Quality of Service for Video Streaming using EDCA in MANET

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Abstract--Mobile Ad-hoc network(MANET) is a collection of wireless terminals that are able to dynamically form a temporary network. To establish such a network no fixed infrastructure is required. Here, it is the responsibility of network nodes to forward each other's packets and thus these nodes also act as routers. In such a network resources are limited and also topology changes dynamically. So providing Quality of service(QoS) is also necessary. QoS is more important for real time applications for example Video Streaming. IEEE 802.11e network standard supports QoS through EDCA technique. This technique does not fulfill the requirements of QoS. So, in this project modified EDCA technique is proposed to enhance QoS for Video Streaming application. This technique is implemented in NS2 and compared with traditional EDCA.

Keywords: MANET, QoS, EDCA, Video Streaming.

I. INTRODUCTION

Mobile Ad-hoc Network is a dynamic, self-organizing network of wireless terminals connected by wireless links. MANETs do not need any preexisting infrastructure**.** Some of the characteristics of MANETs include - flexibility, ease of deployment, robustness, infrastructure less-that make them suitable in environments without preexisting infrastructure. The applications of MANET range from military and rescue operations (e.g., to provide battlefield awareness and data dissemination), to business environments, such as video conferencing outside the office (e.g., to brief clients on a given assignment), to recreational Contexts (e.g., to allow user to view a live stream of an event they are attending). In all these scenarios, real-time video streaming is an application of major interest.

A. MAC IN MANET

The primary responsibility of a medium access control (MAC) protocol in MANET is to control the access to the medium that is shared by several network nodes. The performance of Ad-hoc Network depends on the efficiency of the MAC protocol. The MAC protocol of this type of network should be distributed and should provide equal opportunity to all the nodes for the transmission . It should also support real-time traffic.

B. 1.2 IEEE 802.11E STANDARD FOR QoS

The IEEE 802.11e standard defines mechanisms for QoS provisioning in wireless networks. It provides two mechanisms to support QoS: HCCA (Hybrid Coordination Function (HCF) Channel Access for contention free networks and EDCA (Enhanced Distributed Channel Access) for contention based networks for example MANET.

C. EDCA

EDCA provides distributed and differentiated access in wireless environment. Each frame received from the upper layer is assigned to the user priority. Depending upon the user priority the frame is mapped on to the access categories (AC). EDCA defines four ACs as shown in the table below:

Priority	AC	AIFSN	CWmin	CW max	TXOP
3	AC_VO	2	7	15	0.003008
2	AC_VI	2	15	31	0.006016
1	AC_BE	3	31	1023	0
0	AC_BK	7	31	1023	0

Table (1): EDCA Parameter Set

The four access categories include AC_VO(for voice traffic), AC_VI (for video traffic), AC_BE(for best effort traffic) and AC_BK (for background traffic). Each AC has its own buffered queue and behaves as an independent backoff entity. The priority among ACs is then determined by AC-specific parameters, called the EDCA parameter set. The EDCA parameter set includes minimum Contention Window size (CWmin), maximum Contention Window size (CWmax), Arbitration Inter Frame Space (AIFS), and Transmission Opportunity limit(TXOPlimit). The preferred values of each mechanism parameters that the standard recommends are shown in Table 1.

