ISSN : 2322-5157
www.ACSIJ.org

A Mechanism to Mitigate Collision Rate in Wireless Local Networks

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Abstract

Presently, IEEE 802.11 DCF is MAC protocol applied in wireless local networks. DCF would be inefficient, since there are two types of overload: Collision time and channel's idle time. Present paper, evaluated the performance and proposed an efficient MAC protocol for these networks called D-CW. D-CW will decrease both the channel's idle time and the collision time. D-CW, by dividing the value of contention window (CW) by two, reduces the time required for a successful node forwarding, and by selecting variable contention window for packet forwarding from each node with a random uniform function, what if a successful forwarding or an unsuccessful one, decreases the collision time. Stations, after selecting a value from the window contention own, follow the Backoff mechanism, and after counting the number of their own idle slots, do the forwarding. Simulation results indicate D-CW can improve the throughput of the system, delay reduction and collision rate on 802.11 DCF significantly.

Keywords: *IEEE 802.11 DCF, Collision rate, Throughput, CW*

1. Introduction

IEEE 802.11 is defined based on distributed coordination function (DCF) in order to share the wireless media between several stations. DCF resolves the contention in a channel, by applying CSMA/CA method with the algorithm of binary exponential backoff (BEB). DCF postpones the station for access to channel in a period of time randomly, via a Backoff random time. Backoff counter, according to the number of idle slots of the station, waits before trying to forward the packet. If multiple stations choose the same value of Backoff, then, their trying to forward at the same time will cause the collision.

DCF has two types of overload. One of them is the idle time of channel (e.g. Backoff time), which is when the vying stations wait for their forwarding and the second overload, is the collision time when multiple stations do forwarding at the same time. If a few number of stations compete together, then the idle time would be superior overload. If a large number are competing, Collision probability increases which results in channel's productivity loss. In this topic, some Medium Access Control (MAC) protocols are presented. These protocols decrease the total overload, which generates channel idle periods and collision time [1][2][3].

In present paper, we propose an efficient MAC protocol called D-CW, which can reduce both the idle time of channel and the collision time significantly. D-WC stands for Dynamic-Contention Window. In D-WC, when a station transmits a data over channel, it may succeed or fail to send the data. Once a forwarding is completed, if transition of a station leads to an unsuccessful forwarding, this typically means it failed at competing with other stations and the collision is occurred, So for further forwarding, the value of completion window is changed and after this value is doubled, The station makes a range from zero to this twice value and selects a number from this range, and attributes to its Backoff and eventually, the station after passing a time period of DIFS[1], waits for amount of its own Backoff value, and forwards the packet. But if the station has a successful forwarding, it will wait until another packet comes from the layer 3 and be delivered for next forwarding. Hence, in this case the value of contention window is changed as well, and by dividing it (CW[2]) by two and creating a smaller range and selecting a number as Backoff, after waiting for a time period of DIFS, it starts the forwarding. All stations, whether with successful forwarding or not, every time by using the random uniform function, utilize a different CW to forward data. All stations follow a Backoff mechanism, 802.11 to access a channel. Therefore, since D-CW changes the

[1] DCF Inter Frame Space
[2] Contention Window

ACSIJ Advances in Computer Science: an International Journal, Vol. 2, Issue 3, No.4 , July 2013
ISSN : 2322-5157
www.ACSIJ.org

range of [0 through CW] for both the successful and unsuccessful forwarding and when a station has a successful forwarding, its CW will be divided by two and a smaller range will be considered, or when a station has an unsuccessful forwarding, its CW will be multiplied by two and a larger range will be considered, thus the channel idle time and collision time reduce, significantly.

the planning policy of 802.11 DCF utilizes CSMA[1] random access mechanism in order to forward its data, Multiple algorithms of scheduling and distributed with a better performance rather than 802.11 DCF are presented [4][5][6]. Each of the proposed algorithms, compare with 802.11 DCF has a higher operational power. Centralized scheduling algorithms use an access point to access the channel. But distributed scheduling algorithm does not utilize the AP and each station makes the scheduling decision in a distributed way to access the channel.

D-CW operates based on distributed scheduling algorithms and there is no ness to any access point (AP). Moreover, D-CW, works with Multi-hop current. In D-CW, the scheduling of a station in order to forward its data to the channel, would be done based on the contention window (CW), like the scheduling algorithm of DCF. In DCF, since an approximately invariant contention window is used to access the channel, much time is wasted to schedule the data transfer of a station. But D-CW, by applying efficient scheduling policies to assign the channel to each station with the aid of fully dynamic contention window, avoids the vain waiting time for data forwarding and the collision time. Hence, using the dynamic contention window, can make the scheduling completely effective & ideal. Eventually in D-CW, any station in the network, performs an ideal distributed scheduling to access the channel and avoiding the collision, which is the vantage point of this algorithm than to distributed scheduling algorithm of DCF (which is based on a constant scheduling), and reduces the channel allocation time and the collision time. Therefore, in this algorithm the idle time of channel and the collision time will decrease.

