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Performance Analysis of IEEE 802.11 Modified Distributed Coordination Function for Wireless LANs Based on Data rate

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Abstract: *IEEE has standardized 802.11 protocol for Wireless Local Area Networks.The 802.11 MAC standard specifies two access mechanisms, the Distributed Coordination Function (DCF) and Point Coordination Function (PCF). DCF is considered as the basic MAC mechanism, based on the carrier sensing multiple access with collision avoidance (CSMA-CA) protocol, which is introduced to avoid the collision.The main problem with 802.11 MAC layer is the implementation defects of DCF.The Distributed Coordination Function (DCF) in the IEEE 802.11 standard preserves fairness for all clients at the frame level. That is, all clients would achieve the same throughput (in terms of numbers of frames transmitted or received) in the long run without considering their data rates. As a consequence, it will take much longer time for a low data rate client to transmit / receive a frame than clients with higher data rates.It results in the low throughput of fast clients and a poor performance of the whole system. This is regarded as a major problem in IEEE DCF interms of their performance . DCF allows a uniform packet delivery irrespective of the data rate. In the existing system the throughput is independent of the data rate. This can be observed from the throughput analysis. But in the modified version of DCF called MDCF gives a far better performance for nodes with high data rate. Thus in the proposed method high data rate node traffic is optimized. This is achieved by making changes to the MAC layer of IEEE 802.11. The frames and packets are dropped only after analyzing the data rate. Packets from nodes with high data rate are given preference over packets from nodes with low data rate.Performance Analysis is done based on various parameters and results show that proposed sysytem(MDCF)is better than normal DCF.*
Keywords: *DCF,MDCF*

I. Introduction

Wireless Technology has become an essential part of our day to day life.Wireless Technology has impacted the world in many ways.Success in wireless networks has made our life so convenient and free.Users are so much addicted to this wireless technologies and devices such as mobile phones ,laptopes etc.Computer Networks are interconnected components of computer that helps to exchange data.There are different types of computer networs that are classified based on size and scale of operation.They are local area network (LAN),Wireless local area network(WLAN) ,wide area network (WAN),metropolitan network (MAN) etc.LAN connects different devices in a net- work within a short distance.But at the same time in Wireless local area network(WLAN) users can move around within a large coverage area. Wireless Local Area Networks (WLANs) are densely deployed all around the world .It can provide information to the world.It is the main source of information. Further, wireless access networks are becoming popular in now a days to use in combination with other networks to increase availability. They are relatively cheap. This has lead to an increasing interest in using WLANs in home environments. Wireless Local Area Networks (WLAN) are very easy to to set up and administration requirement is less.

We can see a large need of independent mobile users in the next generation of wireless systems.It finds high application for emergency cases like military networks.The introduction of computing devices such as laptops,Desktop computers and 802.11/ Wifi wireless networking have made MANETs an interesting research topic .Many papers evaluate protocols and their special featuresand introduced new protocols.Different protocols are then evaluated based on various parameters such as the packet drop rate, normalized overhead , end-to-end packet delays, network throughput, etc.

The main aim of this paper is to rectify implementation defects of DCF in IEEE802.11 Mac layer. The main problem with 802.11 Mac layer is the implementation defects of DCF. DCF allows a uniform packet delivery irrespective of the data rate. This can be observed from the throughput analysis . Normal DCF is not considering data rate of packets. Data rate can be low data rate or high data rate..But in the modified version of DCF called MDCF(proposed system) gives a far better performance for nodes with high data rate. Thus in the proposed method high data rate node traffic is optimized. This is achieved by making changes to the mac layer of IEEE802.11. The frame should contian additional information about the data rate in order to achieve this. The frames and packets are dropped only after analyzing the data rate. Packets from nodes with high data rate are given preferance over packets from nodes with low data rate.

