IJEAST

INTERNATIONAL JOURNAL OF ENGINEERING APPLIED SCIENCE AND TECHNOLOGY

VOLUME : 3 **ISSUE : 08** **Print / Issue Publication Date: 13-Jun-2019**

ISSN : 2455-2143

Indexed In

Google SCHOLAR
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Crossref

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International Journal of Engineering Applied Sciences and Technology, 2018
Vol. 3, Issue 8, ISSN No. 2455-2143, Pages 70-73

IMPROVING QOS IN ENERGY EFFICIENT HYBRID ROUTING PROTOCOL FOR MANET

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Abstract— **Mobile Ad-hoc network's inbuilt characteristics like self organization, frequent topology change, high mobility of nodes, and limited resource make quality of service in routing a difficult task. Unfair distribution of traffic density is one of the reasons of congestion in network and leads to higher packet loss, additional delay and earlier battery exhaustion on certain nodes. Energy Efficient Hybrid Routing Protocol (EE-HRP) performed well in medium dense and slow mobility network. To improve its performance in more dense network we have to reduce routing overhead of EE-HRP. For that we include QoS parameters like congestion intensity, queue delay and route aggregation in EE-HRP.**

Keywords— **MANET, Hybrid routing, EE-HRP, energy-efficient routing.**

I. INTRODUCTION

Mobile Ad-hoc network (MANET) is recent trends in today's communication era that has been developing enormously over the past few years [Ghode S.D et.al. (2013)]. Many researchers have developed a number of routing schemes to cope up with highly dynamic MANET environment. The reduction of routing overhead is a major concern in these routing protocols and still remains a vigorous area of research [Rajesh M.V et. al. (2017)]. A huge amount of real-time traffic uses high bandwidth and is responsible to congestion [Walikar G. A et.al. (2017)]. Conventional routing protocols uses minimum hop count to route packets without considering precise QoS constraints [Verma V. et.al. (2018)]. Therefore the path discovery and relay node selection is not adaptive and flexible in it [Sharma R. et.al. (2017)]. In [Ghode S.D et.al. (2016)] a novel energy efficient hybrid routing protocol (EE-HRP) is proposed which combines certain properties of based on transmission power control, load distribution approach and sleep/power down approach. We add QoS parameters like congestion intensity, queue delay and route aggregation in EE-HRP so that its performance can be improve in highly dynamic and more dense network.

The rest of the paper is organized as follows. Overview of earlier proposed hybrid protocol EE-HRP is mentioned in section II. Improvement in EE-HRP by adding QoS parameters is explained in section III. Experimental results are presented in section IV. Concluding remarks are given in section V.

II. OVERVIEW OF EE-HRP ALGORITHM

In In EE-HRP, the zones are created using location ID and nodes are assigned to particular zone using location ID of nodes and movement speed. Then communication within zone is performed by Intra-zone routing and communication outside the zone is performed using Inter-zone routing. Here source node broadcast route request (RREQ) message [Ghode S.D et.al. (2016)]. The RREQ contains <source_id, destination_id, hop_count, LT_m, Er_{min}, N_{sleep}, N_{speed}>. As RREQ packet travels along route m, the value of N_{sleep} and LT_m is updated such that the node having residual energy below certain Threshold value Th (in this case below 30%) are omitted from route. The destination node then calculate route selection indicator R_f^m as in eq. 1.

$$R_f^m = LT_m/hop\_count \qquad (1)$$

The destination node selects route with maximum R_f^m. In EE-HRP as traffic increases the packets are dropped due to congestion [Ghode S.D et.al. (2016)]. Moreover, when mobility speed is increased the routing overhead is increased because due to mobility the network topology changes and zone head has to update routing table according to topology changes which increases routing overhead [Kumar Abhishek (2017)]. To reduce this overhead we have to first collect and calculate queue length, stability of zone, and queuing delay of each node. The route is calculated based on the estimated parameters. Secondly, we assign priority to these routes and the source node will select particular path based on priority [Kuo W-K. et.al. (2016)]. To further reduce the control overhead, we aggregate the routes towards particular zone.

III. QOS BASED EE-HRP

To ensure QoS in proposed EE-HRP we add two more parameters into RREQ message. First is congestion intensity (CI) which is ratio of number of packets in the queue to the buffer size and second is queuing delay (QD) which is waiting time in the queue.

