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Frame Aggregation And Fragment Retransmission For Very High Throughput WLANs

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Abstract

In IEEE 802.11n an aggregate medium access control (MAC) service data unit (A_MSDU) contains multiple sub frames with a single sequence number. It has a major drawback in environment with high error rate because if any sub frames are corrupted then the entire A_MSDU will be lost, which results decrease in throughput. In AFR (aggregation frame retransmission) scheme retransmission is done only for packets which are erroneous but retransmission delay is not measured. In this work retransmission delay is minimized which in turn reduces the end-end delay. A performance evaluation is made by calculating the retransmission delay which improves performance of IEEE 802.11.

Index Terms – IEEE 802.11, MAC, A_MSDU, AFR (Aggregation frame retransmission), End-End Delay

1. INTRODUCTION

In recent years, adhoc networks has become famous because of their fast configuration and easy deployment. They can be arranged in any economically possible areas. An ad-hoc network do not require wired infrastructure. Stations can arrange themselves and move unusually, unpredictably there will be change in network topology. As a consequence, the ad-hoc network is able to adapt fastly with different number of stations[1].

IEEE 802.11 remote LAN has encountered gigantic development in most recent ten years. First and foremost standard that was showed up in 1997 characterizes the remote LAN MAC & physical (PHY) layers details that give information rate up to 1 Mbps and 2 Mbps over the 2.4Ghz range. Later IEEE 802.11 g was affirmed supporting higher rates up to 55 Mbps and working within the reach 2.4Ghz range. In IEEE 802.11 the basic medium access system is conveyed co-appointment capacity (DCF). Discretionary access component is point co-appointment function (PCF).IEEE is a situated of media access control (MAC) and physical layer (PHY) determinations for executing WLAN PC correspondence in 2.4,3.6,5 & 60Ghz recurrence groups. The 802.11 family comprise of arrangement of half-duplex over the air balance methods that utilization the same fundamental convention 802.11 was first remote systems administration standard in crew. In any case, 802.11b was the first generally acknowledged one took after by 802.11a, 802.11g, 802.11n, 802.11ac.Other gauges in the family are administration alterations and expansions or amendments to past details.

Ad-hoc networks have some important necessities which are more functional by helping applications in which QoS is necessary [2]. With a growing demand for multimedia applications it is anticipated that traffic differentiation which is free from error and support services like heterogeneous will be provided by adhoc networks. Multimedia traffic is normally audio-visual and delay sensitive whose content under a certain limit requires the end-to-end delay. Much development has been made in QoS for wireless networks, but there are many problems in ad-hoc networks which are unsolved. Few provocations include lack of centralized control problems, unidirectional link issues, limited transmission range, frame losses due to collisions and transmission errors, battery and computational power constraints.

The IEEE 802.11 has two basic modes of operation they are infrastructure and adhoc mode.. In infrastructure mode an access point that serves as a bridge to other networks is used for mobile units to communicate where as in adhoc model mobile units sends in peer-peer way. IEEE 802.11 standard has a problem of CSMA/CA when a station transmit senses the channel first. If no activity is found station waits for a particular period of time and then transmits if in case medium is still free. If packet is received an acknowledgement frame is received from receiving station once successfully received by sender. Advantages Of WLAN: i) Very flexible within the reception area as WLAN can be fixed in any area. ii) No wiring difficulties as WLAN iii) More robust against disaster**.** Disadvantages Of WLAN: i) Low bandwidth as wireless lan sends packets in different direction so the bandwidth efficiency becomes less due to many transmissions in different direction ii) Standard take their time (eg:802.11) as the frame transmission takes particular time period for succesful transmission.

