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Link Stability and Energy Aware routing Protocol for Mobile Adhoc Network

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Abstract: *MOBILE ad hoc networks (MANETs) have more popularity among mobile network devices and wireless communication technologies. A MANET is multihop mobile wireless network that have neither a fixed infrastructure nor a central server. Every node in a MANET will act as a router, and also communicates with each other. The mobility constraints in mobile nodes will lead to problems in link stability. Energy saving, path duration and stability will be two major efforts and to satisfy them can be difficult task. A self node which is present in the network may also consume little energy during the transmission. This proposed approach tries to account for link stability and for minimum drain rate energy consumption. In order to verify the correctness of the proposed solution a objective optimization formulation has been designed and a novel routing protocol called Link-Stability and Energy aware Routing protocols is proposed. This novel routing scheme has been compared with other two protocols: PERRA and GPSR. The protocol performance has been evaluated in terms of Data Packet Delivery Ratio, Normalized Control Overhead, Link duration, Nodes lifetime, and Average energy consumption.*
Keywords*-component; Energy Consumption, Link Stability, Routing, Self node*

I. INTRODUCTION

Energy is important in order to improve the efficiency and life time of the network. When we are offering more stability under the node mobility will leads to selection of shorter routes. This shortest path may not be suitable in all the cases, because the selection of shortest path will optimize the energy and can leads to selection of more fragile node. Our model will minimize the energy consumption and maximize the link stability.

The link stability probability is based on the random probability. Energy is important in order to extend the life time of the network. Link and path stability among the nodes can offer more benefits in terms of energy saving over MANET. The Description of some works related to link stability, energy metrics, and their respective protocols was given in this section [1] [2] [3] [4] [5] [6] [7] [8] [9]. The aim of energy-aware routing protocols is to reduce energy consumption in transmission of packets between a source and a destination, to avoid routing of packets through nodes with low residual energy, to optimize flooding of routing information over the network and to avoid interference and medium collisions. Many energy efficient routing protocol proposals were originally studied for sensor networks, where the limited energy of nodes is a strong constraint; in MANET, however, the requirements are different: a node has generally more hardware resources (capable of better performance, but consuming more energy) and the protocol must preserve the resources of every node in the network (not only a subset of them, because each node can be, at any time, source or destination of data). A single node failure in sensor networks is usually unimportant if it does not lead to a loss of sensing and communication coverage; ad-hoc networks, instead, are oriented towards personal communication and the loss of connectivity to any node is significant.

In the routing protocol design of mobile nodes, many issues need to be considered in order to offer many important properties such as scalability, QoS support, security, low power consumption and so on. In this chapter we focus on the energy issues facing some important aspects going from the energy model definition for the computation of the energy consumption to energy-aware metrics definition and routing protocol design. If a network composed of mobile nodes communicating using a wireless radio and where each node can communicate with each other using the other mobile nodes as relay nodes is applied in a communication system, many challenging design issues need to be addressed. MANET technology became, in the last years, more commercial in comparison with the past where it was used for military purpose and this implies more additional features to offer to the end user with particular reference to quality of service, security and to node lifetime duration. In this chapter energy saving techniques at network layer and the routing strategies that allow better energy expenditure and load distribution in order to prolong the network lifetime are considered. After defining a simple energy consumption model to use as reference for the protocol performance evaluation and after introducing some well-known energy based metric, some routing protocols belonging to different families of routing strategies are briefly presented. Section 2 discusses about related work, section-3 discusses about proposed system followed by implementation in Section-4. Section-5 discusses about result being accomplished and finally some concluding remarks are made in Section-6.

II. RELATED WORK

A. Mobility – Induced error on Geography Routing in MANET

In Geographic routing, the packet forwarding technique was solely based on the location information of neighbors [10]. Geographic routing in GPRS consists of two forwarding modes. i) Greedy packet forwarding, ii) Perimeter forwarding. Initially the packet was forwarded by greed forwarding in which all the nodes were identified the location based on the neighbor nodes. The packet forwarding mode has been changed in to perimeter forwarding mode when the node was found out the maximum location Final Stage.

B. Routing Protocols for MANET using Mobility Prediction

In the MANET the nodes can construct a path in the network using the routing capacity of the intermediate nodes. The communication was established in wireless multi-hop fashion. In other words the communication is established in a wireless multi-hop fashion. The node can also have other characteristics such as small size and battery powered, making the node not only mobile but also portable [11]. As a result MANET can operate in places and situations where traditional networks cannot work properly, such us in disaster recovery areas, rural zones, and third world countries.

C. Energy Efficient Routing Protocols for MANET

Energy efficient Routing will be the most important Design in MANET. Since mobile nodes are powered by batteries with limited capacity. Power failures of a mobile node not only affect the node alone, it will affect the entire network life time [12]. The routing protocols were proposed in MANETs are table-driven and on-demand driven routing. Routing in MANET includes new generation of on demand routing schemes (AODV, DSR, TORA, ABR etc) [13].Proactive routing schemes (OSPF, RIP) compute global routes in the background [14]. The Benefit of proactive routing includes low latency access, alternative paths for effective call acceptance control. These protocols concentrate on the energy properties scheme of applications.

D. Greedy Perimeter Stateless Routing for MANET

GPRS routing algorithm uses geography to achieve small per node routing state, small routing protocol message capacity, robust packet delivery etc. GPRS will use immediate neighbor information in forwarding decisions [15]. Routing protocol will relay on end to end state delivery path between a forwarding router and packet’s destination.

