A New MAC Protocol for Supporting Differentiated QoS in IEEE 802.11 Multihop Wireless Networks

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I. ABSTRACT*

In IEEE 802.11 multihop wireless networks, each node uses DCF to randomly contend for the medium access to transmit their packets. There is multimedia transmission that needs QoS guarantee. Even that the IEEE 802.11e provides differentiations of MAC access (EDCF), it still remains random manner and can not guarantee the end-to-end QoS in this access network to meet requirements like delays, jitters, or even bandwidth. Furthermore the hidden terminal problems is more serious in the multihop networks. The IEEE 802.11 PCF provides central coordination to meet QoS requirement but it requires an infrastructure. So it can't be used in multihop wireless networks. Here we propose a new MAC scheme which can provide QoS guarantee in multihop wireless networks. We propose the global coordinator to gather the information about conflict links and the requests for scheduling contention-free access. We also provide an adaptive approach for new coming request to avoid global re-scheduling to reduce overhead and to improve the performance.

Keyword：multihop, QoS, 802.11e

II. INTRODUCTION

There is a growing need to support quality of service (QoS) in multihop ad hoc networks. However, wireless multihop ad hoc networks represent distributed systems, and stations communicate without the fixed infrastructure. To communicate with stations out of transmission range relies on peer wireless stations that operate as routers on behalf of source-destination pairs. Rerouting among stations causes topology and network load conditions to change dynamically, making it difficult to support real-time applications with indicated quality requirement. Another challenge in supporting QoS for real-time applications is associated with the design of the medium access control (MAC) protocol. The random nature makes it difficult to maintain required quality and reservations.

A. IEEE 802.11 MAC protocol

The basic IEEE 802.11 Medium Access mechanism is called Distributed Coordination Function (DCF) and is based on the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol[11][12][13] (see Fig.1).

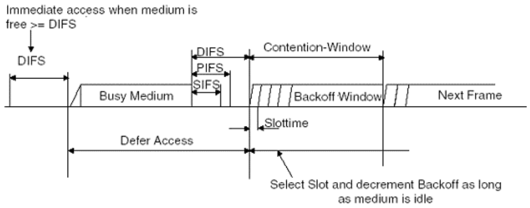

Fig.1. IEEE 802.11 MAC

B IEEE 802.11e

The differentiation between high priority and low priority is the order to transmit. The 802.11e draft has defined the differentiation schemes to provide different access preferences to stations. The EDCF in 802.11e is the basis for the HCF. The QoS support is realized with the introduction of Traffic Categories (TCs). MSDUs are now delivered through multiple backoff instances within one station, eachbackoff instance parameterized with TC-specific parameters. In the CP, each TC within the stations contends for a TXOP and independently starts a backoff after detecting the channel being idle for an ArbitrationInterframe Space (AIFS); the AIFS is at least DIFS, and can be enlarged individually for each TC. After waiting for AIFS, each backoff sets a counter to a random number drawn from the interval [1,CW+1]. The minimum size (CWmin[TC]) of the CW is another parameter dependent on the TC. Priority over legacy stations is provided by setting CWmin[TC]<15 (in case of 802.11a PHY) and AIFS=DIFS. See Fig. 2 for illustration of the EDCF parameters. As in legacy DCF, when the medium is determined busy before the counter reaches zero, the

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backoff has to wait for the medium being idle for AIFS again, before continuing to count down the counter. A big difference from the legacy DCF is that when the medium is determined as being idle for the period of AIFS, the backoff counter is reduced by one beginning the last slot interval of the AIFS period. Note that with the legacy DCF, the backoff counter is reduced by one beginning the first slot interval after the DIFS period. After any unsuccessful transmission attempt a new CW is calculated with the help of the persistence factor PF[TC] and another uniformly distributed backoff counter out of this new, enlarged CW is drawn, to reduce the probability of a new collision. Whereas in legacy 802.11 CW is always doubled after any unsuccessful transmission (equivalent to PF=2), 802.11e uses the PF to increase the CW different for each TC:

*newCW [TC]>=((oldCW[TC]+1)*PF)-1…(1)*

The CW never exceeds the parameter *CWmax[TC]*, which is the maximum possible value for CW.One crucial feature of 802.11e MAC is the Transmission Opportunity (*TXOP*). A TXOP is defined as an interval of time when a station has the right to initiate transmissions, defined by a starting time and a maximum duration. TXOPs are allocated via contention (*EDCF-TXOP*) or granted through HCF (*polled-TXOP*). The duration of an EDCF-TXOP is limited by a QBSSwide TXOP limit distributed in beacon frames, while the duration of a polled TXOP is specified by the duration field inside the poll frame. However, although the poll frame is a new frame as part of the upcoming 802.11e, also the legacy stations set their NAVs upon receiving this frame. More details about polled TXOP follow in the next subsection. The prioritized channel access is realized with the QoS parameters per TC, which include AIFS[TC], CWmin[TC], and PF[TC]. CWmax[TC] is optional.

