Energy Aware Quality of Service Routing Protocol

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Abstract: **The wireless Ad-Hoc network is infrastructure less with nodes in the network area are randomly moving and communicating between nodes while roaming. In this paper we propose the TDMA Based Energy Efficient Quality Of Service Routing Protocol (EAQOSRP). The network scenario is established by considering 1000 X 1000 area and displaying randomly moving nodes using TCL. The resource reservation is used to decompose the total simulation time of network into smaller time slots depending upon number of nodes in the network using TDMA technique. The route is established between Source and Destination node using AODV with QOST and Multi hop routing technique using C++. The data packets are scheduled at Source node by assigning priority and the path is established between nodes using shortest path and implemented using C++. It is observed that the values of Energy Consumption, Packet Delivery Ratio, End to End Delay and Throughput are improved Compared to Existing a logarithm.**

Keywords **– Time Division Multiple Access (TDMA), high load traffic, Quality of Service (QoS), Wireless Ad-Hoc Networks (WANs).**

I. INTRODUCTION

Ad hoc wireless network is a part of wireless Communication network. This network does not require any infrastructure. It is a distributed Routing network, and it supports for reusing of frequency dynamically. As Ad-Hoc network has different features so it has to solve different issues as energy constraint, shared bandwidth and mobility. So it is required to design protocols which support both MAC and Network layer. Sensor network is another part of Ad-Hoc network used to sense the environmental conditions which may be periodic conditions or non periodic conditions. Sensor node can be used for monitoring heat, temperature, humidity, intrusion detection and etc. Major challenge for Sensor network is to manage the energy constraint of nodes that form the network. For multimedia traffic are delay and energy sensitive specifically for Ad-Hoc and sensor network, hence an Ad-Hoc network should be designed that finds an efficient path to the destination and end to end delay should be negligible. Hence Quality of service Support can be achieved for an efficient routing and MAC protocol. MAC protocol is classified as Contention Based, Contention based with reservation and Contention based Scheduling protocol. In case of Ad-Hoc network, the energy and Bandwidth are precious resources. So utilization of these resources should be efficient. Using reservation mechanism, that is time division multiple access, is based on time slots. Time slots are reserved for time and energy sensitive traffic. Scheduling mechanism considers traffic load available at the nodes and amount of delay at the packets. Routing protocols should be designed to find shortest path to the destination using minimum energy and time. These routing protocols are classified as proactive and reactive Routing protocols. The reactive protocols are on demand protocols, they are used to find feasible path to destination finding shortest distance.

Contribution: In this paper TDMA Based Energy Efficient Quality of Service Routing Protocol is proposed the network scenario is developed by TCL. The TDMA is used to decompose the simulation time into smaller times for Multi hop routing Technique. The route is established using Multi hop technique with AODV protocol. In scheduling the data packets are assigned priority and the path between nodes are identified using Shortest Path.

Organization: The paper is organized as follows: survey of related work is mentioned in section II. The proposed model EAQOSRP is explained in section III. Algorithm is described in section IV, simulation results and performance analysis in section V. Finally section VI, Conclusion of the paper.

II. LITERATURE SURVEY

Heping Wang et al., [1] proposed a hybrid medium access control (HMAC) protocol with an embedded cross-layer optimization solution to provide routing-layer coarse-grained end to- end Quality-of-Service (QOS) support for latency-sensitive traffic flows. And they proposed a novel channel reservation technique to reduce end to end delay. Atef Abdrabou et al., [2] proposed a model based on Quality of Service (QOS) routing scheme for IEEE 802.11 ad hoc networks. It provides stochastic end to end delay guarantees,

