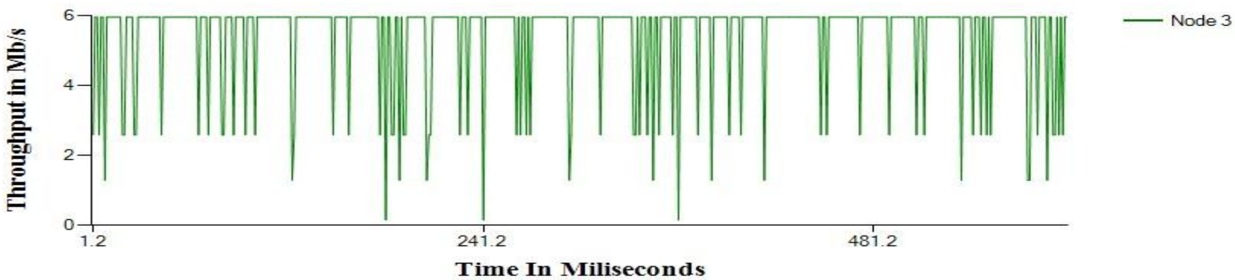

Figure-9: Throughput graph node 3

Figure-10: Success cycle node 0

Figure-11: Success cycle node 1

Figure-12: Success cycle node 2

Figure-13: Success cycle node 3

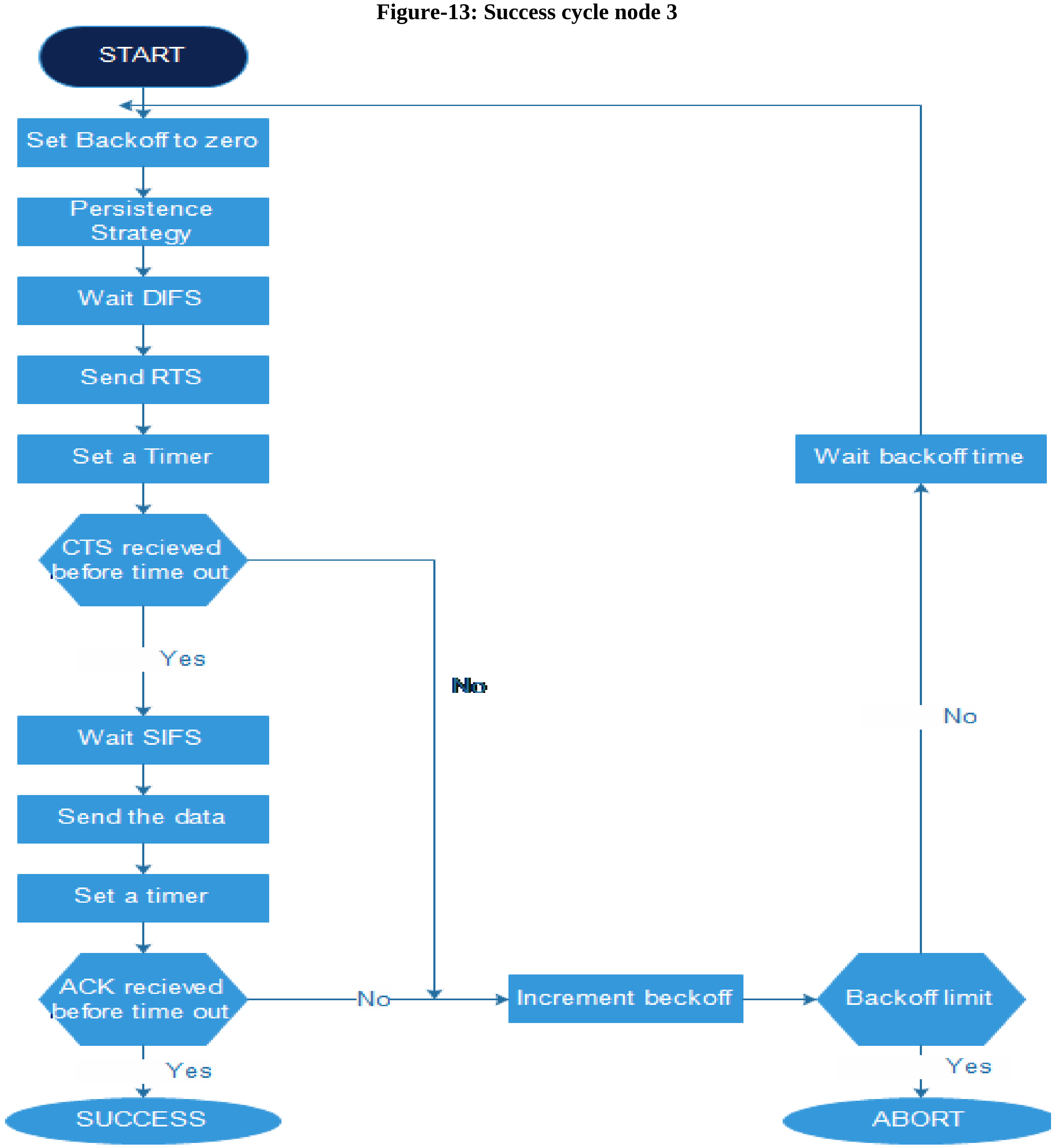

Figure-14: DCF Flow Chart

Table-1: Successful packets information.

Nodes	Successful Packets	Network Collisions	Packet loss
Node O	23003	4123	0
Node 1	23369	4032	0
Node 2	22804	4017	0
Node 3	23260	4054	0

Table-2: Node collisions in the network.

Node 0 Collisions with other nodes		Node 1 Collisions with other nodes		Node 2 Collision with other nodes		Node 3 Collisions with other nodes	
Node 1	1412	**Node 0**	1412	**Node 0**	1476	**Node 0**	1478
Node 2	1476	**Node 2**	1423	**Node 1**	1423	**Node 1**	1441
Node 3	1478	**Node 3**	1441	**Node 3**	1363	**Node 2**	1363

Table-3: Packets retransmission by each node.

Packets Retransmission by each node				
CW	**Node 0 Ret.**	**Node 1 Ret.**	**Node 2 Ret.**	**Node 3 Ret.**
63	2963	3010	2935	3028
127	464	391	432	395
255	64	69	46	65
511	6	8	15	9
1023	3	0	4	1

Conclusion: The focus of this paper was to trace the cyclic behavior of nodes in the WLANs. In this study successful packet cycle information, collision cycle information, packet loss cycle information in context of the respective cycles had been explored.

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