INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 6.078
(Volume 6, Issue 3)
Available online at: www.ijariit.com

Enhancing QoS in MAC layer for IoT enabled multihop mobile networks

Ramyadharshni S. S.
ramyasakthi05@gmail.com
K S R Institute for Engineering and Technology, Namakkal, Tamil Nadu

Prakash M.
prakashmathialagan@gmail.com
Mitosis Technologies, Chennai, Tamil Nadu

ABSTRACT

Mobile Adhoc Networks (MANET) within the internet of Things (IOT) framework is one of the most important wireless networks in which mobile nodes are interconnected and transmit packets in a distributed way to provide various IoT oriented services. The heterogeneity characteristic feature of IoT pose technical challenges on MAC layer such as the increasing network traffic load, heterogeneous Quality of Service (QoS) demands. To overcome these problems, a super frame structure is designed that helps to prioritize voice and data packets and that helps to improve the performance in MANET. Within each super frame, voice packets access the channel in contention free period (CFP) for its transmission and data packets content for channel access in a contention period (cp). so, the maximal QoS performance is achieved by adapting to the network traffic load variations and that supports for the heterogenous QoS demands. In addition to the large coverage area, multihop connection is enabled that helps to reduce the energy consumption of the nodes.

Keywords— *Voice and Data Separation, Bit Matrix, Channel Access, Multihop Mobile Networks, QoS*

1. INTRODUCTION

The Internet of Things is the network of physical devices, vehicles, home appliances, mechanical, digital machines, computing devices and other items embedded with electronics, software, sensors, actuators, and network connectivity which empower these objects to connect each other and its ability to transfer data over a network without requiring human-to-human or human to computer interaction. The IoT is one of the most promising network infrastructures towards the next generation wireless network evolution. Various IoT oriented intelligent applications such as environment monitoring, intelligent control for smart homing and industrial automation can be realized using IoT framework (Yang et al. 2016). To support the increasing number of nodes and user demands, an IoT enabled mobile ad hoc network emerges as a promising wireless network to provide seamless Internet access for end users. A MANET consists of a group of self organized nodes, interconnected for communication in a peer to peer manner, without any centralized control. Each mobile node can function as a sender, receiver or an intermediate node of the data in the network (Li J et al. 2013). Due to low cost and simplified implementation, MANETs are widely deployed for applications such as smart home networking, prompt response in post disaster areas and tactical networks for the purpose of command interactions. IoT Enabled MANET is one of the most important wireless networks, in which mobile nodes are interconnected and transmit packets in a distributed way to provide various IoT oriented services. To improve the performance for IoT enabled MANETs, proper medium access control is required to distributed coordinate communications and interactions among mobile nodes. The unique characteristics of IoT pose technical challenges on MAC such as the increasing network traffic load, heterogeneous Quality of Service demands and the increased interference level in a multi-hop environment with a continuous injection of nodes and longer communication distances (Kabara and Calle, 2012). Hence, MAC for an IoT enabled MANET is required to achieve consistently maximal performance by adapting to network traffic load variations, providing the heterogeneous QoS guarantee, and eliminating the interference in a multi-hop environment.

Internet of Things is a new revolution of the Internet and it plays an important role in a modern world. It can access information that has been aggregated by other things and provides components for complex services. The goal of the Internet of Things is to enable things to be connected anytime, anyplace, with anything and anyone ideally using any network and any service. The Internet of Things is not a single technology, but it is a mixture of different hardware and software technology. The Internet of Things provides solutions based on the integration of information technology, which refers to hardware and software used to store, retrieve and process data which includes electronic systems used for communication between individuals or groups. It is possible that the level of diversity will be scaled to a number a manageable connectivity technology that address the needs of the IoT applications that are adopted by the market and supported by a strong technology alliance. The fundamental characteristics of the IoT are Interconnectivity, Things related services, heterogeneity, Dynamic changes, enormous scale, safety and connectivity.

