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A Routing Protocol for Efficient Bandwidth Utilization of IEEE 802.11e in Ad-hoc Network

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Abstract

IEEE 802.11 MAC algorithm & physical layer are not supportive for multimedia applications which require certain level of QOS guarantees in terms of bandwidth utilization, reliable data transfer and latency. Existing MAC layer protocols fails to support service differentiation. As 802.11 was primarily designed for single access category. However priority management is incorporated through the mutual cooperation of higher layers. In order to overcome the problems with existing MAC protocol, EDCA or 802.11e was developed. The protocol allocates different traffic with different priorities and stores them is specific queues. Therefore different types of traffic packets do not overlap. EDCA is purely a MAC layer adaptation. Further in the proposed work, Routing layer obtains the information about available bandwidth from MAC layer and incorporates the same as cost. It obtains multiple paths for each session and shares the route cache globally. Thus best path is selected for Audio, then video and then data. It ensures better channel share and delivery ratio of audio over the other access types.

Keywords – *IEEE 802.11, MAC, EDCA OF IEEE 802.11e ,bandwidth, QoS.*

1 Introduction

With the introduction of the IEEE 802.11 standard, wireless local area networks (WLANs) have gained widespread acceptance. Due to the ubiquitous nature of wireless access networks, the need for broadband multimedia applications such as packet telephony, streaming media, videoconferencing and video call on WLANs have begun to be realized, and consequently the related issues have become active research topics. Performance analysis of IEEE 802.11 WLANs has been a dynamic research area for more than a decade. Because of the complex architecture of the medium access control (MAC) layer, it is difficult to model networks operating in real-time. The most challenging task in such networks is providing the required quality of service (QoS) support e.g. guaranteed throughput, delay, jitter and packet drop rate for the applications. The basic IEEE 802.11 MAC uses the distributed coordination function (DCF) and the point coordination function (PCF)[1][2][3]. Use of PCF in 802.11 MAC is optional. In the PCF, an AP periodically polls (by sending beacon frames) a mobile station to send packets. PCF splits the time period between the beacon frames into a contention free period (CFP) and a contention period (CP). During CP, the DCF is used.

The IEEE 802.11e is an amendment to the IEEE 802.11 standard created by the Institute of Electrical and Electronics Engineers LAN/MAN Standards Committee (IEEE 802), a standard that allows devices to connect to a wireless local area network (WLAN).The 802.11e uses a hybrid coordination function (HCF) which basically enhances the PCF and DCF. The HCF gives two modes for channel access, called EDCA (enhanced distributed channel access) and HCCA (HCF controlled channel access)

2. IEEE 802.11e EDCA

All printed material, including text, illustrations, and charts The newly proposed IEEE 802.11e medium access control protocol for QoS guarantee extends the existent IEEE 802.11 medium access control protocols and newly defines the HCF (Hybrid Coordination Function). HCF is proposing two methods: EDCA Enhanced Distributed Channel Access) and HCCA (HCF Controlled Channel Access) models.

The EDCA model is designed to provide a differentiation service based on priority, and is similar with the DCF (Distributed Coordination Function) model of existing 802.11 MAC. The EDCA model is the defining concept of AC (Access Category) for QoS support. Each AC has competition parameters, AIFS[AC](Arbitration Interframe Space) that alternate DIFS (Distributed Interframe Space), CWmin[AC] and CWmax[AC] [1][3].