instead of average delay guarantees, in the delay sensitive bursty traffic sources. Mylene Pischella et al., [3] proposed resource allocation for downlink orthogonal frequency-division multiple accesses (OFDMA). The scheme uses a subcarrier and power-allocation method that differentiates users per service type to fulfil the QOS requirements of each user. Wei Ye et al., [4] proposed S-MAC, a medium access control (MAC) protocol designed for wireless sensor networks. S-MAC uses a few novel techniques to reduce energy consumption and support self-configuration. It enables low-duty-cycle operation in a multi hop network. Monica et al., [5] proposed Deployment of the nodes in a wireless sensor network to satisfy continuous sensing with extended network lifetime while maintaining uniform coverage in the deployment region is the major challenge in wireless sensor networks. Keming DU et al., [6] proposed a bandwidth-aware routing protocol of BARP, which is based on the existing Dynamic Source Routing protocol (DSR), Maintaining the Integrity of the Specifications used to find a route in maximum bandwidth from a source node to a destination. Jong-Woon Yoo et al., [7] proposed Cooperative Networking protocol (CONET), which dynamically reforms clusters according to each node's bandwidth requirement, energy use, and application type. Z. Chen et al., [8] proposed novel energy efficient self organization and medium access control (MAC) protocols for wireless sensor networks. The proposed protocols are based on Time Division Multiple Access (TDMA) principle and are referred to as TDMA. Gang Lu, et al., [9] proposed DMAC. It is designed to solve the interruption problem by giving the active/sleep schedule of a node, an offset that depends upon its depth on the tree.

Shu Du et al.,[10] proposed RMAC (the Routing enhanced MAC protocol), that exploits cross-layer routing information in order to avoid the routing problems without sacrificing energy efficiency. In RMAC, a setup control frame can travel across multiple hops and schedule the upcoming data packet delivery along that route. Yuan Li, et al., [11] proposed two new algorithms to control and exploit the presence of multiple schedules to reduce energy consumption and latency. The first one is the global schedule algorithm (GSA). GSA is a fully distributed algorithm that allows a large network to converge on a single global schedule to conserve energy. Secondly fast path algorithm (FPA). Hetal Jasani et al., [12] proposed the QoS performance of MANETs by comparing the results of using AODV and DSR routing protocols. Using the OPNET Modeller, they have conducted an extensive set of performance experiments for those protocols with a wide variety of settings. Sheriff M. ElRakabawy et al.,[13] proposed a feasible end-to-end congestion control algorithm for overcoming the severe deficiencies of TCP in IEEE 802.11 multihop wireless networks. Arjun P. Athreya et al., [14] proposed a routing mechanism that uses crosslayer strategies. The cross-layer strategy involves incorporating feedback and information from layers below the network layer to make decisions at the network layer. They proposed a path evaluation mechanism for the paths returned by multi-path routing mechanism. Sahar kianian, et al., [15] proposed a new content-based routing approach with use of ant colony optimization for MANETs, called CARMAN. This approach exploits the behaviour of ant-like agents for route discovery process. CARMAN is a simple routing protocol with autonomous traffic management and topology changes adaptation.. Chhagan Lal, et al.,[16] proposed a comparative analysis of mobile ad-hoc routing protocols over real time video streaming. The analysis exploits the built-in support for real time multimedia streaming in MANETs. Prof. Rathnakar Acharya et al.,[17] proposed to improve the QoS, the original IEEE Medium Access Control (MAC) protocol is enhanced to IEEE 802.11e standard by introducing new coordination functions, which has both contention based and contention free medium access methods. The Network Simulator-ns-2 [18] [Online] reference material state-of-the-art techniques and solutions, and supports them with easy-to-understand examples on different routing protocols and behaviour of mobile nodes in wireless network. Siva ram murthy, B.S. Manoj's reference book [19] Ad Hoc Wireless Networks: Architectures and Protocols presents state-of-the-art techniques and solutions, and supports them with easy-to-understand examples on different routing protocols and behavior of mobile nodes in wireless network. Bhavyesh Divehi, [20], proposed work on MANET, it is a self-configuring network of mobile nodes connected by wireless links, to form an arbitrary topology. The nodes are free to move randomly. Thus the network's wireless topology may be unpredictable and may change rapidly.

III. PROPOSED MODEL

In this chapter the proposed EAQOSRP model and definitions include Energy consumption, Average energy consumption, Packet delivery ratio, Throughput, End to end delay, Packet arrival interval and path length are discussed in detail.