A super frame structure is proposed to prioritize voice and data packets in IEEE 802.15.4 and a bit matrix algorithm is used to prioritize the voice and data packet. In each super frame voice packets access the channel in contention free period and data packets access the channel in contention period. In MANET, nodes can randomly move within the network coverage area and also entering or leaving from the network that makes the network traffic load vary with time. The traffic load variations can lead to QoS performance degradation. Hence, a MAC protocol should be adaptive to the varying number of nodes in the network to maintain consistently high network performance (Karp and Kung, 2000). The increasing demand for supporting heterogeneous services for an IoT based MANET, QoS support for different types of applications such as the packet delay is important for delay sensitive voice traffic, while throughput is more concerned for best data traffic. Therefore, the network is expected to not only provide as high as possible throughput for best effort data traffic, but also ensure a bounded packet loss rate for delay sensitive voice communications or even multimedia streaming. Hence, QoS aware MAC is required to coordinate the channel access for heterogeneous traffic that supporting both audio and text packets. In a single hop the packets are transmitted in a end to end manner. In that transmission it takes more energy to transmit from source to destination so that in a large network coverage area a multi-hop connection is established to reduce the energy consumption.

The remainder of this paper is organized as follows. Related works section portrays literature reviews that are relevant to multimedia traffic in WPAN and supporting the heterogeneous services. These short summaries give a deep understanding of existing technique and various methodologies for creating the super frame structure. Multihop MAC section consists of detailed description of the proposed architecture, overall design and the modules involved in the proposed system. Results and Discussions section briefs about the execution environment and the tool proposed to be used for the implementation. Conclusion and future works give outcomes and possible extensions of the proposed system followed by the attachment of references.

2. RELATED WORK

This section contains works of various authors on QoS monitoring systems for tracking the packets, routing algorithms for the packet travel and resource allocation schemes for allocating the packets.

2.1 QoS Monitoring Systems

Salman Taherizadeh et al., (2015) described an multilevel monitoring framework to ensure system health and adapt an IoT application in response to varying quantity, size and computational requirements of arrival requests. This research work presents a multi-level monitoring approach based upon a non-intrusive design intended to enable IoT based time critical cloud-based applications to autonomously reconfigure and adapt to changing workload at runtime. The innovative horizontal scaling method is able to add more container instances into the pool of resources in order to share the workload or remove some running containers, if this does not significantly affect the QoS. The QoS metrics such as end to end delay, throughput and performance are considered.

2.2 Routing algorithms

M. Vijayalakshmi et al., (2016) described an Energy Aware Multicast Cluster based routing to enhance the QoS of the mobile Ad-hoc network. QoS has no universally agreed definition and predefined parameters. The QoS is described by a certain parameter such as throughput, delay, and drop of packet. This model should consider all challenges executed by Ad-hoc networks, like linkage topology alters due to the movement of its mobile nodes, reliability limitations and power consumption, so it defines a set of services that permits users to choose a number of maintenances that rules such properties like time and consistency. C. Jinshong Hwang et al., (2013) described an ad hoc network and prominent among them are Ad hoc On Demand Distance Vector Routing and Dynamic Source Routing. Quality attributes which are affected by mobile wireless information systems are Functionality, Reliability, Usability, Maintainability, Portability, Quality in Use and Efficiency. The Goal is to carry out a systematic performance of demand routing protocols using QoS parameters. Each node starts its journey from a random spot to a random chosen destination. The different network scenario for different number of nodes and pause times are generated. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. F. Yang et al., (2017) described a novel routing protocol, termed Delay-aware Stable Routing (DASR) protocol, for mobile ad hoc networks. The relative velocity and expected queueing delay of nodes are considered in route discovery, and maintains long link durations and minimization of end to end delay to satisfy the real-time requirements of aeronautical communication services. This routing protocol effectively reduced the end to end delay and avoided unnecessary packet loss. With the increasing number of emergence air rescues, this protocol is to separate the video and audio packets by using a central limit theorem in normal distribution.

