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Improving Geographic Routing in Mobile Ad-hoc Network via Adaptive Position Update and Mobility Based Forwarding

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Abstract:
A Mobile ad hoc network (MANET) is a self-configuring infrastructure-less network of mobile devices connected by wireless. Each device in a mobile Adhoc network is free to move independently in any direction, and will therefore change its connections to other devices very frequently. In geographic routing, nodes need to maintain up-to-date positions of their immediate neighbors for making effective forwarding decisions. Continuous monitoring of beacon packets that contain the geographic location coordinates of the nodes is a popular method used by most geographic routing protocols to maintain neighbor positions. We estimate that periodic beaconing regardless of the node mobility and traffic patterns in the network is not attractive from both update cost and routing performance points of view along network delay and degradation in network lifetime.

Keywords: AODV, DSR, GPS, GPSR, GLS, EAPU

I. INTRODUCTION

An Ad hoc network is a collection of mobile nodes, which forms a temporary network without the aid of centralized administration or standard support devices regularly available as conventional networks. These nodes generally have a limited transmission range and, so, each node seeks the assistance of its neighbouring nodes in forwarding packets and hence the nodes in an Ad hoc network can act as both routers and hosts. Thus a node may forward packets between other nodes as well as run user applications. By nature these types of networks are suitable for situations where either no fixed infrastructure exists or deploying network is not possible. Ad hoc mobile networks have found many applications in various fields like military, emergency, conferencing and sensor networks. Each of these application areas has their specific requirements for routing protocols. Since the network nodes are mobile, an Ad hoc network will typically have a dynamic topology, which will have profound effects on network characteristics. Network nodes will often be battery powered, which limits the capacity of CPU, memory, and bandwidth. This will require network functions that are resource effective. Furthermore, the wireless (radio) media will also affect the behaviour of the network due to fluctuating link bandwidths resulting from relatively high error rates. These unique desirable features pose several new challenges in the design of wireless Ad hoc networking protocols. Network functions such as routing, address allocation, authentication and authorization must be designed to cope with a dynamic and volatile network topology. In order to establish routes between nodes, which are farther than a single hop, specially configured routing protocols are engaged. The unique feature of these protocols is their ability to trace routes in spite of a dynamic topology. In the simplest scenarios, nodes may be able to communicate directly with each other, for example, when they are within wireless transmission range of each other. However, Ad hoc networks must also support communication between nodes that are only indirectly connected by a series of wireless hops through other nodes. For example, in Fig 3.1, to establish communication between nodes A and C the network must enlist the aid of node B to relay packets between them. The circles indicate the nominal range of each node's radio transceiver. Nodes A and C are not in direct transmission range of each other, since A's circle does not cover C.

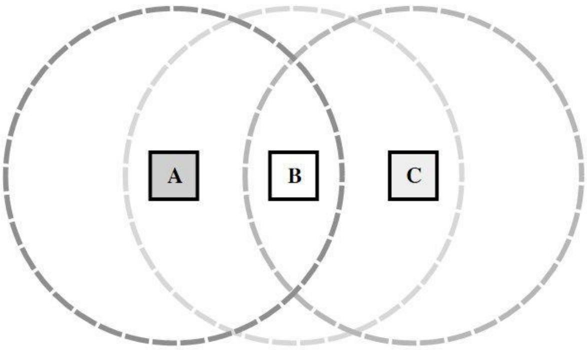

Figure.1. A Mobil Ad hoc network of three nodes, where nodes A and C must discover the route through B in order to communicate.

