ENHANCED QOS SUPPORT IN MMDSR THROUGH HEMM IN IEEE 802.11E NETWORKS

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ABSTRACT

IEEE 802.11e introduced traffic and service differentiation at the MAC layer to achieve QoS in delivering multimedia streams, by putting flow deadlines. Enhanced Distributed channel Access (EDCA) and HCF Controlled Channel Access (HCCF) are two MAC functions in IEEE 802.11e to support QoS in multimedia transactions. MMDSR and its various versions uses EDCA as proper access mechanism in mobile ad-hoc networks because of no centralized access point. EDCA based on prioritization of traffic which leads to a selfish action problem. Pooling scheme seems better but pure HCCA also cannot be a good solution as previous research proved that it has good real time performance and QoS support with CBR traffic only. In VBR traffic, resource utilization is not optimal with pure HCCA. In this paper, we are proposing a concept to combined MMDSR with HCCA-EDCA mixed mode (HEMM) scheduler, instead of pure EDCA to achieve optimal resource utilization with multimedia traffic like video conferencing, video streaming etc. HEMM mode is efficient for medium utilization in IEEE 802.11e so performance of MMDSR can be improved.

Keywords: EDCA, HCCA, HEMM, QoS, CBR, VBR, IEEE 802.11e, MMDSR

I. INTRODUCTION

Now a day's uses of mobile ad-hoc networks are increasing due to the increasing interest of residential and office customers in ubiquitous services. Mobile ad-hoc networks are performing very well because of high configuration mobile devices; this drives users towards an emerging set of applications with Quality of Service (QoS) requirements, such as phone or video conference, video streaming etc. Moreover users are more interested in multimedia transactions like video conferencing, video streaming, multimedia file sharing etc. Mobile ad-hoc network is a self oriented network without any infrastructure. This becomes main advantage of mobile ad-hoc network. Now a day's natural disaster are growing day by day, in affected areas mobile ad-hoc network can work to give technological support to that place.

Nodes in mobile ad-hoc networks are mobile and dependent on battery to stay connected with network. Mobile node in ad-hoc network may be any mobile device with wireless connectivity, like pocket PC, mobile phone, personal digital assistant, laptop etc. Mobile ad-hoc network is a restricted environment but more useful.

In order to support applications which are having specific QoS requirements, IEEE recently published an amendment to the IEEE 802.11 standard, namely IEEE 802.11e [12], which adds the Hybrid Coordination Function (HCF). The latter specifies two access mechanisms: Enhanced Distributed Channel Access (EDCA), which is based on a distributed control and enables prioritized channel access, and HCF Controlled Channel Access (HCCA), which on the other hand requires centralized scheduling, and allows the applications to negotiate parameterized service guarantees in the context of Traffic Streams (TSs). The Hybrid Coordinator (HC) provides scheduling for both the QoS Access Point (QAP) and QoS Stations (QSTAs), by dispensing transmission opportunities (TXOPs) of variable size to both downlink and uplink TSs. Downlink TXOPs are granted for transmission to QoS Stations (QSTAs) from the QAP. Uplink TXOPs consist of data messages transmitted by QSTAs in response to individual polling messages sent from the QAP to TSs. Although the IEEE 802.11e standard does not specify a mandatory scheduling algorithm, it mandates TSs to be provided with a minimum reserved rate, under controlled channel conditions.

Providing an efficient schedule of both CBR and VBR traffic simultaneously is a daunting task. While CBR traffic has a regular arrival pattern, VBR traffic rate varies greatly, with a peak rate which is often much larger than the average rate. Therefore, unlike CBR, VBR traffic cannot be served efficiently when TSs are provided with a fixed service rate. In fact, if a VBR TS is guaranteed a minimum rate equal to its average rate, large bursts are likely to experience high, unfeasible delays. On the other hand, reserving the peak rate would entail a substantial wastage of the reserved capacity. Several HCCA scheduling algorithms have been proposed in the literature (see for example [6] [16] [13] [5] [17] [15]). Some of these (e.g., [17] [15]) are explicitly tailored to CBR traffic, and perform poorly with VBR traffic [18]. Others, instead, (e.g., [6] [16] [13] [5]) try to dynamically adjust the TXOP duration to react to variations in the arrival pattern. These algorithms, although more efficient, often exhibit a large computational complexity.

In this paper, we proposed to combined MMDSR with a simple mixed mode of HCCA-EDCA function, which can be definitely improvement over pure EDCA in MMDSR, that can enhance the performance of MMDSR for both CBR and VBR traffic simultaneously.