A. DEFINITIONS

(i) Energy Consumption (EC): The amount of Energy spent by each node to transmit number of Data packets and is given in an equation 1

EC = Initial Energy assigned to node - The energy used to send data packet…….. (1)

(ii) Average Energy Consumption (AEC): It is an average energy Consumed by an each node to transmit data packets from Source to Destination by Multi hop Routing is given in equation 2

$$AEC = \frac{\text{EC by nodes in of nodes in multi hop}}{\text{number of nodes nodes in Multi hop}} \quad \text{.....(2)}$$

(iii) Packet Delivery ratio (PDR): The ratio of total numbers of data packets successfully delivered to the total number of data packets sent and calculated using the Equation 3.

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PDR=$\frac{\text{Data packets successfully delivered}}{\text{number of packets sent}}$ *100 %.....(3)

(iv) Throughput (T): The ratio of number of Packets delivered to the destination to the time required to travel from Source to Destination and is normally represented by Bits Per seconds (bps) and is given in equation 4.

T= $\frac{\text{Packets delivere}}{\text{time to de}}$ .....(4)

(v) End to End delay (EED**):** It is the delay between Sources to Destination nodes. It is measured by summation of delays of number of hops involved between Sources to Destination using equation 5

EED = $\sum_{i=1}^{n} di$……..……..…..(5)

Where d - hop delay

(vi) Packet arrival interval (PAI): Source generates constant bit rate that varies from 1 to 100 seconds, called as packet arrival interval. (vii) Path length (PL): The varied path length between each pair of source and destination nodes is called path length. The path length can measured as hops.

B. PROPOSED EAQOSRP MODEL

The efficient Routing protocol with QOS is developed in the proposed TDMA based energy efficient Quality of Service Routing Protocol (EAQOSRP) and block diagram is given below in Figure 1.

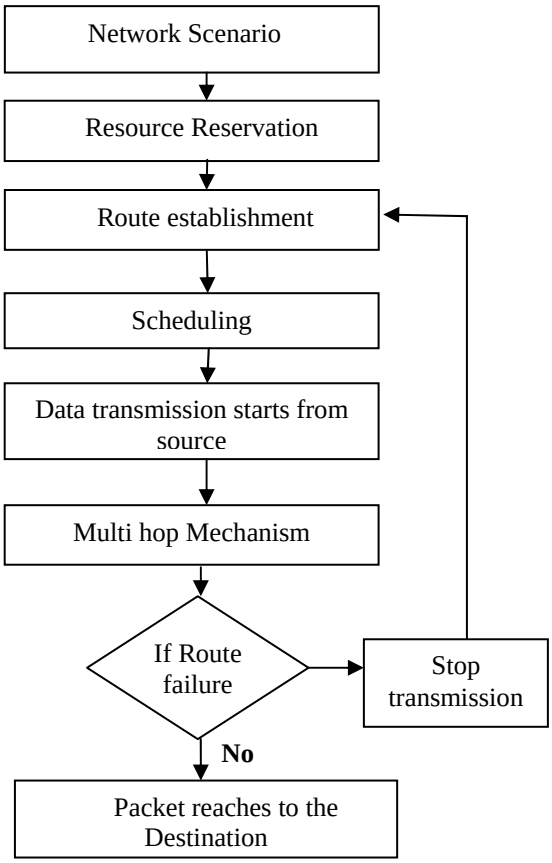

Figure1. Proposed EAQOSRP model

(i) Network Scenario: About 50 mobile nodes are deployed randomly in the network area of 1000 X 1000 , with each node is assumed to have one Omni directional antenna and uses two ray ground reflection radio propagation models. The mobility of 2 m/sec is assigned to each node with mobile nodes is 50 joules. The simulation time 200 seconds is assigned to the total network area. The network scenario also called Network animated file in Ns-2 and shows how the packets are transmitted from source to destination based on single hop as well as multi hop routing. The Tool Command Language (TCL) is used to create network animated file i.e. network scenario.

(ii) Resource Reservation Technique: The Quality of Service in wireless network can be improved by reserving resources like Bandwidth and time slots. The Bandwidth i.e., the maximum data transfer rate of the network which measures how much data can be sent over a specific connection in a given amount of time and is normally represented by Mbps. The bandwidth is reserved, and nodes are allowed for exclusive access to the reserved Bandwidth.

The whole network area simulation time is decomposed into number of time slots to assign time to each node in the network area using Time division multiple access (TDMA) technique. In the proposed network scenario the numbers of nodes deployed are 50 with total simulation time of 200 seconds. The TDMA technique allots 4 seconds of time to each node by decomposing total simulation time of 200 sec and is shown in Figure 2.