With the growing popularity of positioning devices (e.g. GPS) and other localization schemes , geographic routing protocols are becoming an attractive choice for use in mobile ad hoc networks. The underlying principle used in these protocols involves selecting the next routing hop from amongst a node's neighbours, which is geographically closest to the destination. Since the forwarding decision is based entirely on local knowledge, it obviates the need to create and maintain routes for each destination. By virtue of these characteristics, position-based routing protocols are highly scalable and particularly robust to frequent changes in the network topology. Furthermore, since the forwarding decision is made on the fly, each node always selects the optimal next hop based on the most current topology. Several studies, have shown that these routing protocols offer significant performance improvements over topology-based routing protocols such as DSR and AODV .The forwarding strategy employed in the aforementioned geographic routing protocols requires the following information: (i) the position of the final destination of the packet and (ii) the position of a node's neighbours. The former can be obtained by querying a location service such as the Grid Location System (GLS) or Quorum. To obtain the latter, each node exchanges its own location information (obtained using GPS or the localization schemes discussed in [1]) with its neighbouring nodes. This allows each node to build a local map of the nodes within its vicinity, often referred to as the local topology. However, in situations where nodes are mobile or when nodes often switch off and on, the local topology rarely remains static. Hence, it is necessary that each node broadcasts its updated location information to all of its neighbours. These location update packets are usually referred to as beacons. In most geographic routing protocols (e.g. GPSR) beacons are broadcast periodically for maintaining an accurate neighbour list at each node. Position updates are costly in many ways. Each up-date consumes node energy, wireless bandwidth, and increases the risk of packet collision at the medium access control (MAC) layer. Packet collisions cause packet loss which in turn affects the routing performance due to decreased accuracy in determining the correct local topology (a lost beacon broadcast is not retransmitted). A lost data packet does get retransmitted, but at the expense of increased end-to-end delay. Clearly, given the cost associated with transmitting beacons, it makes sense to adapt the frequency of beacon updates to the node mobility and the traffic conditions within the network, rather than employing static periodic update policy. For example, if certain nodes are frequently changing their mobility characteristics (speed and/or heading), it makes sense to frequently broadcast their updated position. However, for nodes that do not exhibit significant dynamism, periodic broadcasting of beacons is wasteful. Further, if only a small percentage of the nodes are involved in forwarding packets, it is unnecessary for nodes which are located far away from the forwarding path to employ periodic beaconing because these updates are not useful for forwarding the current traffic.

II. LITERATURE REVIEW

Quanjun Chen[1] proposes the Adaptive Position Update (APU) strategy for geographic routing, which dynamically adjusts the frequency of position updates based on the mobility dynamics of the nodes and the forwarding patterns in the network. APU is based on two simple principles: 1) nodes whose movements are harder to predict update their positions more frequently (and vice versa), and (ii) nodes closer to forwarding paths update their positions more frequently (and vice versa).The benefits of APU are further confirmed by undertaking evaluations in realistic network scenarios, which account for localization error, realistic radio propagation, and sparse network. *Brad Karp[2] proposes* Greedy Perimeter Stateless Routing (GPSR), a novel routing protocol for wireless datagram networks that uses the *positions* of routers and a packet's destination to make packet forwarding decisions. GPSR makes *greedy* forwarding decisions using only information about a router's immediate neighbours 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. Under GPSR, packets are marked by their originator with their destinations' locations. As a result, a forwarding node can make a locally optimal, greedy choice in choosing a packet's next hop. Specifically, if a node knows its radio neighbours' positions, the locally optimal choice of next hop is the neighbour geographically closest to the packet's destination. Forwarding in this regime follows successively closer geographic hops, until the destination is reached. The main advantage is that with respect to the path length, the end-to-end hops of GPSR are the largest due to the usage of perimeter mode which leads to increased latency. The major disadvantage is that the neighbour finding using beacon update incurs high overhead. *Michele Zorzi[4]* proposes Geographic Random Forwarding is based on the assumption that sensor nodes have a means to determine their location and that the positions of the final destination and of the transmitting node are explicitly included in each message. In this scheme, a node which hears a message is able (based on its position toward the final destination) to assesses its own priority in acting as a relay for that message. All nodes who received a message may volunteer to act as relays and do so according to their own priority. This mechanism tries to choose the best positioned nodes as relays. In addition, since the selection of the relays is done a posterior, no topological knowledge or routing tables are needed at each node, but the position information is enough. Geographic routing is used here to enable nodes to be put to sleep and waken up without coordination and to integrate routing, MAC, and topology management into a single layer. MAC scheme based on these concepts and on collision avoidance and report on its energy and latency performance. The proposed scheme performs significantly better for sufficient node density. The overhead in this scheme is very high.