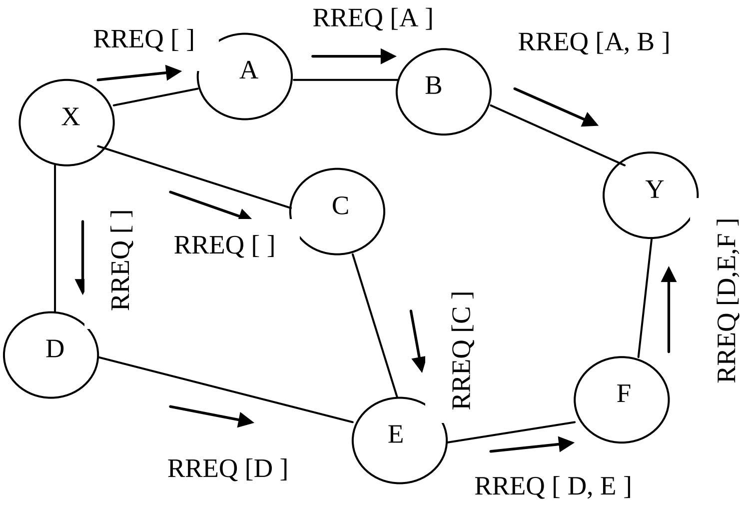

Fig. 1. RREQ message flow in EE-HRP

In fig 1, X is source node zone and Y is destination node zone. The source node will broadcast RREQ which is received by neighbor zone i.e., zone A, C and D. if destination node is in the zone then RREP is send back to source otherwise RREQ is forwarded to another set of neighbor zone like B and E. and then to F and Y.

Each ZH has all the details about communication done by the nodes under respective zone. Because the packets are send or received through ZH only, ZH makes list of all the senders and receivers in the zone by which we can able to calculate congestion intensity in the zone [Das S. K.. (2016)]. ZH also has the data about how many packets are send to node by which we can calculate queuing delay in node. At each zone the value of congestion intensity, queuing delay and average of node remaining energy is calculated and updated value of CI, QD and Er is added in RREQ. The destination is in zone Y which receives multiple RREQ from different zones as shown in fig. now ZH of zone Y calculate path rank (PR) and send RREP message through the path having maximum PR.

$$PR_{max} = \frac{\sum_{i=0}^{N}(LT_i \times Er_{min,i} \times (1-CI_i) \times (1-QD_i))}{N} \qquad (2)$$

Where, LT_i is the lifetime of route, $Er_{min,i}$ is minimum residual energy of node, CI_i is congestion intensity and QD_i queuing delay in node i, N is total number of nodes. We summarize the working of QoS based EE-HRP as follows:

1. Source node broadcast RREQ <source_id, destination_id, hop_count, LTm, Ermin, Nsleep, Nspeed, CI, QD> to neighboring zones.
2. The RREQ travels through the network and value of LTm, Ermin, Nsleep, Nspeed, C, QD is calculated and updated in routing table of Zone head.
3. The destination zone receives RREQ through different routes. It then calculate path rank for each received RREQ using eq. 2.
4. The destination then selects path having maximum rank to send Rote reply (RREP) to the source.

Route Aggregation

Route aggregation [Christopher F et.al. (2004)] means combining multiple routes into single route advertisement. In EE-HRP we use route aggregation to reduce control overhead. This is done as follows:

Each ZH forward RREQ message towards destination node's zone. As RREQ visits a zone, certain values like LT_m, Er_{min}, N_{sleep}, N_{speed}, C, QD is calculated and updated in routing table of Zone head. ZH can use this information for all future RREQ for which LTm time period is valid. And hence need not to update routing entries for each RREQ. However, in new RREQ if destination id is same as in earlier RREQ then instead of calculating new path, the stored path is used. And thus we can reduce overhead in EE-HRP.

IV. PERFORMANCE EVALUATION

We have carried out the performance evaluation of our work using Omnet++ simulator. We have compared working of QoS based EE-HRP against EE-HRP and LEAR. The different parameter setting is shown in table 1 below.