E. Sakhaee et al., (2015) described a routing algorithm based on the relative velocity of mobile nodes, which also incorporates Quality of Service, termed QoS Multipath Doppler Routing. The primary aim of doppler routing is to maintain long link durations, while meeting QoS constraints. This routing protocol is based on data retrieval from nodes, where nodes act as content providers. It utilizes the relative velocity of nodes using the doppler shift subjected to packets assists in selecting stable paths, while maintaining the QoS requirements in highly mobile pseudo-linear systems such as a mobile ad hoc network. But it only gives some theoretical analysis and does not go deep into the specific QoS metrics.

C. Xu et al., (2013) proposed an innovative resource allocation scheme to improve the performance of mobile peer to peer, device to device communications as an underlay in the downlink cellular networks. To optimize the system over the resource sharing of both device to device and cellular modes, we introduce a reverse iterative combinatorial auction as the allocation mechanism. In the auction, all the spectrum resources are considered as a set of resource units, which as bidders compete to obtain business while the packages of the device to device pairs are auctioned off as goods in each auction round. The simulation results demonstrate that the algorithm efficiently leads to a good performance on the system sum rate.

2.3 Resource allocation schemes

Junwoo Jung et al., (2012) described the GTS Allocation Scheme for Bidirectional Voice Traffic in IEEE 802.15.4 Multihop Networks. They discussed the feasibility of voice communications over IEEE 802.15.4 networks. To this end, the personal area network (PAN) coordinator allocates guaranteed time slots (GTSs) for voice communications in the beacon-enabled mode of IEEE 802.15.4. Although IEEE 802.15.4 is capable of supporting voice communications by GTS allocation, it is impossible to accommodate voice transmission beyond two hops due to the excessive transmission delay. This scheme allocates GTSs to devices for successful completion of voice transmission in a super-frame duration and also considers transceiver switching delay. It has lower end-to-end delay and packet drop ratio than the basic IEEE 802.15.4 GTS allocation scheme.

Chao-Ling Hsu et al. (2012) described a Tandem Algorithm for Singing Pitch Extraction and Voice Separation from Music Accompaniment. Singing pitch estimation and singing voice separation are challenging due to the presence of music accompaniments that are often nonstationary and harmonic. Inspired by computational auditory scene analysis, they investigate a tandem algorithm that estimates the singing pitch and separates the singing voice jointly and repeatedly. To enhance the performance of the tandem algorithm for dealing with musical recordings, a trend estimation algorithm is used to detect the pitch ranges of a singing voice in each time in the superframe.

Subhash Chandra Pradhan et al., (2016) described the Minimization of Overhead using Minislot Allocation Algorithm in IEEE 802.16 Mesh Network. Distributed scheduling is an important factor to enhance the network performance in IEEE 802.16 mesh network. The scheduling algorithm of control sub-frame was defined in IEEE 802.16 standard, but distributed scheduling of data subframe was not defined. They proposed a minimization of overhead using minislot allocation algorithm for reducing the overhead of data sub-frame in IEEE 802.16 mesh network. If the available minislots are not contiguous, the granter node searches for the free minislots of data sub-frame to allocate contiguous minislots as long as possible.

Nam Tuan Le et al., (2012) described a new QoS Resource Allocation Scheme Using guaranteed time slot for WPANs. IEEE 802.15.4 and IEEE 802.15.7 are two typical standards for WPANs that support Quality-of-Service through a Guaranteed Time Slot mechanism to allocate a specific duration within a superframe structure for a time division multiplexing transmission. The low bandwidth utilization problem may occur in the GTS mechanism when the allocated bandwidth is less than the available bandwidth. However, this problem has not been resolved thoroughly in any of the standard or current research thus far.This scheme tries to solve the bandwidth underutilization problem by using Network Calculus theory based on the fluid model and greedy algorithm.