E. Minimum Energy Mobile Wireless Networks

Position based algorithm is used to maintain the minimum energy between the user. Each user will be denoted by nodes over two dimensional planes. Each mobile node has a portable transmission set, reception, processing capabilities [1]. This distributed protocol will find the minimum power topology in the Ad hoc networks

F. Stable Path Selection

Five Different Metrics have been proposed for stable path selection. The first technique is based on the local choice of the oldest link as the most stable link; the second class of metrics concerns the selection of the youngest links, because they are considered more resilient to breakage; the third criterion is based on the selection of the link with the highest average residual lifetime value; the fourth one makes selection of the link with the highest persistence probability; finally, the fifth metric focuses on the connection failure probability. The latter approach has been shown to be robust because it is based on the monitoring of the links lifetime of the mobile nodes in the wireless network, in the past and in the present, to predict its behavior, in the future without considering directly parameters depending by underlying mobility model such as node speed or direction. End-to-end delay of a source destination session is another considered performance metric, particularly for real-time applications.

Drawbacks of Existing System

- The network may contain few self nodes. These nodes will make of CPU power during the transmission from source node to Destination.
- The self node may consume the energy. This is not suitable for energy optimization.
- Every node will know about the neighborhood node only,
- Route looping can also occur while transmitting the longer packet. This is not suitable for energy optimization.

III. PROPOSED SYSTEM

The main contributions of the proposed system are the following:

1. A multi-objective mathematical formulation for the joint stability and energy problem is presented.
2. The proposed protocol is based on a geographic paradigm different by other routing protocols accounting for joint metrics, such as PERRA and GPSR. PERRA [16] is an on-demand routing protocol that provides new features achieving power efficiency and reliable data transmission. Greedy Perimeter Stateless Routing (GPSR) [17] is routing protocol for wireless datagram networks that uses the positions of routers and a packet's destination to make packet forwarding decisions.
3. Adoption of a novel stability metric based on the residual link lifetime concept. This metric is considered because it is independent on the transmission radius and node speed parameters that can be affected by measurement errors.
4. A novel energy aware-metric, adopted in our previous contributions, has been introduced in the proposed optimization model in order to consider not only the residual energy but also its time variation associated with the traffic load.
5. The multi-objective routing algorithm is integrated in the scalable routing protocol and its performance is tested through simulations and comparison with PERRA [16], GPSR [17].

In this study, it is assumed that each wireless node has the capability of forwarding an incoming packet to one of its neighboring nodes and to receive information from a transmitting node. In addition, each node is able to identify all its neighbors through protocol messages. It is assumed that each node does not enter in standby mode and each node can overhear the packet inside its transmission range and it is not addressed to itself.

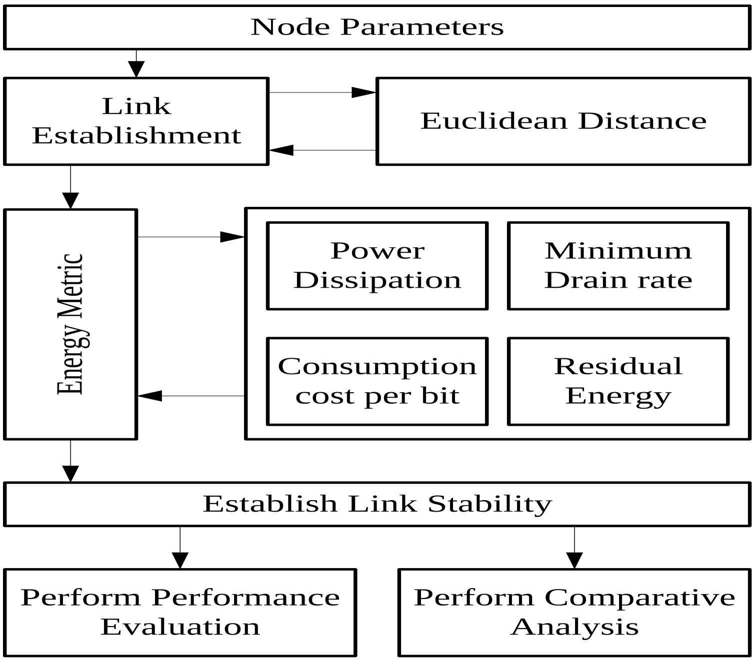

Figure 1 Overall Schema of Proposed System

The PROPOSED FRAMEWORK algorithm (See Figure 1) requires each node i to advertise its location (x_i, y_i, z_i), rate of energy consumption (MDR), and link stability index for each link outgoing by node i. We will insert the information mentioned above in PROPOSED FRAMEWORK HELLO packet. Each node broadcasts HELLO packets to all its neighbors that are in its communication range; each node in PROPOSED FRAMEWORK maintains the table of its direct neighbors. When a node receives the HELLO packet, it updates the information of the neighbor, if neighbor ID is already present in table or adds neighbor information, if it is a new neighbor.

The data forwarding strategy of PROPOSED FRAMEWORK is based on a greedy technique such as GPSR. However, differently by GPSR, the next hop selection tries to minimize the joint energy stability metric. PROPOSED FRAMEWORK packet forwarding presents high scalability property because only the neighborhood and destination knowledge are necessary for the greedy technique. The flexibility of energy-stability-based greedy forwarding is offered through the capability to weight the stability and the energy consumption on the basis of the interest of the application layer. This means that if an application is more sensitive to the path stability and, consequently, the link stability, it is possible to give more importance to the si;j index.

