Optimum Backoff in CSMA-CA for Ad-Hoc Vehicles Network in Motorway

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ABSTRACT

With current technological developments, wireless networks are becoming popular. VANET is a type of MANET that allows data to be transferred between nearby vehicles. These types of communications can help prevent accidents and investigate post-crash accidents or traffic jams by allowing vehicles to share and broadcast safety information with other vehicles to alert drivers. VANETs offer many possibilities for many new applications. This paper provides an evaluation of mobility influence on the initial backoff contention windows performance. The study evaluates basic performance metrics such as packet delivery ratio, throughput and average end-to-end-delay by using the network simulator (NS-2). They propose four dynamic value initial backoff of contention windows mechanisms to alleviate network performance degradation due to high mobility. The nodes are running in the same direction and at constant speeds in terms of a varying number of initial backoff of contention windows and to determine the influence routing protocol.

Keywords: Ad-hoc Networks; Routing protocols; Network Simulator.

1 Introduction

Mobile Ad-hoc Network (MANET) is collected of wireless mobile nodes interconnected with each other through an autonomous configuration in the absence of any infrastructure. Vehicular Ad-hoc network is a particular kind of MANET, where smart vehicles act as nodes [1], [2], [3].

Vehicular Ad-hoc Network (VANET) has become one of the most important research areas in the field of wireless communication. Vehicle to Vehicle data transfer is one of the main challenges within the design of VANET because it needs to design a dynamic routing protocol. Routing in traditional MANET is different from the VANET routing because of extremely dynamical topologies [4], [5].

This paper discusses the Optimum backoff window for Ad-hoc Vehicles Network in Motorway in terms of the mobility influence and of the total packet delivery ratio, throughput and the minimum end-to-end delay. Also, two ray ground channel has been used in the NS-2 simulator.

2 Media Access Protocols

The Medium Access Control sublayer (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) where a single broadcast transmission channel needs to be shared by multiple competing machines [6].

2.1 Aloha

The ALOHA protocol [7] 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, which doubled the throughput of the pure ALOHA system [8].

2.2 Carrier Sense Media Access (CSMA)

The maximum achievable throughput in the ALOHA protocols is low because of the 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.

2.3 CSMA with Collisions Avoidance (CSMA/CA)

The Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) was designed for the popular Wi-Fi wireless network technology (IEEE 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 [8].

3 Backoff Window Algorithm

In this paper, compare the capabilities of varied initial backoff contention window algorithms and better performance-based on metrics.

The proposed exponential backoff mechanism employed in the CSMA protocol is a slotted binary algorithm [9]. 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 DIFS time, the node generates a random backoff period. This procedure minimizes the probability of collisions during contention. The backoff time can be calculated using the following equation:

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

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 [10].

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 backoff senses the channel during each slot_time; if the channel state sensed is idle during that slot_time, the backoff procedure decreases its backoff time by the amount of slot_time. If the channel state sensed is busy after that, the backoff 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 backoff procedure is allowed to resume [11]. The node should start transmission whenever the backoff timer reaches zero, as shown in Figure1.

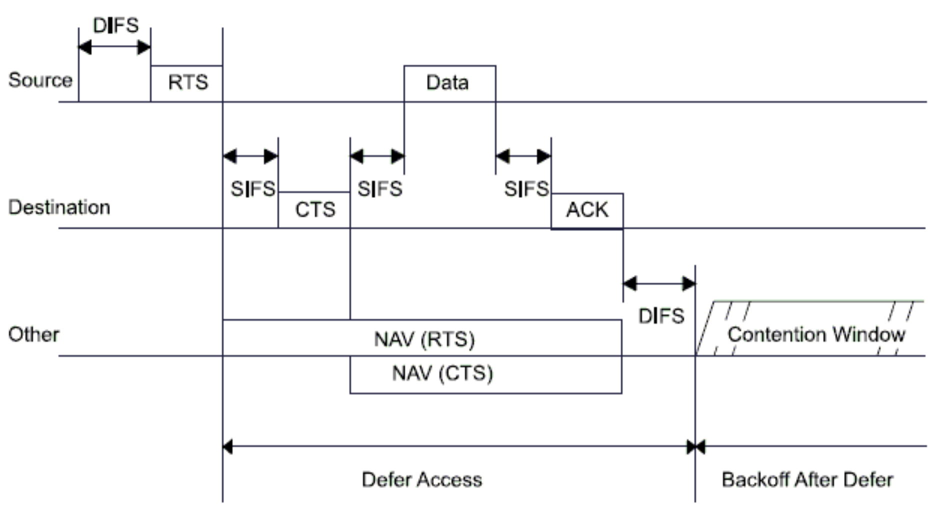

Figure 1: *CSMA/CA Protocol Mechanism*

4 Network Simulation

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 [12].