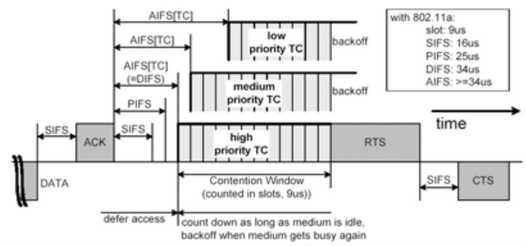

Fig.2. 802.11e protocol

C. The Hidden terminal problem

One problem concerning the carrier sensing of the DCF mode is the so-called hidden terminal problem. A station, that may be outside of transmission range of a sending station and thus senses the medium idle, may however well be within transmission range of the receiver of that ongoing communication. If it starts transmitting itself , this causes Collision. To deal with the hidden station problem, the DCF MAC protocol can use the Request To Send (RTS) / Clear To Send (CTS) mechanism. If a station captures a RTS packet from another station and it is not the destination of the RTS packet it reads the intended transmission duration from the RTS packet and stays silent for that time. The same happens if only a CTS packet is received i.e. by a station outside the transmission range of the sender but within the range of the receiver. This guarantees that all stations within the range of either sender or receiver have knowledge of the transmission and its duration. Thus it reduces the collision probability.

III. MOTIVATIONS/ RELATED WORKS

The future IP network is about to provide end to end QoS, there are many researches on scheduling discipline to maintain queuing delay and transmission throughput. However these scheduling schemes in wired networks have fixed link capacity to do resource management, but not in 802.11 wireless networks. The packet that scheduling schemes decide to send may have no TXOP (Transmission Oppurtunity) in MAC or backoff for the busy medium it sensed or even suffer collisions due to concurrent transmissions performed by other stations. The packet scheduling will not go well due to these uncertain situations at each transmission. Furthermore, the distributed nature of 802.11 MAC protocol makes it difficult to maintain a stable bandwidth or delay-jitter. Neighboring stations contend the common medium to transmit their traffic. If we prefer the transmission on a certain station, then we defer the transmissions around. Especially when a packet transmission over multiple hops, it suffers various delay and bandwidth on each hop. This motivate us to develop a access scheduling on 802.11 mutihop wireless network to providing MAC QoS to fulfill the real QoS. There are several solutions to support QoS in 802.11 WLAN, but few in multihop wireless networks. We take a look on the QoS schemes used in WLAN, and see what is different in multihop wireless networks.

A. QoS Techniques in 802.11 WLAN

The researches about WLAN QoS are mainly dealing with adjusting the parameters of 802.11e MAC protocol, like Inter-FrameSpace (IFS), Contention Window (CW), and Backoff Algorithm [7][1][2][3][6][12]. Different IFSs provide the absolute priorities between stations to gain access in the common medium [2][6]. It could used to differentiate realtime and nonrealtime traffic, but stations using large IFS will suffer starvation. The schemes of adjusting CW provide relative priorities between stations [7][6][12]. Stations measure their throughput independently and dynamically adjust the CW to meet their bandwidth requirement or fairness. Since contention is not promised to succeed, each stations just try best effort to approximate the require quality. When it is in heavy loading, the contention between stations will result of serious collisions. Another kind of QoS techniques is polling, like PCF, HCF of 802.11e, and the Distributed TDM. They provide different priorities through different polling frequency and different number of slots to transmit. However these polling schemes are limited in the infrastructure of LAN. But we are inspired from them to design a global coordination scheme to provide QoS. [7][17[5]

B. QoS in 802.11 Multihop Wireless Network

In 802.11 multihop wireless networks, each node distributedly contends for the medium in its local influence range to transmit their packets. The differentiation mechanisms in WLAN will suffer hidden terminal problems and the priority offered by differentiation will be eliminated. Besides, in the multihop wireless network, packets should be take care of its required quality at each hopping along its path. End to end QoS is difficult to provide with only differentiation between stations. The TXOP in these stations should be schedule to maintain their requirement. So there are researches to scheduling the access among stations in the multihop network, the "Distributed Multihop Scheduling". [9][10]

