Abstract

Objective: The main objective of our research is to improve the QoS in Media Access Control (MAC) and Physical (PHY) layer and to provide more deterministic network performance so that data's that were transferred by the network nodes could in a better quality and network resources could be utilized effectively. Methods/Statistical Analysis: The performance of QoS of IEEE 802.11 in MAC and PHY layer are studied using an enhanced opportunistic auto rate protocol e-OAR. The proposed algorithm uses distributed protocol for access control. This works by providing delay to the packets to increase efficiency of output. By allocating nodes in the basis, strength and efficiency of nodes will increase transmission efficiency by the help of e-OAR. Findings: The main function of MAC layer is secure packet delivery, access control and security in a network. PHY layer in IEEE802.11 standard describes two forms of spread spectrum modulation. The enhancement required in order to get a good QoS is by minimizing the time delay in transfer of data in physical nodes as the nodes are made of physical parts loss less transmission. For the competent use of a multi-rate physical layer, an e-OAR might be used which is very close to MAC layer. Absolute QoS guarantees is critical to provide, the relative QoS guarantees may be equipped by differentiation services. But, to provide characterized services, 802.11 protocols needs to be altered and it introduces three means for modifying DCF performance of 802.11 for assisting the differentiation of service. It decreases packet delay for improving performance of the system. Applications/Improvements: The QoS of IEEE 802.11 in MAC and PHY layer for improving throughput and packet delay of channel by using an e-OAR performance is interpreted in this study. The relative proposal guarantees are achieved using service differentiation DCF.

Keywords: Ad-hoc network, Enhanced Opportunistic Auto Rate Algorithm, MAC Layer, PHY Layer, Quality of Service

1. Introduction

In early years, the primary creators of internet stimulated ahead of telephone network scheme. Everywhere, the network had intelligence and also the end-terminals were moderately dumb. However, the telephone network scheme offers QoS in the procedure of definite assembly and also a voice quality, when the requests are recognized. To maintain QoS on multi-hop routes, QoS is essential to be examined for end-to-end path in addition to each hop. Accordingly, PHY and MAC layers were accountable for providing QoS in a single-hop. The
routing layer is possible for the QoS metrics to achieve end to end route.

The IEEE 802.11b is known to be a steady standard that can be separated into two layers they are Media Access Control (MAC) and Physical (PHY) layer. However, these 2 layers only permit a practical parting of the standard and also further significantly permits a particular data procedure to be utilized using numerous RF transmission procedures. Whereas, MAC protocol can be presented in wireless network controls and While, MAC convention can be displayed in remote system controls and furthermore can accomplish the get to and parcel transmission in a dispersed way, with minimum conceivable inconveniences included can achieve the access and packet transmission in a distributed manner, with minimum possible inconveniences involved.

1.1 IEEE 802.11
The IEEE 802.11 MAC sub-layer comprises of dual medium accesses to coordination works that incorporate Distributed Coordination Function (DCF) and discretionary Point Coordination Function (PCF). DCF has basic access for IEEE 802.11 and furthermore constitutes the Carrier Sense Multiple Access (CSMA) alongside Collision Avoidance (CA) calculation required using a contention calculation. Discretionary PCF utilizes a brought together surveying system which requires nodes to play out the part of PC. The PC consistently surveys locations to allow them for transmitting.

1.2 MAC Layer in IEEE 802.11
In IEEE 802.11 reference model, MAC layer is the terminal sub-layer of data connection layer in seven-layer OSI model. The MAC sub-layer conveys tending and channel get to control systems that permit a few terminals or network nodes to communicate inside an IEEE 802.11 system that are in a similar area, e.g.ad-hoc network. The MAC executing hardware is referred to as media get to controller. The primary function of MAC layer in IEEE802.11 system is to guarantee a protected packet delivery, get to control and security of the system. Subsequently, the task of priority and guaranteeing the adaptive participation of nodes that are present in the transmission of MAC layer will expand QoS system.