The regular unicast and multicast data exchange between nodes can be performed as follows: In unicast each node turns on its radio during its own slots and sleeps during all other slots, but in this proposed work every slot turns on because of multi hop while transmitting packet from source to destination, it depends on some intermediate nodes.

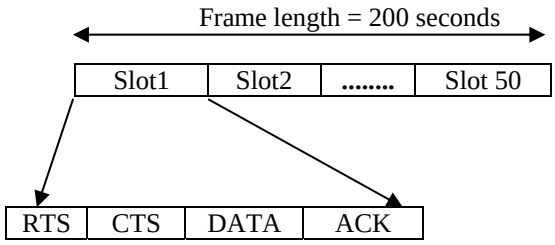

Figure 2: Resource Reservation technique

The source node first sends "Request To Send" (RTS) control packets to request slot reservation to the intended destination. The destination node on receiving RTS packet, it responds by sending clear to send (CTS) packet on the same slot. Sender node on receiving the CTS packet successfully gets the reservation for the current slot, and then transmits the data information to the destination. The whole operation of TDMA, RTS and CTS are implemented using C++.

(iii) Route Establishment Techniques: The number of packets to be sent from source to destination require path to be established using various route establishment techniques. The routing may be (i) single hop routing i.e., packets are sent from source to destination directly without any nodes between source to destination, and

(iv) Multi hop routing i.e., packets are sent from source to destination using intermediate nodes. The readily available ad-Hoc on demand distance vector (AODV) routing protocol is used as base protocol in the proposed model. The advantage of AODV protocol is that route is established between nodes only if requested by source nodel i.e., on demand and hence extra traffic communication is minimized. In the proposed model, the Quality Of Service Technique (QOST) is used in addition to base AODV protocol.. The QOST also checks the Route failure between source and destination. The QOST is used to improve performances by established route check, if route failure is observed then the technique inform source node to establish the route. The shortest path between source and destination is computed based on Dijkstra's algorithm. The AODV is implemented with TCL and QOST is implemented using C++.

(v) Scheduling Mechanism:

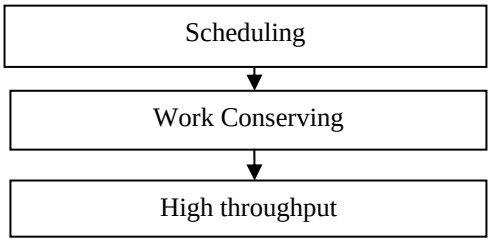

Figure 3 Scheduling Mechanism

The Scheduling is network bandwidth management by packet scheduling at nodes and transmission scheduling between nodes. The scheduling decisions are based on energy available at nodes, and the small time available at nodes after transmission of its own data Packets, to transmit data packets stored in the buffer to transmit over the specific path the number of data packets delivered to the destination increases with scheduling which intern throughput increases.

The scheduling technique provides QOS support which considers factors called traffic load at nodes and delay targets of packets. Every node maintains scheduling table that holds packet information with priority. The Source node transmits data packets with header information that has source ID, destination ID and priority. At the receiver this information is copied into the ACK packet that has been sent in response to the data Packet. The neighbour nodes update their scheduling tables on receiving data and Acknowledge packet. The whole Scheduling is implemented using C++.

(vi) Multi hop Mechanism: The excess delay occurred at upstream nodes is compensated by the downstream nodes increases the priority of the packet so that they can reduce end to end delay, so this multi hop technique is used to carry time sensitive traffic on Ad-Hoc wireless network.

IV. ALGORITHM

Problem Definition:

The effective wireless Communication in Ad-Hoc networks using TDMA and QOST along with base protocol AODV is developed. The algorithm has energy efficient, high throughput and low end to end delay.

The Objectives of the algorithm are:

(i) To reduce the Energy Consumption and in turn increase the battery life

(ii) To reduce End to End delay for High traffic

(iii) To increases throughput Assumption.

(iv) The nodes are randomly distributed over a given area, and each node has a unique identifier.

(ii) Each node uses a short-range radio to communicate with neighbours to save energy.

