Enhanced Energy Efficiency in Adaptive Position Update using Low Energy Adaptive Clustering Hierarchy Protocol

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***Abstract*- In the Mobile Ad hoc Network, nodes are moving dynamically so that for routing the nodes need to maintain the positions of their neighbours to find the effective forwarding. The most common method for finding the location coordinates of the node is the periodic broadcasting of beacon packets. We indicate the regular beaconing anyway of the traffic patterns and node mobility in the ad hoc network in energy efficient view. For that we use the Adaptive Position Update in that use two rule: Mobility Prediction (MP) and Advanced On Demand Learning (AODL) rules. We use the LEACH algorithm to forwarding the beacon packets with less energy consumption. Our study consumes less energy that is evaluated in terms of cost, energy consumption, packet loss and traffic and improves the packet delivery ration and average end-to-end delay.**

Index Terms- Wireless communication, algorithm/protocol design and analysis, routing protocols.

I. INTRODUCTION

Mobile Ad Hoc Network is a robust infra structure less wireless network [1]. The ad networks are formed to work without any centralized framework. In practice the network nodes communicate with each other even if there is no static infra structure such as backbone network and base station and centralized management functions or Internet Service Providers (ISPs) are available. It can be designed either by fixed and mobile nodes or by mobile nodes. Nodes randomly affiliate with each other to form virtual topology.

A MANET is an autonomous system of mobile nodes. The system may work independently, or may have the gateways to interface with a fixed network. There is current and future need for dynamic ad hoc networking technology [1]. The characteristics of the MANET are dynamic topologies, variable capacity links, energy constrained operations and limited physical security.

Manuscript received March 19, 2014

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With the increasing in location system, and positioning devices [2], the geographical routing protocols are an impressive way to use in the mobile ad hoc network [3],[4],[5]. The Mobile Ad hoc Network (MANET) is the set of nodes communicate and move, without any kind of fixed wired infrastructure. Several works [3],[5] have shown that these routing protocols offer significant performance improvements over topology-based routing protocols such as DSR [7] and AODV [8].

In the position based routing protocol, nodes periodically broadcast beacons to announce their presence and location to their neighbours. Each node saves all neighbours and their current positions in a neighbour table. The nodes within the transmission range that receives the beacons are present in this table. If a node does not receive any beacon within a certain interval called neighbour time- out interval from one of its neighbours [9], then that node is considered as left from the transmission range or is unreachable due to any other reason and that node is deleted from the neighbour table.

Position updates are costlier in many ways. Each update uses the node energy, wireless bandwidth and rise in risk of packet collision in the Medium Access (MAC) layer [10]. Thus data packets are lost and routing performance is decreased due to these packet collisions. The end-to-end delay is increased due to the retransmission of lost data packet. Distinctly, cost for sensing the beacon updates and traffic conditions within the network is more than employing a static periodic update policy.

Adaptive Position Update [10] is a beaconing strategy for geographical routing and it includes two rules for activating the beacon process. First rule, Mobility prediction estimate the simple mobility prediction scheme when the location information broadcast in the previous beacons become incorrect. Second rule, On-Demand Learning (ODL) goal is to increasing the accuracy of the topology along the routing paths between the communicating nodes.

In this paper we propose the Low Energy Adaptive Clustering Hierarchy (LEACH) algorithm is used for forwarding the beacon packets and analyzed the protocol based on network lifetime, stability period and the network throughput.

II. RELATED WORK

In geographic routing, the locations of the node's neighbours and location of the packet destination is used to make the forwarding decision at each node. So the forwarding nodes need to maintain these locations. Different works are done to discover and maintain the location of destination eg. GLS [11], Quorum System [12].

Some of the routing systems, e.g.,[13][14], simply consider that a location of its neighbours are known by the forwarding node. Others, e.g., [3],[15],[16], use periodical broadcasting of beacon to exchange the neighbours' locations. Each node broadcasts a beacon with a fixed interval in the periodic beaconing scheme. If a node does not receive any beacon from its neighbour for a neighbour time-out interval, the node assumes this neighbour has moved out of the range and deletes the outdated neighbour from its list.

T. Braun at. [9] have prove that periodic beaconing can produce the inaccurate local topologies in highly mobile ad-hoc networks, which decreases the performance, e.g., frequent packet loss and longer delay. The reduction in performance is due to the outdated entries in the neighbour list. They proposed many simple optimizations that adapt beacon interval to traffic load, including distance-based beaconing (DB), speed-based beaconing and reactive beaconing.

In the distance-based beaconing, when a node moved a distance d, transmits a beacon. The node removes an outdated neighbour if the node does not receive any beacons from the neighbours. This method is adaptive to the node mobility and it has two problems. First, slow node may contain many outdated neighbours in its neighbour list. Second, the slow node may not detect when the fast node is passed over it, this is due to the infrequent beaconing of the slow node.