1.3 PHY layer in IEEE802.11
IEEE802.11 physical layer is categorized into three sub-adaptive layer they are, PLCP layer and Physical Medium Dependent (PMD) layer. The PHY control layer will take care of control issues like tuning the channel. The OAR algorithm for 802.11 concerns that all STAs in sending end have the same physical conditions as the receiving STA (same power, same efficiency), so when two or more STAs (nodes) emit packets in the same slot time, collision occurs, all their packets are lost but in practical consideration it may not happen for instance one STA is close to the receiving STA and the remaining other STAs are far from it then the ability in receiving the data's will differ hence in our proposed algorithm e-OAR the priority of the STAs is based on the efficiency and distance of the node from source STAs.

1.4 Distributed Coordination Function (DCF)
DCF is the as of late used procedure that shows up in a discretionary Point Coordination Function (PCF) Protocol. DCF is the simple and vital MAC component of heritage IEEE 802.11 WLANs. It is entrenched on transfer or senses multiple accesses to with CA (CSMA/Collision evasion). The Collision avoidance algorithm sets up a dispersed MAC built up over a constrained evaluation of the position of channel. In case, if the channel is hard, the MAC postpone spending the medium creates futile and after that acknowledges for an additional interval, named as the DIFS (DCF Inter-outline Space). For real data, DCF works on discrete-time and back-off scale. In this way, the time simply follows the futile DIFS is situated and a station is adequate for passing on just the happenings at begin of every slot period.

1.5 Quality of Service (QoS) Routing Protocol
QoS routing protocol examine each route with adequate resources in command for fulfilling the requirements of QoS of a movement. The data concerning the accessibility of means is accomplished using a resource management component that supports the QoS routing procedure in examining for possible paths of QoS. The QoS routing procedure must discover paths which devour least resources. The metrics of QoS could be categorized as multiplicative, additive and concave metrics.
The proposed study is to evaluate the QoS which is mainly based on the estimation of IEEE 802.11 in MAC and PHY for improving the packet delay and throughput of the channel by using an Enhanced Opportunistic Auto Rate (OAR) algorithm to achieve a relative guarantees by using service differentiation DCF.

2. Literature Review

IEEE 802.11 MAC architecture which is examined by assessing the performance level of internet application. Numerous adapters were analyzed with OPNET simulation where a number of scenarios of WLANs functioning at 1 and 2Mbps transmission rate were processed. The contending applications that were studied are video conferencing, e-mail and World Wide Web. The outcomes stated in the research are adverse to the previously published outcomes, indicating that no proper decision could be found from these adapters. The output shows that the process will not be efficient for high traffic loads and have drastic effects on https application. It is concluded, that network operator should be cautious in applying these adapters, particularly while the real-time application traffic load is huge.

Suggested an Improved Opportunistic Auto Rate (IOAR) procedure. The procedure utilizes either one power controller rate adaptation for improving the throughput performance by increasing SNR. Using adaptive rate, entire packets are sent with equal power however the transmission rate is changed for reducing packet drops because of worst channel condition.

Proposed system will reduce the packet losses because of transmitting packets at improved data rates. They introduced a “safety margin” for deciding optimum rates and power levels for reducing the possibility of overestimating gains of channel. The performances were improved in comparison with OAR protocol.

The study has inspected about the MAC convention in an impromptu system and proposed a versatile MAC convention with QoS support in view of IEEE 802.11- AMP that needs a task. In AMP, nodes in the system could take part in channel conflict, the channel is accessed using nodes by versatile sitting tight time for medium unmoving, and nodes execute back off instrument adaptively as per the system load. The examinations and recreations demonstrate that the AMP convention could give better QoS backing to higher-need movement in the system. It takes care of concealed terminal issue, expands utilization of the channel, and furthermore considers decency issues as far as utilizing restricted channel data transmission.

The authors reviewed about IEEE 802.11 WLANs that offers best feature supporting QoS. They talked about the features of QoS which were encapsulated by IEEE 802.11 standard at PHY, MAC layers and furthermore required in different higher-layer recommendations. They likewise reviewed new design improvements in Software Defined Networking (SDN) and Cloud Networking that could be utilized to simplify provisioning of QoS in IEEE 802.11-based systems.

A load balancing algorithm was sent to improve the performance of the network. This algorithm will progressively balance out the network capacity by issuing the portable stations among Access Points (APs). They have utilized Riverbed Modeler 17.5 Simulator to deliver the proposed result for load balancing algorithm. This algorithm demonstrated the viability of the distribution load and enhances the execution of system as far as throughput, data dropped and load on an AP.