Two key approaches in Qos is integrated service (Int serv) and differentiated serv (diff serv) in which intserv has two important features i.e call setup and reserving resources. In diffserv we mark packets based on priority and transfer the packets. IEEE 802.11ac**:**This is also called wi-fi providing high throughput WLANS on 5Ghz band. Features are i) 800 ns regular guard interval ii) Binary convolutional coding iii) Single spatial stream iv) 80 Mhz channel bandwidth**.**

QoS alludes to an expansive accumulation of systems administration advancements and procedures. The objective of QoS is to give ensures on the capacity of system to convey unsurprising results. Extent of QoS incorporate accessibility, data transmission, dormancy, and blunder rate. QoS is uniquely vital for new era of web applications, for example, Voip, Video on interest, other shopper administrations. QoS spins around two unique models: one went for giving strict every stream ensures to the detriment of supplementary usage and sending intricacy, and a second one, less difficult however all the more free, conceived to separate the conveyance of total movement classes. In this model, the Resource Reservation Protocol (RSVP) is utilized to demand and store assets through a system. IntServ requires deterministic limits appointed to every stream. On the off chance that QoS is given to streams independently, it is called individual QoS. It is additionally conceivable to give QoS to various streams taken together. This is called total QoS.

In Diffserv, prioritization is acknowledged on an every casing premise. DiffServ can be effectively used to give low-dormancy to basic system activity, for example, voice or feature gushing while giving straightforward best-exertion administration to non-discriminating movement, for example, document exchanges or web browsing. The level of QoS provisioning is normally in light of parameters or imperatives, regularly known as QoS metrics. The most regular QoS measurements characterized at the MAC layer that ought to be considered while assessing QoS MAC layer components include: least throughput, greatest edge delay, most extreme variety of casing postponement (jitter), and most extreme edge misfortune ratio.1) Minimum throughput measured in bits/s 2) Maximum edge deferral measured in seconds 3) Maximum variety of edge postponement known as jitter measured in seconds 4) Maximum edge misfortune proportion measured in percents

1.1 PROBLEMS AFFECTING QOS IN WIRELESS ADHOC NETWORKS:

Important issues affecting Qos are Inherent issues in which unreliable wireless channels results varying transmission rates and retransmission. Fairness with medium access protocol needs to make certainly that no particular station is given priority over other. As the frame size increases bandwidth is wasted by collision which becomes relatively large, so the efficiency automatically decreases with increase in collision rate, as the WLAN has flexibility and large frame transmission can be performed anywhere**.**Channel losses is measured as bit error rate (BER) whose value represents the number of channels lost during transmission. Tcp is a connection oriented protocol in which frames transmission is guaranteed with the acknowledgement. Qos deliver predictable results which improves the efficiency of WLAN by providing guaranteed quality of service[3].

1.2 FRAME AGGREGATION

In wireless adhoc networks packets send normally frames which are aggregated in the form of MSDU (MAC service data unit) which is transmission unit form upper layer to lower physical layer. MSDU’s are combined to form as a single MPDU which is performs transmission of frames to lower layer[4].Since the primary constraint of the legacy 802.11 MAC layer is the overhead coupled with MAC header, utilizing bigger bundles is one answer for decrease the overhead brought about by MAC header. In this connection, IEEE 802.11n proposed the total plan where various casings are transmitted together into accumulated bundles. Actually, the conglomeration plan diminishes the season of transmitting overheads, and decreases the holding up time brought about by arbitrary back-off period amid progressive outline transmissions. Generally, A-MSDU is planned to endure numerous MSDUs to be transmitted to the same beneficiary linked in an one MPDU. The top MAC layer gets parcels from the Link Layer and these supported parcels are then collected to frame a solitary A-MSDU.

For every MSDU sub frame in an A-MSDU outline, the MSDU sub frame incorporates the Sub frame Header, the MSDU information payload and the Padding field. The Sub frame Header incorporates three fields: the Destination Address, the Source Address and Length which demonstrates the MSDU information payload. The AMSDU total is mediocre for parcels having the same source and destination. The most extreme length A-MSDU that a station can get is either 3839 bytes or 7935 bytes. A solitary A-MSDU contains numerous MSDU sub frames. A solitary AMSDU casing is trans-mitted in the wake of including the Physical Header, the MAC header and the FCS field. The guideline of A-MPDU is to send numerous MPDU sub frames with an interesting PHY header in the objective to diminish the overhead PHY header.

