Influence of Initial Backoff Contention Window on Mobile Ad-Hoc Network

Sami F. Alahmar[1], Omar O. Aldawibi[2*]
[1]Department of Electrical & Computer Engineering, Faculty of Engineering, Elmergib University, Libya
[2]Department of Electrical and Electronic Technologies, Higher Institute of Engineering Technology, Zliten
*Corresponding author email: **omar.aldawibi@hpiz.edu.ly**

Abstract— **With current advances in technology, wireless networks are increasing in popularity. Mobile Ad-hoc network (MANETs) is a collection of mobile nodes connected with wireless links. MANET has no fixed topology as the nodes are moving constantly form one place to another place. In Ad-hoc networks, nodes can perform several actions like sending packets, forwarding packets, responding to routing messages, sending recommendations among others. The set of performed actions define the node's behavior. All the nodes must cooperate with each other in order to route the packets. A routing protocol is used to find routes between mobile nodes to preserve data integrity, delivery, throughput, delay, packet loss for trust management in mobile Ad-hoc networks.**
This paper discusses the influence of the backoff initial contention windows algorithm and better performance based on metrics such as packet delivery ratio, throughput, average end-to-end delay and total energy consumption by using the network simulator (NS-2).

***Keywords*— Ad-hoc Networks, Routing protocols, Media Access Protocols, Network Simulator.**

I. INTRODUCTION

The IEEE 802.11 standard specifies the Physical Layer (PHY) and Medium Access Control (MAC) layer of a Wireless Local Area Network (WLAN). At the MAC layer, positive Acknowledgement (ACK) is used to achieve reliable delivery of data packets between network nodes [1]. The receiver of a data packet has to transmit an ACK to the sender of the packet if it receives the packet successfully. The packet is considered lost and the sender has to retransmit the packet if the sender does not receive the ACK before the retransmission timer of the transmitted packet times out. The MAC layer provides the Distributed Coordinate Function (DCF) and the Point Coordinate Function (PCF) to support and control access to the trans-mission channel, where PCF is optional while DCF is mandatory. DCF allows multiple independent nodes to interact with each other without a central controller, which is typically suitable for Mobile Ad-hoc Networks (MANETs). The basic channel access mechanism of IEEE 802.11 is shown in Figure 1. If the medium is sensed to be idle for a duration of DIFS, the node accesses the medium for transmission. Thus the channel access delay at very light loads is equal to the DIFS. If the medium is busy, the node backs off, in which the station defers channel access by a random amount of time chosen within a contention window (CW). The value of CW can vary between CWmin and CWmax. The time intervals are all integral multiples of slot times, which are chosen judiciously using propagation delay, delay in the transmitter, and other physical layer dependent parameters. As soon as the backoff counter reaches zero and expires, the station can access the medium. During the backoff process, if a node detects a busy channel, it freezes the backoff counter and the process is resumed once the channel becomes idle for a period of DIFS. Each station executes the backoff procedure at least once between every successive trans-mission.

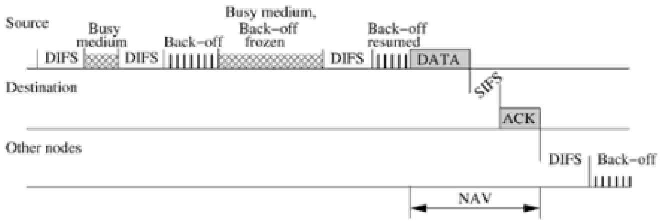

Fig 1. IEEE 802.11 DCF and RTS-CTS mechanism.

In the scheme discussed so far, each station has the same chances for transmitting data next time, independent of the overall waiting time for transmission. Such a system is clearly unfair. Ideally, one would like to give stations that wait longer a higher priority service in order to ensure that they are not starved. The backoff timer incorporated into the above mechanism tries to make it fair. Longer waiting stations, instead of choosing another random interval from the contention window, wait only for a residual amount of time that is specified by the backoff timer.

In this paper, we analyse the performance of the influence of the back-off initial contention window algorithm used Crowded in a MANET.

II. MEDIA ACCESS PROTOCOLS

The Medium Access Control sub layer (MAC) forms the lower half of the data link layer. It directly interfaces with the physical layer. It provides services such as addressing, framing, and Medium Access Control. Unlike the LLC, these services vary with the physical medium in use. Of these, medium access control is considered to be the most important service. It is relevant to networks (such as LANs)

Received July 2019, Received in received from October 2019, Accepted December 2019, and Published July2020

where a single broadcast transmission channel needs to be shared by multiple competing machines [2].