The author has recommended models that are derived based on total delay distribution of networks by considering IEEE802.11 Distributed Coordination Function (DCF) MAC protocol where it is divided into two key steps:

i) design of entire delay of Probability Generating Function (PGF)
ii) numerical inversion of PGF

They evaluated the performance of these models which introduced two types of errors namely modeling and inversion errors. The process has been demonstrated on queuing, total delay distribution model and MACs for an IEEE DCF medium access procedure under saturated circumstances for a hop communication.

3. Proposed Algorithm

3.1 Quality of Service Support using DCF based Service Differentiation

DCF is the key 802.11 MAC layer functionality for scattered access to the shared medium. Since DCF has ad-hoc networks choice as centralized controller are not present whereas access point has the controller. Though it is challenging for offer complete QoS guarantees, comparative QoS assurance could be indulged
through service separation. Though, to permit differentiated services, the 802.11 procedure is to be altered and it offers three ways for modifying the DCF functionality of 802.11. The factors needed to be improved to accomplish service differentiation are:

**Back-off increase function**
While DCF is being determined, a station must regulate the channel of previous transmitted data. A station might initiate transmit once consuming stable so that the channel is normal throughout an interval of time extensive than the Distributed Inter Frame Space (DIFS). If the channel is hard when the transmission in course completed and in command to exclude a potential collision using additional active (waiting) stations, then the station will delay an arbitrary interval of time (the back-off time) previously to start the transmit:

\[
\text{Backoff \ _\ time} = CW \ \ rand(x) \ aSlotTime
\]

Here; \( \text{rand}(x) \) is random function, \( CW \) is the Contention Window, which is a parameter depends upon physical layer used in an unproductive manner for sending an RTS or data packet, the extreme back-off time is doubled up \(^{13}\). Additional, back-off time is calculated as shown below:

\[
\text{Backoff \ _\ time} = \left[2^{(2^i)} \ \ rand(x)\right] \ Slot_{time}
\]

Where,
\( i \) is set of successive back-offs accomplished for the transmitted packets. For supporting various priorities, the back-off calculation could be altered as shown:

\[
\text{Backoff \ _\ time} = \left[P_j^{(2^i)} \ \ rand(x)\right] \ Slot_{time}
\]

Where,
\( P_j \) is the priority of node \( j \),
\( Slot_{time} \) is the slot time of network

### 3.2 Distributed Coordination Function
Inter Frame Spacing (DIFS)

In Figure 1 (IEEE 802.11 DCF), the lowest interval of required time earlier starting new packet transmission later the channel is subjected to busy mode. The lesser flow importance should be lowered therefore it is important to, rise the DIFS period for packets of that specific flow. In addition, it is tough to procure an accurate relation among DIFS period for a flow and its corresponding throughput. Figure 2 (Service Differentiation with various DIFS values) shows many DIFS value and consistent relative priorities.

**Proposed algorithm – NS2 Implementation:**

```c
#include <stdio.h>
#include <string.h>
#include "agent.h"

class hmac : public Agent {
public:
    hmac();
protected:
    int command(int argc, const char* const* argv);
private:
    int E1,E2,E3,E4;
    int S1,S2,S3,S4;
    int FC;
    inttdma;
    intcsma;
    void initiate(void);
    void transaction (int,double,double);
};

static class hmacClass : public TclClass {
public:
    hmacClass() : TclClass(" Agent/hmac") {}
TclObject* create(int, const char*const*) {
    return(new hmac());
}
} hmac;

hmac::hmac() : Agent(PT_UDP) {
    bind("E1" , &E1);
    bind("E2" , &E2);
    bind("E3" , &E3);
    bind("E4" , &E4);
    bind("S1" , &S1);
    bind("S2" , &S2);
    bind("S3" , &S3);
    bind("S4" , &S4);
    bind("FC" , &FC);
}

int hmac::command(int argc, const char* const* argv) {
    if(argc == 2) {
        if(strcmp(argv[1], "initiate") == 0) {
            initiate();
            return(TCL_OK);
        }
    }
    return(TCL_OK);
}
```
Hussain Basha Pathan, Suresh Varma P, Satya Rajesh K

Indian Journal of Science and Technology

Vol 10 (9) | March 2017 | www.indjst.org

{342x743} return(Agent::command(argc, argv));