5 Model Parameters

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, throughput and average end-to-end delay in different scenarios i.e., for 8_16_32 and 64 slots in the initial backoff connection window as show in the Table 1.

Table 1: *Simulation Parameters*

Parameters	Details
Simulator	NS2.35
Area of simulation	250 m * 250 m
Node Placement	Moving at Same
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 Vehicles	8
Transmission Rate	1 Mbps
Min Speed	15 m/s
Max Speed	45 m/s
Traffic Type	TCP
Initial Energy	1000 J

6 Performance Metrics

The simulations were performed using Network Simulator (Ns-2), which is popularly used for Ad-hoc networking community [13], [14]. The routing protocols were compared based on the following 3 performance metrics:

- Packet Delivery Fraction (PDF), The ratio of data packets delivered to those generated by the sources [%].
- Total throughput is the total number of packets successfully received per unit of time [bps].
- Average end-to-end delay : is the delay calculated by averaging the time that needed for each data packet to be transmitted from the source to its final destination [sec].

7 Results and Discussion

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

Figures 2,3,4,5,6,7,8,9 and 10 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] respectively; in a variety of number of speed.

Figure 2 and 3 shows the packet delivery ratio and throughput of the AODV routing is the best performance with the initial backoff contention window (equal 15 slots), and varying number of speed (from 15 to 45 m/s) at the same direction.

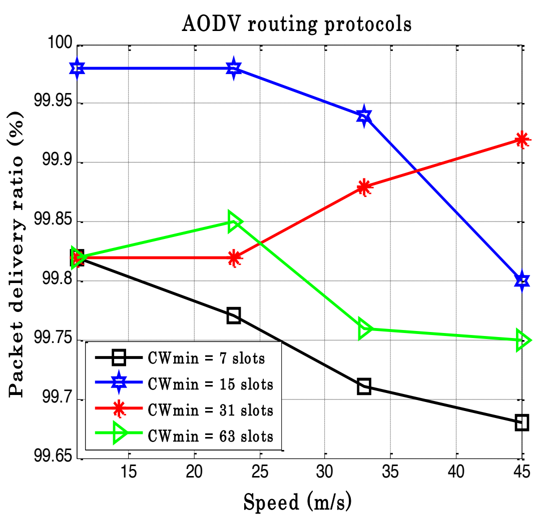

Figure 2: *Packet Delivery Ratio (%)*

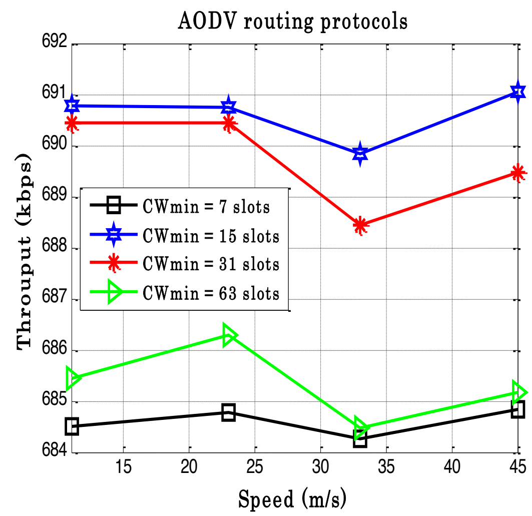

Figure 3: *Throughput (kbps)*

Figure 4 shows the average end to end delay of AODV routing is the best performance with the initial backoff contention window (equal 7 slots).