Fig 1 shows the 802.11e MAC with four transmission queues, where each queue behaves as a single enhanced DCF contending entity, i.e., an AC, where each queue has its own AIFS and maintains its own Back-off Counter BC. When there is more than one AC finishing the back-off at the same time, the collision is handled in a virtual manner [1][2]. That is, the highest priority frame among the colliding frames is chosen and transmitted, and the others perform a back-off with increased CW values. EDCA has received most attention recently. The reason is that the Wi-Fi Alliance has already “standardized” a subset of the 802.11e standard, called Wi-Fi Multimedia (WMM). EDCA is the major part of WMM, while HCCA is not included

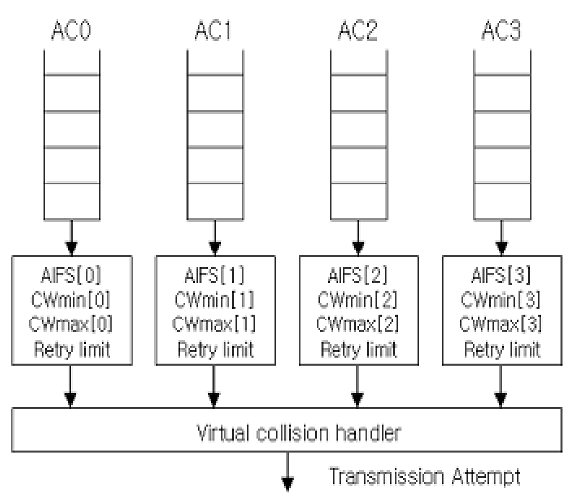

Fig 1: structure of the EDCA model

Each frame from the higher layer arrives at the MAC along with a specific priority value. Then, each QoS data frame carries its priority value in the MAC frame header. An 802.11e STA shall implement four access categories (ACs), where an AC is an enhanced variant of the DCF 0. Each frame arriving at the MAC with a priority is mapped into an AC as shown in Table II. Note the relative priority of 0 is placed between 2 and 3[1]. The fig2 shows the channel access of EDCA

TABLE II
PRIORITY TO ACCESS CATEGORY MAPPINGS

Priority	Access Category (AC)	Designation (Informative)
1	0	Best Effort
2	0	Best Effort
0	0	Best Effort
3	1	Video Probe
4	2	Video
5	2	Video
6	3	Voice
7	3	Voice

Basically, an AC uses AIFSD[AC], CWmin[AC], and CWmax[AC] instead of DIFS, CWmin, and CWmax, of the DCF, respectively, for the contention process to transmit a frame belonging to access category AC. AIFSD[AC] is determined by where AIFS[AC] is an integer greater than zero. Moreover, the backoff counter is selected from [1,1+CW[AC]], instead of [0,CW] as in the DCF. The fig2 shows the EDCF channel access

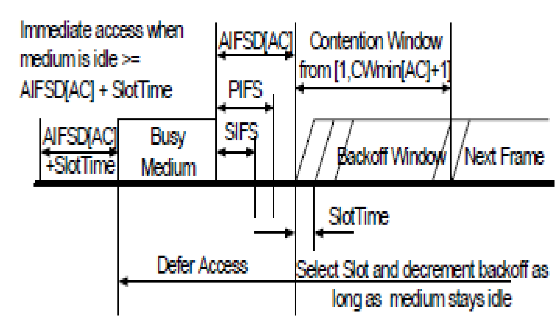

Fig 2: IEEE 802.11e EDCF channel access

3. Proposed Methodology.

AODV Routing Protocol is used for routing in the network. The Ad-hoc On-demand Distance Vector (AODV) routing protocol provides on-demand route discovery in mobile Ad-hoc networks. It uses an on-demand approach for finding routes, that is, a route is

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established only when it is required by a source node for transmitting data packets.

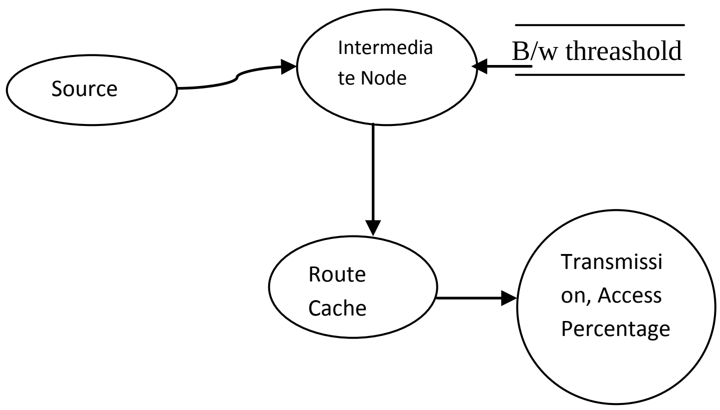

Fig 3: Data Flow Diagram (DFD)