}void hmac::initiate(void) {

printf("n Process Initiated \n");

printf("n S1 %d \n",S1);

printf("n S2 %d \n",S2);

printf("n S3 %d \n",S3);

printf("n S4 %d \n",S4);

printf("n CSMA Mode activated\n");

csma=1;

txmission(E1,10.0,17.0);

txmission(S1,19.0,25.0);

txmission(E3,28.0,36.0);

csma=0;

txmission("n TDMA Mode switch over\n");

txmission(E2,38.0,43.0);

txmission(S2,45.0,50.0);

txmission(E4,54.0,60.0);

txmission(S4,63.0,70.0);

printf("n CSMA Mode activated\n");

csma=1;

txmission(E3,93.0,100.0);

txmission(S3,102.0,108.0);

}void hmac::txmission(int src, double st, double et) {

Tcl& tcl = Tcl::instance();

printf("n Transmission from %d to FC \n",src);

tcl.evalf("createflow %d %d %f %f \",src,FC,st,et);

3.3 Enhanced Opportunistic Auto Rate (OAR)

OAR could be categorized as adaptable across users, manipulating periods of a high-quality channel for achieving an important gain in throughput. In specific, short time-scale channel variations for various IEEE 802.11 channels have the least degree of correlation between themselves. The important point is that two channels have a robust independent component although existence from a similar couple of devices, because of the point that separation of channel in frequency domain is more when compared with coherence bandwidth.

Wireless channels among node pairs have a tendency for modification over time, however if there are numerous nodes waiting to direct possible way to be one decent channel at several known time. OAR works finest if channels were steady enough that it could direct numerous packets among modifications in channel environments. OAR regulates the channel situations by means of calculating the acknowledged signal strength of 802.11 control packets. Nonetheless; the source node coordinates a RTS packet while it needs to begin a transmission. The reimbursed CTS packet consists of established RTS signal quality, which is utilized to control the finest bit rate to refer RBAR procedure. Then the OAR transmits a burst of packets by observing the signal quality data of the link-level affirmations for guaranteeing the quality of channel. The rate determination of OAR is shown in the Figure 3 (OAR selection of rate).

If the transmission at unique rate is sustained selected through RTS-CTS exchange, error rates might be developed enormously if the channel quality packet losses or the selection rate develops sub-optimal when the quality channel is developed throughout the cycle. However, there is a choice to decrease the throughput development or progress in the optimal rate selection, if sender and receiver adjust the rate of data throughout a cycle. The available data distribution rates of throughput could be intended as shown. Consider SNR2, SNR5.5 and SNR11 represent the least essential SNR for maintaining 2, 5.5 and 11 Mbps rates of transmission, correspondingly. Then the possibility that rate is possible is intended as shown below:

\[
p(R = 0) = p(SNR < SNR_2) \\
p(R = 2) = p(SNR_2 \leq SNR < SNR_{5.5}) \\
p(R = 5.5) = p(SNR_{5.5} \leq SNR < SNR_{11}) \\
p(R = 11) = p(SNR_{11} \leq SNR)
\]

In OAR, the development of quality of channel has two differing effects on modification of the delay. Initially, as the likelihood of an advanced rate of transmission raises the packet transmission time reductions, all nodes skill lower delay and also, as a consequence, the average delay gets reduced. Consequently, the back-to-back transmissions of the packets present nominal values of delay which raise the range of arising delays and therefore develop the variance.

Though back-to-back packet transmissions of Opportunistic Auto Rate effect in lesser average MAC access delay, it progresses the delay variance. The MAC
admittance delay for a stream is the time interval among effective sequential packet transmissions. To calculate the MAC access delay, a basic model for calculating the delay circulation of single-rate IEEE 802.11 was developed.

Analysis
The Table 1 gives the relationship between outputs of the proposed e-OAR algorithm with the existing system. Hence delay of transmitting packets was compared with the existing one; delay of the transmission is calculated by the total time taken for communication. The residual energy is the amount of energy utilized by nodes that were in the communication. Hence, it is found that the improved E_OAR has reduced delay, increase in residual energy and reduced packet loss in the output.