Rest of the paper is organized as follows: First in section 2, we review the related works. Then in section 3, D-CW protocol is proposed. In section 4, D-CW protocol is compared with 802.11 protocol and some results are presented in section 5.

2. Related Works

When multiple user compete together to access the wireless channel, several problems arise while accessing the wireless media, which MAC wireless protocol addressed that [7]. The main objectives of MAC wireless protocol are:

1) Productivity improvement of the channel
2) Minimization of end-to-end delay for packet forwarding in the network
3) Provide a fair share of media for each node
4) Providing quality of service (QoS)
5) Effective use of limited energy

Obviously, not achieving to these goals only depends on the way of competing between the stations of a media, and this is the main problem in wireless communications which depends on the way of contention resolving between different stations.

Over the years, a considerable number of multiple access protocols are implemented on link layer various technologies. MAC protocols in WLAN[2] networks, can be divided into two large groups called Reservation MAC protocols and Contention MAC protocols. Reservation protocols, reserve the sources to transfer the packets, statistically or dynamically. Hence, they are called channel division protocol which can be divided into three groups:

1- TDMA protocol: In this protocol a channel is allocated to each user for a constant time.

2- FDMA protocol: In this protocol a specific frequency is allocated to each user.

3- CDMA protocol: in this protocol a separate code is allocated to each user in order to encode the transitions across the spectrum.

Reservation protocols are managed via an access point (AP) or a base station (BS).

The networks with Reservation MAC protocol, are determined by existed sources such as the codes and available frequencies. On the other hand, we have contention protocols. These protocols let the nodes to compete on the media, so they are called random access protocols. These protocols are scheduled as distributed to use the channel, and do not require any central access point (AP). Therefore, lack of the central controller and lower price and easiness of this method, made Contention MAC

[1] Carrier Sense Multiple Access

[2] Wireless Local Area Network

protocols more popular than Reservation MAC protocols in WLAN market. Additionally, distributed nature of them is suitable for ad-hoc networks which do not have any central point. Yet, in 802.11 standard MAC protocol, with increasing the number of WLAN devices in an area, contentions on using a common media increases as well. Therefore, inefficiency because of the high collision rate in wireless local networks especially in high terrific is the main challenge of our problem. In present paper, an efficient MAC protocol is proposed. A MAC protocol based on the Contention, includes all or part of following components:

- Carrier Sense (CS) hardware is able to sense the channel for being busy or free
- Collision Detection (CD) hardware is able to detect the collision while transmitting the frame
- Collision Avoidance (CA) mechanism
- ACK mechanism in order to determine unsuccessful transitions when it is not possible to distinct the collision
- Backoff mechanism to postpone the transitions

When the number of stations is large and variable, or their traffic is relatively explosive, reservation methods such as TDMD, FDMA, and CDMA are not appropriate options. Hence, the most basic Contention protocols which take the situation of TDMA, FDMA and CDMA methods, are Pure ALOHA [8] and Slotted ALOHA [9].

The main idea in Pure ALOHA is simple: users are allowed to forward data without considering channel status, whenever they have data to transfer. Since this simple mechanism results in many collisions, Slotted ALOHA was proposed. At that time, it was divided into discrete sections and a station was allowed to forward the frame only at the beginning of a slot. In this approach, it was required for users to know the range of these time sections properly. In this method, the collision possibility was high as well, therefore in order to reduce the collisions more, Carrier sense function was proposed. A large range of MAC protocols, are designed based on his function, which are known as CSMA protocols. In CSMA, only one station, starts the transition when it senses the channel and then if it was free, will begin its own transmission. So interference with other stations is prevented.

Karn has proposed a new design called MACA[1] [10]. In this design, transmitter stimulates the receiver to send a short frame to the stations around, so the stations which are in its board and hear this short frame, avoid sending the information through the receiving of frame. Actually this mechanism is presented to solve the problem of hidden nodes, in which control frames called RTS/CTS[2] are used before the transition.

In a study conducted by electrical engineers in CSMA/CA[3] mechanism, a control frame in MAC protocol, called ACK is presented for unsuccessful transitions. Moreover, IEEE 802.11 DCF [11] protocol works based on CSMA/CA.