IV. IMPLEMENTATION

The proposed system is implemented in 32 bit Windows OS with 2.84GHz Intel Core-i3 processor with programming tool Matlab. Figure 1 highlights the architecture of the proposed system that majorly considers path stability metrics more than link stability metric. The proposed system is classified with energy metric evaluation and link stability metric which considers mainly the power dissipation factor that frequently alters with respect to the mobility of the nodes in the simulation area. The system mainly uses greedy approach where the data packets are forwarded based on the heuristic nature of the energy factors considers. The architecture is quite flexible for usage of minimum energy consumption even with highest mobility. The proposed system also exhibits the input entity as mobile node parameters e.g. number of nodes, initialized energy, Euclidean distance between two nodes, neighborhood nodes etc. The internal process signifies the implementation of PROPOSED FRAMEWORK protocol that ensures the better and efficient path with minimum energy consumption. Therefore, the output will result in a energy-aware stabilized path in the proposed system.

Fig.1 also exhibits the that the main process is basically decomposed to sequentially two more sub-processes termed as Energy aware metric and establishing path stability protocol. Initially, after encapsulating all the node parameters, a process is designed for initializing energy parameters which leads to generation of power consumption in transmission and power consumption in receiving. The next process consider the above two data (*Tx_power_Cons* and *Rx_power_Cons*) for evaluating power dissipation and the same is used again for applying the condition for selection of the neighboring nodes. Once the condition for selection of neighboring nodes are satisfied, exponential weighted moving average is estimated that finally leads to minimum drain rate estimation.

The energy aware metrics are considered which allows the nodes to perform broadcasting of location, rate of energy consumption and link stability index value to the neighboring nodes. It is important to point out that, starting from node i, the generic non-destination neighboring node j can be selected if and only if both the following conditions are satisfied: i) j has enough energy to receive the information sent from node i, and ii) j is able (in terms of energy) to transmit the information toward another relay node. The link stability index is evaluated using path loss exponent, which leads to evaluate the best distance. Greedy heuristics are applied that finally results in best and robust path exploration with highest value of residual energy of the node present in the stabilized links. The data forwarding strategy is based on a greedy technique. The next hop selection tries to minimize the joint energy stability metric. Proposed packet forwarding presents high scalability property because only the neighborhood and destination knowledge are necessary for the greedy technique. The flexibility of energy-stability-based greedy forwarding is offered through the capability to weight the stability and the energy consumption on the basis of the interest of the application layer. This means that if an application is more sensitive to the path stability and, consequently, the link stability, it is possible to give more importance to the stability index. On the other hand, an application that needs to prolong the network lifetime and to reduce the energy consumption also selecting longer route with higher data packet end-to-end delay. The algorithm responsible for the design is elaborated below:

Algorithm: Algorithm for Configuration and Visualization of Mobile Adhoc Network
Input: Number of nodes
Output: Number of sectors and cylinders
START
1. Initialize R_1 as the Transmission range.
2. Initialize number of mobile nodes, velocity.
3. Randomly initialize the Link Stability Index.
4. Design arc using r=[(2*pi)*R_1]/number of sectors in mobility area.
5. Estimate Number of Cylinder = (R_1/r);
6. Estimate the Angle of Orientation=360/ Number of Sectors in mobility area
7. Calculate number of cylinders
8. For r_t=1:m_cyl (t= 0:0.05:6.28)
9. x_1 = (x + r_t*r*cos(t))';
10. y_1 = (y + r_t*r*sin(t))';
11. XS_1=[x_1; x_1(1)]; YS_1=[y_1; y_1(1)];
12. Draw Cylinder (XS_1, YS_1);
13. End
14. Visualize selection of mobile Nodes in simulation area

END

Algorithm: Algorithm for Selection of best path

Input: Number of Nodes, Node location, Residual Energy, Stability index
Output: Selection of best stabilized path.
START
1. Initialize node i and node j
2. IF d (i, j) < R.
3. Link Exist.
4. ELSE
5. Link breakage
6. Estimate Link Life [t_{fin}- t_{in}]
7. Start advertisement using HELLO PACKET
8. HELLO PACKET= [Node_ID, Node_location, Residual Energy, Stability Index]
9. Estimate path-loss exponent
10. Apply Euclidean Distance among nodes with highest residual power.
11. Check for energy dissipation
12. Evaluate the best path in ascending order.
13. Extract the best path based on time of simulation and residual energy.
14. If Current Link Stability index < Minimum Link Stability index
15. Then Current Link Stability index = Minimum Link Stability index
16. Extract best path
END

V. RESULT DISCUSSION

The proposed system is evaluated with respect to PERRA and GPSR routing protocol. PERRA [16] uses a route discovery procedure through the RREQs propagation that involves just nodes that meet the source's energy requirements before transmitting data packets. Data packets are transmitted through the optimum path on the basis of the minimum residual energy, path stability, and total estimated energy to transmit and process a data packet. Alternative routes are prepared in case of link break and used before an actual break occurs. Similarly, GPSR [17] makes greedy forwarding decisions using only information about a router's immediate neighbors in the network topology. When a packet reaches a region where greedy forwarding is impossible, the algorithm recovers by routing around the perimeter of the region. By keeping state only about the local topology, GPSR scales better in per-router state than shortest-path and ad-hoc routing protocols as the number of network destinations increases. Under mobility's frequent topology changes, GPSR can use local topology information to find correct new routes quickly. The proposed system has considered the similar node parameters for the comparative performance evaluation of the proposed system with respect to PERRA protocol and GPSR protocol.