Ghalem Boudour et al., (2016) proposed an reservation mac scheme for an on and off nature of voice traffic, resource reservation for voice traffic in Adhoc network is a very challenging task. In this paper we propose an adaptive reservation protocol for voice/data support. The proposed scheme allocates slots to voice sources each time they wake up and gives them high priority to send their reservation requests over data sources. The bandwidth unused by idle voice sources is rendered temporarily available for reservation. Simulation results show that the proposed scheme improves the performances of voice traffic in terms of dropping rate. A node reserve the channel resource for multi-hop packet transmission in consecutive order, so that the packet transmission between a source node and a multi-hop away destination node is possible within a superframe when the network coverage area is very large, the nodes can transmit a packets in a multi-hop environment.

2.4 Multihop MAC

The proposed architecture for Multihop MAC is shown in the Figure 1. Initially creating a adhoc network for identifying the packet status in a network to identify whether it is an voice packet or data packet. The voice maximization algorithm using a bit matrix is designed for separating both voice and data packet and giving a high priority to voice and low priority to data. If the packet is a voice packet means initially it has to accessing the mini slots followed by the contention free period. If the packet is a data packet, it accesses the channel in a contention period. A super frame structure is created for each packet that helps to allocate the channel for each packet. The collision that takes place between voice and data packet is avoided by using a TDMA scheme. The time slot is allocated for the packets in different session.

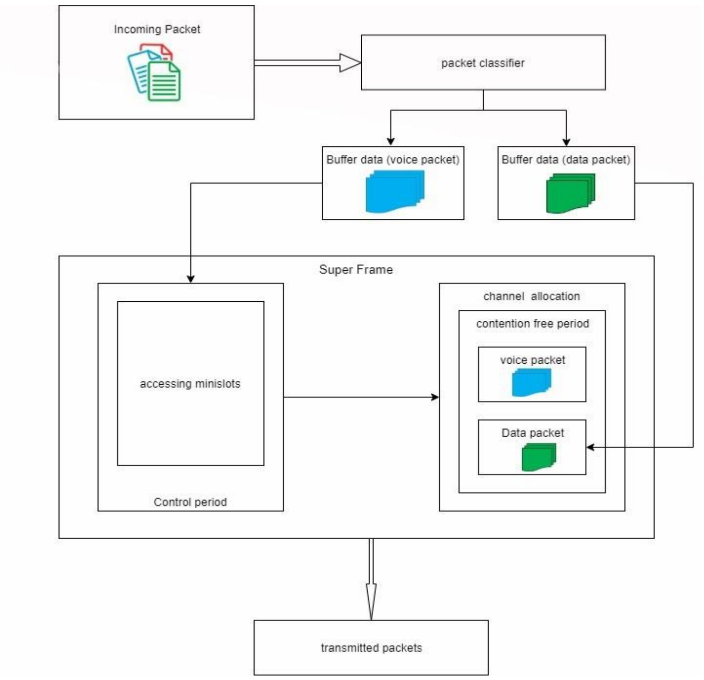

Fig. 1: Architecture of Multihop MAC

The packet is to be transmitted in a multi hop network established so that the energy consumption of each node gets reduced. The modules to create a mobile adhoc network, identifying the packet status in the network, avoiding collisions by allocating the time slot for transmission of packet in different sessions from TDMA scheme.

2.5 Separation of Voice and Data

The packet arrives into the network the network is to transmit both the voice and data packet properly. The voice packet does not able to resend the information but the data traffic has the ability to resend information. For efficient transmission, each voice node is represented by an on/off model, which is a two state markov process with the on and off states being the talk sprut and silent periods.Both the periods are independent and exponentially distributed with mean (1/α) and (1/β). During talk sprut period, the voice packets are generated at a constant rate of λ packets. A delay sensitive voice traffic, each packet should be successfully transmitted within the bounded delay to achieve the voice communication quality, otherwise the packet will be dropped. The bounded rate was calculated by using a normal distribution with mean E[x] and variance D[x] being N_v E[x] and N_vD[x].