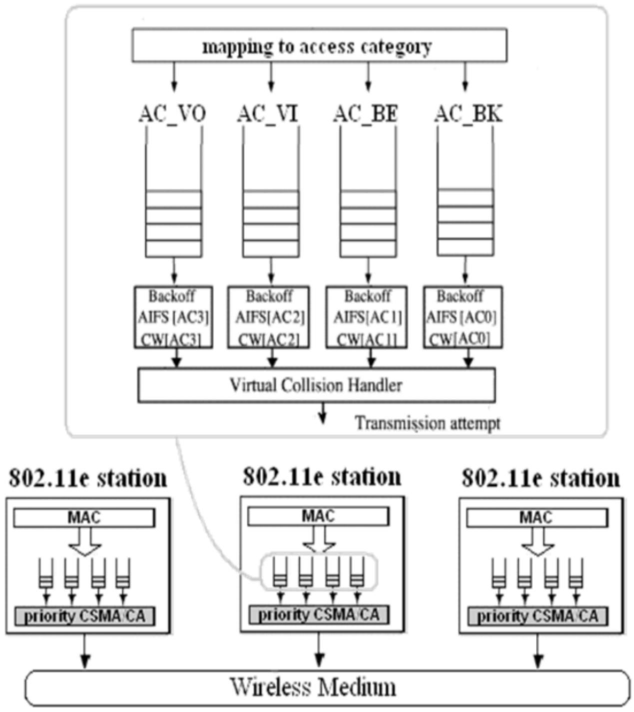

Fig (1): Four Access Categories in IEEE 802.11e

Figure 1 demonstrates the operations in 802.11e EDCA. To achieve differentiation, instead of using fixed DIFS (Distributed Interframe Space) (as in 802.11 DCF), EDCA assigns higher priority ACs with smaller CWmin, CWmax, and AIFS(Arbitration Interframe Space) to influence the successful transmission probability in favor of high-priority ACs. The AC with the smallest AIFS has the highest priority, and a station needs to defer for its corresponding AIFS interval. The smaller the parameter values (such as AIFS, CWmin and CWmax) the greater the probability of gaining access to the medium. Each AC within a station behaves like an individual virtual station: it contends for access to the medium and independently starts its backoff procedure after detecting the channel being idle for at least an AIFS period. The backoff procedure of each AC is the same as that of DCF. When a collision occurs among different ACs within the same station, the higher priority AC is granted the opportunity to transmit, while the lower priority AC suffers from a virtual collision, similar to a real collision outside the station. The value of AIFS can be obtained from the following equation:

$$AIFS = SIFS + AIFSN \times T_{slot}$$

Where T_{slot} is the length of the slot time and SIFS is the Short Inter-Frame Space of DCF.

II. QOS IN MANET

QoS is a set of service requirements to be met by the network while transporting a flow. A flow is a packet stream from a source to a destination (unicast or multicast) with an associated QoS. A fundamental requirement of any QoS mechanism is a measurable performance metric. Typical QoS metrics include available bandwidth, packet loss rate, Estimated delay, packet jitter, hops count, throughput and path reliability. Analogous to today's Internet, ad hoc networks are being designed to provide best-effort service i.e. do not provide any guarantees regarding packet loss or delay, available bandwidth, jitter etc. In a best-effort service model, packets are dropped regardless of their importance. If a packet is lost, the sender can simply retransmit the lost packet. This method is efficient for applications that do not require bounds on packet delay or other QoS metrics.

However, real-time applications, such as video-on-demand (VoD), video streaming and Internet telephony have, are sensitive to packet loss and delay .Consequently, the best-effort service may not be suitable for these applications. The QoS parameters such as bandwidth, jitter, delay, packet loss rate etc. are differed from applications to applications. For example, bandwidth, delay and jitter are service requirements in multimedia applications. Military applications require strong security. Search and rescue operations require availability of the network whereas little energy is the requirement in conference applications. The primary goal of QoS provisioning is to achieve more deterministic behavior by proper utilization of the network resources.

Because of the issues that occur in MANET such as -limited availability of resources, lack of central coordination, dynamic network topology, error prone wireless channel, imprecise state information, hidden and exposed terminal problems – it is very difficult to achieve QoS in MANET.

A. *Related Work*

Many authors have proposed different protocols that provide QoS in MANET for different parameters. The following table describes those protocols and the parameters supported by the protocols.

MAC Protocol	T	D	J	P	B
PRTMAC	✓	✓			
PS2MAC	✓	✓		✓	
QoS Assured,Fair ed MAC Protocol	✓	✓			
Syncless Time divided MAC Protocol	✓	✓	✓		
Distributed TDMA based MAC Protocol	✓	✓			
ECF-MAC		✓			
Priority-MAC	✓	✓			
EDCA	✓	✓			
QPART		✓			✓

Table (2): QoS aware MAC Protocols

(Where T is for Throughput, D is for Delay, J is for jitter, P is for packet delivery ratio, B is for Bandwidth and E is for Energy.)