II. Related Works

For both centralized and ad-hoc networks IEEE802.11technology implements different Medium access control methods. IEEE 802.11 consists set of media access control (MAC)[8] and physical layer specifications.It is mainly used for implementing wireless local area network (WLAN)in different frequency bands. They are created and maintained by IEEE LAN/MAN standards committee.Different medium access control methods are DCF (Distributed Coordination Function),PCF(Point Coordination Function)and HCF (Hybrid Coordination Function).The Distributed Coordination Function (DCF) is the fundamental MAC technique used in IEEE802.11 WLAN. It is based on the Carrier-Sense Multiple Access and Collision Avoidance (CSMA/CA) scheme. IEEE 802.11 provides various transmission rates. For example, in IEEE 802.11a, discrete rates are available ranging from 6 Mbps to 54 Mbps.Eventhough various transmission rates are available in IEEE 802.11, there is no standard approach defined to select the appropriate rate while ensuring fairness among the nodes. Here am giving importance to IEEE802.11 DCF.DCF is most commonly used media access control method.

III. Mac Layer Of Ieee802.11 Dcf

The IEEE 802.11 DCF is widely used in wireless communications. It uses carrier-sense multiple access with collision avoidance (CSMA/CA].During Transmission of frames ,there is a probability of collision [7] .The retransmissions of the collided frames are done according to the binary exponential backoff rule. In 802.11 DCF protocols, initially, or when a station finishes any frame transmission, it has to check the wireless medium before starting the next transmission. If the channel is found to be idle for a minimum amount of time equal to Distributed Inter-Frame Space (DIFS), the station enters into a backoff procedure .It randomly selects a backoff timer between 0 and its current contention window (CW).when the channel is sensed idle for a short slot time (ST),backoff timer is decremented by 1 and is frozen when the channel is sensed busy until the channel becomes idlefor another DIFS time. As soon as backoff timer reaches 0, the station starts to transmit immediately at the beginning of the new slot. After the station sends the frame out, it is expecting to receive an acknowledgment (ACK) from the receiver station after an idle time equal to Short Inter-Frame Space (SIFS).If ACK is not received within ACK Timeout,the transmission is considered failed, and the current CW is doubled. The station then reselects its backoff timer and when the timer reaches 0 retransmits the frame again, until either the frame is sent out successfully, or the retransmission count reaches retryLimit (the frame will be dropped out in thiscase). When a station senses an error in the transmission, it has to wait for an Extended Inter-Frame Space (EIFS) before entering the backoff procedure.This is the way in which DCF works.

IV. Existing System

Numerous papers have reported the performance problems of 802.11 DCF, and proposed many solutions to them. To name just a few, 802.11 DCF has severe performance degradation and throughput disparities among contending flows in the topologies such as hidden-terminal (HT), information asymmetry (IA), flow-in-the-middle (FIM), and packet.DCF is used because it supports high data rates . The 802.11 cell shows the performance problems if there exists nodes that works with different bit rates.Some nodes are having high bit rate while some others have lower bit rate. The throughput of all hosts that have higher bit rate [2] are decreased, and all the hosts in the wireless cell experience the same throughput regardless of the transmission rate. In terms of the channel utilization, this is quiet unfair because the higher bit rate node defers transmission longer than that of the lower bit rate node.The best way to rectify this problem is the redesign of the underneath Mac layer.

