

# Adaptive Quality of Service Medium Access Control protocol for IEEE 802.11 based Mobile Ad hoc Network

Y. Srinivasa Rao, Mohammed Ali Hussain

**Abstract:** Mobile ad hoc network is an infrastructure less wireless multi hop network with heterogeneous mobile nodes dispersed in wireless communication zone. MANET has different application in different fields, due to its distributed, adaptive and self-formation capabilities. Providing quality of service communication is one of the important considerable issue in MANET. One of the major fact to achieve the QoS communication is efficient MAC protocol. This paper defines an adaptive – QoS MAC protocol (AQMP) for IEEE 802.11 based MANET. AQMP protocol improve the QoS based on majorly four considerations I). Prioritize the nodes based on their network load, II). Assignment of nodes for medium access, III). Prioritize the traffic based on their sensitivity, and IV). Assignment of MAC settings to prioritized traffic. Performance results indicates that proposed MAC protocol out perform in comparison with existing adaptive MAC protocols.

**Index Terms:** MANET, QoS, MAC, Priority, access category and simulation.

## I. INTRODUCTION

Mobile ad-hoc network, contains wireless mobile heterogeneous devices circulated in wireless communication zone to provide communication in critical sensitive applications without pre-defined infrastructure or central base station [1]. Devices communicate each other directly if both exist in a radio communication medium of one another, else communication is possible with the help of intermediate nodes. This type of communication is called multi hop communication, and which leads to degradation of quality of communication. Moreover peer to peer network causes the implementation of QoS in communication to be more challenging [2]. Particularly providing QoS in communication for real time traffic is more challenging in MANET. Quality of service is the strength to give the dissimilar priorities to different applications, data and end users. QoS goal is to achieve a particular level of efficient performance in communication. QoS achievement parameters are bandwidth, delay and packet loss. Based on application and type of communication QoS parameters can vary. Real time traffic such as voice and multimedia are very sensitive to delay, so QoS parameters for voice and multimedia communication is delay. Achieving QoS communication is challenging in MANET is more challenging in comparison with wired or wireless infrastructure based network due to its characteristics such as mobility, heterogeneity in mobile devices and constrained resources.

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Y. Srinivasa Rao, Department of Computer Science, Dravidian University, Andhra Pradesh, India

Dr. Mohammed Ali Hussain, Department of Electronics and Computer Science, KL Deemed to be University, Andhra Pradesh, India

Moreover shared medium in MANET is also limited. One can achieve the QoS communication in any network through efficient Medium access control protocol and it comes under the data link layer. The primary functionality of MAC protocol in MANET is to access the channel for communication of packets between two nodes. MAC protocol is responsible to manage and coordinate multiple radio communication mediums. This protocol is responsible to solve the issues between different channel accesses [3-4]. Thus MAC protocol is responsible for medium access there by reliable and efficient data transmission between communicating entities. So efficient MAC protocol is a key to achieve QoS communication in MANET.

In this paper we achieve the QoS communication in MANET by the following contributions.

- I). Prioritize the nodes based on their network load
- II). Assignment of nodes for medium access
- III). Prioritize the traffic based on their sensitivity, and
- IV). Assignment of MAC settings to prioritized traffic

## II. BACKGROUND

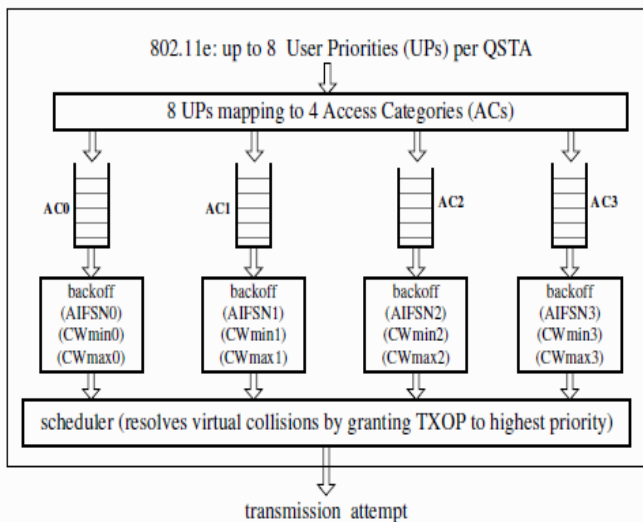
The IEEE 802.11 specifies two methods for channel access. First method is distributed coordination function (DCF), which is contention based approach for channel access and second method is point coordination function (PCF), which is contention free approach for channel access [5-6]. Distributed coordination function works based on the principle of Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA), which is the default approach for accessing channel in wireless networks. It provides equal opportunity or priority to all the nodes to access the medium. For instance, any node wants to participate in communication, then it checks the medium for its status whether it is engaged in other communication or it is free. If it finds the medium as free, then the node needs to wait for some predefined interval of time i.e., DIFS (distributed coordination function inter frame space). Again it checks whether the medium is free or busy, if it is free then it starts the communication [7-8].

If it finds that the medium is not free then the node waits for a random interval of time and senses the medium again.