III.PROPOSED ALGORITHM

Geographic routing scheme uses Periodical beacon broadcasting to exchange neighbours' locations. In the periodic beaconing scheme, each node broadcasts a beacon with a fixed beacon interval. If a node does not hear any beacon from a neighbour for a certain time interval, called neighbour time-out interval, the node considers this neighbour has moved out of the radio range and removes the outdated neighbour from its neighbour list. The neighbour time-out interval often is multiple times of the beacon interval. Periodic beaconing can cause the inaccurate local topologies in highly mobile ad-hoc networks, which lead to performances degradation, e.g. frequent packet loss and longer delay. The outdated entries in the neighbour list are the major source that decreases the performance.

A. Mobility based forwarding node selection (Highly stable Greedy forwarding)

In Mobile Ad-hoc Networks if forwarding nodes have high mobility, may chances to make local topology inaccuracy. If the node involved in the forwarding path node moves frequently then there is the situation of frequent beacon update is required which leads to network traffic in turn packet collision. Hence it is required to select the nodes with low mobility which means selection of stable node as forwarder based on its mobility. This project with low mobility based forwarding node selection that improves routing performance more than APU. Source node finds the distance of each neighbour from itself at particular time (t). After certain time (t+T) it finds the distance again. If the difference between the two distances is less than the threshold, the neighbour is considered as highly stable neighbour. To apply highly stable greedy forwarding distance between destination and highly stable neighbours are calculated. The neighbour which is having the minimum distance is selected as forwarder.

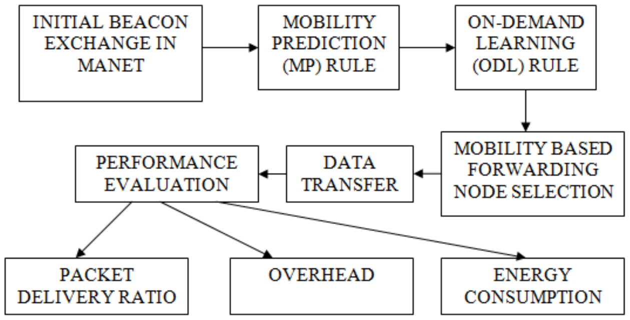

Figure .2. Block diagram to show working of the proposed system

B. Algorithm for selection of forwarder

Step1: Find distance [d(t)] of each neighbor from source at time T

Step2: Find distance [d(t+T)] of each neighbor from source at time (T+t)

Step3: If {[d(t+T)] ~[d(t)] < Threshold }→ Select the neighbor as high stable link

Step4: Find distance D_{des} between destination and the node having high stable link

Step5: Link having minimum D_{des} is selected as next hop

IV. SIMULATION AND RESULTS

The adaptive position update and mobility based forwarding node selection schemes can be simulated and tested in a simulated environment with the help of a network Simulator tool. To test the performance of our work, we ran simulations using ns-2.35. We use the IEEE 802.11 MAC protocol in RTS/CTS/Data/ACK mode with a channel data rate of varied from 1.0 to 2.0. The packet size used in our simulations is 1500 bytes. The topologies vary according to the different Simulation purposes.

A. Simulation Parameters

SIMULATOR	Network Simulator 2
NUMBER OF NODES	48
INTERFACE TYPE	Phy/WirelessPhy
MAC TYPE	802.11
QUEUE TYPE	Droptail/Priority Queue
QUEUE LENGTH	200 Packets
ANTENNA TYPE	Omni Antenna
PROPAGATION TYPE	Two ray Ground
ROUTING PROTOCOL	DSR
APPLICATION AGENT	CBR
TRANSMISSION POWER	1.0watts
RECEPTION POWER	1.5watts
SLEEP POWER	0.01watts
IDLE POWER	0.0watts
INITIAL ENERGY	100Joules
SIMULATION TIME	40seconds