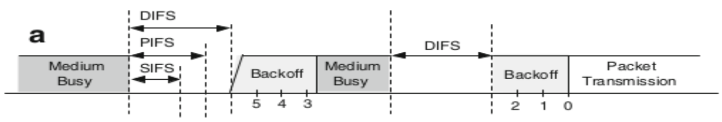


Fig 1.Back off Mechanism

V. Proposed System

Thesis focuses to reduce fairness in IEEE 802.11 DCF at the frame level for all clients.This fairness is considered as one of the defects in MAC layer of IEEE 802.11 DCF. The Distributed Coordination Function (DCF) in the IEEE 802.11 standard provides fairness at the frame level for all clients.That is, all clients would gain same throughput regardless of their data rates. As a consequence, it will take much longer time for a low data rate client to transmit / receive a frame than clients with higher data rates. This leads to the low throughput of fast clients and results in poor performance of the whole system. One solution to this problem is redesign of underneath MAC layer ,which is a tedious task.In some cases it may cause further degradation of low data rate clients.The IEEE 802.11 MAC is responsible to provide reliable delivery mechanism for user data over noisy and unreliable wireless channels. The IEEE 802.11 MAC specifies two access mechanisms i.e. the polling-based Point Coordination Function (PCF) and the contention-based Distributed Coordination Function (DCF). PCF is not widely deployed because of its complexity, and limited QoS provisioning.Polling schemes used in PCF is also inefficient. In this project, we only look into the IEEE 802.11 DCF which is the most prevalent MAC protocol. The IEEE 802.11 protocol is based on Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA).

The main problem with 802.11 MAC layer is the implementation defects of DCF. DCF allows a uniform packet delivery irrespective of the data rate. Throughput is independent of the data rate. This can be observed from the throughput analysis of the existing system.But in the modified version of DCF called MDCF gives a far better performance for nodes with high data rate. Thus in the proposed method high data rate node traffic is optimized. This is achieved by making changes to the MAC layer of IEEE 802.11. The frame should contain additional information about the data rate in order to achieve this. The frames and packets are dropped only after analyzing the data rate. Packets from nodes with high data rate are given preference over packets from nodes with low data rate. Existing system does not considering performance anomaly problem[3] .Throughput is independent of data rate.Data rate means amount of information flowing through the system.It can be low data rate or high data rate.

Packets from nodes with high data rate and low data rate are given preference.First it checks whether packet comes from node with high data rate or low data rate.A threshold value is set to check whether it is a high data rate node packet or low data rate node packet.Packets from nodes with high data rate are given preference over packets from nodes with low data rate.It is assumed that high data rate node packet carries most valuable information.So our aim is to minimize the packet drop of high data rate node packet.For identifying high data rate threshold value is used.If a corresponding packet have size more than threshold value,that packet is considered as packet from high data rate node.Next is to reduce the packet drop of node that are having high date rate.By considering packet drop of the node,throughput of the system can be increased.

VI. System Design

To evaluate the effectiveness of the proposed method, simulation scenarios were carried out in NS-2[5] with network consists of randomly placed nodes in 600 *500 square area.Simulation starts with creation of an environment that consists of any fixed number of nodes.Packet size and data rate are mentioned.Now we have to find out the packet that are coming from high data rate node and low data rate nodes.For that we need to identify the node with high data rate and low data rate.The Distributed Coordination Function (DCF) in the IEEE 802.11 standard maintains fairness for all clients at the frame level.The main problem with 802.11 MAC layer is the implementation defects of DCF. DCF allows a uniform packet delivery irrespective of the data rate. Throughput is independent of the data rate. The algorithm is simulated using the c++ coding of ns2.

6.1.Module Division

Module 1: Setting up a IEEE 802.11-based WLAN: An IEEE 802.11-based WLAN consists of one- or several Basic Service Set(s) (BSS). The nodes can move around while communicating(not stationary). IEEE 802.11[9] also describes Independent Basic Service Sets (IBSS).Independent base service set is a BSS without an Access point. Any node can initiate a network, by transmitting periodic beacon frames. Such system is implemented in this paper where no access point is defined .As more nodes join this network, all involved nodes take turn to transmit these beacon frames. Nodes communicate directly with each other, no AP is involved.A BSS consists of a set of nodes that communicate via an Access Point (AP). These network types are not further described here. Several BSSs can be connected with Distributed System (DS). Within one BSS, one Coordination Function (CF) controls the medium access to the shared wireless channel, i.e. a Medium Access Control (MAC) protocol.