II. RELATED RESEARCH

Recently, many researchers have focused their efforts on providing mechanisms to improve the MAC (Medium Access Control) level to make configuration parameters evolve dynamically depending on events of the Ad Hoc network. Some proposals modify the MAC parameters to provide dynamic service differentiation based on access categories that modify the contention window sizes used in the back-off algorithm [8,9,11]. The proposal [18] dynamically adjusts the backoff interval according to the priority and collision rate to arrange a fair scheduling mechanism to access the medium. Proposal [4] has the same goal although based on modifying the waiting times of the stations to access the medium, resulting in a fair and efficient scheme. A dynamic TXOP (Transmission Opportunity) allocation in IEEE 802.11e is proposed in [10] to enhance the QoS experienced in the network. Similarly, in [5] the TXOP value dynamically changes depending on the number of packets remaining to be sent in the buffers. A sensing backoff algorithm is presented in [1], where every node modifies its backoff interval according to the results of the sensed channel activities. Very few works has been considered the possibility to integrate the service provided by HCCA with the resource available for EDCA. The IEEE 802.11e standard describes a further access policy, the HCCA-EDCA Mixed Mode (HEMM), where both these function are used. HEMM is not well documented and avery few studies [14,8,18] enhancement of paper have analyzed the QoS provisioning of the whole HCCA-EDCA system. In [14] a model of the channel utilization is presented, considering both HCCA and EDCA modes. It shows that incrementing the portion of HCCA increases the medium utilization of large WLAN in saturation conditions and the determinism in the channel control. Instead large EDCA networks are affected by growing collisions that degrade their performance. In [8] the efficient resource control for elastic traffic over EDCA and HCCA functions is analyzed using an economic model. In [18] the Adaptively Tuned HCF (AT-HCF) algorithm is introduced.

III. IEEE 802.11E MAC PROTOCOL

The IEEE 802.11e standard [2] describes those enhancements to the MAC services and functions of the IEEE 802.11 standard [12] aimed at enabling Quality of Service provisioning. The IEEE 802.11 specifies two access functions, respectively Distributed Coordination Function (DCF) and Point Coordination Function (PCF). In IEEE 802.11e, two additional access mechanisms are defined: the Enhanced Distributed Channel Access (EDCA) and the HCF Controlled Channel Access (HCCA), both in the context of the Hybrid Coordination Function (HCF).

Enhanced Distributed Channel Access (EDCA): The first mode of channel access is EDCA, which is a parameterized version of the previous distributed channel access mechanism of 802.11b. To provide prioritized QoS, 802.11e enhances the original DCF by classifying traffic through the introduction of access categories (ACs). Each AC has its own transmission queue and its own set of channel access parameters. The prioritization in channel access through EDCA is shown in Fig. 1. The differentiation in priority between each AC is realized by setting different values for the channel access parameters.

The following are the most important additional parameters:

• Arbitrary interframe space number (AIFSN): The minimum time interval for the medium to remain idle before starting backoff.

• Contention window (CWmin and CWmax): A random number is drawn from this interval for the backoff mechanism. • Transmission opportunity (TXOP) limit: The maximum duration for which a node can transmit after obtaining access to the channel.