The simulation is performed on node number that varies from 50-100 with variation in other node-determinants too (transmission range, residual energy etc.). Figure 2 highlights the evaluation of the energy consumption with respect to the flow of the simulation. It can be seen that proposed scheme has less energy consumption compared to PERRA protocol. However, usage of GPSR using the same simulation environment proved the best energy restoration with respect to node energy conservation. Figure 3 shows the trends of packet delivery ratio where it can be seen that although GPSR has highest packet delivery ratio, but the proposed system ensures very smooth packet delivery ratio. In order to ensure the minimum drain rate, the proposed system ensures the packet delivery ratio that is superior to PERRA protocol but less superior to GPSR protocol.

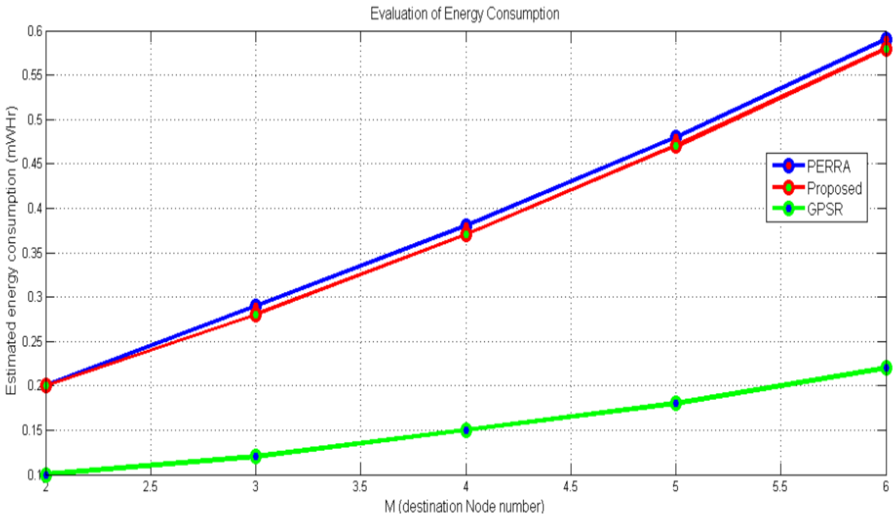

Figure 2 Evaluation of Energy Consumption

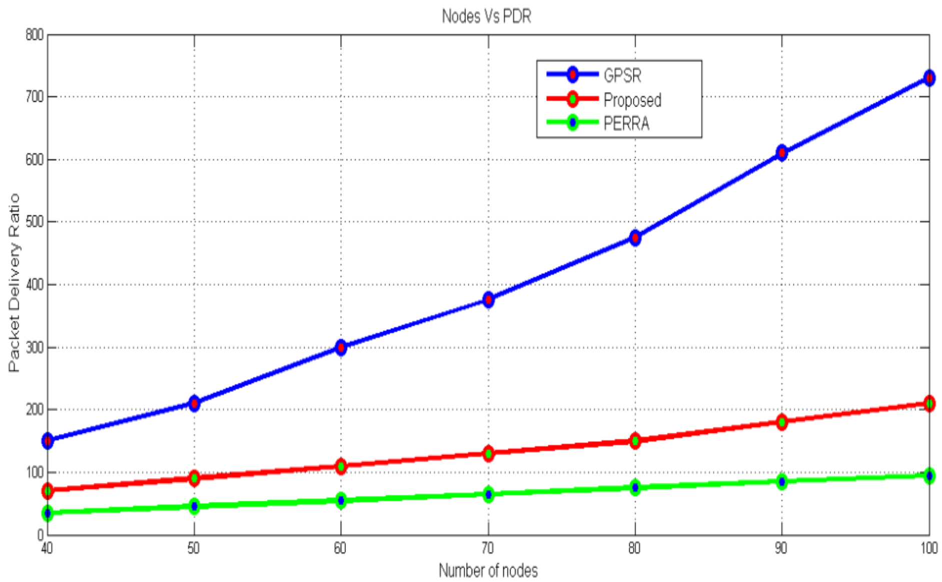

Figure 3 Number of Nodes Vs Packet Delivery Ratio

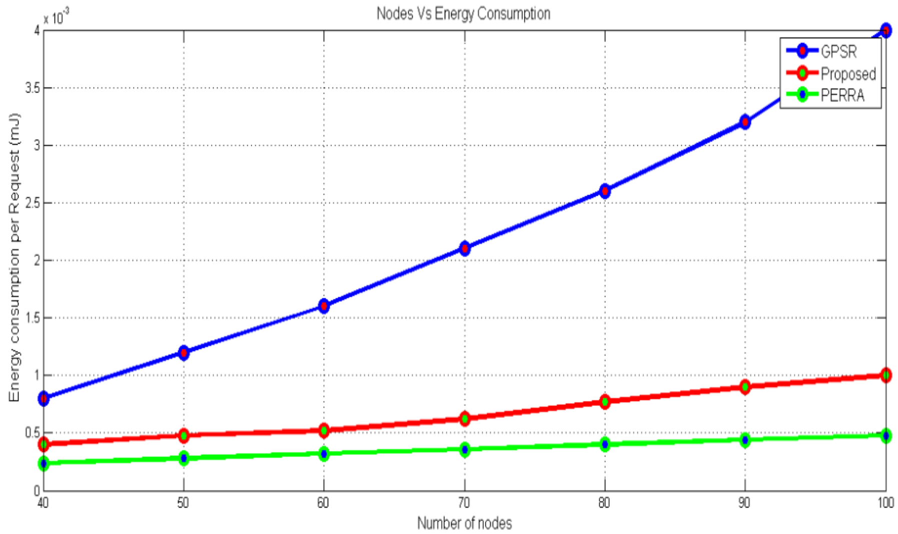

Figure 4 Number of Nodes vs Energy Consumption

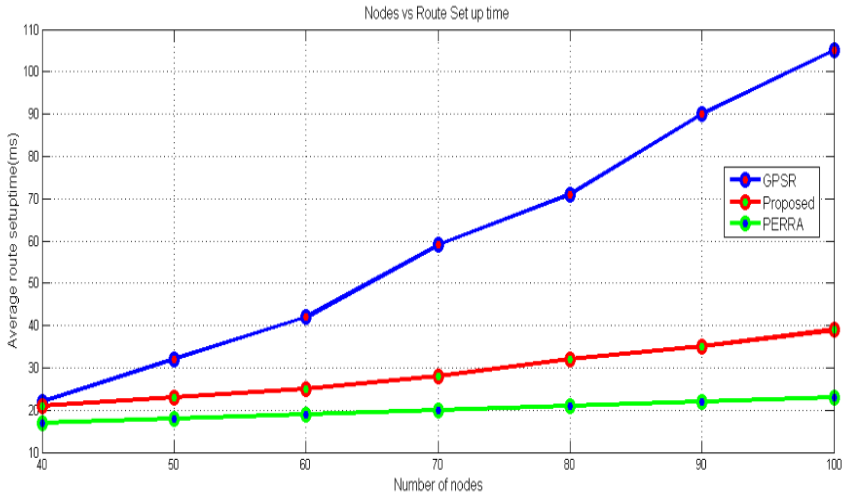

Figure 5 Number of Nodes vs Route Setup time

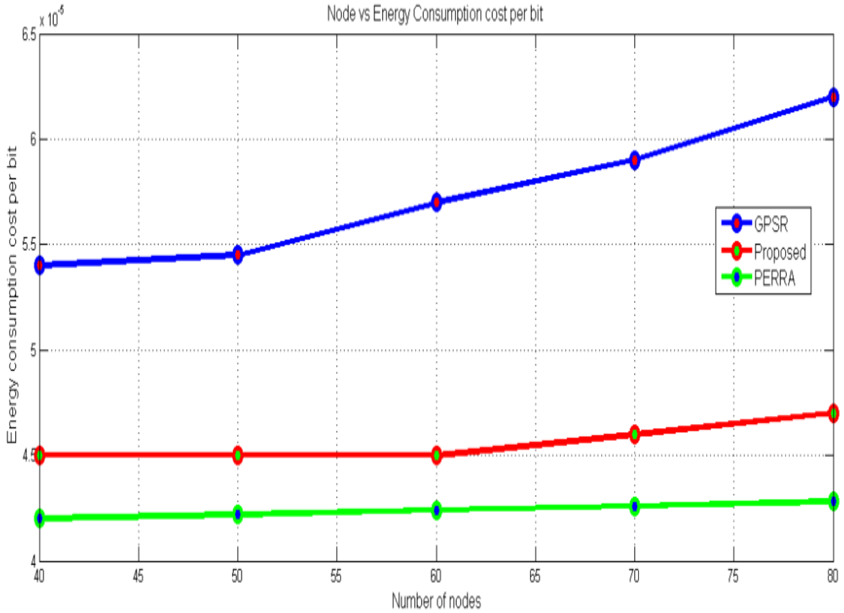

Figure 6 Number of Nodes vs Energy Consumption cost per bit

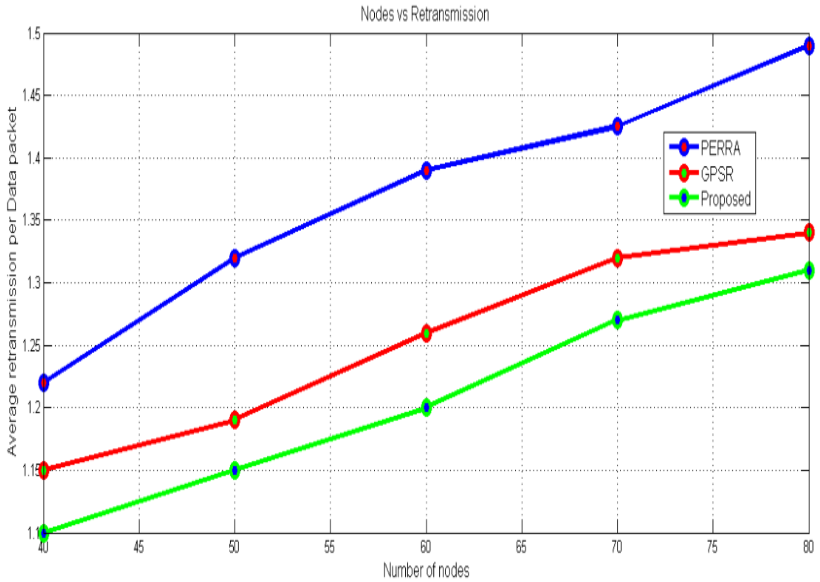

Figure 7 Number of Nodes vs Retransmission