Methods that have been studied so far such as the approaches that use CSMA/CA and the methods of MACA and DCF, utilize an binary exponential backoff design which is called BEB, to reduce the successive collisions [11]. Whenever the collision occurs, BEB makes the value of the contention window (CW) double, till it reaches to a pre-defined maximum value, and after a successful forwarding, this value is minimized again, which depends on different IEEE standards. For example in 802.11b standard, minimum and maximum of this window are CWMin=31 and CWMax=1023, and in 802.11g standard we have: CWMin=15 and CWMax=1023. Thus, if a node forwarding fails, every time the size of window of this node is doubled, it will find less chance to transmit. As a result, fairness problem happens to that node [12][13].

DCF protocol simulation results [14] show that this protocol works well in light and small networks, but does not have a good efficiency in the networks with high traffic.

In order to increase MACA protocol efficiency, a researcher called BaharGavan presented a new design known a MACAW [15]. In this design, they have decided to apply BEB algorithm on a data current independently, instead of each station. So, since the collisions decrease, efficiency will be more than MACA.

Cali et. al. [1] tried to improve the channel efficiency, by dynamic tuning of Backoff window (Dynamic Tuning Backoff). In DTB, optimizing the value of Backoff window depends on the number of active stations in network, and in real networks it is not easy to estimate the number of active stations.

Kwon et. al. have proposed a design called Fast Collision Resolution (FCR) [16]. FCR algorithm is suitable for successful nodes. This algorithm works as follow: it will use smaller contention window for successful nodes and if a constant number of free slots is determined successively, FCR algorithm reduces Backoff timer exponentially, so

[1] Multiple Access Collision Avoidance

[2] Request to Send/Clear to Send

[3] CSMA with Collision Avoidance

each nodes will not spend the vein time in waiting. But it makes the problem of inherent fairness worse, because FCR always operate in favor of successful nodes. Therefore, Kown merged FCR with SCFQ algorithm to make the fairness more [17].

Abichar and Chang [18] have proposed the algorithm of CONTI. Conti eliminates some rival nodes, after passing a slot. This elimination is based on a random selected value among a Boolean local variable. By choosing appropriate parameters, CONTI makes a rapid contention algorithm possible. According to CONTI a contention resolution period (CRP) starts immediately after DIFS, and ends when a node wins to the vial nodes and forwards the packet and or all active nodes withdraw from the completion. However, CONTI has a problem called competitive deadlock problem. Simulation results indicate existence of competitive deadlock [18].

Marshal et. al. inspired by the playoffs, have presented a new Contention algorithm for wireless MAC protocols called K-round elimination contention (K-EC) [19]. In this algorithm a champion is chosen only after multiple round of playoff match. The process to resolve the contention includes k round of contention, which in each of them, some vial nodes will be removed. It is expected that after k round of contention, only one winner remains. Also it does not have the problem of contention resolution failure. Analysis and simulations, show its high efficiency and ability even in light networks or heavy networks with hundreds of competitive nodes. Other auxiliary facilities, such as QoS capabilities can be easily merged in K-EC. Moreover, K-EC characteristics make it possible to separate it from MAC protocol and run it directly in final hardware. This, simplifies MAC protocol dramatically and so improves system performance.

In Heusse, Rousseau, Guillier and Duda research, the algorithm of idle sense is presented [3]. Unlike PERMA [20]and K-EC, idle sense operates according to contention window (CW) mechanism, like DCF standard algorithm. The main idea of idle sense is to use an optimal number for the slots between two successive transitions. This optimal number for physical layer of 802.11b equals to n_i^{target} = 3.91. This number is appropriate for lots of scenarios with different number of contention stations. Hence, Idle sense, senses the number of the slots of all the stations and tunes CW high or low, to adjust the number of idle slots with target value.

In research of Hosseinabadi and Vidya an efficiency evaluation algorithm of MAC protocol for wireless local networks called Token-DCF, is presented [21]. Token-DCF reduces both the idle time and the collision time, significantly. In Token-DCF, when a station performs the forwarding on the channel, it is possible to rate one of its neighbors. When the transitions are finished, the rated station, if it is available, starts the transition after a short period of time called SIFS (Short Inter Frame Space). The non-rated stations look for a Backoff 802.11 mechanism to access the channel. So the rated channel does not have the resolution phase of contention and possession without the channel mediation. Since in Token-DCF, contention resolution is performed according to signs and rates allocation, therefore, idle time and collision time are reduced significantly.

3. D-CW Algorithm

In this section, first we have high level review on D-CW and then, two types of overload, idle time reduction and collision time reduction are reviewed, and eventually D-CW protocol details is presented.

3.1 Review

D-CW operation in high level is as follows. D-CW uses a dynamic contention window to allocate to CW of each node, in this way that, if any node wants to send a packet, first selects a value between 0 through CW for its contention window. Selection mechanism is based on random uniform function. We called this selected value as backoff (bo). First transition of each station, selects a value within [0 to CW] which CW here is CWMin which can be different from the first transition of the other station. When a station selects a different value for its contention window, after a time period of DIFS (Distributed Inter Frame Space), if channel is sensed as free, it starts counting its Backoff and after finishing the counting, transfers data.(Transmission format of a frame in D-CW frame is same as IEEE 802.11.) after the transfer is completed. Eventually, node waits for a short period time of SIFS till its ACK, meaning confirmation of a successful transmission, is sent to transmitter node, and in this case transition is finished.