III. PROPOSED SCHEME (M-EDCA)

The Proposed Scheme is based on the value of Channel Utilization (CU). Depending on the value Of CU the size of contention window will be changed. In ad hoc networks, the IEEE 802.11e EDCA that uses EDCF is deployed. Each source-destination link connection is composed of a number of nodes. Channel utilization of a network is determined by each node's utilization of network link. For any node, there are three states: transmitting/receiving, waiting, and idle. We define channel utilization (CU) and contention ratio (CR) as follows:

Ttransceive = tsend + treceive

twait = tbackoff + tNAV

ttotal = To

CU = ttransceive / ttotal

CR = twait / ttotal

Where to is the observation period. Tsend is the effective send time during To, and treceive is the effective receive time during To. Tbackoff and tNAVare are waiting time. The CU and CR values are monitored by each node and updated at the end of each observation period (To).

We set "To" to the interval during which packets have been sent. The CU and CR values are collected through the link. First, The CU and CR values are inserted into the header of packets. Second, when a sender generates a packet, these CU and CR fields are set to the maximum (1.0) and the minimum (0.0) respectively. Third, after receiving the packet, every intermediate-node compares its own two metrics with the values kept in the packet header. If the CUvalue of any node is smaller than that in the packet header, or if the CRvalue is larger than that in the header, the node has to replace the corresponding fields in the packet header by its own value.

Then, these two fields are copied to ACK in the destination. At last, the sender estimates the channel busy status through the CU and CR values in the ACK, and adjusts its contention window sizes accordingly.
if (CU < CUmax and CR > CRmin){
cwnd = cwnd – (CUmax – CU)*cwnd}

IV. IMPLEMENTATION

The Proposed Scheme (M-EDCA) is implemented in Network Simulator NS - 2.29.The performance is compared with traditional EDCA.

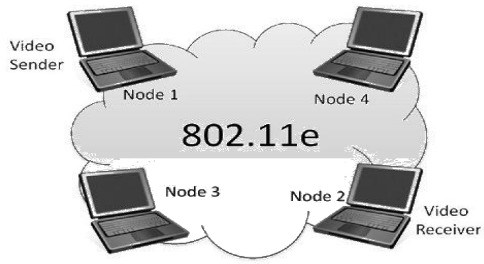

Fig (2): Network Topology used in Simulation

Channel Type	Channel/Wireless Channel
MAC Protocol	Mac/802_11e
Routing Protocol	AODV
Channel Rate	1Mbps
Traffic Type	Video
Video Format	QCIF
Packet Size	1500 bytes
Number of Nodes	20

Table (3): Simulation Parameters

A. RESULTS

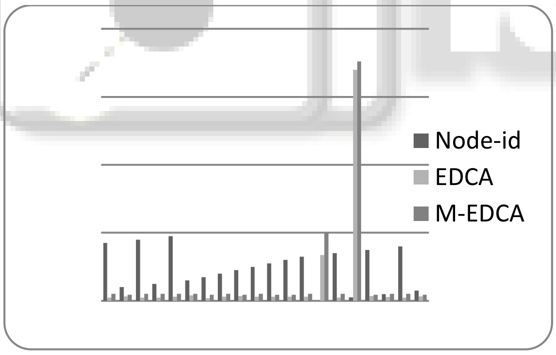

Fig. (3): Throughput Comparison: EDCA V/s M-EDCA

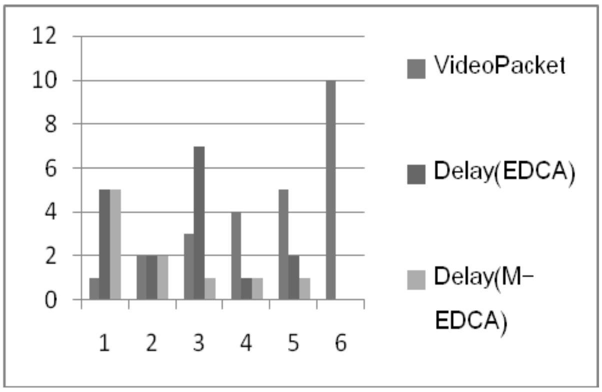

Fig (4): s Average End to End Delay Comparison: EDCA V/s M-EDCA

V. CONCLUSION

As compared to wired networks, QoS maintenance in wireless networks is difficult. Because of the issues that occur in wireless environment, it is possible to enhance QoS in MANET. QoS optimization is provided by EDCA technique in IEEE 802.11e based networks .Finally, maximum throughput and minimum delay is achieved by modified EDCA technique.

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