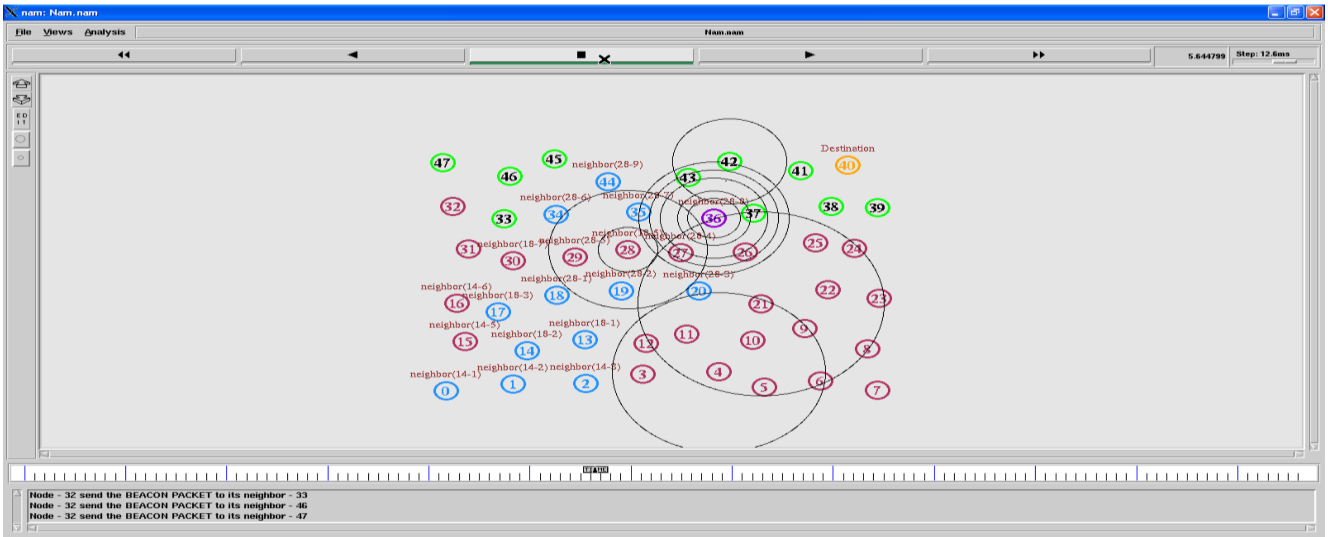

Figure.3. Simulation Screenshot

Performance Evaluation Parameters

PDR

PDR is the proportion to the total amount of packets reached the receiver and amount of packet sent by source. If the amount of malicious node increases, PDR decreases. The higher mobility of nodes causes PDR to decrease.

PDR (%) = Number of packets successfully delivered to destination /

Number of packets generated by source node

Energy Consumption

It is the amount of energy consumed by the nodes for the data transmission over the network

Energy Consumption= Sum of energy consumed by each node

Overhead

Overhead = Number of messages involved in beacon update process

From the trace obtained from the data transmission from source to destination, performance metrics such as energy consumption, overhead, and packet delivery ratio are obtained using the awk script. Awk script processes the trace file and produces the result. Using the results obtained from awk script graph is plotted for performance metrics using xgraph tool available in ns-2.

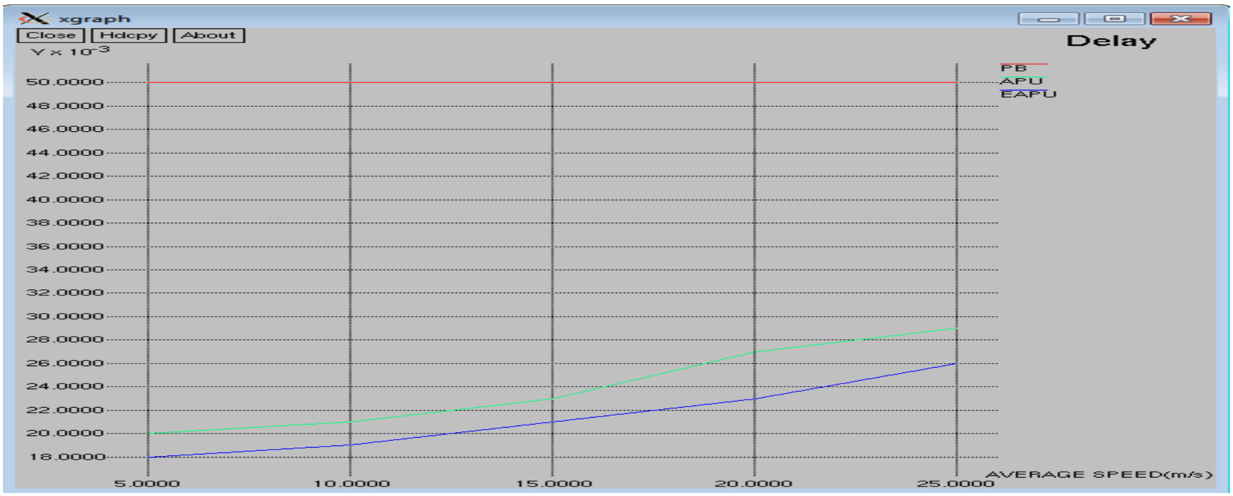

Figure.4. Delay Vs Speed(m/s)