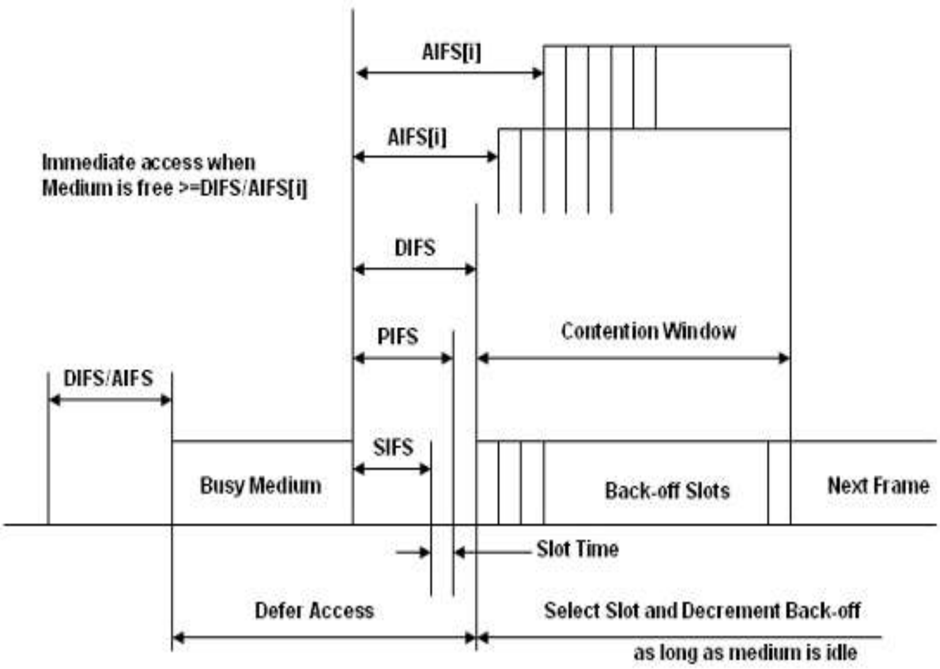

Fig. 1 EDCA Access Prioritization

HCF Controlled Channel Access: HCCA provides a centralized polling scheme to allocate guaranteed channel access to traffic flows based on their QoS requirements. Fig. 2 illustrates the HCCA channel access scheme. In this period, the AP polls nodes for a TXOP duration, which is calculated from reservation requests sent by the nodes. The TXOP is initiated by a poll request from the AP and during this duration, transmissions can occur in both the uplink and downlink directions. The TXOP allows for multiple contention-free transmissions and ends if one of the following conditions occurs: neither the AP nor the node have any packets left to transmit, the channel idle time has exceeded the timeout period, or the TXOP duration has expired.

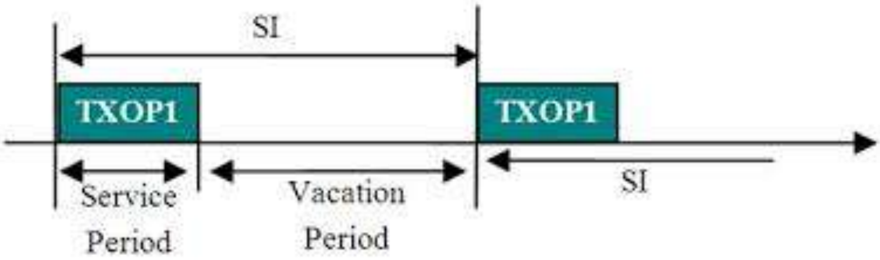

Fig. 2 HCF Controlled Channel Access

IV. MMDSR WITH HEMM

MMDSR (multipath multimedia dynamic source routing), is the algorithm is the extension of DSR, as a routing protocol to find available path in the network. In this scenario the number of path should not exceed more than three paths at a same time, due to excessive overhead increase and small improvement. This routing algorithm is suitable for multimedia transmissions like video streaming.The QoS parameters considered are: minimum expected bandwidth, maximum percentage of data losses, maximum delayand maximum delay jitter. Here, video is distributed using RTP/RTCP (Real Time Protocol/Real Time ControlProtocol) over UDP as transport protocols. One of the most used data types in video-streaming is MPEG-2 hierarchical scalable multi-layer encoded video, which is used in MMDSR. Layered coding allows enhanced layers of several qualities to be transmitted, given that a minimum bandwidth is guaranteed to transmit a base layer. MPEG-2 encoded video is formed by sets of frames, typically somewhere from 4-20 frames each, called GoP (Groups of Pictures). In a GoP there are three types of frames: I, P and B. According to our framework, there are three paths and three type of frame (I, P and B) which a priority defined for each frame. The most important video coded frame (I–frame) send through the best path, while the second important frame (P -frame) send through second best path and then the last frame which is B-frame send through the last path. In case of two paths, I frames would send through the best path and then P and B frame send through the second available path. And if there is only one path available, all the frames should be sending together through the same available path. These video characteristics can be taken into account when planning a QoS aware scheme. For example, different priorities could be assigned to the video frames according to their importance within the video flow. This way, I frames should have the highest priority whereas B frames should have the lowest one. The standard defines two different access mechanisms: the Enhanced Distributed Channel Access (EDCA) and the Hybrid Coordination Function Controlled Channel Access (HCCA). The proper access mechanism used in MMDSR is EDCA that there are four different Access Categories (AC), as depicted in Fig. 3. Each packet from the higher layer arrives at the MAC layer with a specific priority value and it is mapped into an AC. In MMDSR the mapping of the different packets into each one of the four Access Categories of the IEEE 802.11e MAC is defined as follows:

• AC0: high priority packets (signalling + I frames)

• AC1: medium priority packets (P frames)

• AC2: normal priority packets (B frames)

• AC3: low priority packets (best effort)