For every A-MPDU, each MPDU sub frame incorporates a MPDU outline, the MPDU delimiter and the cushioning bytes. Numerous MPDU sub frames are connected into one bigger A-MPDU outline. All the MPDU sub frames inside an A-MPDU ought to be tended to the same beneficiary, yet the MPDU sub frame could have distinctive source address. With A-MPDU, is completely framed MAC PDUs are consistently collected at the base of the MAC. A short MPDU delimiter is professed to each MPDU and the total displayed to the PHY as the PSDU for transmission in a solitary PPDU. The MPDU delimiter is 32 bits long and comprises of a 4-bit saved field, a 12-bit MPDU length field, a 8-bit CRC field, and a 8-bit mark field. The 8-bit CRC covers the 4-bit held and 12-bit length fields and approves the uprightness of the header. The MPDU is cushioned with 0-3 bytes to round it up to a 32-bit word limit. A station promotes the most extreme A-MPDU length that it can get in its HT Capabilities component. The promoted most extreme length may be one of the accompanying: 8191, 16383, 32767, or 65 535 bytes. The structure of frames are in the form of ethernet frames but size of that frames are small so additionally we can combine still more no of frames. The main disadvantage of A-MSDU is that the entire packet becomes huge i.e one MAC protocol unit and has only single cyclic redundancy check, because of this there is a chance of increase in probability of error which results in zero benefit of aggregation[2].But in case of A-MPDU in case of event failure part of it can be retransmitted and increase the efficiency.

In rest of the paper is gathered as follows. Section II presents literature review about the problem. In section III we explain about frame aggregation and importance of calculating retransmission delay and the throughput. Section IV simulation results are presented.

2. LITERATURE REVIEW:

Considering increase in efficiency at MAC layer work has been concentrated on contention time to be reduced which results in transmission overhead[3]. However Xiao.et.al in [3] represents theoretical throughput upper limit exists by extending the data rate without reducing overhead, performance extends in terms of throughput and delay. Mac layer efficiency is diminished nearly half when PHY rate is increased twofold at a condition of no idle slots and no collisions.

Li.T.Q.Ni.D provide an AFR scheme to improve productivity at MAC layer which uses optimum frame sizes. Multiple frames are combined into one frame and are transmitted. If any error occurs instead of retransmitting whole frame, only the frames containing error are resend again. Depending on the load conditions size of optimal frame is selected called “zero-waiting”. In this mechanism, once MAC wins a transmission opportunity frames will be transmitted. Frame sizes are adapted automatically to channel state and physical rate, there by maximizing productivity and reducing delay.

Y.xiao describes about frame aggregation has two methods of aggregation MAC protocol data unit (A-MPDU) and protocol service data unit (A-MSDU). Minimization of overhead is achieved as multiple MPDU’s and are acknowledged with single extended ack frame. A important disadvantage of using A-MSDU is transmission of large frames results in lost or corrupted frames in an error prone channel. So when error occurs whole frame has to be retransmitted which result in performance degradation of IEEE 802.11.Depending on the capability of station, extended frame size of A_MSDU may be up to 8kb.

Hewlett Packard developed a scheme for improving the performance of MAC protocols related to TCP/IP multimedia traffic and small packets, which has a problem with small packets and their performance. But their consequences cannot be analyzed properly which will be overcome by presenting a frame packet grouping to improve throughput and reduction of latency over MAC protocols based on CSMA/CA.

Martin.Heusse,Franck.Rousseau, defines method which optimize fairness and productivity that dynamically adopt with physical channel conditions. A new scheme is derived for best access fairness from distributed co-ordination function in which all the users utilize same values of contention window (CW).We should detect adverse transmission conditions which degrade the transmission bit rate.