A. Aloha

The ALOHA protocol [3] is one of the oldest multiple access mechanisms. ALOHA had its origins in the Hawaiian Islands. It was borne out of the need for interconnecting terminals at the campuses of the University of Hawaii, which were located on different islands. It was devised in the 1970s at the University of Hawaii. The original ALOHA system is referred to as pure ALOHA. Roberts extended this system and developed what is called the slotted ALOHA system [3], which doubled the throughput of the pure ALOHA system [4].

B. Carrier Sense Media Access (CSMA)

The maximum achievable throughput in the ALOHA protocols is low because of wastage of bandwidth due to packet collisions. Packet collisions could be reduced by having the nodes sense for the carrier signal on the channel before they actually start transmitting. Carrier sense multiple access (CSMA) protocols are those in which nodes, before transmitting, first listen for a carrier (i.e., transmission) on the channel, and make decisions on whether or not to transmit based on the absence or presence of the carrier.

C. CSMA with Collision Avoidance (CSMA/CA)

The Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) Medium Access Control algorithm was designed for the popular Wi-Fi wireless network technology [802.11]. CSMA/CA also senses the transmission channel before transmitting a frame. Furthermore, CSMA/CA tries to avoid collisions by carefully tuning the timers used by CSMA/CA devices.

III. Backoff Window Algorithm

this paper is comparing the capabilities of varied initial backoff contention window algorithm and better performance based on metrics.

The proposed exponential backoff mechanism employed in the CSMA protocol is a slotted binary algorithm . Any node desiring to send data utilizes both the physical and virtual carrier sense functions to determine the state of the medium. The node senses the channel, if the channel is free it will start sending, otherwise the node should defer transmission. After Distributed Interframe Space (DIFS) time, the node generates a random back-off period. This procedure minimizes the probability of collisions during contention. The back-off time can be calculated using the following equation:

$$Backoff\_time = \text{int}\,(CW \times Random(0,1)) \times slot\_time \qquad (1)$$

where, Backoff_time is the time that must be deferred before the node starts the transmission, CW is the contention window which is an integer between CWmin and CWmax, Random (0,1) is a pseudo random number between 0 and 1, slot _time is the duration time, and int is the integer part of the equation [5].

The CW starts initially at CWmin and takes its next value every time there is an unsuccessful transmission. When CW reaches CWmax, it remains at this value until it is reset. Any node that performs back-off senses the channel during each slot_time; if the channel state sensed is idle during that slot_time, the back-off procedure decreases its back-off time by the amount of slot_time. If the channel state sensed is busy after that, the back-off procedure is frozen for that time slot until the channel is to be sensed again. The channel should be sensed as idle for DIFS time, before the back-off procedure is allowed to resume [6]. The node should start transmission whenever the back-off timer reaches zero, as shown in Figure 2.

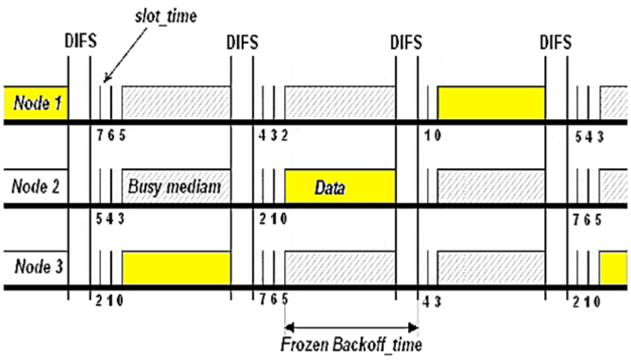

Fig 2. Backoff and frozen backoff time procedures

IV. Simulations and Module Parameters

The network simulator [NS-2] is discrete event simulation software for network simulation. However, ns-2, an open software that has been built by a number of different developers, suffers from a number of known and unknown bugs [7].

Table 1: Simulation parameters

Parameters	Details
Simulator	NS2.35
Area of simulation	250 m * 250 m
Node Placement	Moving
MAC protocol	802.11
Radio Propagation model	Two Ray Ground
Routing Protocol	AODV,DSR,DSDV
Simulation Time	150 sec
Packet Size	1000 Byte
number of mobile nodes	50
Transmission Rate	1 Mbps
Node speed	10 m/s
Traffic Type	TCP
Initial Energy	1000 J

The parameters were different routing protocols like as AODV, DSDV and DSR are chosen for simulation using the performance metrics such as Packet Delivery Ratio,

Received July 2019, Received in received from October 2019, Accepted December 2019, and Published July 2020

Throughput, End-to-end Delay and Throughput, Total Energy Consumption in different scenarios i.e., for 8_16_32 and 64 slots in the initial back-off connection window [8].