Note that in Multihop networks, at any time, it is possible to have multiple active stations in network. In this kind of network, stations follow a Backoff mechanism of IEEE 802.11 standard to access the wireless media. Figure 1 shows 802.11 DCF Backoff mechanism. In this mechanism, stations after a time interval of DIFS, sense the channel. If channel is sensed as free, then, the node waits for a random time period of contention: a Backoff *b* node, is selected by a distributed uniform function within [0,CW],

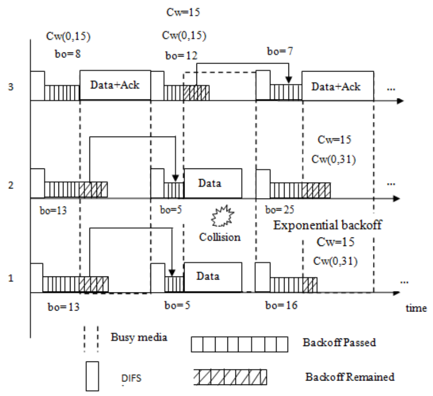

Fig. 1 Approach of access the media in IEEE 802.11DCF.

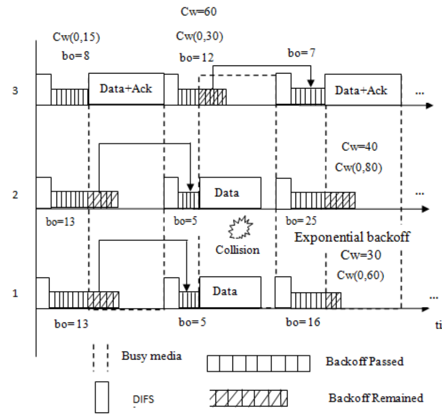

Fig. 2 Approach of access the media in D-CW.

which b is an integer, and the node waits for b time slots, before starting the transmission.

Since it is possible that in high traffic, with probability of 1-p, two different numbers in one selection, and with probability of p, two similar numbers in one selection within [0 & CW] be selected, if with probability of p two similar numbers are chosen, then absolutely collision occurs, which any station after finishing the transmission, checks the channel status. If collision is happened, first, each node allocates the value of CWMin to its own CW, which CWMin is variable, depending on different standards, and after multiplying its CW by two, selects a random value from the doubled range of [0 to CW] and allocates it to its Backoff (bo), and after counting the number of bo slots, sends the packets again and if collision re-occurs, doubles this value till it reaches to pre-allocated maximum value, and after a successful transmission, range of [0 to CW] backs to its minimum value. But if collision does not occur, the same previous range of [0 to CW], by choosing another random value and allocating it to bo, starts transmission for next packet. This channel access approach in 802.11 DCF, has two problems: 1- First problem, is that with the probability of p, when collision happens, (Since each node, utilizes a value of CWMin to exponent its CW. So all the nodes, begin to exponent their CW, starting from an origin value, which eventually the range of an exponential node is equal to other ranges), the possibility of selecting the same random number within a range by two nodes, is high. In this method, network causes increasing the collision rate in high traffics. 2- The second problem, is that since this program always pays attention to the last successful node, then the fairness problem occurs.

channel access mechanisms in the protocol D-CW is shown in Figure 2. in the protocol D-CW, since each station, First, the station selects a Backoff value to its transition, through the range of 0 to CWMin, with the probability of p it is possible that two stations or more, select the same number via the random uniform function within this range and with the probability of 1-p, two stations or more, select a different number via the random uniform function. Eventually, after an interval of DIFS, if it senses the channel as free, after finishing Backoff counting, will transform the packet. After the transition, each node checks the channel status, which two cases arise: 1- Channel is not free: in this case collision is happened, so each node uses BEB mechanism to transmit again. First, each node selects a different value via random uniform function and allocates it to its CW which this value is varied between [(CWMax-CWMin)*0.8]. then doubles this value so the range of[0-cw] is doubled and finally after re-selecting a random value within this range and after counting the number of Backoff slots, sends the packet again and if collision occurs afresh, doubles this range till it reaches to the pre-defined Maximum value, and after a successful transition, this value backs to the minimize value. 2- Channel is free: in this case collision is not occurred and transition is done successfully, which in this case, first, allocates a CW value from the range of [((CWMax-CWMin)*0.8] to its own CW, and divides the CW by two and then using it, makes a range, which by selecting a random value within this range and allocating it to Backoff, starts forwarding of the next packet.