In the speed-based beaconing, the beacon interval is relying on the node speed. Nodes piggyback their neighbour time-out interval in the beacons. A received node compares the own time-out interval with piggybacked time-out interval and then it select the small time-out interval for this neighbours. This reduces the first problem in the distance-based beaconing. But has the problem of fast node may not detect the slow nodes.

In reactive beaconing, data packet transmission triggered the beacon generation. For each data transmission, node first broadcasts a beacon request packet. The neighbours receiving the request packet respond with beacons. Thus, accurate local topology for the node is build before the data transmission. But this lead to the problem of high traffic load in the network due to excessive beacon broadcasts.

Q. Chen at [10] proposed the mobility prediction to build an enriched view of the local topology. Nodes positions are estimated and predicted using the linear kinematic equations based on the last announced beacon parameters. If the location predicted from the equations is different from the actual location, then a new beacon is broadcast to announce the

Characteristic changes to its neighbours.

III. PROPOSED WORK

In our approach we use the LEACH algorithm in the APU technique to improve the energy consumption. The Mobility Prediction(MP) rule sends the beacon packets to its neighbour nodes to announce the nodes location and based on this beacon packet neighbour node predict the location. The On-Demand Learning(ODL) rule is used to maintain the accurate local topology along the routing paths between the communicating nodes. The LEACH algorithm is used to reduce the energy usage by the beacon, data packets and forwarding in the network. LEACH works in two phases: setup phase and steady phase. The block diagram of the APU using LEACH is shown in Fig. 3.1.

In geographical routing the packet destination is found by the location of one-hop neighbour nodes to decide the effective forwarding decision of that node. To do so the nodes need to maintain a up-to-date updates of its neighbouring packets so that the forwarding decision will be succeeded perfectly within the local topology. To maintain the neighbouring position the most popular method used by geographical routing protocol are broadcasting the periodic beacon packets that contains the geographical location coordinates.

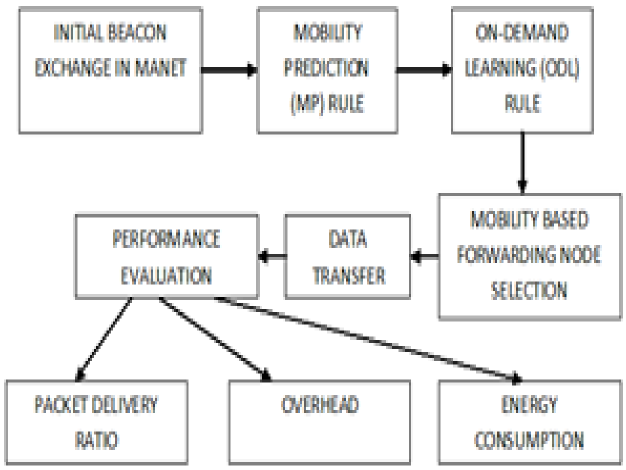

Fig.3.1 Block diagram of APU using LEACH

A. *Initial Beacon Exchange in MANET*

Nodes which are located within the communication range are known as neighbours. In manet each nodes starts to send beacon packet to its neighbour nodes to find the position and location of its neighbouring coordinates. By this way each node identifies its neighbour by sending beacons. Thus a particular node will set up a list of nodes that are neighbour to it and starts communicating to other nodes and exchnges the messages.

B. *Mobility Prediction (MP) Rule*

The Node is triggered when there is change in the location of the node. The change in the location of the node is cannot be predicated because it moves in the random direction. So the beacon packet is send when the deviation is greater than the threshold condition and it is known as Acceptable Error Range (AER). It act node to send the beacon packets to the neighbouring nodes.

The current position and speed is stored in the beacon transmitted by the nodes. In real time scenario, the nodes will estimate their positions periodically by providing linear kinematics equations based on the factors that parameterized from the lat announced beacon. When there exist a change from actual location to predicted location, broadcasting of new beacon will be send to the neighbours about the changes that have been encountered based on the mobility characteristics.

C. On-Demand Learning (ODL) Rule

The name itself provides that, On-demand a node broadcasting a beacons i.e., In a particular area the node will involves in the forwarding activities in response to the data. This rule states that whenever a node sense a data transmission from a new neighbour (i.e., overhears a beacon with a data packet) a beacon will be broadcasted as a response such that we imply a new neighbour who is contained in the neighbour list of the node. In practical, to avoid from collision with other beacons a node waits for a small random time interval before responding with the beacon. The data packets are piggybacked from their location updates and thus it entered into the promiscuous mode where all nodes are operated which allows them to catch all the data packets transmitted in their locality.