The Distributed Multihop Scheduling coordinates the priority between stations for end to end QoS by piggybacking information on IEEE 802.11 four-way handshake (RTS-CTS-DATA-ACK) and let stations around overhear the information appended. The information is about the priority of the HOL(head-of-line) packet after the current one. When the four-way handshake is performing, the stations overhearing the priority information construct the local priority table. Upon each packet transmission, stations adjust the CW according the priority table to dynamically schedule their access to medium.

The priority is represented by the packet deadline. The packet deadline is calculated by its bandwidth and end to end delay requirement. Packets with early deadline will have high preference to transmission. Thus stations in the network distributed coordinate their transmission to approximate ideal scheduling to maintain the end-to-end QoS in the network.

However the priority table maintained by each node has problems of incompleteness, especially between hidden terminals. The incomplete tables may make the approximation of scheduling go wrong and the chain effect of backoff turns down the network performance.

The observations above motivated us to propose a solution for guaranteed QoS in multihop wireless network. The main point is to manage MAC access in the whole multihop wireless networks, and maintain the end-to-end quality of multihop traffic flows.

IV. MAC SCHEDULING SCHEME

To introduce our MAC Access Scheduling Scheme, we have several main parts to stress. We will introduce the tree-base architecture to construct our system and provide the routing. And describe the packet scheduling in network layer to support our scheme. Then we propose the method to build the Disjoint Set to avoid collision. And following with our core of MAC Access Scheduling Scheme, we will describe the quality calculation, QoS allocation, and our scheduling algorithm.

A. Architecture

Our goal is to schedule the MAC access in order to provide the substantial bandwidth and required delay bound to provide QoS in Multihop wireless network. The packet may pass several hops from the source station to the destination station. We need to know the information about the routing (hopping sequence) for our scheduling to decide the certain path the packet flow goes. Here we introduce our tree-based structure to globally manage routing and operate our MAC access scheduling scheme by the tree root, which is the global coordinator.

1)Tree Construction

In the beginning, the tree has only one node - the root (global coordinator), periodly sending out the advertising information token. This token records the information about the tree: (Tree ID, Tree structure, Public Contention Intervals)

The stations that receive the advertising information token (AD)will update the information and then transfer the information token to travel the whole tree in DFS (Depth First Search) order. Stations that heard this token could register to the sender. The sender replies message to accept or reject. If to accept the registration, this sender-replying message will announce the global public contention time intervals for free transmission and also the whole tree structure with this new station joining in. Here the station will keep record with the sender as its parent and the sender also keep record with the station as its child. Then the sender will update the new tree structure to the tree root. After the root receives this update, it updates the tree structure for next time advertising. If this station makes disassociation with its parent, this update information will also be forwarded to the tree root in the same way.

A station which has registered to the tree could communicate with any other station in this network, even the internet if the root is connected to the internet backbone. The routing based on the tree structure decides a packet forwarded to the parent of a certain child.

2)QoS Allocation

A traffic flow generated form a source station to a destination station has already decides its path (hopping sequence), since our network is constructed as the tree topology. Each source-destination station pair will has a unique hopping sequence to transfer its packet. We should allocate QoS required by this traffic flow on every link along this path to meet the end-to-end delay and substantial bandwidth. A link (Parent to Child or Child to Patent) may suffer multiple flows and each flow has different QoS requirement. We have to calculate the total QoS requirement on a link for allocation. First we go on classifying traffic into classes.

B. Traffic Classification

As our goal to serve QoS-required traffic in IP layer by providing the required quality in MAC layer. We need to classify traffic according to their QoS requirement. Due to the characteristics of the air interface, we classify traffic into classes according to UMTS 3GPP traffic classification. There are four classes, namely Conversational 、Streaming 、Interactive、Background

C. Packet Scheduling

We use Earliest Due Date First to scheduling outgoing packet in Network layer. Every packet arriving in the queue is time-stamped with its arrival time. Each class has its delay target to maintain QoS. We schedule packets according to the packet **Deadline**. Each packet in head-of-line of these queues is calculated with its Due date :

$$Deadline = arrival\_time + delay\_target \ldots (2)$$

At each time of delivery to lower layer (MAC), we examine the head of line packets of these queues and serve the packet with earliest due date.