3. PROPOSED SYSTEM

In AFR scheme frames are aggregated and send as packets. In an error high environment there is chance of packet drop[1]. Normally when there is a packet loss then all the packets had to retransmitted again which leads to decrease in efficiency of IEEE 802.11.So to avoid that degradation in performance we have a novel scheme called AFR in that scheme we send only the packets that are dropped as a result the efficiency of IEEE 802.11 is improved by increase in throughput but retransmission delay is left unmeasured. we proposed a scheme in such a way that retransmission delay is considered so that by calculation of retransmission delay we show that delay is reduced more than 10ms which improved the significant performance of IEEE 802.11n. We assume that there are ‘n’ no of nodes which are homogeneous and Traffic of wireless LAN is also homogeneous. But Channel is with finite buffers and noisy with no hidden terminals. Single hop transmission is in IEEE 802.11ac WLAN with fixed frame size and every packet is in generic time slot at any point. Transmission of packets is done in such a way that frames are aggregated and retransmission delay is calculated with packet error rate (PER) as fixed value.

Notations	**Description**
B	Number of stations
M	Retry limit
T_{CW}	Contention window regarding time
T_{SIFS}	Time duration of SIFS
T_{DIFS}	Time duration of DIFS
T_{EIFS}	Time duration of EIFS
Tack	Acknowledgement time
T_S	Duration ofsuccessful transmission
T_e	Expected duration of an error packet
T_I	Expected duration of Idle Time
T_r	Expected duration of Retransmission time
PR	Probability of station transmitting frames
τ	Probality function of markov chain
O_s	Overhead of successful frame
O_e	Overhead of error frame
Oc	Overhead of collision
PR_{busy}	Probability of busy station
PR_{cf}	Probability of collision free station
MAC_{oh}	Medium access overhead
AGG_{oh}	Aggregation overhead
δ	Packet error rate
Ω	Physical mode rate
$E[L_f]$	Expexted payload size of successful frame
E[T]	Expected slot duration

The packet error rate (PER) is the quantity of inaccurately got information packets isolated by the aggregate number of available bundles. A bundle is announced as error if no less than one bit is incorrect. The desire estimation of the PER is indicated as PER_z^j (L_{pld},Ω) and PR_{busy} is probability of station to be busy and PR_{cf} is the probability of a station which is collision free. Here the probability is considered as ‘PR’ and MAC_{oh} is the medium access overhead, AGG_{oh} is the aggregation overhead and τ is the station probability to transmit frame.

$$s^{j}_{pld}\,(L_{pld},\Omega) = \frac{PR_{busy}PR_{cf}\,((1- PER^{j}_{z}(L_{pld},\Omega))(L^{j}_{pld} - MAC_{oh} - Agg^{j}_{oh})}{T_{I} + T_{s} + Tc + T_{r} + T_{e}}$$

$\tau = 2\,(1\text{-}2PR) / (1\text{-}2PR)\,(W+1) + PRW\,(1 - (2PR)^{m})$ is the station probability whether frame will be transmitted or not. $PR = 1 - (1-\tau)^{B-1}$

$$T_{I} = (1 - PR_{busy})\,T_{slot}$$

$$T_{s} = PR_{busy}BPR_{cf}\left[1 - \Sigma^{B}_{j=1} PER^{j}_{z}(L_{pld},\Omega)\right]\left[E_{j}\{L^{j}_{pld}/R_{\Omega\,j}\} + O_{s}\right]$$

$$T_{c} = PR_{busy}(1\text{-}BPR_{cf})\,O_{c}$$

$$T_{e} = PR_{busy}BPR_{cf}\,\Sigma^{B}_{j=1} PER^{j}_{z}(L_{pld},\Omega)\left[E_{j}\{L^{j}_{pld}/R_{\Omega\,j}\} + O_{e}\right]$$