For calculating Mean,

$$E[x] = \int_0^{N_v} x.f(x).dx$$

$$E[x^2] = \int_0^{N_v} x^2.f(x).dx$$

For calculation variance

$$var[x] = E[x^2] - [E[x]]^2$$

Calculating y_m,

$$\frac{E[X - y_m | X > y_m]}{E[x]} = P_L$$

y_m is the maximum number of transmitted voice packets in each superframe.P_L is a bounded rate of voice packet loss rate? Due to various traffic load variations, TDMA time slot allocation is used for efficient resource utilization. During voice traffic on and off characteristic, only active nodes should be allocated one time slot in each superframe and divide that into two categories type 1 and type 2 node. Type 1 nodes are already activated nodes and type 2 nodes are newly activated nodes. The packets are arranged bit by bit in a minislots by using a bitmatrix algorithm. The bit matrix algorithm is used for arranging the packet by a continuous bit. So that the delay can be reduced and the buffer occupancy also very low.

Table 1 Algorithm for Voice Capacity

ALGORITHM 1: VOICE CAPACITY

INPUT: CH (no.of channel), F(no. of frames), N_m (Number of minislots in each control period) T_{ctrl} (control period duration)

OUTPUT: a_m (allocated minislots)

```
Initialization: f←1,c←1
while ( c< CH)
while (f1<F and a_m < T_ctrl ) {
        for j (1 to s) {
if (bitmatrix (j,f,c)==0) {
while (a_m< j && bitmatrix(j,f,c)==0) {
 a ←a_m U bitmatrix(j,f,c) }
 if (a==n) break;
else {
if ( a_1<a_m)
a_1←a_m
continue;
}}}
if (a_1> N_m && a_1< n)
a←a_1 // allocated minislots
f1← f1+1
}}
```

2.6 Super frame creation

A guaranteed voice packet loss rate reduction and truncated carrier sense multiple access and collision avoidance is used for data nodes to access the channel. The accurate on and off model is used for voice traffic generation and exploit the voice traffic multiplexing to improve the voice capacity. Since voice service is a packet not transmitted after a delay bound.It should be dropped or lost and those packets are stored in a buffer and the voice packet delay has to be evaluated in a parallel transmission from the buffer status puts on and off stages.The separate buffers are created for both voice and data packets,the size of the existing superframe is a 32 bit that is not enough for storing both the voice and data packets. so that the size of the superframe is extended to 64 bit. Superframe order determines the length of the active period and beacon order is the interval between two successive beacons. The superframe includes two parts that is active period and inactive period.The relation between superframe order and the superframe duration can be expressed as follows.

$$S_D = \text{abaseSuper frame duration} * 2^{so}$$

$$B_I = \text{abaseSuper frame duration} *2^{bo}$$

The minimum length of the superframe (abaseSuperframe Duration) corresponds to the symbols such as 0 to 15 for both superframe order and beacon order. The original superframe structure is shown in the fig 2.The original structure contains 32 bit and the text files are transmitted through contention period and audio files are not supported by this period.

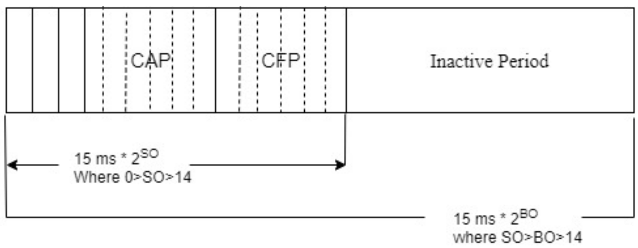

Fig. 2: Structure of a Superframe

The modified superframe structure is shown in the fig 3. In this structure, it consists of both contention period and contention free period.

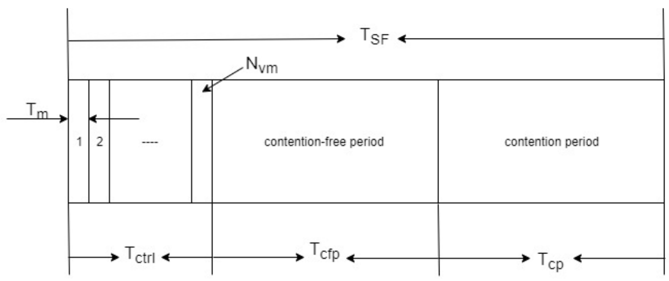

Fig. 3: Contention free period and contention period

2.7 Channel allocation

The capacity of the channel is identified and assigning the packets using Time scheduling and frequency channel allocation scheme. Based on the frequency, allocate the channel in which the packets having high frequency and the arrival rate of the packet. The packet is scheduled by using time scheduling algorithm. The voice packet is allocated in a higher order channel and the data packet is allocated in a medium or a low order channel.