D. MAC Quality Allocation for A New Request

When a new application generated by a station, its packet would be passes to Network layer for classification and scheduling. When the packet is delivered to the MAC layer, it is checked with the source-destination IP and port number in the IP header to distinguish if this is a new generated flow. If it is a new one, make allocation to the tree root for the new flow using the public contention time to send allocation request to the root.

When the root get the allocation request of the new traffic flow (source-to-destination , traffic class), it first find out the hopping links from the source station to the destination station by checking the record of tree structure. Then the root starting to allocate quality of its class on each hopping links.

A link (Parent-to-Child or Child-to-Parent) may suffer several flows. Each flow belongs to a certain class with QoS requirement. We need to calculate the total quality requirement on this link for allocation.

Each traffic flow of a certain class has its mean data rate. We assume they are Rc, Rs, Ri, Rb, as mean data rate of Conversational class, Streaming class, Interactive class, Background class respectively.And the number of flow in the class X on the link is Nx. Then we calculate the sum of mean data rate as the mean rate of this class. We define b as the single time slot bandwidth. So we got the time slots needs for each class:

$$Sx = Nx * Rx / b \quad ,x=class \ldots (3)$$

Then we have the required quality entities of this link .The quality entities are combination of the four class: (Sc , Ss , Si , Sb)

With the quality entities of each link, the MAC layer has to allocate the MAC quality of links to providing the substantial bandwidth and maintain the delay bound.

E. MAC Access Scheduling

When an allocation arrives at the root (global coordinator), the root start to schedule the MAC access of the whole multihop network. Before scheduling, the root needs the information about conflict between links that can not make transmission at the same time. We define a link’s Disjoint Set, DS(L),for link L. The links in the set can not make transmission in the same time with link L.

1)Disjoint Set

When we use the advertising information token (AD) to traverse the whole tree. At the time the packet is transmitting on a certain link, other stations around heard AD or AD_ACK should set all its links (including form and to) conflict with the link it heard. Each station keeps record on the conflict links. When the AD arrives at the station, it makes update of the conflict information within AD. Each AD traversal the root gathers this information to build the new Disjoint Set of every link. The Disjoint Set not provides information about the links swhich could not transmit at the same time, therefore avoid the **hidden terminal problems**.

For example in Fig.3, when node E want to transmit packet to node B, the transmission of node E makes the nodes (C, D) to be silent. However node A do not hear that and may try to make transmission to node B. When the signal strength of A break the receiving of node B from node E. The node B fails to receive from both node E and node A. Then node E transmits in vain and would retry next time. This serious problem wastes the precious air-transmission resource and make power saving to be bad. Even we use RTS-CTS to test transmitting station and clear transmission range to avoid hidden terminal, it still makes the performance down. In the figure, if node A know the transmission on E->B is about to go and know the link E->B is conflict with itself. Then it could avoid this collision of hidden terminal. In other side, if node F know E->B is about to transmit, it could make transmission on F->G instead of F->C. Since F->C conflict with E->B.will waste its transmission resource. If node F know link F->C was conflict with link E->B currently transmitting, it could use is transmission resource on link F->G. Here we go o demonstrate this scheme to generate Disjoint Set.

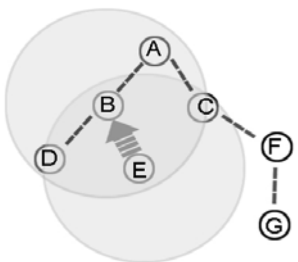

Fig.3. Example of Hidden Terminals

2)MAC Access Scheduling Algorithm

Here we go to introduce our MAC Access Scheduling Algorithm. We have the input of quality entities of links for 4 classes respectively $S_C^i, S_S^i, S_I^i, S_B^i$, for every link i. And our delay bound parameters $D_C^i, D_S^i, D_I^i, D_B^i$

Here we have four stages to perform the scheduling. In each stage, we schedule for each class in order of class priorities. In the beginning of class stage, we sort the quality entities of this class in order of their length from the biggest to the smallest.

We set the current timeline to the length of delay bound of this class. To begin schedule with the head of quality entities, we search the timeline for the *occupied intervals* with length large than the current quality entity. The occupied intervals are the intervals which were inserted with previous quality entities. We try to schedule it to join the quality entities in this interval by checking the Disjoint Set for the links of these quality entities. If the link of current quality entity does not conflict with the links of quality entities in this interval, it joins this interval.