. To start a route discovery, the source node floods the RREQ (Route Request) packet in the network. when a route is not available for the desired destination by specifying the destination node and the cost and access percentage to its neighboring nodes. When The intermediate node checks the available bandwidth at that node, if the required bandwidth for transmission is present then the intermediate node is selected for the path to reach destination. Intermediate node send the RREP and the cost is updated. The intermediate node maintain the route cache its store the RREP and access percentage. Once the path from source to destination is got the transmission is carried out. The fig 3 shows the that flow diagram. In this technique we incorporate the channel bandwidth as cost in the routing decision. We obtain multiple paths from source to destination and store the routes in a global route cache. The best path is reserved by Audio traffic followed by video and data. We use Appropriate Traffic Generators for generating audio and video traffic from respective trace files.

Initially the bandwidth for audio and data packet transmission. At the intermediate node the available bandwidth is calculated. The audio bandwidth (AB) at time t is calculated as

$$AB(t)=AB - Pa*ASize(t).$$

Where Pa = Total audio packets in the queue.
Asize = size of audio packet.

The cost of the path is calculated by,
Cost = bandwidth/(1+cost1) cost1= Audio Queue * cu_audio + Video Queue * cu_video + DataQueue*cu_data

Where, cu_audio is channel utilization for audio transfer, cu_video is channel utilization for video transfer, cu_data is channel utilization for data transfer.

The channel utilization is calculated

Totalchannelutilization=DataDelivered+VidRecv+ AudioRecv. cu_audio=AudioRecv/ Total channel utilization.cu_video=VidRecv/ Total channel utilization.data=DataDelivered/ Total channel utilization.

4. Simulation Results.

The OMNET network simulator is used for the simulating. The simulation is carried out in the [500,500] network area and simulation is carried out for 150 seconds. The simulation parameter considered are Packet Delivery Ration, Latency and throughput. In this section, we analyze the performance of the multimedia transmission scheme by using the efficient bandwidth estimation in the IEEE 802.11e EDCA mechanism. We compare the results of AOMDV and AODV**.**