D-CW has two main parts: 1) an approach to reduce the idle time, 2) an approach to reduce the collision time, which both of them use Backoff mechanism to access the media.

3.2 Idle Time Reduction

D-CW reduces the idle time by using the mechanism of dividing CW by two and making a smaller range, and selecting a random value within this range and allocating this value to each node. As is discussed in section 3-1, after forwarding a packet, the node checks channel status. If channel is sensed as free, then packet transmission from that node, was successful. So D-CW algorithm presents a mechanism and says if a node with a Backoff value within the range of [0 to CW], which has had a successful packet forwarding, if has a packet to transmit for a second time, it does not select a number within previous range to allocate it to its bo like DCF. But, by re-selecting a number in the range of [(CWMax-CWMin)*0.8] and allocating it to CW value of each node, divides CW value by 2 and via re-choosing a random number in new doubled range, allocates this number to bo to perform next transmission. So, each node, waits for a less time to transmit its next packet, automatically. As a result, D-CW algorithm, reduces the idle time by this mechanism.

3.3 Collision Time Reduction

D-CW reduces the collision time, by using the mechanism of selecting the value of dynamic CW and allocating this value to CW of each node. As is discussed in section 3-1, after a packet forwarding via a node, the node checks the channel status. If channel is sensed as busy, then packet forwarding from that node was unsuccessful and leaded to collision. So D-CW algorithm, tries to send that packet again: First, each node selects a different value within the range of [(CWMax-CWMin)*0.8] by using a random uniform function, and allocates this value to its CW. In this approach, different values are allocated to each node, so by multiplying them by two, the range of [0 to CW] doubles and the selected value within this range, will be allocated to bo of each node to transmit the packet. There is a little chance that the values of (bo)s be equal. Hence, since the selected values of all of the nodes are different from each other, collision rate is decreased. As a result, by using D-CW algorithm, we reduce the collision time which this mechanism leads to collision time reduction in wireless local networks.

3.4 Protocol Details

When we have multiple active groups in network and each of them have several packet to forward e.g. from origin A to destination B, the procedure of transmission by each node (as is discussed in section 3.1) is as follows: First, the node which wants to send a packet, enters the contention phase and after spending a time period of DIFS, uses CSMA mechanism to sense the channel and after channel is sensed as free, via the third line 1-4-3 code, selects a number within [0 to CW] by using random uniform function and puts it in the variable of slot (which CW has the same value as CWMin). Then via the fourth line, estimates the expected time to send a packet from each node. After passing the expected time of each node, forwards the first packet.

Code 1-4-3:selset a value in the range[0to CW] for transmission

```
1) if (++rtx_ < rtxlimit_ ) {
2) delay += max (channel_ ->txstop( ) + ifs_ -now, 0.0) ;
3) int slot = Random : : integer (cw_) ;
4) s.schedule (h,p,delay + slottime_ * slot) ;
5) cw_ = min(2*cw_,cwmax_) ;
6) }
7) else
8) resume (p) ;
```

The node, after transmitting the first packet, by using MAC protocol mechanisms, checks channel status via the first line of 2-4-3 code. In this line, with if conditional command, this is checked that the channel is free or busy. There are two cases: if channel is busy, is-idle function returns zero value which Not of zero, is the value of 1, and the commands of line of 2, 3 & 4 are run and if channel is free, is-idle function returns 1 which its Not is zero and the command in the line of 7 runs.

Code 2-4-3: for checking the channel status

```
1) if (!is_idle( )) {
2) inc_cw ( ) ;
3) mhBackoff_.start (cw_,is_idle( )) ;
4) return 0;
5) }
6) else {
7) dec_cw() ;}
```

As is discussed in section 3-1, if the channel is sensed as busy, it means the transmitted packet by the node, has caused the collision and the packet forwarding was unsuccessful and it must be sent again. So, it utilizes BEB mechanism to transmit the packet once more. This mechanism, by multiplying CW by two, tries to forward the packet successfully, which the second line command implements this operation. When we want to implement the operation of multiplying CW by two, first a value is selected as a random uniform function within the range of [(CWMax-CWMin)*0.8] according to 3-4-3 code.