If it checks down for join and it happens to find a disjoint quality entity, we do not give up this interval directly. We try to split the interval into joint part and disjoint part. If the length of the joint part is larger than the current quality entity, we do splitting and schedule it into the joint part. If the length is not big enough, we give up this interval (see Fig.4).

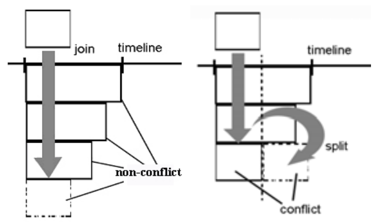

Fig.4. Join and Split

When we search the occupied intervals onto the end of timeline and the quality entities is not scheduled yet. We start search again for the *free interval.* The free intervals are intervals which are not inserted with any quality entities. If the length of the interval is larger than the current quality entity, we insert it directly. Otherwise we give up this interval. We perform this algorithm to schedule each quality entity.

If we schedule out quality entity of this class, then we duplicate the current schedule timeline to reach the length of Delay Bound of next class and continue scheduling next stage of class.

If there is quality entity which fails to insert to any interval, this means resource runs out and the latest allocation request is rejected. Then we keep the old schedule and just reply the rejection to the request.

3)Packet Dispatch Disciplines

After the scheduling completes and the stations receive the new schedule, they dispatch their packets according the cycle of scheduled timeline. In the scheduled timeline, there are three kind of intervals for each station, Public Intervals, Private Intervals, and Forbidden Intervals.

The Public Intervals provide free transmission for stations needed. In the Public Intervals, stations use pure DCF to transmit their packets of highest priority. Since stations traditionally contend for medium access, collisions and backoff may happen in this interval. If the turnaround time of RTS-CTS-DATA-ACK is larger than the remaining time of this interval, the transmission opportunity is taken back and it chooses the packet with fit size to send.

The Private Intervals indicate a certain link of the station gets the transmission opportunity for a specified traffic class. Stations transmit packet of this class in the interval. If packets of this class are all sent out and there is remaining time of this interval, other packets which are dispatched on the link could take the transmission opportunity in the order of their priority. The same as Public Intervals, exceeding turnaround time is not permitted, but the turnaround time in this interval is only duration of DATA-ACK. Since the Private Intervals guarantee Collision- Free, we do not need to perform RTS-CTS before the DATA transmission.

The Forbidden Intervals is the intervals provided to links of other stations. Stations in this intervals is not permitted to perform any transmission to avoid disturbing other stations' transmission. Therefore, the new packet dispatch will be the searching order of public interval and private interval.

4)Scheduling Adaptation

The global coordinator to the whole network broadcasts the result of schedule. Without acknowledge of successful receive the schedule result, there may be stations which do not receive new schedule. Although the inconsistent schedule will decrease the performance, stations are soon to find the inconsistence of schedule. Since inconsistent schedule will result collision or backoff in Private Intervals. Stations occur collision or backoff will postpone its transmission and wait for the AD to travel by. The AD will carry the correct schedule and stations restore its cycle of new schedule timeline according to the correct schedule.

If a single allocation request arrives, we do not re-schedule the whole network access in the first time. We just find a joinable interval to join or a free interval to insert. If there is no room for joining or inserting, we go to re-schedule for it. In the part of admission control, we provide an adaptation to handle with traffic flows with rate-jitter, like typical VBR traffic.

To describe the level to tolerate the bursty of VBR traffic. We define a value for the level of expected quality：

$$\mathit{Satisfaction} = \frac{\mathrm{DelayTarget}/2}{\mathrm{E[delay]}} \quad \ldots (4)$$

The satisfaction (SA) represents the currently suffered quality. When the mean delay of the VBR traffic increasing, the SA goes down. We want to reflect relationship between the bursty traffic and the length of public contention interval by presenting the value of SA. To calculate the bursty of the network , we model the VBR flow acts as an Poisson Process with exponential inter arrival time. For the Poisson type of traffic, the rate-jitter of combinational flows could be calculated through its variance, which is the sum of rate-variance.

$$\sigma^2_{\mathrm{network}} = \sum_{\#\mathrm{VBR\_flows}} \#\,\mathrm{hops} \times \sigma^2_{\mathrm{flow}_i} \quad \ldots (5)$$

To maintain a specific satisfaction, we need enough public contention intervals to handle with the burty traffic. Hence we perform simulations on various network rate-variance and provide different length of public contention intervals to observe their satisfaction. Then we got the result as Fig.5.