$T_{r} = (1 - PR_{busy})\,T_{slot}$, Where $T_{I}, T_{S}, T_{C}, T_{e}, T_{r}$ are idle time, time taken for successful transmission, time taken for collision, time taken for erroneous packet, time taken for dropped packet to retransmit and O_{s}, O_{c}, O_{e} are overheads of successful transmission, error and collision respectively.

$$Os = T_{H} + T_{DIFS} + 3T_{SIFS} + T_{ACK} + T_{RTS} + T_{CTS} + 4Tprop,$$

$$Oc = T_{EIFS} + T_{RTS} + Tprop,$$

$$Oe = T_{H} + 2T_{SIFS} + T_{EIFS} + T_{RTS} + T_{CTS} + 3Tprop,$$

4. SIMULATION & RESULTS:

Here we give importance for evaluation of retransmission delay as it improves performance of IEEE 802.11 which reduces end-end delay. Retransmission delay is a part of end-end delay,the network simulation NS-2 is discrete event simulation software which is helpful to perfom network simulations and it performs events like sending, dropping, receiving, forwarding packets. Many experiments are performed using NS-2 and retransmission delay is evaluated. With the experimental results we conclude that retransmission delay is reduced less than 15ms whose performance is improved and is shown in graphs. Finally this novel scheme improves throughput and reduce delay which over all improves performance of IEEE802.11.We observe that the throughput curve is improved than in AFR scheme and the delay is also reduced up to 10ms in our proposed system.

4.1 Simulation Parameters:

Propagation model	Two ray ground
Antenna	Omni antenna
MAC access protocol	IEEE 802.11
Routing protocol	AODV routing protocol
Number of nodes	20-30
Simulation time	1000sec
Simulation environment	1000*1000
Transmission range	250-550m
Channel capacity	2 Mb/s
MAC header	288 bits
PHY header	192 bits
HTC (high throughput channel)	4 bytes
PHY preamble/ header	40 μs
Time slot	9 μs
Retry limit	m = 7
SIFS	16 μs
DIFS	34μs
EIFS	89μs
L_{agg}^{max}	7935 bytes
A_MSDU	3839 bytes
Frame length	1,500 bytes

Here in graph 4.3.1 x-axis shows Nodes and y-axis shows throughput and in graph 4.3.2 x-axis shows Nodes and y-axis shows delay which reduced end-end delay. Retransmission delay is shown in the graphs whose delay is less when compared to aggregation frame retransmission technique. So finally we conclude that the result obtained here by shows that performance throughput is improved and mitigation in delay is performed and overall improves the efficiency of IEEE 802.11 particularly regarding its delay which in turn reduced end-end delay.

Retransmission delay is calculated by considering the frame loss in which packet drop is considered for each and every station and also the sequence number of the messages send to the receiver throughout the communication. But while considering the end-end delay the retransmission delay should be considered as it is a part of the end-end delay.