V. Performance Evaluation

The simulations were performed using Network Simulator (Ns-2), which is popularly used for ad-hoc networking community. The routing protocols were compared based on the following performance metrics:

A. Packet Delivery Fraction (PDF)

The ratio of Data packets delivered to those generated by the sources [%].

B. Total throughput

The total number of packets successfully received per unit of time [bps].

C. Average end to end delay

The delay calculated by averaging the time that needed for each data packet to be transmitted from the source to its final destination [sec].

D. Total energy consumption

The total energy consumed by all networks [Joules].

VI. Results and Discussion

This section discusses the influence of different initial backoff contention windows on different time slots for mobile Ad-hoc networks.

Figures 2,3,4 and 5 show the performance of different routing protocols for two sources versus the packet delivery ratio [%], the total throughput [bps], average end to end delay [sec] and energy consumption [Joules] respectively; in a variety of number of nodes.

In figure 2 shows The performance DSR , DSDV is better if the number of nodes is small. As for in the case of congestion, note a small decrease in the Packet delivery ratio. The performance of AODV is better at the beginning and decreases slightly with increase in number of nodes.

The AODV is improved by increasing the initial back-off contention window. when the initial back-off connection window is small , the packet delivery rate is small. So, the AODV is influenced from the initial back-off contention window compared to the other routing protocols.

The performance DSR decreases and varies with the number of nodes in the networks. The performance of the DSDV is slightly better and packet delivery ratio is less in DSDV routing protocol , however remains constant as the number of nodes increases.

In figure 3 The throughput is way much higher in DSDV when compared with DSR and AODV routing. Throughput in AODV increase moderately as number of nodes increase. The DSR throughput's is high when is the number of nodes is little and remains constant as the number of nodes increases. The performance of DSDV routing is better at the beginning and remains constant as the number of nodes increases.

In Figure 4 shows that the average end-to-end delay in DSDV routing is better than of in AODV routing in small, medium and large networks. While DSR routing has higher end-to-end delay observed in all kinds of networks.

window comparison with the other routing protocols.

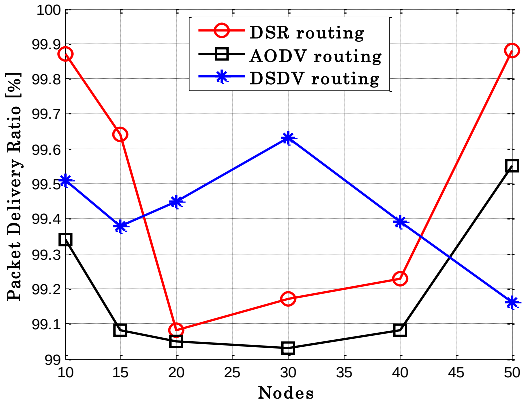

Fig. 2. Packet Delivery Ratio (100 %)

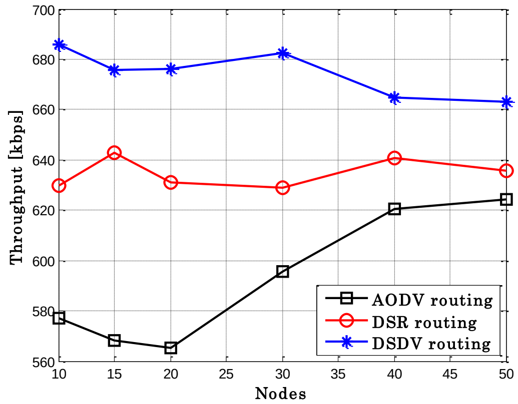

Fig. 3. Throughput (kbps)

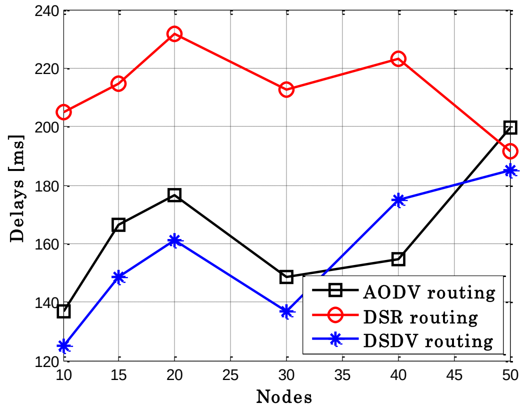

Fig. 4. End to End Delay (ms)

The performance AODV routing increases and varies with the number of nodes in the networks. Average delay is less for DSDV routing protocol and decreases and varies with the number of nodes in the networks. The performance of DSR is higher end-to-end delay with more number of nodes than in comparison with the other two protocols. DSR is affected by

Received July 2019, Received in received from October 2019, Accepted December 2019, and Published July 2020

initial back-off connection window comparison with the other routing protocols.