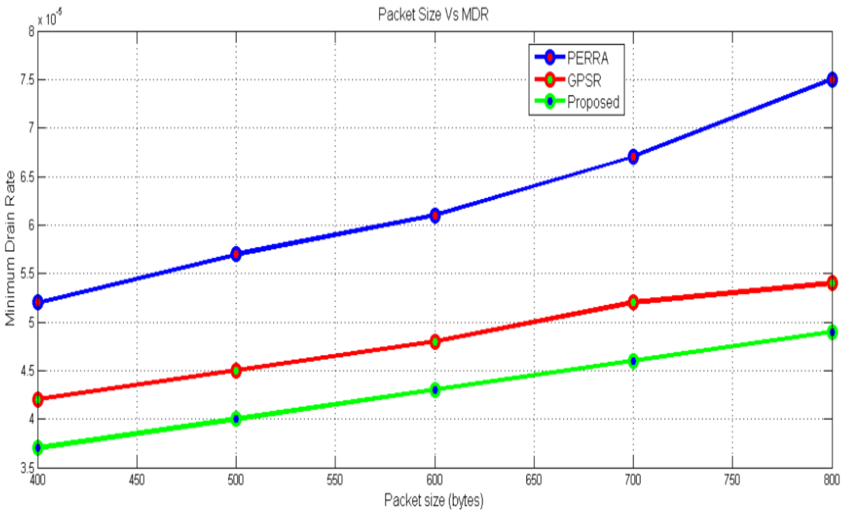

Figure 8 Packet Size Vs Minimum Drain rate

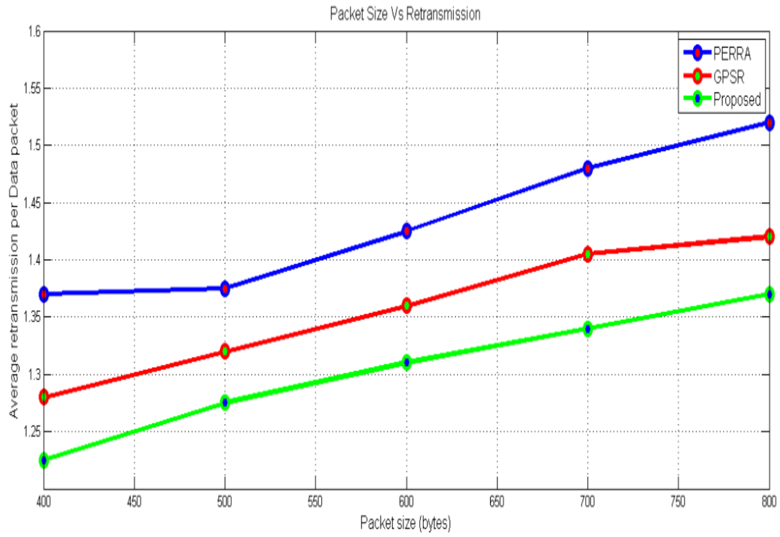

Figure 9 Packet Size vs Retransmission

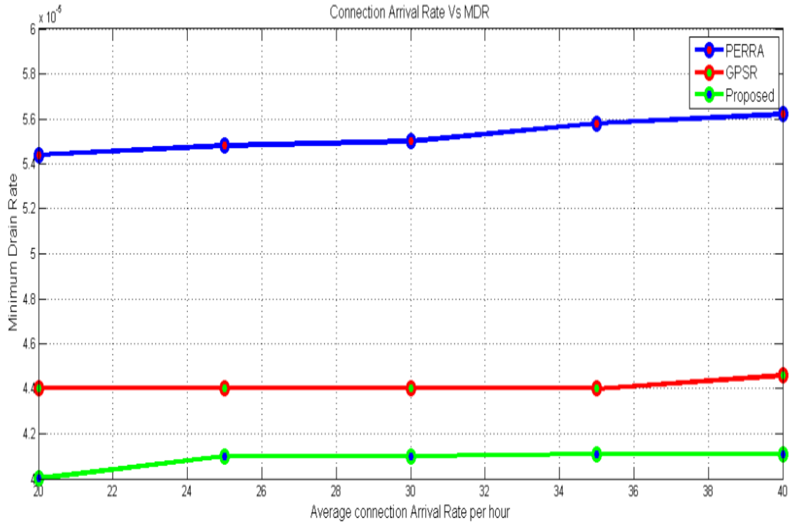

Figure 10 Connection Arrival Rate vs Minimum Drain Rate

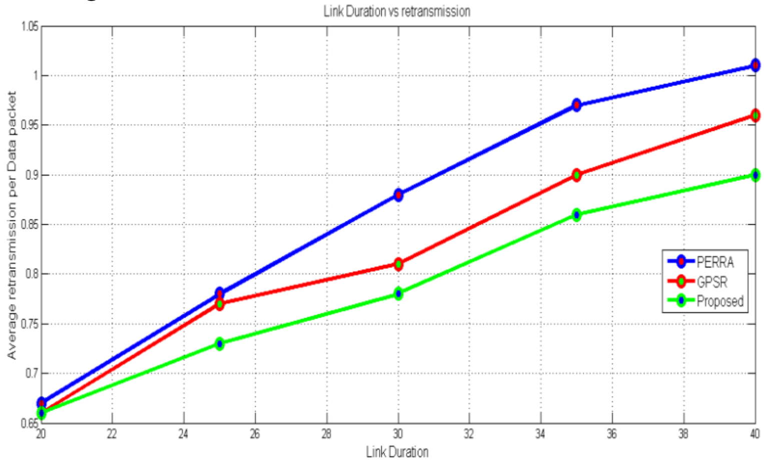

Figure 11 Link Duration vs retransmission

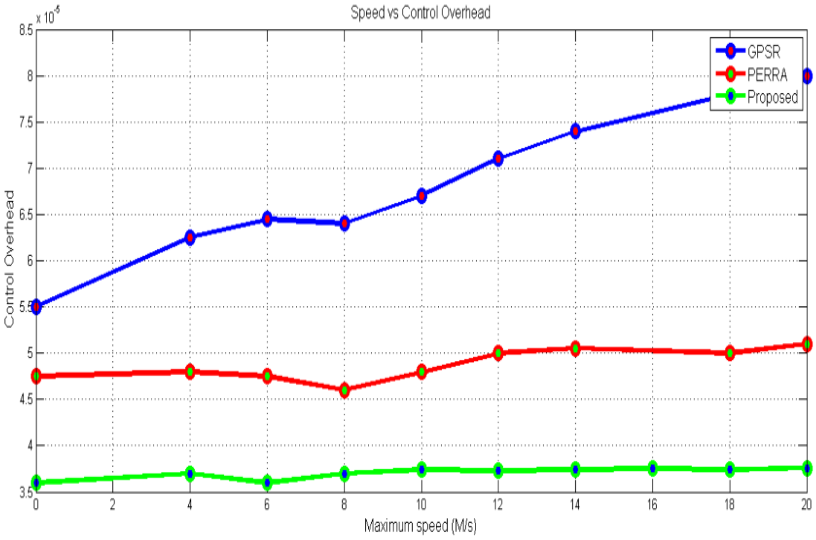

Figure 12 Speed vs Control Overhead

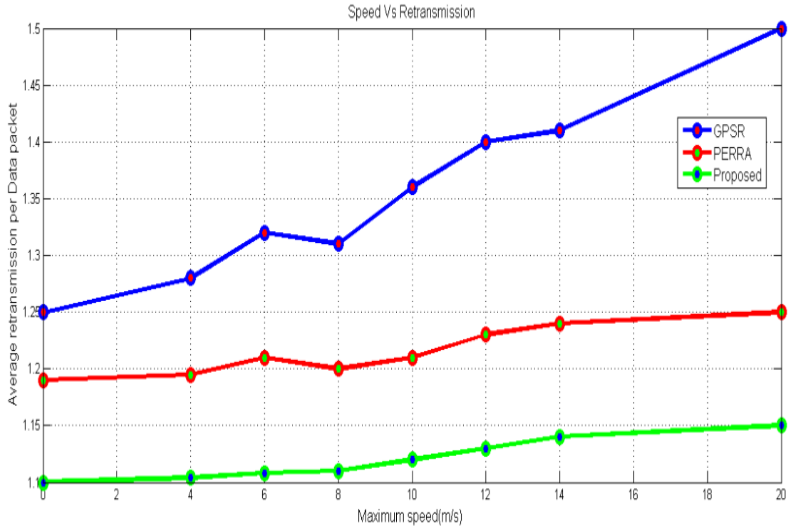

Figure 13 Speed vs Retransmission

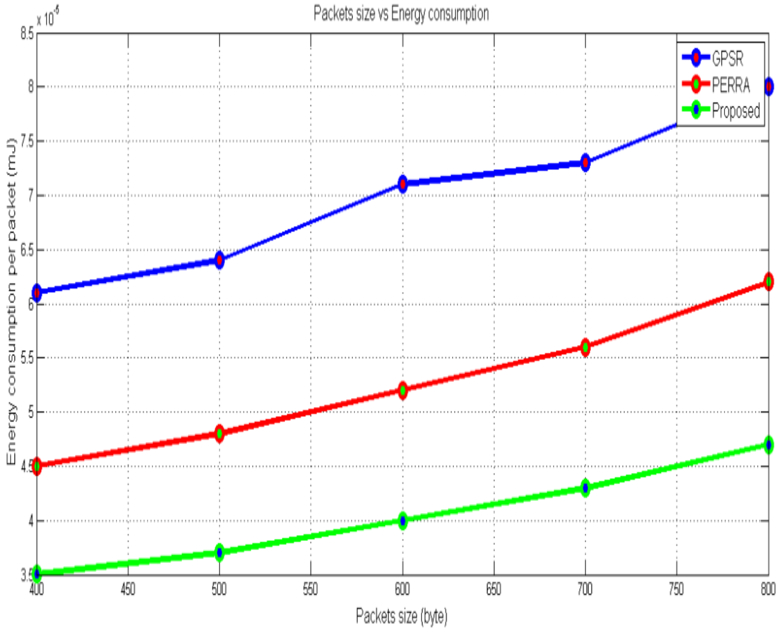

Figure 14 Packet Size Vs Energy Consumption

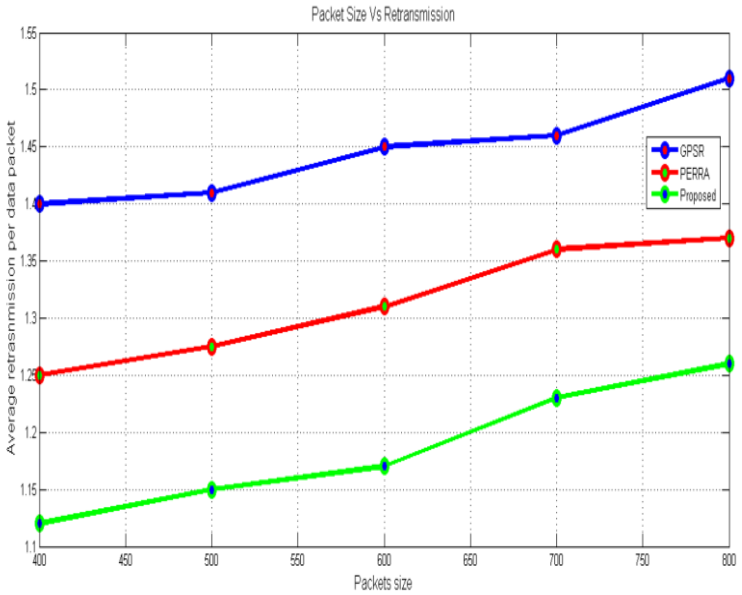

Figure 15 Packet Size vs Retransmission

Figure 4 shows the variation of number of nodes with respect to energy consumption. It can be seen that with increase of number of nodes GPSR has highest energy consumption which truncates the possibility of better performance in fig.2 and fig.3. Figure 5 shows the variation of number of nodes with respect to route set up time. It can be seen that increase in the number of nodes maximizes the route set up time in case of GPSR. However, proposed protocol performs much better compared to GPSR in this respect. Figure 6 shows the variation of the number of the nodes versus energy consumption cost per bit. The system shows that the there is an abundant increase of energy