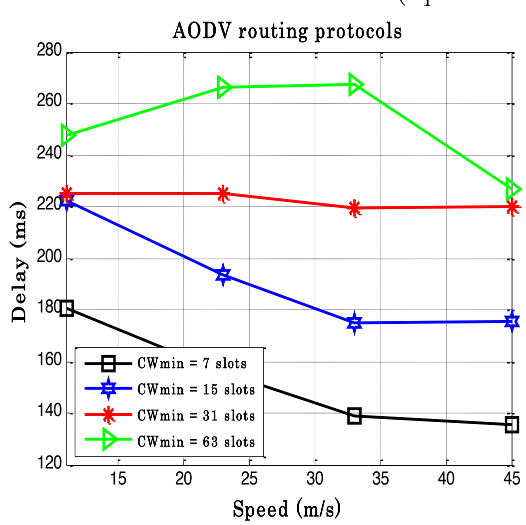

Figure 4: *End to End Delay (ms)*

Figure 5 shows the AODV routing outperformance DSR routing in low mobility situation with the initial backoff contention window (equal 7 slots). On the other hand in high mobility situation, the DSR routing outperformance AODV routing with the initial backoff contention window (equal 31 slots).

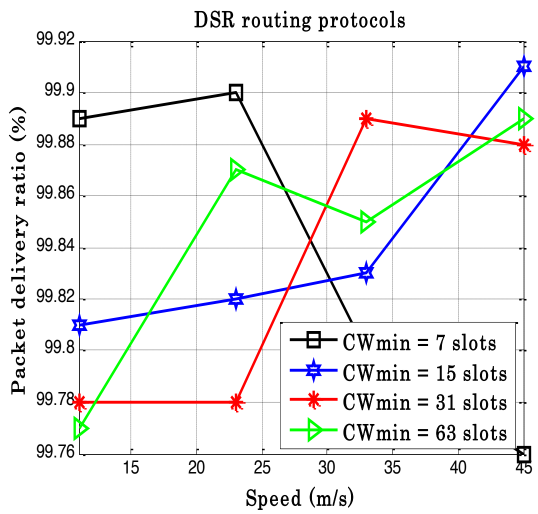

Figure 5: *Packet Delivery Ratio (%)*

Figure 6 shows the throughput of DSR routing is the best performance with the initial backoff contention window (equal 31 slots).

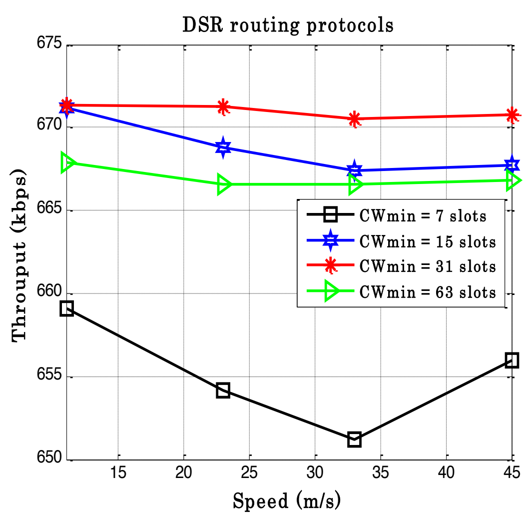

Figure 6: *Throughput (kbps)*

Figure 7 shows the average end to end delay of DSR routing is the best performance with the initial backoff contention window (equal 15 slots).

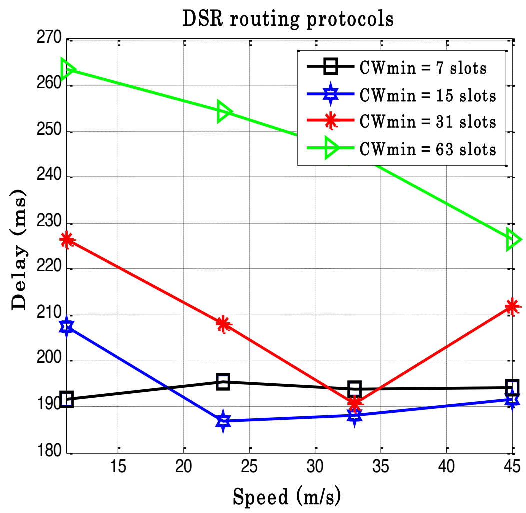

Figure 7: *End to End Delay (ms)*

Figure 8 and 9 shows the packet delivery ratio and throughput of the DSDV routing is the best performance with the initial backoff contention window (equal 15 slots).