Table -1 Simulation Parameters

Simulation parameters	**Simulation values**
Simulation Time	0-100 sec
MANET standard	IEEE 802.11e
Number of nodes	50-800
Base protocol	ZRP
System Bandwidth	2 Mbps
Traffic type	CBR
Packet Size	512 bytes
Node Mobility	0-100 m/s
Transmission power	2.0 mW
Reception power utilized	5.0 mW
Simulation Environment	1500 * 1500
Channel Propagation	Wireless / Two ray Ground

We have used various performance metrics like packet delivery ratio, routing overhead and total power consumed. For simulation we consider two scenarios. In first network scenario we vary number of nodes and check the performance of QoS based EE-HRP in small and large network. And in second scenario we consider maximum movement speed of nodes and check effect of node mobility on QoS based EE-HRP.

Fig. 2 shows performance analysis for routing overhead. Fig 2(a) shows that the routing overhead of QoS EE-HRP is almost 10-15% less and it perform better in dense network. Fig 2(b) shows that routing overhead is less even if speed of mobile nodes is increased. The routing overhead is reduced because in QoS EE-HRP uses route aggregation by which ZH stores all the forwarding information in his table and use this information for new incoming packets hence there is no need to find routes for same destination node. Thus reduces the routing overhead.

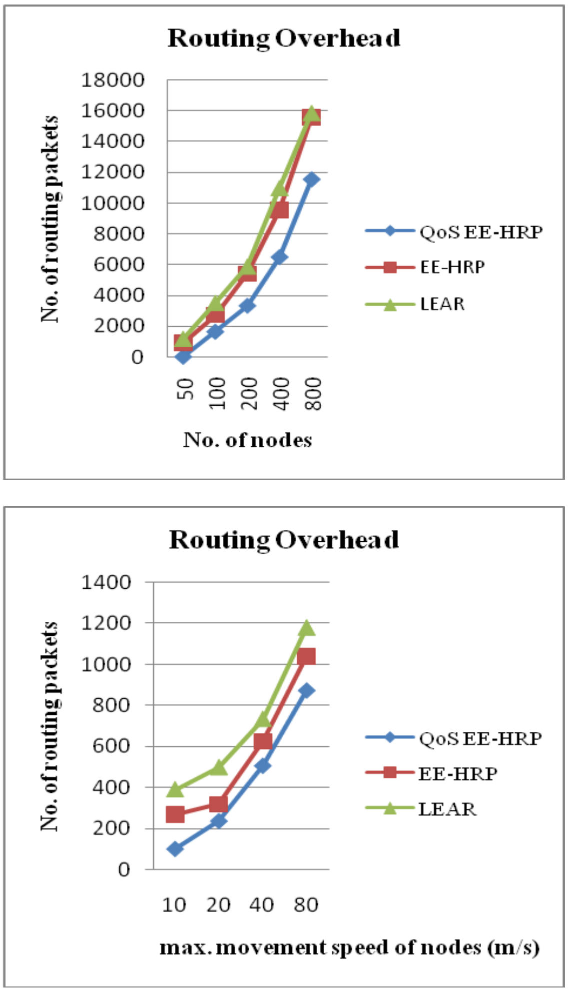

Fig. 2: routing overhead a) with varying no. of nodes b) with varying movement speed of nodes

Packet delivery ratio is increased in QoS EE-HRP which is comparatively more than EE-HRP and LEAR. In QoS EE-HRP, ZH calculates congestion intensity of the zone. The RREQ packet is forwarded by the zone having less congestion intensity and hence less packets are dropped and packet delivery ratio is increased. From fig 3 (a) we see that packet delivery ratio of QoS EE-HRP is increased by almost 5% than EE-HRP. It works well in low traffic as well as in dense network. Also mobility of nodes does not affect the performance of QoS EE-HRP.