The traffic access voice and data nodes for slot Sequence Number analyzing the load of voice packet time slot duration verifying of each neighbouring nodes from the source node till reach the destination node. So, the slot number has monitored the voice packets are transmitted successful or not within these time slot regions and it is stored. The buffer indicator has monitoring the buffer status on or off verifying under voice or data packet transmission within this time slot specified and stored their status. Finally, slot sequence number is the TDMA Slot Sequence Number for identifying the current status of the packets details with increasing the congestion window size.

Table 2: Algorithm for Channel Allocation

ALGORITHM: CHANNEL ALLOCATION

INPUT: No. of packets generated(P_G) and flag bit
OUTPUT: Channel Number

Initialisation : channel num : 0, isNotSetChannel : true
Repeat
if the node receives a packets then
if isNotSetChannel is true then
check whether there is any free channel
if there exists some free channel then
channelNum = the number of free channel
Else
channelNum= rand() %(£ - 1)
end
broadcast a RTS with ChannelNum and a CTS with recvChannelNumber
Else
drop the received packet
End
End
End Algorithm

2.8 Mutihop connection establishment

During high mobility, the packet collision will occur and simultaneously travel time of the packet will also be increased. An efficient routing algorithm for MANET is developed in a enhanced in wpan. These standard contains several parameters and methods to automate the selection of getting the channel status by sending adv messages. During route discovery process a path between source and destination may consist of two or more intermediate nodes. Route maintenance and optimization of route is discovered to send the packet in the correct path.

3. RESULTS AND DISCUSSIONS

The simulation results are provided to validate the accuracy of the analytical results. All the simulations are carried out using NS2(Network Simulator). Initially create a mobile adhoc network to transmit the packets and set the traffic for the incoming packets. The simulation parameters are shown in the Tab 1. The packets are arrived with a poisson process after that based on the voice or data, the traffic rate will change accordingly.

The size of the packet is 1024 bytes out of which 200 bytes has a headers and check bytes. The remaining bytes that contains the data and the audio packets. The constant bit rate (CBR) traffic is set during voice packet transmission at a specific arrival time. The packets are arrived with the rate of 0.1 packet per second. For data packets, the FTP traffic is set to access the channel during contention period. The voice and the data packet transmission is shown in the figure 4.The packet carries the information of source node, destination node, mac id, protocol used for routing and it gives the information about the current status of the packet that is whether the packet is delivered or it is stored in a buffer.

Table 3: Simulation parameters

PARAMETERS	VALUES
Simulation Time	100 ms
No. of nodes	25
Packet size	1024 bytes
No. of queue length	128
MAC protocol	WPAN
Routing protocol	Aodv
Packet type	Voice and data
Connection type (voice)	CBR
Connection type (Data)	FTP

The graph is plotted by taking throughput as y axis and simulation time as x axis. The comparison of the original wpan and the modified superframe are shown in the fig 4. using a bit matrix algorithm, the packets are transmitted with less buffering. This result exhibit that the throughput gets increased when compared to original WPAN.