4. Results and Discussion

4.1 Delay Calculation of the Network
The delay difference between OAR algorithm and the enhanced-OAR algorithm is given in Figure 4. The delay values are calculated by using the trace files in network simulation. By using the modified MAC protocol, the delay generation is reduced when compared with the existing OAR method. Efficient MAC protocol reduces the collision in the network that leads to reduced delay and loss in the network.

4.2 Energy Calculation of the Network
The energy variation in terms of the simulation time period is calculated. The energy level changes according to the input. The energy model in the object tool command (otcl) file exemplifies energy level of the network during the process of communication. The energy level of network is determined by calculating the energy of all individual nodes. By increasing the energy efficiency of the network, energy consumption is reduced. The graphical representation is in Figure 5.

4.3 Packet Delivery Ratio (PDR) of the Network
The performance analysis of node is completed by processing the PDR network. The PDR of the network is graphically shown in figure 6. The proportion of the packets was gotten productively by utilizing the sink which is contrasted with amount of packets that have been sent by the sender. To assess PDR, total number of packets directed, quality of packets and recreation end time is necessary.

4.4 Residual energy of the Network
Data transmission is recognized between nodes that consist of user datagram protocol, type of agent and constant bit rate protocol for traffic. To find the energy process at various time periods, residual energy of the network is generated by accessing individual nodes inbuilt variable “energy”. By receiving high residual energy, the difficulties to get energy back-up in remote conditions are reduced. The graphical representation is shown in the Figure 7.

5. Conclusion
In this research paper, an enhanced Opportunistic Auto Rate (OAR) is developed to adjust multi-hop Ad hoc networks in a directive for enhancing the throughput in multi-rate links. Though, there were numerous avenues that needed an additional study for planning a QoS allowed ad-hoc network. For those packets which navigate multiple hops, end-to-end QoS is an effectiveness of the quality of service metrics at every intermediary link. Where, end-to-end QoS could be enhanced via executing a MAC layer that organizes with additional intermediate nodes on a multi-hop path. The OAR protocol enhances at the duration of high-quality channel circumstances. However, the main mechanism of OAR is to use resourcefully direct multiple back-to-back data packets when the quality of channel was equitable in manner. As channel coherence period characteristically expands multiple packet transmission times for mobile and non-mobile users, OAR attained important throughput gain as associated to adaptation mechanisms.

In wireless networks, the physical layer properties of the channel could be improved continuously and it was the basic challenge faced by WSN. Based on the quality of channel, the rate of data could be changed for sustaining in the suitable bit error rate. The 802.11b standard works in 2.4 GHz band that could support 1, 2, 5.5 and 11 Mbps. The enhanced OAR algorithm is used in the multi-rate physical layer effectively which was close to the MAC layer is anticipated. By using this algorithm, throughput in the channel is improved. DCF based on service differentiation further reduces the packet delay to improve the efficacy of the system.
Figure 1. IEEE 802.11 DCF.

Figure 2. Service Differentiation using Different DIFS Value.

Figure 3. OAR selection of rate

Figure 4. Delay Calculation of Network.

Figure 5. Energy Calculation of Network.

Figure 6. Packet Delivery Ratio of the Network.

Figure 7. Residual Energy of the Network.
Table 1. Relationship between existing and proposed algorithm

| Time (ms) | Delay | Residual Energy | Packet Loss |
|----------|-------|-----------------|-------------|
|          | OAR   | E_OAR           | OAR         | E_OAR     | OAR   | E_OAR   |
| 20       | 0.037 | 0.015           | 96.2        | 96.1      | 0.989 | 0.9951  |
| 40       | 0.0443| 0.0319          | 86.8        | 88        | 0.986 | 0.99    |
| 60       | 0.0454| 0.033           | 80.03       | 81.001    | 0.978 | 0.98    |
| 80       | 0.0469| 0.039           | 74.6        | 77        | 0.96  | 0.971   |
| 100      | 0.0498| 0.042           | 71.9        | 73.2      | 0.955 | 0.965   |
| 120      | 0.053 | 0.042           | 68.43       | 70.4      | 0.948 | 0.96    |