The algorithm for TDMA Based Energy Efficient Quality of Service Routing Protocol using proposed method is given in Table 1.
The network scenario is created using TCL. The resource reservation, root establishment and scheduling is simulated on TCL using C++.

Table 1: Algorithm of Proposed Protocol

(i) The 50 mobile nodes are deployed randomly in the network area of 1000*1000 m^2 with each node is assumed to have one Omni directional antenna.
(ii) The mobility of 2 m/sec is assigned to each node with an energy of 10 joules per node, i.e., the total energy of 50 mobile nodes is 500 joules
(iii) The simulation time 200 seconds is assigned to the total network area
(iv) The TDMA scheme is used in the network area.
(v) A source node starts its packet transmission by first sending RTS control packets to request slot reservation request for intended destination. The receiver on receiving the RTS packet, it responds by sending CTS packets on the same slot. Sender node on receiving the CTS packet successfully gets the reservation for the current slot, and then transmits the data information to the destination.
(vi) The routing protocol AODV is used as a base protocol in the proposed model.
(vii) In The proposed model, the QOST is used in addition to base AODV protocol. The QOST also checks the route failure between source and destination
(viii) If route failure is observed then the technique inform source node to re-establish the route.
(ix) The shortest path between source and destination is computed using Dijkstra's algorithm.
(x) The number of packets to be sent from Source to destination is established using multi hop routing.
(xi) The Scheduling is network bandwidth management by packet scheduling at nodes and transmission scheduling between nodes. The scheduling decisions are based on energy available at nodes, and the small time available at nodes after transmission of its own data Packets, to transmit data packets stored in the buffer to transmit over the specific path.
(xii) The multi hop technique is used to transmit data packets.

V. PERFORMANCE ANALYSIS

The Proposed Energy Efficient Quality of Service Routing Protocol (EAQOSRP) for Wireless ad-Hoc network has been implemented using Ns-2**.** The parameters Energy Consumption**,** packet delivery Ratio, throughput and End to End delay have been compared with Ad-Hoc on Demand Distance vector (AODV). The network parameters such as Network area, Initial energy, Data rate and Bandwidth values are tabulated in Table 2.

Table 2: Network parameters

Parameter	Symbol	Value
Network area	A	1000X1000m
Num of Nodes	N	50-200
Packet length	L	50 Kbytes
Initial energy	E	500 joules
Bandwidth	B	20kbps
Simulation time	T	200s
PAI	T	1-100 sec

The 50 mobile nodes are deployed randomly in the network area of 1000*1000 with each node is assumed to have one Omni directional antenna and uses two ray ground reflection radio propagation models. The mobility of 2 m/sec is assigned to each node with energy of 10 joules per node. The total energy of 50 mobile nodes is 500 joules. The data packet size is assigned with 50 KB, and is forwarded along the shortest paths toward the destination. Source generates constant bit rate that varies from 1 to 100 seconds, referred as packet arrival interval.

The EC valves between Existing and proposed EAQOSRP with Respect to PAI is tabled in given Table 3

Table 3: The variation of EC with PAI for existing and proposed model

PAI (seconds)	**EC (joules)**	
	AODV	**EAQOSRP**
10	6.98	6.24
20	6.98	6.24
30	6.98	6.22
40	6.97	5.75
50	6.97	5.75
60	6.97	5.74
70	6.97	5.73
80	6.96	5.73

The EC for existing model and proposed model decreases as the values of PAI increases. It is observed that the values of EC is less in the case of proposed model as compared to existing model

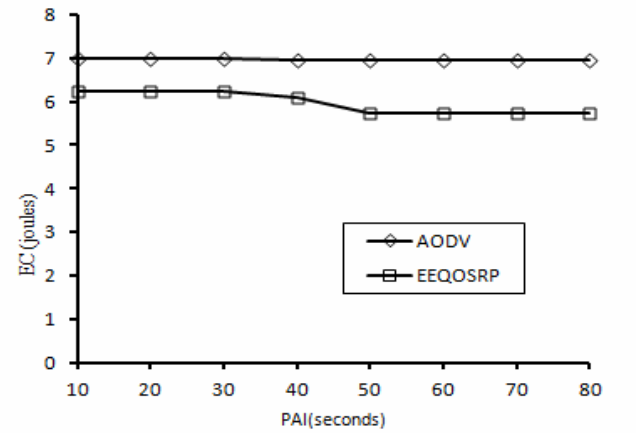

Figure 4 shows EC with PAI for Existing and Proposed Model

The variation of EC with PAI is shown in figure 4. The values of EC for existing model are almost constant for variation in PAI. The values of EC decrease with increases in PAI in proposed model. The values of EC are lower in the case of proposed model compared to existing model
The AEC values between Existing and proposed EAQOSRP with Respect to PAI is tabled in given Table 4

