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Efficient power aware broadcasting technique for mobile ad hoc network

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Abstract

A mobile ad hoc network is a collection of mobile nodes which are able to organise by themselves. In MANET a mobile station (MS) can communicate with nodes outside of its transmission range by employing intermediate nodes as relays. To find a path to a specific destination node, the source node broadcast route request packet that are forwarded to all other nodes. A simple flooding scheme is employed in AODV, where every node rebroadcasts these route request packets even if some of its neighbours have already broadcast the requests. So there is redundancy in broadcasting which could potentially leads to high channel contention and collision so the broadcast storm problem will occur in MANET. In order to avoid this broadcast problem different types of techniques was implemented such as simple flooding method, probability based method, area based method, neighbour knowledge based method, efficient and dynamic probabilistic broadcasting methods are used. Instead of power loss it cause link failure then the process of data transfer is terminate and it diminishes the overall the network performances and will cost a large amount of network resources. In this, paper it proposed a new way of broadcasting technique called "Efficient Power Aware broadcasts (EPAB)" to provide an optimal path with suitable bandwidth and battery capacity. EPAB will help in increasing the throughput by decreasing the packet loss due to non-availability of node having enough battery power to retransmit the data packet to next node.

Keywords:-Ad-Hoc Network; AODV protocol; Efficient and Dynamic Probabilistic Broadcasting (EDPB); Power Aware Routing protocol (PAR); Efficient power aware broadcasting (EPAB); Glomosim Simulator.

1. Introduction

A mobile ad hoc network (MANET) is a special type of wireless mobile network which forms a temporary network without the aid of an established infrastructure or a centralised administration. The applications of MANETs range from the civilian use to emergency rescue sites and in battlefield. Each node in MANET is a router. If a source node is unable to send a message directly to its destination node due to limited transmission

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range, the source node uses intermediate nodes to forward the message towards the destination node. The main challenges in MANET are reliability, bandwidth and battery power [1, 2].

AODV (Ad hoc On Demand Distance Vector Routing) is a popular route protocol for MANET. It uses an on-demand mechanism and discovers routes only when a source node needs them. It's able to maintain routes even when the topology of the network is dynamic. AODV is well suited for MANET in that it has low processing and memory overhead and low network utilization [3]. The network has unpredictable characteristics, its topology, signal strengths fluctuates with environment and time, communication routes breaks and new ones are formed dynamically. In this context, communication algorithms and protocols should have very light in computational and storage needs in order to conserve energy and bandwidth. This research is organized as follows: Section II and III summarize a related work and overview of existing broadcasting. In Section IV describes the Efficient Power Aware Broadcasting algorithm. The simulation environment and results are evaluated in section V. Finally, the conclusions are given in the last section.

2. Related work

In simple flooding method, a source node of a MANET disseminates a message to all its neighbours, each of these neighbours will check if they have seen this message before, if yes the message will be dropped, if no the message will re-disseminated at once to all their neighbours. The process goes on until all nodes have the message. Although this method is very reliable for a MANET with low density nodes and high mobility but it is very harmful and unproductive as it causes severe network congestion and quickly exhaust the battery power. Although flooding ensures that broadcast packet is received by all network nodes, it generates many redundant transmissions which can trigger high transmission collision and contention in the network, a phenomenon referred to as the broadcast storm [4, 6].

The probability based approach tries to solve the problems of the simple flooding method. Each node $I \in N$ is given a predetermined probability pi for re-broadcasting. In this context, having some nodes not to rebroadcast minimizes the network congestion and collisions. In this approach there is a danger that some nodes will not receive the broadcast message. Pi = 1, the number of messages in a simple flooding method probability based approach is reduced to a simple flooding approach. More efficient broadcasting reduces pi as the number of neighbour density increase and vice versa [7].

Area Based Method is comprised of distance and location based approaches. *Distance based Approach*: The counter is used to decide either to drop a message or to rebroadcast, in this section a distance between a receiving node and its neighbours will decide between the two. Let d be the distance between the receiving node and the source node, if d is very small then the rebroadcast coverage of the receiving node is also very small. If d is large then the rebroadcast coverage is large. If d = 0 then the rebroadcast coverage is 0 too. A receiving node will normally determine the threshold distance D and set the RAD and redundant messages will be stored until the RAD expires. When RAD expires, all distances from source nodes will be checked, if $d < D$ then they received messages will be dropped, otherwise the messages will be rebroadcast. The role of distance can even be directly replaced by the signal strength by setting the signal strength threshold.