In figure 5 the AODV and DSR routing are consuming less energy than DSDV routing. The DSDV consume higher energy due to the influence of initial back-off contention.

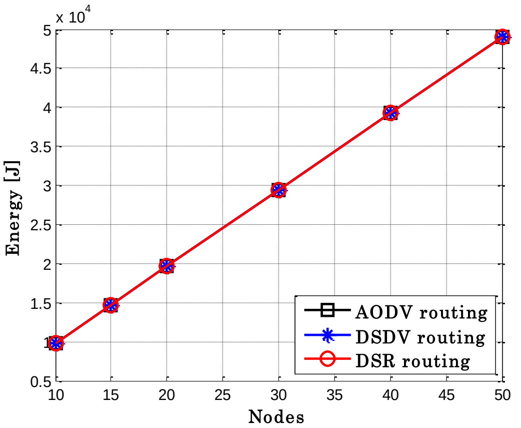

Fig. 5. Power Consumption (Joules)

VII. Conclusions

In mobile model DSDV performance is the best considering its ability to maintain connection by periodic exchange of data's. The performance DSR decreases and varies with the number of nodes in the networks. The AODV is improved by increasing the initial backoff contention window. when the initial back-off connection window is small , the packet delivery rate is small. So, the AODV is influenced from the initial backoff contention window compared to the other routing protocols. As far as Throughput is concerned, DSDV perform better than is less for AODV routing protocol and remains constant as the number of nodes increases. Overall, our simulation work shows that DSR performs lower in a network with a slight number of nodes but decreased slightly if the number of nodes are increased. In DSR routing is influenced by increasing the back-off connection window. The higher back-off connection window, the lower the throughput. That is, influence DSR routing influence with the back-off contention window. Average End-to-End Delay is the least for DSDV but increased slightly if the number of nodes are increased. The average end-to-end delay in DSDV routing is better than of in AODV routing in small, medium and large networks. While DSR routing has higher end-to-end delay observed in all kinds of networks. Clearly, there is a high delay in the DSR protocol, the initial back-off is higher. DSR is affected by initial back-off connection window comparison with the other routing protocols. All the routing protocols are consuming the same energy but more energy consumption in mobile. As soon as the network congestion increased the power consumption increased, however The DSDV consume slightly higher than others in energy due to its routing table. The DSDV consume higher energy because affected by back-off contention window comparison with the other routing protocols.

In models in PDR we note AODV affected by initial back-off connection window, throughput and average end-to-end delay we note DSR affected by initial back-off connection window, also energy consumption we note DSDV affected by back-off contention window comparison with the other routing protocols.

References

[1] LAN MAN Standards Committee of the IEEE Computer Society, "IEEE

[2] 802.11 Standard –wireless LAN medium access control and physical layer specifications," June 1997.

[3] S. Kumar, V. S. Raghavan, and J. Deng, "Medium access control protocols for ad hoc wireless networks: A survey," *Ad Hoc Networks*, vol. 4, pp. 326-358, 2006.

[4] K. J. Kumar, B. Manoj, and C. S. R. Murthy, "RT-MuPAC: Multi-power architecture for voice cellular networks," in *International Conference on High-Performance Computing*, 2002, pp. 377-387.

[5] B. Manoj and C. Murthy, "Throughput enhanced wireless in local loop (TWiLL): the architecture, protocols, and pricing schemes," *ACM Sigmobile Mobile Computing and Communications Review*, vol. 7, pp. 95-116, 2003.

[6] M. Natkaniec and A. R. Pach, "An Analysis of the Back-Off Mechanism Used in IEEE 802.11 Networks," in Proc. Fifth IEEE Symposium on Computers and Communications, 2000, pp. 444-449.

[7] The NS manual: formerly known as notes and documentation, 2003. URL: http://www.isi.edu/nsnam/ns/. Page accessed on April 21, 2005.

[8] G. Bianchi, "Performance analysis of the IEEE 802.11 distributed coordination function," IEEE Journal on Selected Area in Comm, vol. 18, no. 3, pp. 535-547, March 2000.

Received July 2019, Received in received from October 2019, Accepted December 2019, and Published July 2020