drainage cost per bit on GPSR protocol. Figure 7 shows the comparison of number of nodes versus retransmission. It can be seen that proposed system has comparatively lesser event of retransmission even with increase in higher number of nodes and thereby claiming to be better optimization of the energy factor in the proposed system. Figure 8 shows the comparison of the proposed protocol with respect to PERRA and GPSR considering Packet size versus minimum drain rate. It can be observed hypothesis turning true when the proposed system shows less score of minimum drain rate as compared to PERRA and GPSR.

Figure 9 shows the result for impact of data packet size with the retransmission. The results shows that even with higher usage of data packet size, the proposed system performs considerably less events of retransmission as compared to PERRA and GPSR. Figure 10 shows the results of connection arrival rate versus minimum drain rate. It can be seen that our proposed system has considerably less drain rate when connection arrival rate is incremented as compared to PERRA and GPSR. Fig. 11 shows the link duration versus retransmission. Just like the previous result, it can be seen that proposed system has considerably less retransmission event when the link duration is maximized as compared to PERRA and GPSR. Fig.12 shows the impact of mobility on control overhead. The result addresses the dynamic topology of MANET by truly targeting to minimize as less control overhead as possible and thereby it outperforms the traditional PERRA and GPSR protocol. Fig.13 is the continuation of Fig.12, where we are interested to find the impact of mobility on retransmission. The proposed scheme shows that by introducing random waypoint mobility (RWM) and our proposed geometrical topology development in MANET in sector and cylinder has greatly minimize the retransmission events as compared to PERRA and GPSR protocol. Fig. 14 shows the impact of packet size to the energy consumption in MANET. Due to the consideration of minimum drain rate and cost per bit of data packet, the proposed system shows considerably lesser power consumption compared to GPSR as well as PERRA routing protocol. Fig.15 shows the impact of packet size on the event of the retransmission. The proposed system shows considerable less events of retransmission compared to PERRA and GPSR.

VI. CONCLUSION

The proposed system discusses about a scalable routing protocol based on the joint metric of link stability and energy drain rate, has been proposed. It is based on the local topology knowledge and it makes use of a greedy technique based on a joint metric and a modified perimeter forwarding strategy for the recovery from local maximum. Its performances have been compared with other three protocols proposed in literature such as GPSR and PERRA. The proposed protocol inherits the scalability of GPSR improving the performance in terms of node selection with higher link duration when a higher weight is given to the stability index and a higher residual energy is given to energy aware index. Proposed framework reduces the variance permitting a lower dispersion of node energy around the average, because the use of an energy aware metric is able to consider not only the residual energy but also the drain rate trend and the traffic load on each single node. A higher traffic load on a specific node implies a higher drain rate and faster energy consumption. This means that also the energy metric of PROPOSED FRAMEWORK is better than PERRA permitting to discriminate between nodes with the same residual energy but with different traffic load. The proposed protocol outperforms PERRA in terms of control overhead and in terms of a higher capability to balance traffic load due to the minimum drain rate metric included in the joint metric. Moreover, also the average link duration can be longer in comparison with PERRA and GPSR, due to the capability to better discriminate the node behavior associated not only with the current node condition but also with the history of link lifetime.

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