Module 2: Setting up an environment(DCF) that does not consider Data rate: Our aim is to increase the performance of IEEE 802.11 DCF.Performance can be calculated from throughput calculation.Throughput is independent of data rate.Datarate means amount of information flowing through the system.It can be low data rate or high data rate.Packets from nodes with high data rate and low data rate are given same preference in this Scenario.The main problem with 802.11 MAC layer is the implementation defects of DCF. DCF allows a uniform packet delivery irrespective of the data rate. This can be observed from the throughput analysis. Data rate is the one of the main criteria we have to consider in the case of DCF.Implementation of DCF suffers from many de- fects.One such defect is uniform packet delivery.That problem can be reduced by reducing the packet drop of node that are having high data rate. Here it is assumed that all packets in DCF [10]environment provide uniform packet delivery for nodes in WLAN environment.Packet size can be retrieved from frame for- mat.Packet that carries more information is not giving any special consideration.So through- put of the system is never increasing.It affects whole performance of the system .So we have to set up an environment that considers data rate.

Module 3: Setting up an environment MDCF that consider Data rate/packet size : But in the modified version of DCF called MDCF gives a far better performance for nodes with high data rate. Thus in the proposed method high data rate node traffic is optimized. This is achieved by making changes to the MAC layer of IEEE 802.11. The frame should contain additional information about the data rate in order to achieve this. The frames and packets are dropped only after analyzing the data rate. First it checks whether packet comes from high data rate node or low data rate node.A threshold value is set to check whether it is a high data rate node packet or low data rate node packet.Threshold value is set at the MAC layer of IEEE 802.11 .That value is compared with the packet size.If that packet size is greater than threshold value ,it is considered as a packet from high data rate node.Otherwise it is a low data rate node. Packets from nodes with high data.

Module 4: Comparison of DCF and MDCF based on various parameters : Performance analysis of above two modules are made on the basis of throughput,packet drop,normalized overhead and Average delay.The scenario was also implemented in order to obtain more in depth analysis of DCF and its successors in case of larger wireless networks. Each of them is acting as a sink or receiver for nodes. AODV is also set as the routing protocol and the simulation time is also set to the standard of 25 seconds. For a good system, throughput must be high and at the same time normalized overhead packet drop and delay must be low. Throughput is the ratio of successful message delivered at the destination. Throughput of proposed system MDCF is compared with normal DCF . Throughput of Proposed system is higher than that of normal DCF. Packet drop incase of normal DCF is high.For analyzing packet drop ,We are calculating packet drop that occurs at each destination.It is found that packet drop in MDCF is low compared to DCF.Delay is the time needed for the packet to reach the destination.Average delay[6] incase of MDCF is low compared to normal DCF.Delay means the end-to-end delay of one packet needed for sending from source node to its destination. This means the time taken when a packet is received at the MAC layer at the source node from higher layers, until the whole packet is received at the MAC layer at the destination node.Normalized overhead is the overhead that is incurred while routing a packet. Normalized overhead is same for both,but little more for MDCF.

VII. Experimental Setup and Result Analysis

Two simulation scenarios are implemented, one that implements normal DCF and another one that implements MDCF(modified DCF). The simple scenario is based on an Ad hoc network consisting of fixed number of nodes .The idea of the scenario is to have nodes in motion in order to simulate the performance of a network in motion. The scenario was also implemented in order to obtain more in depth analysis of DCF and its successors in case of larger wireless networks. Each of there of them is acting as a sink or receiver for nodes. AODV [17]is also set as the routing protocol and the simulation time is also set to the standard of 25 seconds.Some Assumptions are made in this paper.Stations are in the transmission range of each other.No hidden and exposed terminals.Time is divided to slots and stations are synchro- nized to these slots. Ideal channel is assumed. Frame loss is occurred only by collisions and interferance does not occur.