The other mechanism of IEEE 802.11 to access the channel is Point coordination function [9], which accesses the medium through a centralized method by controlling and coordinating the channel access mechanism with the help of polling other nodes and permitting them to access the contention free channel.



Both, point coordination function (PCF) and Distributed coordination function (DCF) used to access the contention free channel and are used for inter frame spacing coordination and controlling. Later IEEE 802.11 e is developed to provide QoS communication by developing EDCA10 mechanism, which is the enhancement of existing 802.11 distributed coordination function (DCF) by enabling the distributed channel access shown as Figure 1. It is the method of enabling the service differentiation to the various traffic patterns. IEEE 802.11 e EDCF is shown in figure 1. Enhanced DCF categorized the incoming traffic towards the node into four sub categories i.e., access sub category for best effort, voice, video and background traffics. EDCA defines different channel access settings to different sub categories incoming traffics, so that every incoming traffic has its own priority to access the channel. Parameters setting of EDCA are CWmax(),CWmin(),AIFS (), and retry-limit. Every sub access subcategory has buffer space, queue and behave as a self-sufficient back-off entity[15].



**Figure.1 IEEE 802.11e EDCA**

## PROPOSED WORK

1). Prioritize the nodes based on their network load and Assignment of nodes for medium access

This work prioritize the nodes based on their network load. This prioritize of nodes is done because of providing the authority to nodes to participate in medium access contention. Moreover here we do not have any frame format or structure. Only those nodes can participate in channel contention, which has the sufficient network load to handle the current communication scenario. When the number of nodes has the enough load to participate the channel contention, which interns improve the channel utilization. In contrast, when the number of nodes have the not enough load to participate the channel contention, which interns reduces the channel utilization. Network load of nod is commuted as follows.

Network load status is computed by queuing theory by computing the packet delay inside the node queue and buffer space occupied the packets . Without the loss of generality, we calculated the number of packets is arrived towards the queue (A) in the particular interval of time It is calculated by exponential weighted moving average method11 in Eqn(1) as

$$A = \alpha A_c + (1 - \alpha) A_p \quad (1)$$

Where,  $(A_p)$  is an average number of packets arrived to queue during preceding time interval, and  $(A_c)$  is an average number of packet arrived to queue during present time interval.  $\alpha$  and  $\beta$  are known as weighted constants, and values of  $\alpha$  and  $\beta$  are in the range of 0 to 1. Initially we assume that the no packets are arrived and considered it as zero event. In the same manner, we calculated the average packets departed from the queue of node in particular time interval as Eqn(2) follows.

$$T = \alpha D_c + \beta \quad (2)$$

Where,  $(D_p)$  is an average number of packets departed from queue during preceding time interval, and  $(D_c)$  is an average number of packet departed from queue during present time interval.  $\alpha$  and  $\beta$  are known as weighted constants, and

values of  $\alpha$  and  $\beta$  are in the range of 0 to 1. Initially we assume that the no packets are departed and considered it as zero event. If packet arrival rate is more than departure rate towards the node buffer queue. Then queue size will get increases and it does not have chance to participate in channel contention If packet arrival rate is less than departure rate towards the node buffer queue. Then queue size will get increases here also, but node has chance to participate in channel contention. However this condition is satisfied only to the infinite size queue size buffers, but MANET has limited queue size buffers. In this conditions, node can participate in channel contention effectively only when node queue size does not reach the certain threshold level and packet waiting time inside the queue should also less than certain time limit. In this paper we are only considering the packet waiting time inside the node queue. If it is low enough to certain threshold value then it indirectly reduces the queue size at node buffer. The threshold value is computed based on the transmission delay form source to destination and number of hops needed to reach the destination.Thus, we calculated the packet waiting time inside the node queue by following Eqn(3) as, packet waiting time inside the node queue

$$(W_t) = (1 / (D - A) ) * \text{Size of packet} \dots(3)$$

If  $(W_t) \geq \text{Theshold}$ , then the node will not enter into the channel contention. We assign this node as the low priority nodes. Only high priority nodes are participated in channel contention mechanism. Initially every node assign with high priority to act in channel contention mode. So every node has ability to act in a channel contention mode. During communication, each node computes the **packet waiting time inside the node queue ( $W_t$ )** in that time period and if it finds that the node **packet waiting time inside the node queue ( $W_t$ )** value is greater than the threshold value then the node loss its priority to act in channel contention, it means that node has high load.

However, after some fixed amount of time node again compute the **packet waiting time inside the node queue ( $W_q$ )**, if it is less than the threshold value then node get the higher priority and act in channel contention mode.

III). Prioritize the traffic based on their sensitivity

According to calculated **Rating factor** values and ITU-T recommendation12, voice sessions are categorized  
Voice session value above 80 is higher priority  
Voice session value between 70 to 80 is medium priority  
Voice session value below 70 is low priority

According to calculated **Rating factor** values and ITU-T recommendation, voice sessions are categorized

We assume that at application layer video data is encoded with H.264/AVC13 and it provides substantial importance in in compression efficiency .H.264 supports temporal scalability and data partitioning with different priorities, and known as partitions. H.264's VCL layer that divides the original streams through DP (data partitioning). Whenever DP is aided, alongside the slices of IDR (Instantaneous Decoder Refresh) pictures, additional three other types of slices are generated i.e., partition A , Partition B and Partition C as shown in Table 1. All these slices are directly passed through NAL in order with hearer indicting with slice type. First slice transmitted is PSC.