6. References

Research article

1. Henty BE. A Brief Tutorial on the PHY and MAC layers of the IEEE 802.11 b Standard. 2001. White paper, Intersil.
2. Bianchi G. Performance analysis of the IEEE 802.11 distributed coordination function. IEEE Journal on selected areas in communications, 2000; 18(3):535–47. https://doi.org/10.1109/49.840210
3. Baroudi U, Mohiuddin MA. Performance analysis of Internet applications over an adaptive IEEE 802.11 MAC architecture. Journal of the Franklin Institute. 2006; 343(4):352–60. https://doi.org/10.1016/j.jfranklin.2006.02.003
4. Malone D, Duffy K, Leith D. Modeling the 802.11 distributed coordination function in nonsaturated heterogeneous conditions. IEEE/ACM Transactions on networking. 2007; 15(1):159–72. https://doi.org/10.1109/TNET.2006.890136
5. Ashraf M, Jayasuriya A. Improved Opportunistic Auto Rate protocols for wireless networks. IEEE, 19th International Symposium on Personal, Indoor and Mobile Radio Communications. 2008 September; p. 1–6. https://doi.org/10.1109/pimrc.2008.4699555
6. Geng R, Guo L, Wang X. A new adaptive MAC protocol with QoS support based on IEEE 802.11 in ad hoc networks. Computers and Electrical Engineering. 2012; 38(3):582–90. https://doi.org/10.1016/j.compeleceng.2010.06.002
7. Malik A, Qadir J, Ahmad B, Yau, KLA, Ullah U. QoS in IEEE 802.11-based wireless networks: a contemporary review. Journal of Network and Computer Applications. 2015; 55:24–46. https://doi.org/10.1016/j.jnca.2015.04.016
8. Krishan R, Laxmi V. IEEE 802.11 WLAN Load Balancing for Network Performance Enhancement. Procedia Computer Science. 2015; 57:493–99. https://doi.org/10.1016/j.procs.2015.07.371
9. Sinha P. QoS issues in Ad-Hoc networks. Ad Hoc Networks Technologies and Protocols. 2005; p. 229–47. doi:10.10107/0-387-22690-7_8. https://doi.org/10.10107/0-387-22690-7_8
10. Villalon J, Cuenca P, Orozco-Barbosa L. Limitations and capabilities of QoS support in IEEE 802.11 WLANs. IEEE, Proceedings of 2005 Pacific RIM Conference on Communications, Computers and Signal Processing. 2005; p. 633–36. doi:10.1109/PACRIM.2005.1517369. https://doi.org/10.1109/PACRIM.2005.1517369
11. Reddy TB, Karthigeyan I, Manoj BS, Murthy CSR. Quality of service provisioning in ad hoc wireless networks: A survey of issues and solutions. Ad Hoc Networks. 2006; 4(1):83–124. doi:10.1016/j.adhoc.2004.04.008. https://doi.org/10.1016/j.adhoc.2004.04.008
12. Wang Q, Jaffres-Runser K, Scharbarg JL, et al. A thorough analysis of the performance of delay distribution models for IEEE 802.11 DCF. Ad Hoc Networks. 2015; 24(PB):21–33. doi:10.1016/j.adhoc.2014.07.027. https://doi.org/10.1016/j.adhoc.2014.07.027
13. Ben Hassouna A, Koubaa H, Kamoun F. A model for deploying an opportunistic MAC protocol in NS-2. 2012 6th International Conference of Sciences of Electronics, Technologies of Information and Telecommunications, SETIT 2012. 2012; p. 604–11. doi:10.1109/SETIT.2012.6481981. https://doi.org/10.1109/SETIT.2012.6481981
14. Sengupta J, Grewal G. Performance evaluation of IEEE 802.11 MAC layer in supporting delay sensitive services. International Journal of Wireless and Mobile Networks.
15. Alam MK, Latif SA, Akter M, Arafat MY, Hakak S. Performance analysis of MAC layer scheduling schemes for IMM applications over high speed wireless campus network in IEEE802.11e. Indian Journal of Science and Technology. 2015; 8(S3):53–61. https://doi.org/10.17485/ijst/2015/v8i1/47907

16. Anh NH, Giang PT. An Enhanced MAC-Layer Improving to Support QoS for Multimedia Data in Wireless Networks. Indian Journal of Science and Technology. 2016; 9(20).

17. Saini JS, Sohi BS. A Survey on Channel Assignment Techniques of Multi-Radio Multi-channel Wireless Mesh Network. Indian Journal of Science and Technology. 2016; 9(42). https://doi.org/10.17485/ijst/2016/v9i42/92192