Code 3-4-3: Selecting random CW

```
1) cw_= int ( ( Random : : uniform ( ) *
   (phymib_.getCWMax ( ) –phymib_.getCWMin( ))  *0.8) +1
```

Then it calls inc-cw() function, which is an implemented internal function (code 4-4-3)

Code 4-4-3: procedure of multiplying CW by 2

```
1)  inline void  inc_cw ( ) {
2) cw_ = (cw_ << 1) + 1 ;
3) if (cw_ > phymib_.getCWMax ( ))
4)   cw_ = phymib_.getCWMax ( ) ;
 5)  }
```

In first line, inline function is used. Inline function tells the compiler to replace all function calls with its completed code. In second line by using the left hand bit shift operator, double pre-allocated CW. Then in third line if CW is more than CWMax, in next line (fourth line), allocates the value of CWMax to CW. After commands block in inc-cw function is finished, program running procedure, returns to calling place (line of 3 in 2-4-3 code). Now, there is a doubled value in CW which the third line selects a value within is-idle (which equals to zero now) to CW [0 to CW] for Backoff time. Eventually, in fourth line, the command Return0 finishes the function.

But in the time channel checking, if the node senses the channel as free, else part of 2-4-3 code runs. Which in 7th line of this function a command called dec-cw is brought. If the channel is free, it means the packet forwarding of that node was successful and first selects a value within [(CWMax-CWMin)*0.8] as random uniform function according to 3-4-3 code. And then runs the 7th line command and calls dec-cw function. 4-4-3 shows dec-cw operation.

5-4-3 code: Procedure of dividing CW by 2

```
1) inline void dec_cw ( ) {
2) cw_ = int ((cw_ >> 1)) + 1 ;
3) if (cw_ < phymib_.getCWMin ( ))
4)   cw_ = phymib_.getCWMin ( ) ;
5) }
```

As previous, in fifth line inline function is used. In second line of 5-4-3 by using the right hand bit shift operator, divides CW by two. Then in third line, if the value of CW is less than CWMin, in next line (fourth line) allocates CWMin to CW. After the block commands in dec-cw function is finished, the running procedure returns to calling place (7th line of 2-4-3). Code of 2-4-3 which shows end of commands block and eventually program running procedure and one or multiple packet forwarding are finished. Hence, in this way, procedure of packet transmission from one or multiple node goes on.

4. Evaluation and comparing the protocol

We have performed D-CW and DCF 802.11 [22] simulation, to measure and compare efficiency of these two MAC protocols.

Wireless ad-hoc network, is a network in which stations transition place in a random and uniform square area. Currents are multi-hop. In multi-hop current, receiver stations are placed in an area, random and uniformly. We run the simulation for multi-hop network with dimensions of 500m*500M. Amount of effective transition is limited to 100m. RTS/CTS mechanism of 802.11 standard is off. Radio emission model, of Two Ray grand is assumed. Each simulation last 5 seconds and presented results run more than 10 times. At any run, a random network topology is considered different. We measure the results of D-CW and 802.11DCF in the graphs such as throughput average, collision probability, end-to-end average delay and data traffic control. Table 1 reports the values of wireless network parameter, which is analyzed in this section.

4.1 parameters evaluation in multi-hop networks

Figure*s* 4 through 7 evaluate multi-hop network parameters with the number of different nodes. Network dimension is 500m*500m. Network traffic is ftp, which means always a traffic stacks in transition line of each link. Packet forwarding line, depending on the number of network nodes, are different. For example, for a scenario with 5 nodes, transition line can hold 5 packets and for the scenario with 10 nodes, transition line of each link holds 10 packets and it continues this way. Moreover, when a buffer is loaded, new packets will be neglected. Payload size in this network is 1000 bytes. All currents are multi-hop.

Table 1: simulated parameters.

Row	*Parameters*	*Parameters values*
1	SIFS	16μs
2	DIFS	34μs
3	SlotTime	9μs
4	CWMin	15
5	CWMax	1023

The total throughput of D-CW and DCF 802.11 are shown in Figure 4. The procedure of computing the throughput in network is as follows: how much a packet utilize a channel in forwarding time, so we must divide data length by total channel time to obtain efficiency of channel for each node.

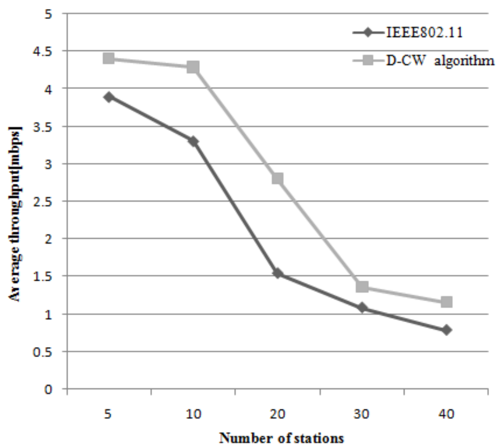

Fig. 4 The average of throughput.

The throughput increase, achieved by D-CW is about 40.2%.