Besides, the location of the final destination was stored in the data packet, any node that sense a data packet also checks its current location and identifies whether the destination falls under the transmission range or not. If it comes under the transmission range then it will added to the neighbouring node list else it is forwarded to other node yet to receive the beacon. In addition, this peculiar identification finds zero cost (i.e,. no beacon need to be transmitted for this process) .

The responsibilities of the node to send the forwarding packet at those particularly nodes gives the accurate local topology, So the frequency of the beacon updates was increased in order to APU senses the transmission of data packets. Finally a wealthy view of local topology was build in forwarding packets by the nodes.

D. Mobility Based Forwarding Node Selection

From the output got from the mobility prediction rule and on-demand learning rule the nodes will move to an examination considered with speed and velocity of the node to find an accurate local topology in which fast moving nodes are predicted and stored in a separate list of table. Thus this in turns incorporates the nature of nodes and its neighbouring nodes to find the fast predicted routing for transmission.

In MANET there is a chance of occurring inaccuracy in making local topology, if the forwarding nodes have high mobility. There also a situation arise that node involved in the forwarding path moves frequently then often beacon update is required which creates network traffic in packet collision. Hence it is necessary to select low mobility moving nodes i.e., stable node must be selected in order to forwarding on its mobility. Moreover than APU the routing performance has been increased in the forwarding node selection with low mobility.

E. Performance Evaluation:

a) Packet Delivery Ratio (PDR)

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

$$PDR(\%) = \frac{\text{Number of packets successfully delivered to destination}}{\text{Number of packets generated by source node}} \quad \text{-- (1)}$$

b) 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.

c) Energy Consumption

The amount of energy consumed by the sensors for the data transmission over the network

Energy Consumption = Sum of energy consumed by each sensor.

In this paper, we used a concept called LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH) protocol to reduce the energy consumption to maintain the nodes with low frequency beacon in order to improve the lifetime of MANET and to increase the performance. Leach is a hierarchical-based routing protocol that uses random rotation of the nodes required to evenly distribute energy consumption in the network.

Here Leach was applied based on the factor such as network lifetime, packet delivery ratio(PDR),throughput, overhead. It was found that PDR is increased considerably by finding out the ratio of number of packet sent to that of number of packet received that provides better performance of the protocol using several simulation. To reduce the energy usage by the beacon, data packets and forwarding in the network Leach works under two phases. they are: Setup phase and steady phase.

In the setup phase radical of fast mobility node are grouped together and forwarding node was chosen. On the other hand in the steady phase will send the data packet and sent to the next one-hop neighbour node in the network within the transmission region.The steady phase is more longer than the setup phase in order to minimize the overhead cost.

Setup Phase

In this phase, a node which is a predefined fraction,p, was choosen themselves as a forwarding node(say source). This is done according to a threshold vale, T(n).The desired percentage of threshold value depends upon the node p,the transmission range r, and the list of nodes that have not become the node p in the last 1/p transmission range,which can be defined as S.It can be given as

$$T(n) = \frac{p}{(1-p) * \left(r * Mode\left(\frac{1}{p}\right)\right)} \quad \forall n \in S - - - - - (2)$$

Each nodes wants to became a node p which chooses a value between 0 and 1.The node can become a node p iff if the random number is less than the threshold value, T(n).This in turns broadcast the beacon data packet to rest of the neighbouring node to join in the list. According to the strength of beacon signal, the nodes other than the node p within the transmission range which is already present in other node p list will decide to join in the existing node p list, since it sense the beacon within its coverage.

Then a acknowledgement message will be sent to existing node p list intimating that the node was joined in this node p list.

Steady Phase

In this phase the sensor nodes i.e the node other than node p begins to sensing the data packet and send it to the next forwarding route. The node p, after receiving data from all the neighbouring nodes, combines it and then sends it to the next one-hop forwarding route node.

After a certain time, which is predefined, the network again goes back to the setup phase and new node p was chosen. To reduce the interference from nodes belongs to one node p list to another each node p will be communicated by sending the beacon data packet to identify whether the transmission range within the node p or not.

IV. CONCLUSION

In this paper, we have found the necessity to adapt the beacon update scheme in geographic routing protocols to the traffic load and the node mobility dynamics. We adapted the LEACH algorithm to reduce the energy consumption and analyzed the protocol based on network lifetime, stability period and the network throughput. Our algorithm works in two phases: setup phase and steady phase, to reduce the energy usage by the beacon, data packets and for forwarding. We have embedded the LEACH within APU and the energy consumed for our approach is less when compared to energy consumed for APU in terms of packet delivery ratio, average end-to-end delay. In future the GEAR algorithm can be used with APU for security of the transmission in the Mobile Ad hoc Networks.

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