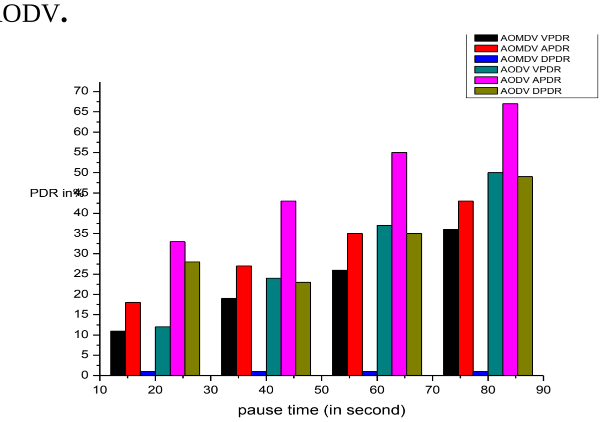

Fig 4: Pause time Vs PDR

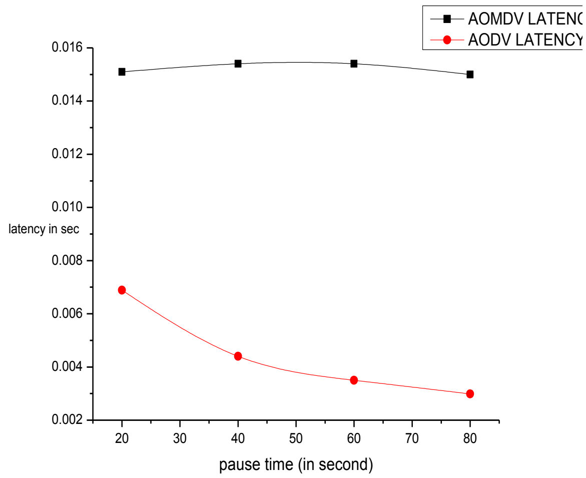

Fig 5: pause time Vs Latency

By above fig 4, we say that the Packet Delivery Ration (PDR) increases as the pause time increases because of the less mobility of the nodes. We see that the audio PDR is more compared to the video and data PDR. From fig 5, above we conclude the latency decreases as the pause time increases. Here the number of nodes is kept constant to the 30. Also we see that AODV PDR is greater than the AOMDV and the Latency much less in the AODV when compared to AOMDV

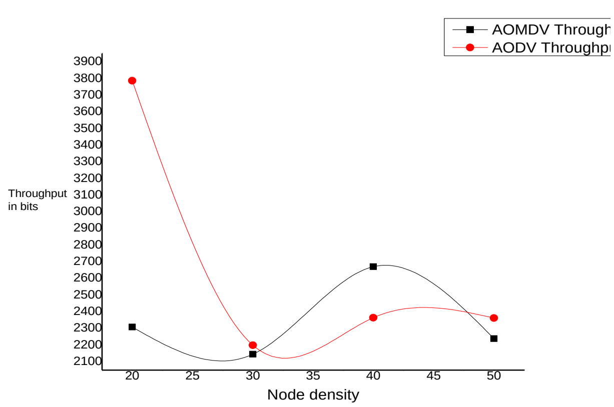

Fig 6 : Node density Vs Throughput

From graph in the figure6, we say that as the node density increases the throughput decreases. Node density increases the congestion in the network .

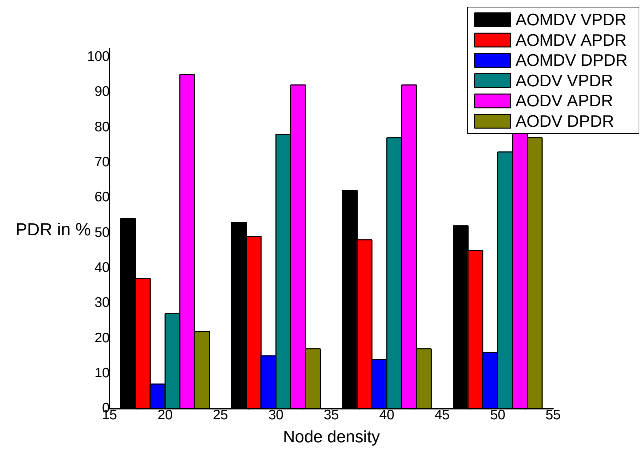

Fig 6 : Node density Vs PDR

From above graph we see that as density of the node increases the packet delivery ration decreases. As the density increases the congestion in network will be more. The Pause time is kept 100 second as a constant value and150 second as the simulation time. The PDR is better in AODV compared to the AOMDV.

4. Conclusion and Future Work

Mobile Adhoc network is easy deployable LAN best suited for campus and office networks. Therefore different types of data and file exchange are more than just normal message transmission. Hence a suitable mechanism is needed to provide this effectively. EDCA is a MAC layer improvement over conventional 802.11b MAC which allocates different bandwidth or channel share to different access categories based on the priority. But If routing layer does not have the knowledge about current channel contention than such a MAC can cause congestion in the transmission.

Therefore we update the technique by incorporating the channel bandwidth as cost in the routing decision. We obtain multiple paths from source to destination and store the routes in a global route cache. The best path is reserved by Audio traffic followed by video and data.

We use Appropriate Traffic Generators for generating audio and video traffic from respective trace files.

Performance shows an improve in quality of transmission in terms of improving PDR, Latency and control overhead over the existing system. The system can be further updated to incorporate link quality in the routing decision to further improve the efficiency of the system.

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