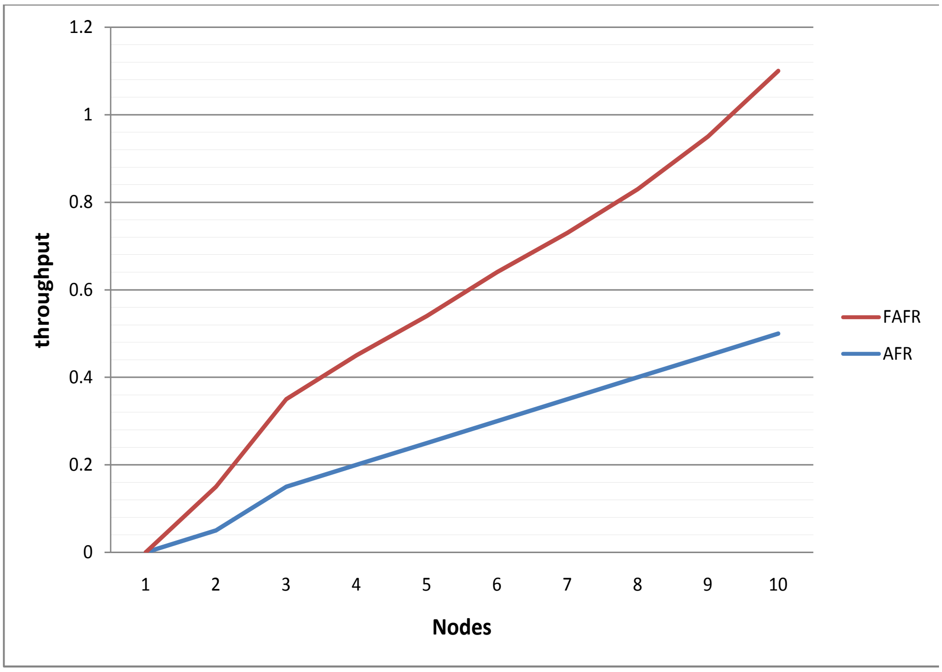

Fig 4.1.1 Throughput graph of frame aggregation with fragment retransmission

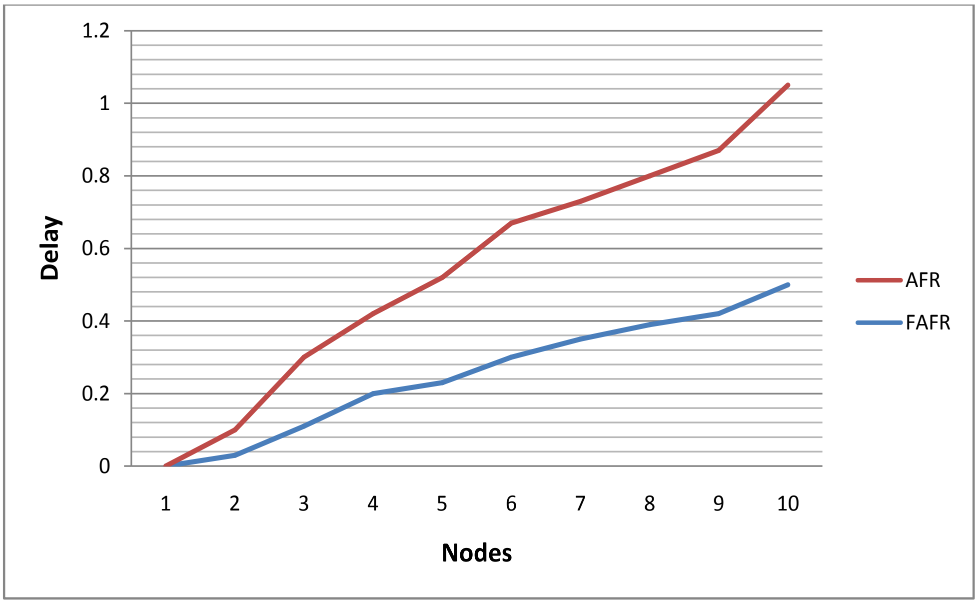

Fig 4.1.2 Delaygraph for frame aggregation and fragment retransmission

4.2 Performance Metrics

We concentrated on two performance metrics for valuation which are throughput and retransmission delay.

4.2.1 Throughput:

The average number of messages delivered per unit time succesfully or it is the average number of bits delivered per second.

4.2.2 Retransmission Delay:

The retransmission delay is the part of end-end delay which is retransmission of data from source to destination by which average time is calculated and specified.

5. CONCLUSION

In this work we developed a model that reduces retransmission delay which is a part of end-end delay in turn allow performance of frame aggregation of MAC efficiency to improve in both saturated and non- saturated conditions. Parameters make possible that MAC throughput improved and enhanced Qos provision by reducing retransmission delay. Future work can a well designed accurate system for investigation and quality of service for the network can be improved further.

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