To evaluate the accuracy and performance of Proposed model , a simulation environment has been set up by the NS-2 simulator (version 2.35). We modify the codes in NS-2.35 specifically for IEEE 802.11 MAC to handle low and high data rates. First, we evaluate the performance 5-20 clients are placed in the system.The clients are randomly placed in the communication range . Threshold value is set in MAC layer of IEEE 802.11 .If the packet size of data reaching the node is greater than a particular threshold value ,node that recives the packet is considered as high data rate node. Furthermore many characteristics are set for the simulation environment as shown in the table.

No of nodes	10,20
Interface type	Phy/WirelessPhy
MAC Type	IEEE802.11
Queue Type	DropTail/PriQueue
Antenna Type	Omni Antenna
Propagation Type	Two Ray Ground
Transport Agent	UDP

Table 1: Characteristics of Simulation Environment.

Performance analysis of DCF and MDCF are made on the basis of throughput ,packet drop,normalized overhead and Average delay.Throughput is the ratio of successful message delivered at the destination. The higher mobility of nodes causes PDR to decrease.Throughput of proposed sysyem MDCF is compared with normal DCF .But throughput of Proposed system is higher than that of normal DCF. Packet drop incase of normal DCF is high.For analyzing packet drop we are calculating packet drop that occurs at each destination.It is found that that packet drop in MDCF is low compared to DCF.The traffic generator used in the simulation is a CBR (Constant Bit Rate)traffic generator over UDP, which is generating traffic randomly by picking up random node pairs as sources and destinations. The simulation time is set to 25 seconds which is simulation time for testing the performance of wireless networks. The routing Protocols is set to AODV(Ad hoc On - demand Distance Vector Routing)[11].AODV is a reactive routing protocol which means it starts a route to a destination only on demand. AODV does not need to know the complete path to the destination. In this case, nodes forward the packets to neighbor nodes of the destination.At the beginning,the scenario was applied for the DCF. As the legacy DCF is already included in the NS2 as the initial function for the wireless LAN. After that, the same scenario was applied for MDCF. In order to implement MDCF in Ns2, a change in the code was done. After a successful transmission of data, a function was called in order to determine data rate(high data rate node or low data rate node.).Changes are made in original MAC-802 11.cc in NS2. The same scenario above was applied for MDCF and the results were conducted.

The proposed system was compared with normal DCF in terms of Average Delay, packet drop,normalized overhead and throughput.Average delay is the time needed for each packet to reach the destination.Packet drop is the total number of packets dropped during the simulation.Throughput is described as the total number of received packets at destination out of total transmitted packets. Throughput is calculated in bytes/sec.Normalized overhead is the overhead that is incurred while routing a packet. Simulation is done in NS2. Fig.2 shows throughput calculation of normal DCF and MDCF. Graph shows that MDCF is far more better than DCF incase of throughput.Throughput is calculated based on number of packets successfully reaching the destination.Performance is calculated interms of throughput ,packet drop,Average delay and normalized overhead.

7.1 Average Delay

Average end-to-end delay of MDCF and DCF were compared. The result shows that the end-to-end delay of MDCF is much lesser than DCF.Average delay for MDCF is 1020ms and for DCF is 2556.98ms.

7.2 Throughput

For evaluation of the performance of the proposed system, throughput for normal dcf and modified dcf were calculated. Throughput is the amount of data delivered per unit time. The Xgraph showing the throughput of dcf and mdcf is given in figure 2. From the figure,it is clear that throughput of MDCF is higher than normal DCF.