Next slice transmitted as IDR

Next slices transmitted as partition A, partition B, and partition C.

Priority of the slices

First slice transmitted is PSC. Higher priority

Next slice transmitted as IDR. Medium priority

Next slices transmitted as partition A (Medium priority)

Partition B, and partition C (Low priority).

**Table 1. Priority of the slices**

Slice type	NRI Value	Priority
Parameter set information	11	Higher priority
IDR picture slice	10	Medium Priority
partition A	10	Medium Priority
partition B	01	Low Priority
partition C	01	Low Priority

IV). Assignment of MAC settings to prioritized traffic

Assignment of MAC setting to voice data is explained in details in our previous paper, reader can refer the paper [2]. We plausibly divided video access category into three parts, such as AC\_ video \_1, AC\_ video \_2 and AC\_ video \_3. Where, AC\_video\_1 has highest chance to contact the medium and AC\_ video \_2 get the chance to access the medium only when AC\_ video \_1 contains no packets. AC\_ video \_3 has lowest priority to access the medium.

Our proposed system animatedly assign the higher priority video slice to AC\_ video \_1 so that the performance of video can be enhanced and it grasps the user agreeable level. Projected system is exposed underneath

Algorithm 1:- dynamic video slice mapping mechanism

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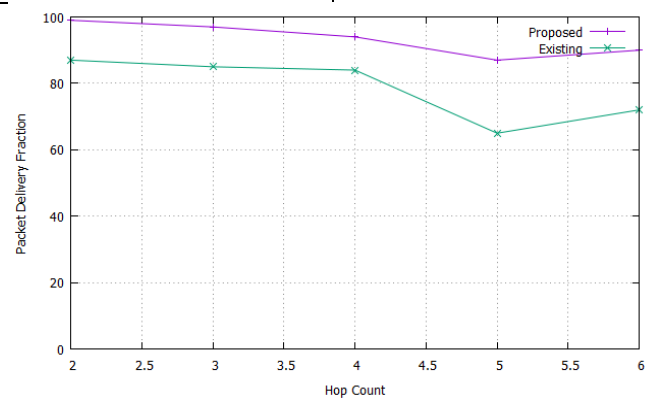
AC_Voice capture the medium
Video slice [i] subject to AC_voice_3
If computational time == 1
For
video slice [i]
Check the NRI value
End for
While Tuning time == 1
If NRI value == 11
Video slice [i] subject to AC_voice_1
Else NRI value = = 10
Video slice [i] subject to AC_voice_2
Else Video slice [i] subject to AC_voice_3
End if
End if
Wait for tuning time == 1
End if
    
```

### III. PERFORMANCE ANALYSIS

We calculate the proposed work performance with NS-214 simulator by necessary extension in predefined MAC libraries of simulator. Results are shown in figure 2 and 3. Performance calculation metrics are Throughput and packet delivery ratio. Performance results are compared with existing QoS MAC protocol. Simulation parameters are shown in Table 2.

**Table 2: Simulation Parameters**

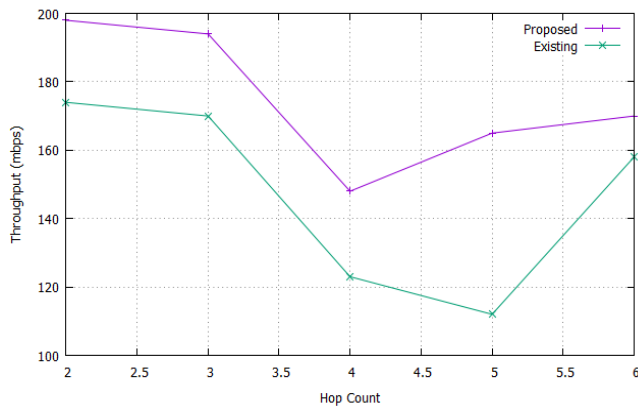
Network Parameter	Value
Number of nodes	50-100
Link layer type	Logical link
MAC type	802.11e, DSMA
Routing	AODV
Traffic	CBR
Transmission range	250m
Antenna	Omni antenna
Network Area	150m *150 m



**Figure 2:- packet delivery fraction comparison**







**Figure 3:- Throughput (mbps) comparison**

Performance results shows that the proposed work extend the quality of voice and video data dynamically mapping the packets to suitable MAC access categories and thereby enhancing the throughput and packet delivery.

## IV. CONCLUSION

This paper discussed the adaptive MAC protocol to enhance the real time traffic performance in MANNET such as video data and voice data. Proposed work dynamically maps the video and voice data to suitable MAC access categories to enhance the performance. Quality of voice data is computed by *Rating factor* and quality of video quality is determined by compression slice type by H.264/AVC. Simulation results indicating that proposed algorithm improve the quality of video and voice over 802.11 based MANET.

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