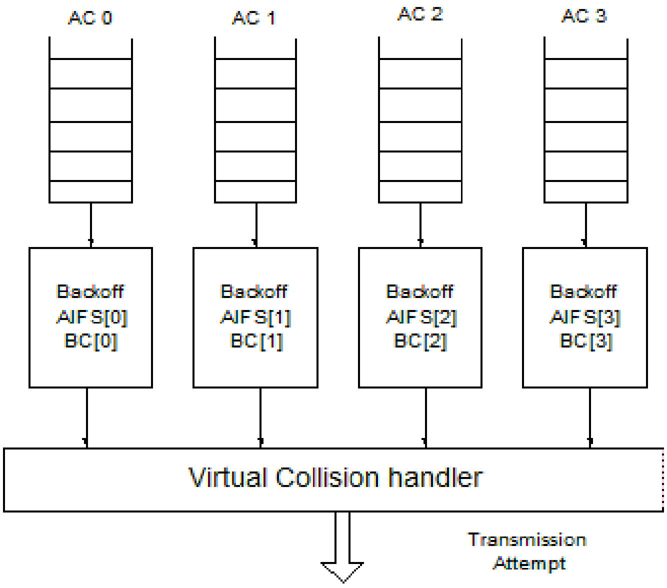

Fig. 3 IEEE 802.11e MAC Protocol's ACs

We first observe that the channel alternates between successful and unsuccessful states. Successful states are due to either HCCA or EDCA, while unsuccessful states are either collisions or idle events. In EDCA, collision is a big problem whereas in HCCA less resource utilization is a problem. To overcome both the problem we can have arrangement of HCCA-EDCA scheduler [19] at each node. According to HCCA-EDCA scheduler TSs are first served by HCCA but when at the end of CAP phase if HCCA still have some data to transmit, it moves the TSs from HCCA queue to EDCA queue by assigning them highest priority EDCA access category. Hence, the traffic that exceeds the assigned HCCA TXOP (the HCCA transmission time threshold) will not be served with parameterized QoS but will be served with prioritized QoS. The detailed description of HCCA-EDCA algorithm:

1. When the CAP phase ends, HC transfers the control of the medium to the HCCA-EDCA mechanism;

2. It checks if the HCCA is empty: in that case it leaves the control to the EDCA function;

3. Otherwise, it moves the data message of HCCA queue to the EDCA function; and

4. If the EDCA period is not yet finished, it starts over from the point 2.

HCCA-EDCA scheduler is a local node scheduler which collaborates with the MAC reference scheduling algorithm or with any alternative one. The centralized scheduler located in the QAP continues to manage the QSTAs that request to send and performs admission control, which remains unchanged. It then computes the scheduling parameters and creates the polling list, and finally it polls the admitted QSTAs. Instead HCCA-EDCA, located in each QSTA, takes action only if the transmitting QSTA does not deliver all enqueued TSs data messages.

In MMDSR, standard IEEE 802.11e is used which uses EDCA access function. Instead of using EDCA we proposed a concept to combined MMDSR with HCCA-EDCA (HEMM) scheduler on every node to solve both the problem to some extent.

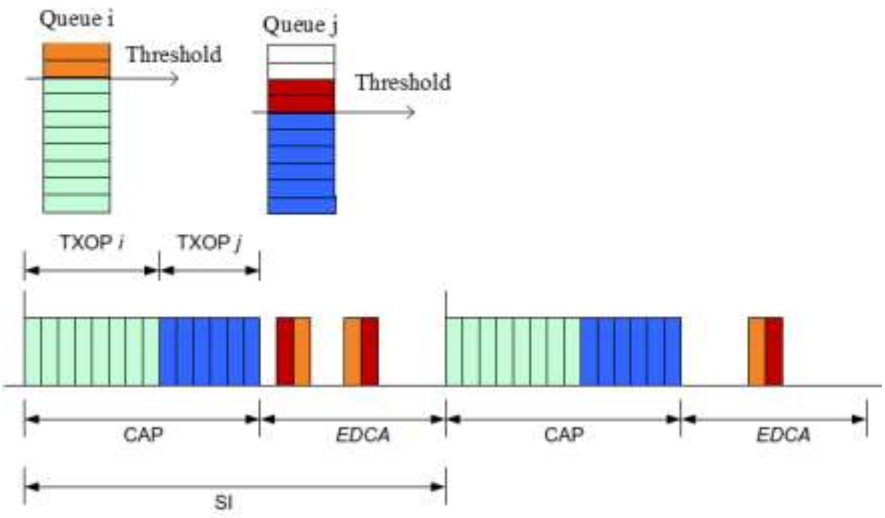

Fig. 4 The HCCA-EDCA Scheduling Mechanism

V. CONCLUSION AND FUTURE WORK

Multimedia transaction is a need of today's environment but QoS support is a need of multimedia transactions in mobile ad-hoc network. MMDSR is multimedia multipath dynamic source routing, it and its all variations uses the MAC IEEE 802.11e, which supports QoS provisioning which is the requirement of services like video streaming or video conferencing. The standard IEEE 802.11e defines two different access mechanisms: EDCA and HCCA. In MMDSR, EDCA is used since no centralized access point is needed in mobile ad-hoc networks but both access mechanisms have their advantages and disadvantages. We are trying to optimize the performance of MMDSR by combining the concept of EDCA-HCCA, which is mixed mode (HEMM) to gain the advantages of both.

In this paper we are suggesting a concept to combine MMDSR with HCCA-EDCA scheduler to improve the performance of MMDSR. Implementation of this concept to show the enhancement in MMDSR is our future work.

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