Average delay in Periodic beacon scheme is high compared to APU and EAPU since periodic beacon causes packet collision and dropping of packets in the network. EAPU reduces the delay by avoiding unnecessary beacon update and do the beacon update adaptively.

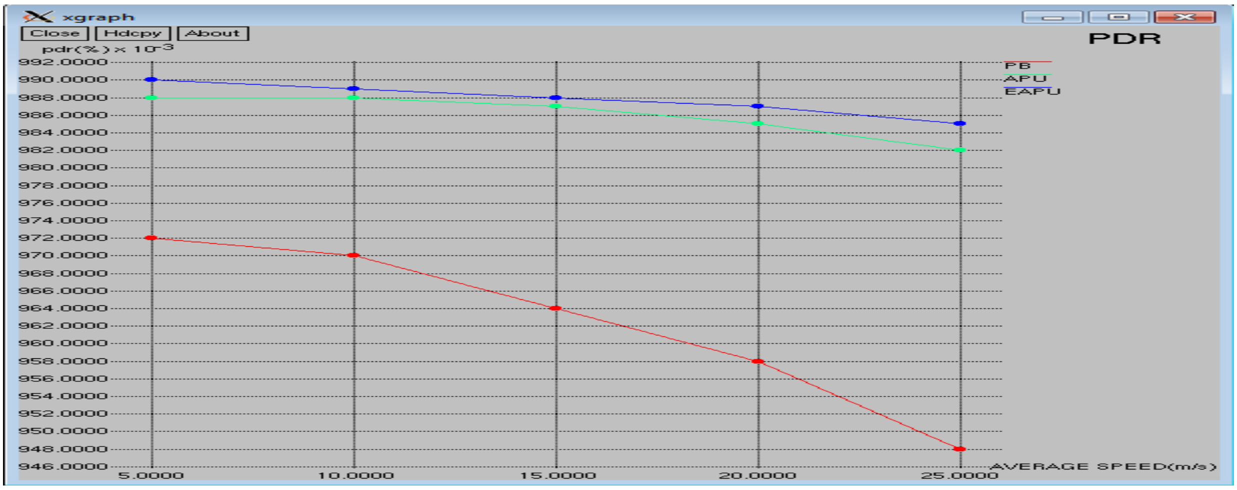

Figure.5. PDR Vs Speed(m/s)

Packet Delivery Ratio in Periodic beacon scheme is low as compared to APU and EAPU since periodic beacon causes collision of packets. EAPU improves Packet delivery ratio by avoiding unnecessary beacon update and do the beacon update adaptively.