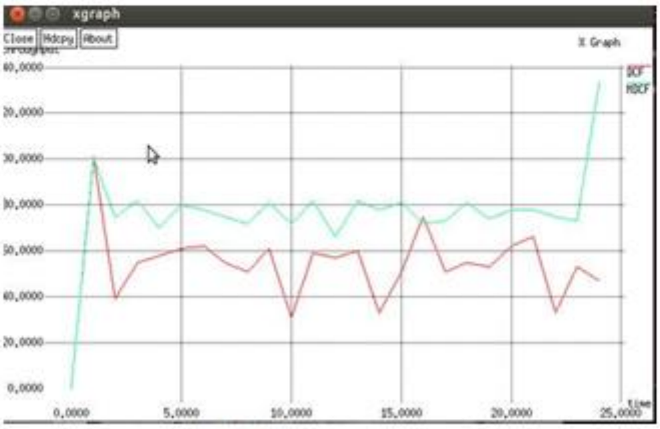


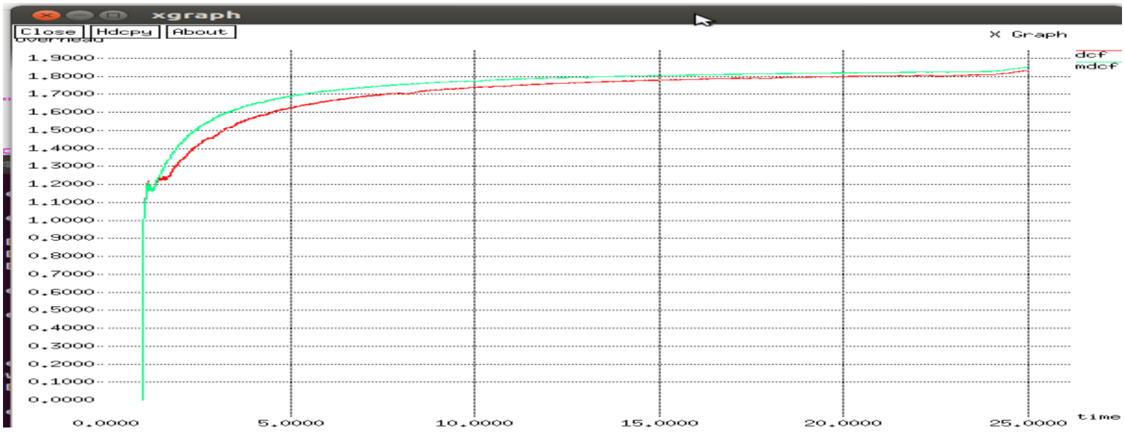
Fig 2. Throughput

7.3 Packet Drop

Packet drop of DCF and MDCF were compared. It shows that Packet drop of MDCF is less when compared to DCF.Packet drop occured in DCF are 738,803 respectively.At the same time packet drop occured in MDCF are 288 ,236 respectively.

7.4 Normalized Overhead

Normalized overhead is the overhead that is incurred while routing a packet. Figure 3 shows the Xgraph based on the comparison of NOH of DCF and MDCF.The figure shows that the normalized overhead is almost same,but little more for MDCF.



VIII. Conclusion

Wireless Local Area Networks is an emergeing technology.Many researches are going on in this area. IEEE has standardized the 802.11 protocol for Wireless Local Area Networks.The 802.11 MAC standard specifies two access mechanisms, the Distributed Coordination Function (DCF) and Point Coordination Function (PCF). DCF is the basic MAC mechanism, based on the carrier sensing multiple access with collision avoidance (CSMA-CA) protocol, which is introduced to avoid the collision.One of the main problem with 802.11 MAC layer is the implementation defects of DCF. DCF allows a uniform packet delivery irrespective of the data rate. Throughput is independent of the data rate. This can be observed from the throughput analysis.So here modified version of DCF have been proposed.But in the modified version of DCF called MDCF gives a far better performance for nodes with high data rate. For obtaining better performance in the proposed method high data rate node traffic is optimized. This is achieved by making changes to the MAC layer of IEEE 802.11. The frame should contain additional information about the data rate in order to achieve this. The frames and packets are dropped only after analyzing the data rate. Packets from nodes with high data rate are given preference over packets from nodes with low data rate.Performance analysis of above DCF and MDCF are made on the basis of throughput,packet drop ,normalized overhead and Average delay.It is found that throughput of MDCF is more than normal DCF.Average Delay and packet drop for Modified DCF is less compared to normal DCF.

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