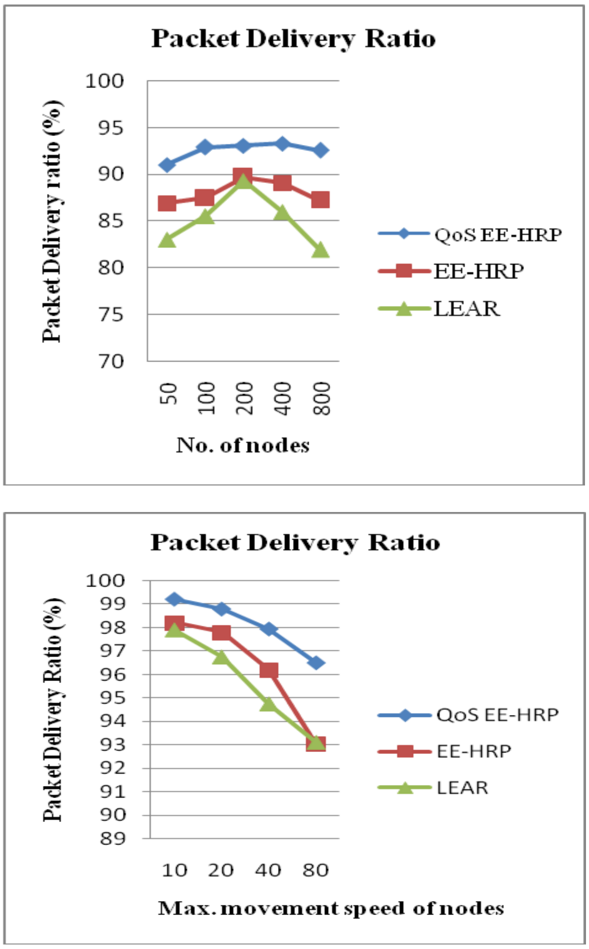

Fig. 3: packet Delivery ratio a) with varying no. of nodes b) with varying movement speed of nodes

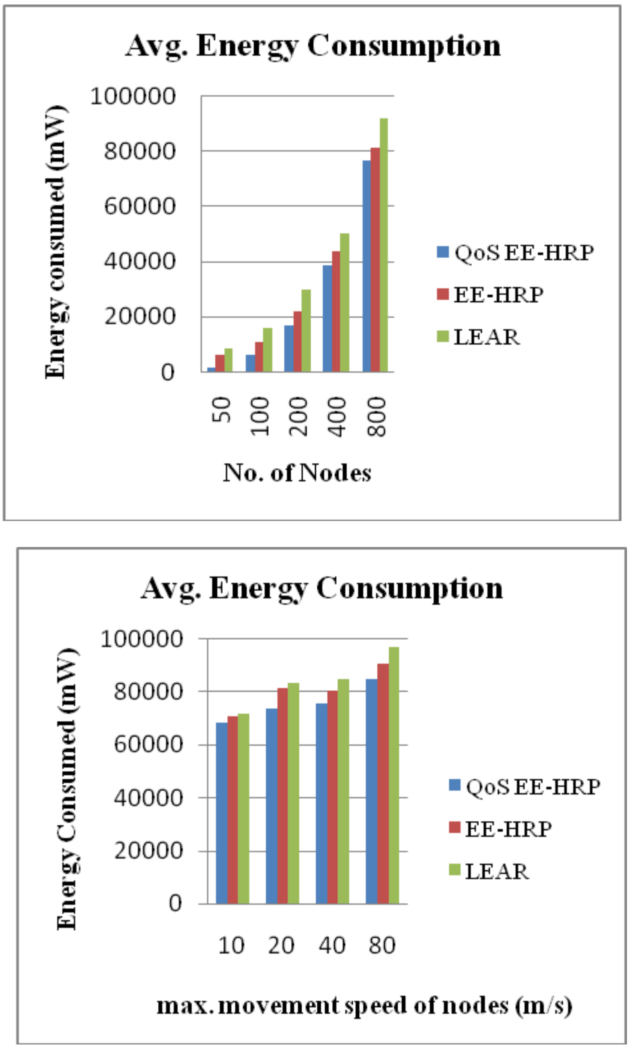

Fig. 4: Average Energy Consumption a) with varying no. of nodes b) with varying movement speed of nodes

As routing overhead is less in QoS EE-HRP the energy consumption is also minimum. The use of congestion intensity and queue delay parameters in RREQ message helps to reduce packet drops and retransmission of data. Because of route aggregation ZH does not require to calculate routes again for same source-destination pair. This reduces overhead in network and thus as shown in fig. 4 energy consumption is reduce to almost 10-20% in QoS based EE-HRP.

V.CONCLUSION

From performance evaluation we can conclude that by adding QoS parameter like congestion intensity, queue delay and route aggregation, the performance of EE-HRP is better in highly dense as well as in high mobility network

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