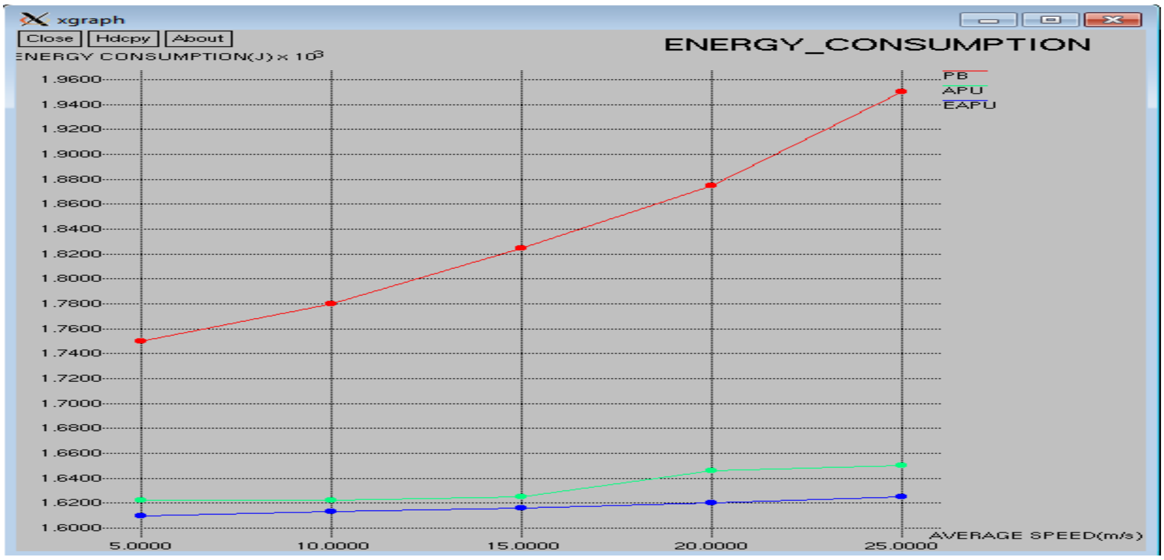

Figure.6. Energy Consumption Vs Speed(m/s)

Energy consumption in Periodic beacon scheme is high compared to APU and EAPU since periodic beacon causes high energy consumption in the nodes. EAPU saves energy by avoiding unnecessary beacon update and do the beacon update adaptively.

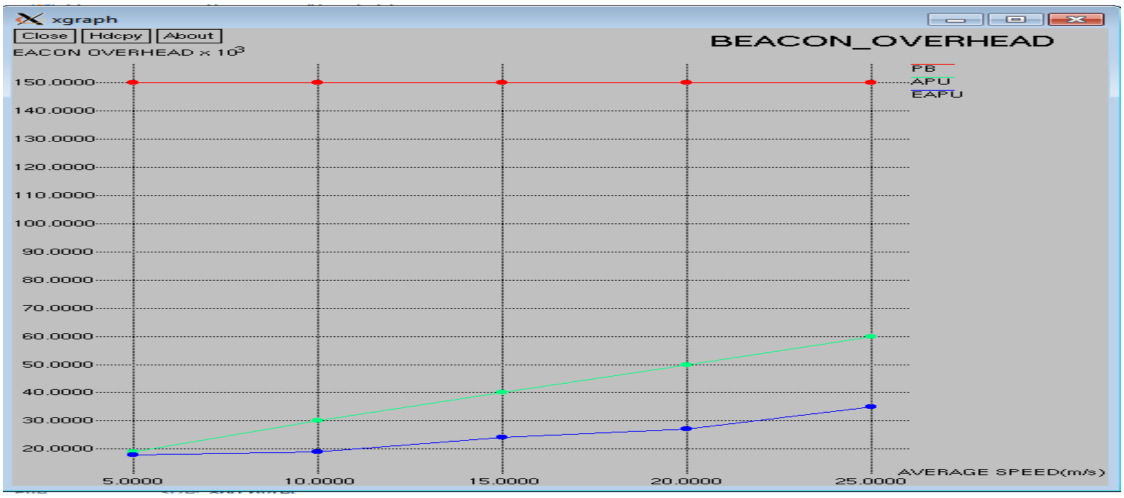

Figure.7. Beacon Overhead Vs Speed(m/s)

Beacon overhead in Periodic beacon scheme is high compared to APU and EAPU since periodic beacon causes increase of overhead in the network. APU and EAPU reduces beacon overhead by avoiding unnecessary beacon update and do the beacon update adaptively.