ACSIJ Advances in Computer Science: an International Journal, Vol. 2, Issue 3, No.4 , July 2013
ISSN : 2322-5157
www.ACSIJ.org

Figure 5 shows the probability of two protocols collision. It means, in average how many of forwarding packs, collides to other packs on the network and destroys. Computing the probability of collision in network is as follows: the number of forwarding packs which is called rpkt is divided by the number of received packets called seqno and subtract the result from the number of 100 to obtain the collision probability. So, DCF collision probability is computer by equation (1):

$$\textit{Collision probability} = 100 - \left[\frac{rpkt}{(seqno+1)} * 100\right] \qquad (1)$$

As you see in Figure 5, collision probability in D-CW is about 65.6% less. D-CW networks have less collisions

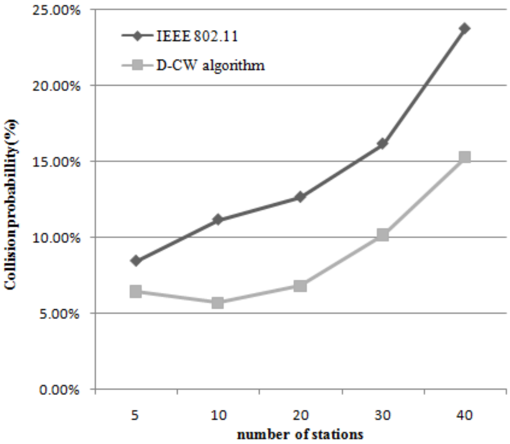

Fig. 5 Collision probability.

compared with 802.11. Moreover, some second transmissions are avoided. Because in D-CW more packet are sent and less collision happens.

Figure 6 depicts the average end-to-end delay. The access delay average, takes the confirmation of pack arriving from the destination, like the delay between the time of pack arriving in a MAC layer and the time that origin takes the packet arriving confirmation from the destination. The access delay of a packet is composed of the waiting time before the transition on the channel and the spent time to re-forward the packet. As you see in Figure *6*, access delay in D-CW is less than 802.11 about 32.2 %. D-CW has a shorter idle time comparing to 802.11. Since the collision repetition reduces, re-transmission of the packets is avoided.

Figure 7 shows data traffic control of two protocols. Data traffic control means the number of sent packets, called seqno, is divided by the number of received packets called rpkt which is computed by equation (2):

$$\textit{Traffic Control /data} = \frac{(seqno+1)}{rpkt} \qquad (2)$$

As you see in Figure 7, data traffic control in D-CW is about 7.7% less than 802.11.

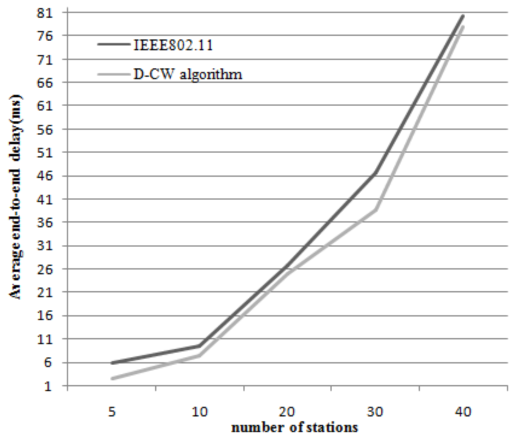

Fig. 6 End-to-end average delay.

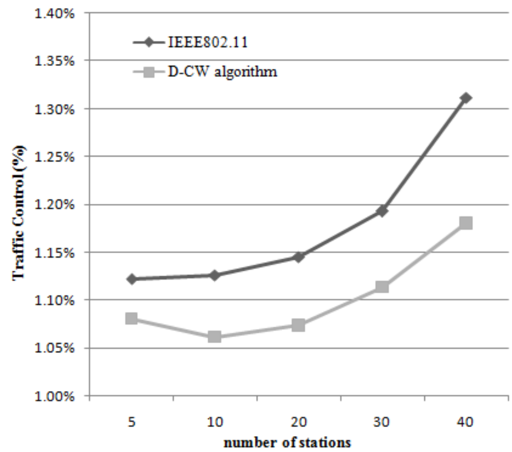

Fig. 7 Data traffic control.

D-CW networks have less data traffic. So, packets forwarding performs more easily and with collision reduction. D-CW algorithm presents a mechanism which says, if a node had two packets to send, if it could select CW from the range of [0 to CW] such that, the first packet be sent successfully, for sending the next packet, it can divide the available contention range of [0 to CW] by two and then selects the CW from the half of the previous contention window, so waits a less time (see Figure *2*). Hence, D-CW spends less time to send its packets. Also D-CW algorithm presents another mechanism in which dynamic value of CW is used. By this mechanism both the idle time and the collision time are reduced.

So, in this paper an algorithm is presented called D-CW, and by choosing useful competitive mechanisms in wireless local networks, the maximum efficiency is achieved comparing to 802.11.