Table 4: The variation of AEC with PAI for Existing and Proposed Model

PAI secs)	AEC (joules)	
	AODV	EAQOSRP
10	0.142424	0.127477
20	0.142424	0.127476
30	0.142424	0.126986
40	0.142424	0.11705
50	0.142377	0.1175
60	0.142389	0.117242
70	0.14246	0.117048
80	0.14246	0.117048

The AEC for Existing model is almost constant and proposed model decreases as the values of PAI increases. It is observed that the values of AEC are less in the case Of proposed model as compared to existing model.

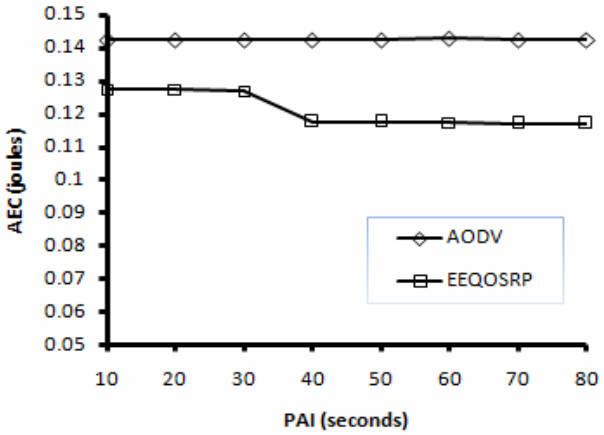

Figure 5 Shows AEC with PAI for Existing and Proposed Model

The variation of AEC with PAI is shown in figure 5. The values EC for existing model are almost constant for variation in PAI. The values of AEC decrease with increases in PAI in proposed model. The values of AEC are lower in the case of proposed model compared to existing model.

The PDR values between Existing and EAQOSRP with Respect to PAI is tabled in given Table 5

Table 5: The variation of PDR with PAI for existing and proposed model

PAI (seconds)	PDR	
	AODV	EAQOSRP
10	1.76	1.77
20	3.49	3.50
30	5.1072	5.17
40	50.971	51.623
50	58.574	59.2836
60	66.42	68.82
70	70.91	78.54
80	79.22	80.76
90	84.69	85.54
100	87.452	90.76

The PDR for Existing and Proposed model increases as the values of PAI increase. It is observed the values of PDR is more in the case of proposed model as compared to Existing model

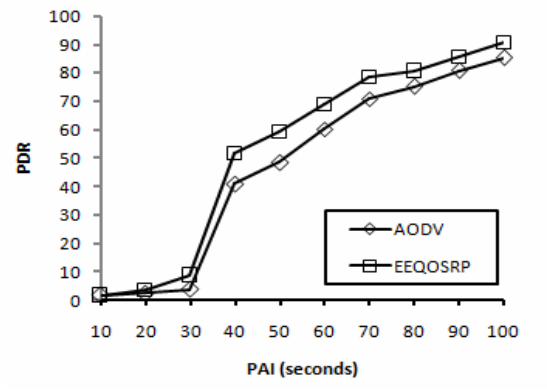

Figure 6 shows PDR with PAI for

Existing And Proposed Model

The variation of the PDR with PAI is shown in Figure 6. The value of PDR for existing and proposed model increases for variation in PAI. The values of PDR are higher in the case of proposed model compared to existing model.

PAI (sec)	T(Bits per second)	
	AODV	EAQOSRP
10	32839.2	32897.2
20	32839.2	32897.3
30	32839.2	32897.2
40	32839.2	33255.6
50	32781.1	33604.1
60	32819.8	33778.1
70	32819.8	33781.4
80	32848.2	3839.6
90	32732.2	33842.7
100	32316.2	33852.2

The T for existing model decreases as the values of PAI increases, and as the values of PAI increase the T increases in proposed model. It observed that the values of PDR are more in the case of proposed EAQOSRP model compared to Existing model.