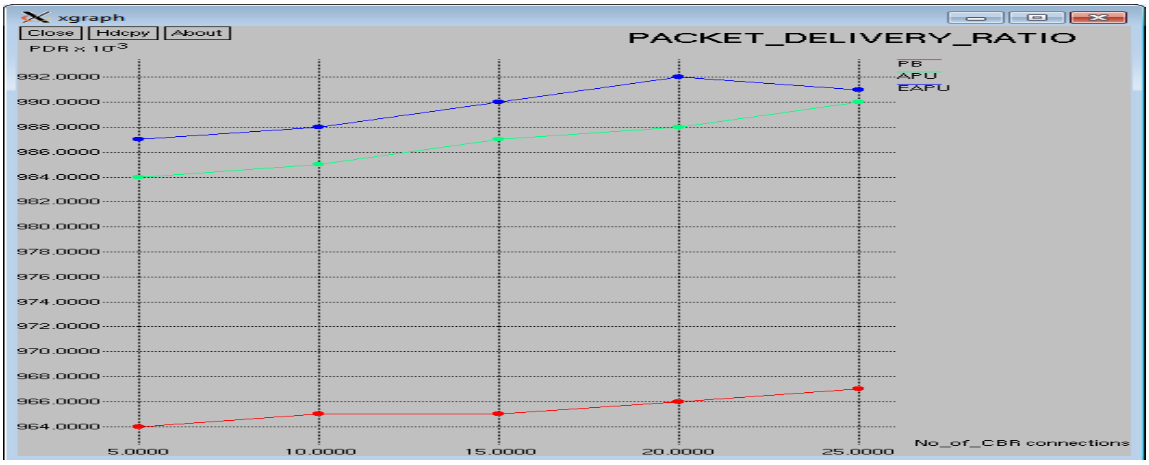

Figure. 8. Packet Delivery Ratio Vs Number of CBR Connections

Packet delivery ratio of EAPU is high compared to APU and Periodic beacon scheme. Since network traffic in EAPU is reduced due to adaptive beacon update and destination route selection instead of periodic beacons in the case of periodic beacon scheme. In PB data gets dropped due to high traffic in the network.

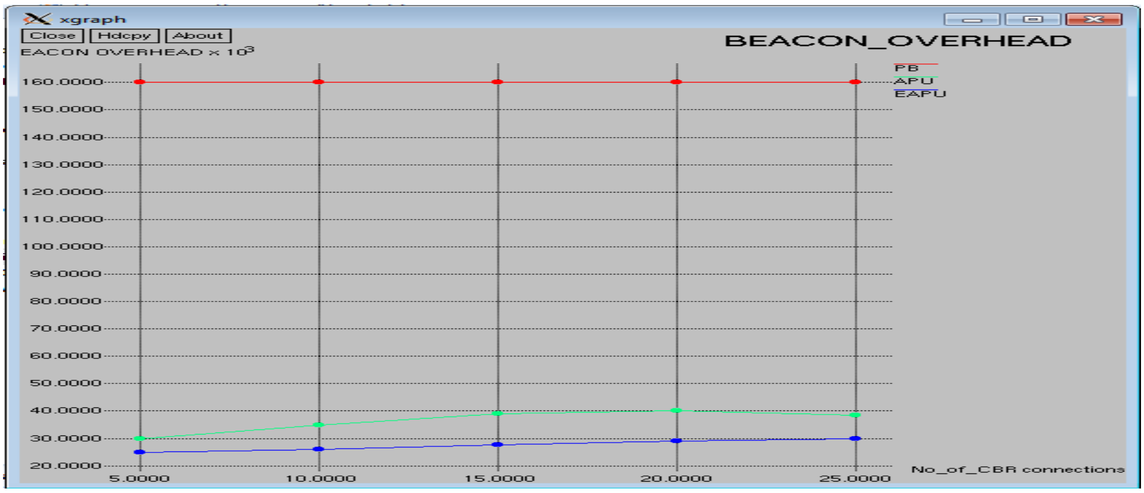

Figure.8. Beacon Overhead Vs Number of CBR Connections

Beacon overhead in Periodic beacon scheme is high compared to APU and EAPU since periodic beacon causes increase of overhead in the network. APU and EAPU reduces beacon overhead by avoiding unnecessary beacon update and do the beacon update adaptively.

V. CONCLUSIONS

In this work, the need to adapt the beacon update is identified and the corresponding policy is employed in geographic routing protocols to the node mobility dynamics and the traffic load. The Adaptive Position Update (APU) strategy is proposed to address these problems. The APU scheme employs two mutually exclusive rules. The MP rule uses mobility prediction to estimate the accuracy of the location estimate and adapts the beacon update interval accordingly, instead of using periodic beaconing. The ODL rule allows nodes along the data forwarding path to maintain an accurate view of the local topology by exchanging beacons in response to data packets that are overheard from new neighbours. Performance of APU is evaluated using extensive NS-2 simulations for varying node speeds and traffic load. Results indicate that the APU strategy generates less or similar amount of beacon overhead as other beaconing schemes but achieve better packet delivery ratio, less overhead and energy consumption.

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