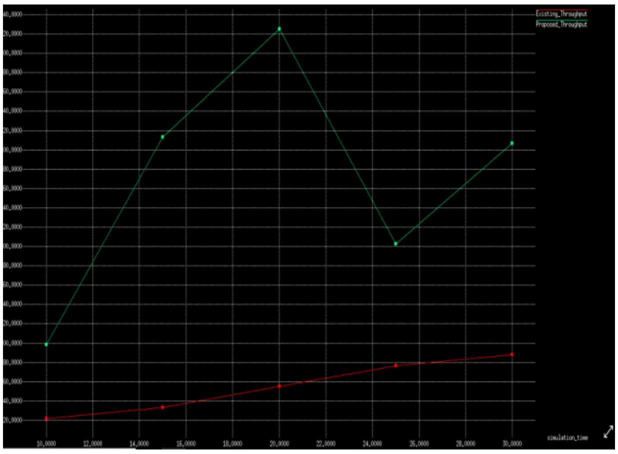

Fig. 4: Simulation time Vs. Throughput

Packet delay is taken as y axis and simulation time as x axis. The comparison of the original WPAN and the modified superframe are shown in the fig 5. This result reveal that the delay gets reduced when compared to original WPAN.

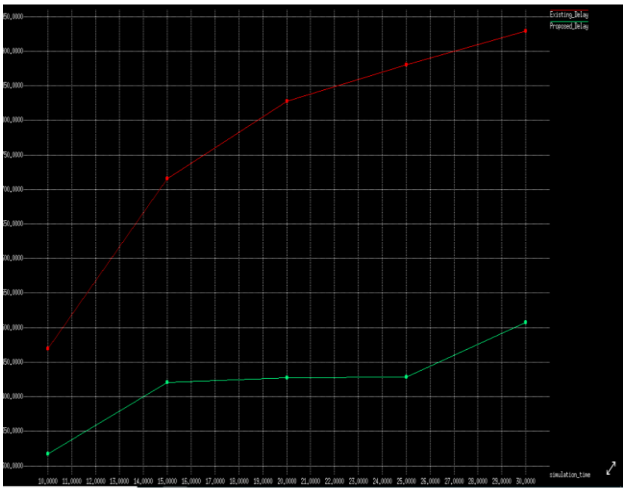

Fig. 5: Simulation time Vs. Packet delay

4. CONCLUSION

In a wpan (IEEE 802.15.4) standard, the bit matrix algorithm is designed for separating both voice and data packet and giving a high priority to voice and low priority to data and also the algorithm for calculating the length of the superframe structure for each packet and allocate the channel for the packet. Finally, transmit multiple packets in multihop connection established. when the number of nodes gets increased that can enlarge the network coverage area, making the communication distance between a pair of end users via the multi-hop transmission range will consume less energy for communication. In multihop network, some nodes staying in the transmission ranges of both source and destination nodes (that are far apart) may relay traffic for the end nodes. To maintain a consistently minimized end-to-end packet delay in a multihop environment with an increased number of nodes is a challenge in MAC.

5. REFERENCES

[1] Al-Fuqaha,M .Guizani, M.Mohan. Aledhari, and M. Ayyash, Internet of Things: A survey on enabling technologies, protocols, and applications," IEEE Commun. Surveys Tuts., vol. 17, no. 4, pp. 2347–2376, Dec. 2015

[2] Yang, S., Liu, Y. and Wei, J., 2016. Social capital on mobile SNS addiction: a perspective from online and offline channel integrations. *Internet Research*, *26*(4), pp.982-1000.

[3] Li, J.L.W., Krairiksh, M., Rahman, T.A. and Al-Shamma'a, A., 2013, December. Keynote speakers: Wireless power transfer: From long-distance transmission to short-range charging. In *2013 IEEE International RF and Microwave Conference (RFM)* (pp. xi-xv). IEEE.

[4] B. Karp and H. T. Kung, "GPSR: Greedy perimeter stateless routing for wireless networks," in Proc. 6th ACM Int. Conf. Mobile Comput. Netw., Boston, MA, USA, 2000, pp. 243–254.

[5] Doukidis, G.I., Mylonopoulos, N. and Pouloudi, N. eds., 2004. *Social and economic transformation in the digital era*. IGI Global.

[6] Kabara, J. and Calle, M., 2012. MAC protocols used by wireless sensor networks and a general method of performance evaluation. *International Journal of Distributed Sensor Networks*, *8*(1), p.834784.