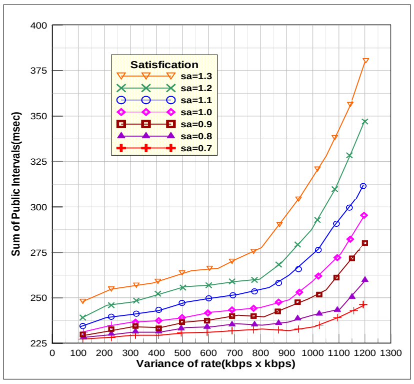

Fig.5. Satisfaction chart

With the satisfaction chart, we could make admission decision by checking variance of the whole network traffic and the sum of public intervals of the new schedule after admit a new request. If we got a SA lower than the network policy, we reject this quest. Thus we could not only utilize the network performance but also maintain network quality to be higher than the level of satisfaction.

In another side, when the link carries traffic of the four classes with number of flow Nc, Ns, Ni, Nb, the combinational arrival rate on the link may be less than the total allocated bandwidth of this link. We measure the un-used bandwidth at each link. When a new flow generated with required quality less than the un-used bandwidth, we could serve it directly without further allocation. This avoids re-scheduling the whole network. When an application flow terminates, the station sends messages to the global coordinator about releasing the indicated bandwidth. But the global coordinator does not announce the whole network to adjust schedule for this. Here it delayed the release [8] of the bandwidth for the purpose of following new allocations request for it.

V. SIMULATIONS AND RESULTS

Here we perform simulations to evaluate our MAC Access Scheduling Scheme (MASS) and compare with Earliest Deadline First (EDF) using pure DCF and Distributed Multihop Scheduling (DMS) using eDCF[10]

We perform our simulation using NCTUNS 1.0 simulator. Fig.6 shows the topology of typical multihop wireless network. To eliminate the influence cause by different routing, the application traffic generated by stations are all set destination to the network tree root (Station A). The connection links between stations represent the relationship of Parent-and-Child.

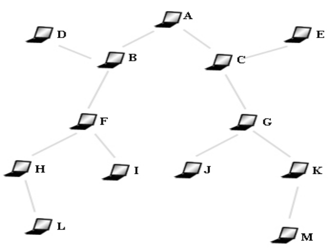

Fig.6. Topology of Simulation

A. Parameters

1)Parameters of 802.11 MAC

Distance between directly connected stations is within the transmission range of 250meters, and the transmission capacity are 24 Mbps. Parameters for IEEE 802.11 are: *aSlotTime* =20us, *RTS Threshold=0, SIFS*=20us, *PIFS*=30us, *DIFS*=40us, *Cwmin=31,Cwmax=1023,aShortRetryLimit=7, aLongRetryLimit=4.*

2)Traffic Characteristics of four classes

We model the Conversational class of traffic as CBR flows with constant packet-generated intervals (20ms), constant packet size (bytes) and mean rate (51.2kbps). The Streaming class of traffic is modeled as VBR flows with constant packet-generated intervals (40ms), various packet size of exponential distribution (mean=500bytes). The Interactive class of traffic is modeled as Poisson process with exponential inter-arrival time (mean=120ms) and various packet size of exponential distribution (mean=374bytes). The Background class of traffic is modeled as flows with substantial generating rate (mean interarrival=480ms,mean packet size=1000 bytes).

3)Parameters of DMS with EDCF

Except the comparison case of EDF with pure DCF, another comparison case is DMS with eDCF. The eDCF parameters it used are listed in the table below. The Delay Target parameter it used is also listed below.[4]

Table I EDCF PARAMETERS

EDCF parameters				
	Con ver.	**Strea m.**	**Intera ct.**	**Backg rd.**
AIFS	**2**	**3**	**5**	**7**
CWmin	**7**	**31**	**63**	**63**
CWmax	**31**	**255**	**511**	**1023**
PF	**2**	**2**	**2**	**3**
Delay Target	**20ms**	**40ms**	**120ms**	**48ms**

B. Simulation Scenarios

We introduce two scenarios to evaluate the performance. In scenario1, we evaluate their efficiency of supporting QoS. We start simulation by generating traffic flow of the four classes one after another. Our MASS do re-schedule for each new flow and broadcast the schedule result after each rescheduling. In scenarios2, we define MID (Mean Interference Density) as the factor of interference.

$$MID = E[\frac{NumberOf\,(HiddenNodes)}{NumberOf\,(NodesUnderConverage)}] \cdots (6)$$

We use the factor to represent the probability to be interfered by other nodes. When a station's MID is high, that means there are many nodes which it has no information about around it. Thus has high probability to be interfered.