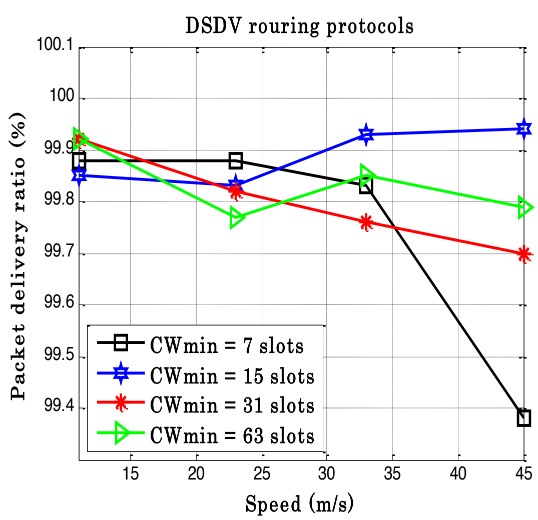

Figure 8: *Packet Delivery Ratio (%)*

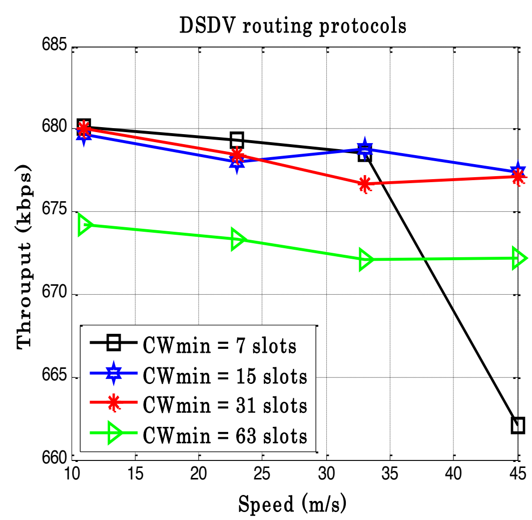

Figure 9: *Throughput (kbps)*

Figure 10 shows the average end to end delay of DSDV routing is the best performance with the initial backoff contention window (equal 7 slots).

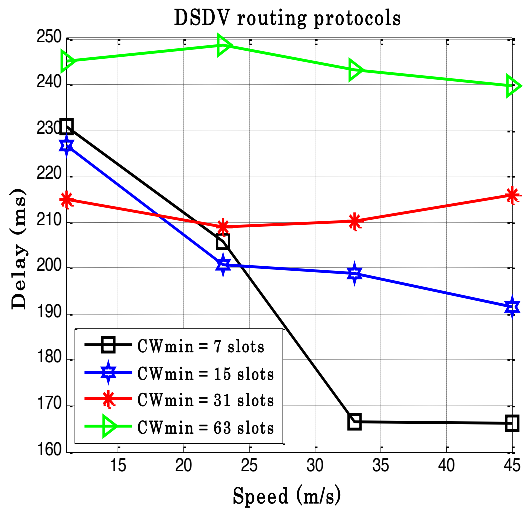

Figure 10: *End to End Delay (ms)*

8 Conclusion

This paper evaluates the performance of three routing protocols namely: AODV, DSR and DSDV using the NS-2 simulator. This involves examining the influence of the initial backoff contention windows (CWmin = 8,16,32 and 64 slots) on the routing protocols, the evolution of the density of the network while the nodes are in mobility. The results lead to important conclusions about the mechanism for backoff contention windows when random access is disabled.

When the value of the initial backoff contention windows equal CWmin = 15 slots, the throughput is higher in the AODV and DSDV routing protocols. But when initial backoff contention windows reduced to CWmin = 7 slots at a varying number of nodes reduces the average end-to-end delay in the AODV and DSDV routing protocols. Although when the value of the initial backoff contention windows CWmin = 31 slots, the DSR routing protocol gains higher throughput than others.

Using initial backoff contention windows CWmin = 15 slots at a varying number of nodes reduces the average end-to-end delay in the DSR routing protocol. DSR protocol is influenced by initial backoff contention windows relative to other routing protocols. In addition, as the initial backoff contention windows increase, the DSR end-to-end average delay increases. Conspicuously, the DSR is affected by the initial backoff contention windows.

AODV and DSDV performance is best when the initial backoff contention windows are equal to 15 slots. Further, in the case of the small end-to-end average delay in the initial backoff contention windows, equal to CWmin = 7 slots.

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