5. Conclusion

This paper evaluates performance of D-CW. D-CW is a distributed access protocol which uses two mechanism to improve the efficiency of network: 1- using dynamic CW for each node to reduce the collision rate. 2- Dividing the value of CE by two for successful nodes to reduce the idle time. Simulation results show that D-CW improves operational power, collision probability, end to end delay and data traffic significantly.

References

[1] F. Cali, M. Conti, and E. Gregori, “Dynamic tuning of the ieee 802.11 protocol to achieve a theoretical throughput limit,” IEEE/ACM Trans. On Networking, vol. 8, no. 6, December 2000.

[2] Y. C. Tay, K. Jamieson, and H. Balakrishnan, “Collision-minimizing csma and its applications to wireless sensor networks,” IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, vol. 22, 2004.

[3] M. Heusse, F. Rousseau, R. Guillier, and A. Duda, “Idle sense: an optimal access method for high throughput and fairness in rate diverse wireless lans,” SIGCOMM Comput. Commun. Rev., vol. 35, no. 4, 2005.

[4] A. Dimakis and J. Walrand. “Sufficient Conditions for Stability of Longest-Queue-First Scheduling: Second-order Properties using Fluid Limits.” Advances in Applied Probability, 38(2):505521, 2006.

[5] L. Jiang and J. Walrand, “A distributed CSMA algorithm for throughput and utility maximization in wireless networks,” 46th Annual Allerton Conference on Communication, Control, and Computing, Page(s):1511 - 1519, September 2008.

[6] J. Ni and R. Srikant, “Distributed CSMA/CA algorithms for achieving maximum throughput in wireless networks”, Information Theory and Applications Workshop, Page(s):250 - 261, February 2009.

[7] S. Keshav, An Engineering Approach to Computer Networking: ATM Networks, the Internet and the Telephone Network. Addison-Wesley, 1997.

[8] N. Abramson, “The ALOHA System—Another Alternative for Computer Communications,” Proc. Am. Federation of Information Processing Soc. Conf., vol. 37, pp. 295-298, 1970.

[9] L.G. Roberts, “ALOHA Packet System with and without Slots and Capture,” Computer Comm. Rev., vol. 5, no. 2, Apr. 1975.

[10] P. Karn, “MACA—A New Channel Access Method for Packet Radio,” Proc. ARRL/CRRL Amatuer Radio Computer Networking Conf., pp. 134-140, 1990.

[11] IEEE 802.11 Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, IEEE Standard 802.11, 1997.

[12] B. Zhou, A. Marshall, and T.-H. Lee, “The Non-Responsive Receiver Problem in Mobile Ad-Hoc Networks,” IEEE Comm. Letters, vol. 9, no. 11, pp. 973-975, 2005.

[13] S. Xu and T. Saadawi, “Revealing the Problems with 802.11 Medium Access Control Protocol in Multi-Hop Wireless Ad Hoc Networks,” Computer Networks, vol. 38, pp. 531-548, 2002.

[14] G. Bianchi, “Performance Analysis of the IEEE 802.11 Distributed Coordination Function,” IEEE J. Selected Areas in Comm., vol. 18, no. 3, pp. 353-547, Mar. 2000.

[15] V. Bharghavan, “MACAW: A Media Access Protocol for Wireless LANs,” Proc. ACM SIGCOMM, pp. 212-225, 1994.

[16] Y. Kwon, Y. Fang, and H. Latchman, “A Novel MAC Protocol with Fast Collision Resolution for Wireless LANs,” Proc. IEEE INFOCOM, Apr. 2003.

[17] S.J. Golestani, “A Self-Clocked Fair Queueing for Broadband Applications,” Proc. IEEE INFOCOM, pp. 636-646, Apr. 1994.

[18] Z.G. Abichar and J.M. Chang, “A Medium Access Control Scheme for Wireless LANs with Constant – Time Contention,” Lecture Notes in Computer Science, vol. 3462, pp. 358-369, Jan. 2011.

[19] B. Zhou, A. Marshall, and T.-H. Lee, “A k-Round Elimination Contention Scheme for WLANs,” *Mobile Computing, IEEE Transactions on*, vol. 6, no. 11, pp. 1230–1244, Nov. 2007.

[20] G. Wikstrand, T. Nilsson, and M. Dougherty, “Prioritized Repeated Eliminations Multiple Access: A Novel Protocol for Wireless Networks,” in *INFOCOM 2008. The 27th Conference on Computer Communications. IEEE*, April 2008, pp. 1561–1569.

[21] Gh. Hosseinabadi, N. Vaidya, “Token-DCF: An opportunistic MAC protocol For Wireless Network, ” in Department of ECE and Coordinated Seience Lab, 2012.

[22] “IEEE Standard for Information technology-Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications,” IEEE Computer Society, 2007.