1)Scenario 1

In this scenario, we use the topology of medium MID 0.2821 to perform simulations.

Fig.7 and 8 show that in DMS with eDCF case the delay of multihop flow is reduced but delay of single hop flow increases. This shows DMS coordinates single hop transmissions to defer for transmissions of hop behind them.Jitter is lower than previous case, but it is still high in the first two classes. Since the DMS still suffer the hidden terminal problem and stations far from 4 hops may have higher probability to maintain an inconsistent priority table.

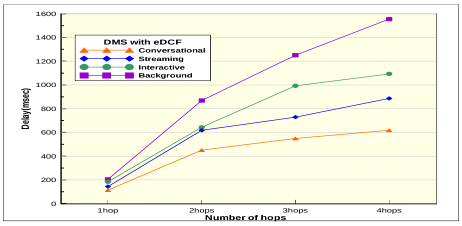

Fig.7. Delay of DMS with EDCF

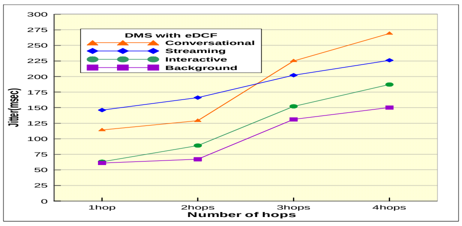

Fig.8. Jitter of DMS with EDCF

Fig.9 and 10 show that our scheme can maintain a low delay, especially the first two classes. And the jitter of Conversational class is extremely low, even the jitter of streaming class is close to the Conversational class.

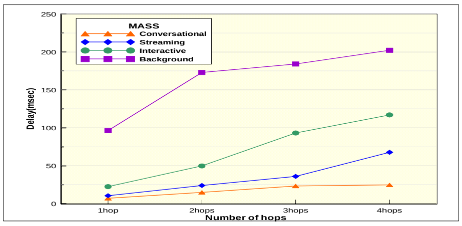

Fig.9. Delay of MASS

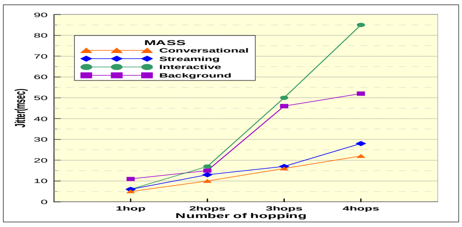

Fig.10. Jitter of MASS

2)Scenario 2

In this scenario, we evaluate the efficiency of scheduling with higher level of interference MID, thus suffering serious hidden terminals. We choose MID equal to 0.5833.

From Fig.11 and Fig.12, EDF+DCF and DMS+eDCF, fail to provide correct scheduling.

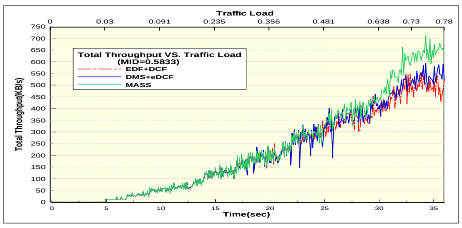

Fig.11. Throughput in High MID case

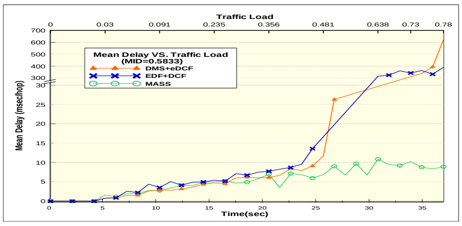

Fig.12. Mean Delay in High MID case

VI. Conclusions and Future work

In this article, we propose the MAC Access Scheduling Scheme to provide required quality on MAC to support QoS in multihop wireless network. We show this scheme achieves network QoS more efficiently and provides guaranteed QoS and maintains the network at stable and good performance. It also utilizes the medium usage by scheduling conflict-free transmissions to perform concurrently. The future work to continue is the issues of station mobility, handoff QoS.

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