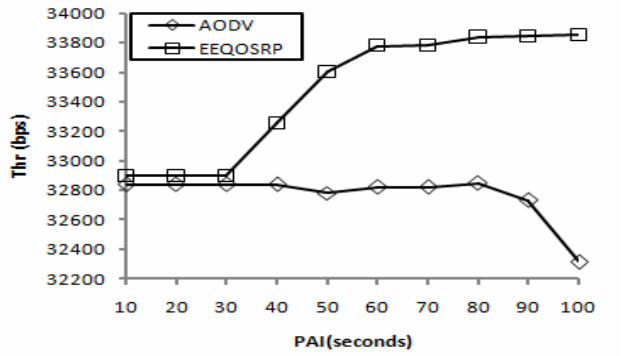

Figure 7 Shows T with PAI for Existing

The variation of the T with PAI is shown in Figure 5.4. The value of T for existing model almost decreases for variation in PAI. The values of T increases with increases in PAI in proposed model. The values of T are higher in the case of proposed model compared to existing model. The EED values between Existing and Proposed EAQOSRP with Respect to Path length (PL) is tabled in given Table 7

Table 7: The variation of EED with PL for existing and proposed model

PL (hops)	EED (seconds)	
	AODV	EAQOSRP
2	0.043	0.043
4	0.051	0.050
6	0.052	0.0513
8	0.1022	0.0523
10	0.1064	0.0524
12	0.1099	0.0635
14	0.1143	0.075
16	0.1247	0.084
18	0.1264	0.087
20	0.1291	0.125

The EED for existing model and proposed model is increase as the values of PL increases. It is observed that the values of EED is less in the case of proposed model compared to existing model

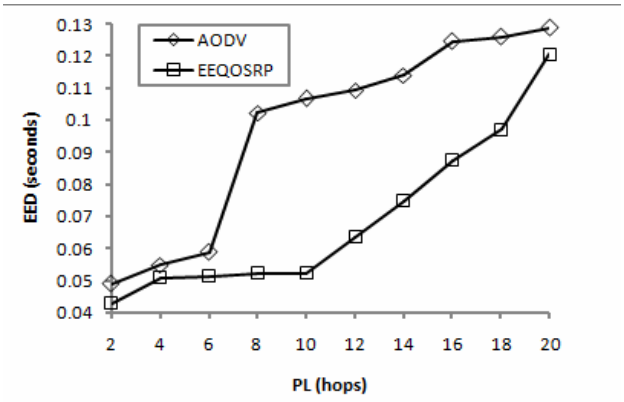

Fig 8 shows EED with PL for Existing and Proposed Model

Variation of the EED with PL is shown in Figure 5.5. The values of EED for existing model and proposed model are increases with respect to the PL. The values of EED are lower in the case of proposed model compared to existing model.

The advantages of proposed model compared to existing model are:

1. The priority is assigned to data packets in scheduling to transmit data packets from source node, hence energy consumption by source node decreases.
2. The multi hop transmission with TDMA is used to transmit data packets reduces time delay
3. The multi hop routing with QOST and shortest Path between Source and Destination increases the values of PDR
4. The Throughput increases since less time delay, high PDR, Multi hop transmission and Shortest Path in the Proposed Model.

VI. CONCLUSION

The Ad-Hoc network has wireless Communication between randomly moving nodes without fixed infrastructure. In this paper TDMA based Energy Efficient Quality of Service Routing Protocol is proposed. The network scenario is established by Considering area, number of nodes, and mobility to nodes using TCL. The multi hop routing technique is used based on TDMA. The AODV protocol is used between two nodes with QOST to establish route with shortest distance between Sources to Destination nodes. The packets are assigned priority at the source nodes and path between sources to destination is identified shortest path between source and destination in Scheduling. The performance values of Energy Consumption, packet delivery ratio, End to End delay, and Throughput are between in the case of proposed algorithm Compared to existing algorithm. In future the proposed algorithm can be tested with DSR protocol to improve performance parameters.

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