[7] Chander Prabha, Dr. Surender Kumar, Dr. Ravinder Khanna, "Wireless Multihop Adhoc Networks", VOL. 1, NO. 2, APRIL 2013

[8] C. Perkins, E. Belding-Royer, and S. Das, "Ad hoc on-demand distance vector (AODV) routing," IETF Netw. Working Group, Fremont, CA, USA, RFC3561, 2003

[9] C.Jinshong Hwang and Ashwani Kush, " Enhancing The Quality Of Service in MANET" IEEE JOURNAL VOL 30,AUG 2013

[10] C. Xu *et al.*, "Efficienct resource allocation for device-to-device underlay communication systems: A reverse iterative combinatorial auctionbased approach," *IEEE J. Sel. Areas Commun.*, vol. 31, no. 9, pp. 348–358, Sep. 2013

[11] E. Sakhaee, A. Jamalipour, and N. Kato, "Quality of Service Analysis in IEEE 802.15.4 Mesh Networks using MANET Routing" CA, USA, RFC3561, 2015

[12] Ghalem Boudour, Cedric Teyssie, Zoubir Mammeri," Adaptive Reservation MAC Protocol for Voice Traffic in Wireless Ad-hoc Networks,"IEEE JOURNAL VOL 30,AUG 2016.

[13] HaoWang ,VyacheslavZalyubovskiy , Vladimir Shakhov and HyunseungChoo," A Traffic adaptive MAC Protocol for asynchronous wireless sensor networks" National conference July 20,2016

[14] Ian D. Chakeres,"AODV Routing Protocol Implementation Design" International conference August 19-21,2012

[15] Jeevan Chalke and Anirudha Sahoo , "A Scheduling and Call Admission Control (CAC) Algorithm for IEEE 802.16 Wireless Mesh Networks" IEEE MILCOM, San Jose, CA, USA, 2010, pp. 2014-2016

[16] J.-R. Cha, K.-C. Go, J.-H. Kim, and W.-C. Park, "TDMA-based multihop resource reservation protocol for real-time applications in tactical mobile adhoc network," in *Proc. IEEE MILCOM*, San Jose, CA, USA, 2010, pp. 2012

[17] Jiong Jin, Member, IEEE, Jayavardhana Gubbi, Member, IEEE, Slaven Marusic, and Marimuthu Palaniswami, Fellow, IEEE," An Information Framework for Creating a Smart City Through Internet of Things", VOL. 1, NO. 2, APRIL 2014

[18] MD. ArafaturRahman , Muhammad NomaniKabir, Saiful Azad and Jahan Ali," On Mitigating Hop-to-Hop Congestion Problem in IoTEnabled Intra-Vehicular Communication,International conference August 19-21,2015

[19] M.vijayalakshmi Research scholar and Dr.D.Sreenivasa Rao, "Energy Aware Multicast Clustering (EAMC) with increased Quality of Service (QoS) in MANETs" 978-1-5090-239 @ IEEE 2016

[20] Qiang Ye, Member, IEEE, and WeihuaZhuang," Token-Based Adaptive MAC for a Two-Hop Internet-of-Things Enabled MANET" IEEE Journal Sel. Areas Commun., vol. 31, no. 9, pp. 348–358, Sep. 2015

[21] Ping Wang, Hai Jiang, Member, IEEE, and Weihua Zhuang, Senior Member, "Capacity Improvement and Analysis for Voice/Data Traffic over WLANs" IEEE Commun. Surveys Tuts., vol. 17, Dec. 2015

[22] SeUng Hyeon and Ki-Il Kim, "A new geographic routing protocol for aircraft ad hoc networks" in IEEE 2010

[23] Salman Taherizadeh and Vlado Stankovski, "Quality of Service Assurance for Internet of Things Enabled Mobile Networks" IEEE J. Sel. Areas Commun., vol. 31, no. 9, pp. 348–358, Sep. 2015

[24] W. Gu, J. Li, F. He, F. Cai, and F. Yang, "Performance Evaluation of Manet Using Quality of Service Metrics" 3rd National conference July 16,2017.