Location based approach: In this approach each node must have the means to establish its own location in order to estimate the additional coverage more precisely. This approach can be supported by global positioning system (GPS). Each node in a MANET will add its own location to the header of each message it sends or rebroadcasts. When a node received a message, the first thing will be to note the location of the sender and compute the additional coverage area to rebroadcast. If the additional coverage area to rebroadcast is less than the given threshold, the message is dropped when the RAD expires, otherwise the message will be rebroadcast. The problem of the location based approach is the cost of calculating additional coverage areas, which is calculating many intersections among many circles. This will drain the scarcely available energy [5, 8].

Broadcasting based on self-pruning is the simplest neighbour knowledge-based method which Lim and Kim referred to as flooding with self-pruning. In this scheme, each node must have the knowledge of its 1-hop neighbours which is obtained via periodic exchange of "hello" packets. A node includes its list of 1- hop neighbours in the header of each broadcast packet. A node receiving a broadcast packet compares its neighbour list to the sender's neighbour list. If the receiving node would not reach any additional nodes, it refrains from forwarding the packet; otherwise the node rebroadcast the packet [9].

3. Existing Efficient and Dynamic Probabilistic Broadcasting

The probabilistic scheme is one of the alternative approaches to simple flooding that aims to reduce redundancy through rebroadcast timing control in an attempt to alleviate the broadcast storm problem. In this scheme, when receiving a broadcast message for the first time, a node rebroadcasts the message with a pre-determined probability p so that every node has the same probability to rebroadcast the message, regardless of its number of neighbours. In dense networks, multiple nodes share similar transmission ranges. Therefore, these probabilities control the frequency of rebroadcasts and thus might save network resources without affecting delivery ratios. Note that in sparse networks there is much less shared coverage; thus some nodes will not receive all the broadcast packets unless the probability parameter is high. So if the rebroadcast probability p is set to a far smaller value, reach ability will be poor. The need for dynamic adjustment, thus, rises. The rebroadcast probability should be set high at the hosts in sparser areas and low at the hosts in denser areas. This proposed simple method for density estimation requires mobile hosts to periodically exchange "HELLO" messages between neighbours to construct a 1-hop neighbour list at each host.

A high number of neighbours imply that the host is in a dense area, whilst a low number of neighbours imply that the host is situated in a sparser area. Rebroadcast probability can be increased if the value of the number of neighbours is too low (or similarly if the current node is located in a sparse neighbourhood), which indirectly causes the probability at neighbouring hosts to be incremented. Similarly, the rebroadcast probabilities can be decreased, if the value of number of neighbours is too high. This kind of adaptation causes a dynamic stability between rebroadcast probabilities and the number of neighbours among neighbouring hosts. The new EDPB algorithm has definitely superior performance over traditional AODV-BF and AODV-FP.

The AODV-EDPB generates much lower routing overhead and end-to end delay, as a consequence, the packet collisions and contention in the network is reduced. This algorithm determines the rebroadcast probability by taking in to account the network density. In order to improve the save rebroadcasts, the rebroadcast probability of the low density nodes is increased while that of high density nodes is decreased. Combine the AODV-EDPB with different approach which suggests solving the broadcast storm problem [13].

A brief outline of the EDPB algorithm is presented in Figure 3.1 and operates as follows. On hearing a broadcast message m at node X, the node rebroadcasts a message according to a high probability if the message is received for the first time, and the number of neighbors of node X is less than average number of neighbors typical of its surrounding environment. Hence, if node X has a low degree (in terms of the number of neighbors), retransmission should be likely. Otherwise, if X has a high degree its rebroadcast probability is set low. EDPB algorithm is a combination of the probabilistic and knowledge based approaches. It dynamically adjusts there-broadcast probability p at each mobile host according to the value of the local number of neighbors. The value of p changes when the host moves to a different neighborhood. Ina sparser area, the rebroadcast probability is larger and in denser area, the probability is lower. Compared with the probabilistic approach where p is fixed, EDPB algorithm achieves higher saved rebroadcast.

```
On hearing a broadcast packet m at node X
Get the broadcast ID from the message: n bar, average number of
neighbour(threshold)
Get degree n of node X (no. of neighbours of node X)
If packet m received for the first time then
If n<n bar then
Node X has a low degree
Set high rebroadcast probability p=p1;
Else
Node X has a high degree
Set low rebroadcast probability=p2;
End if
End if
Generate a random number RN over [0,1]
If  RN <= p then
Rebroadcast the received message;
else
drop the message
end if
```

Fig 3.1: Efficient and dynamic probabilistic broadcasting Algorithm

4. Proposed Efficient Power Aware Broadcasting Algorithm

Most of the routing protocols for ad hoc networks were adopted from existing wired–network routing which need not consider power consumption since its nodes are usually powered by an energy network or from cellular wireless networks whose base stations (i.e. routers) are also powered not by batteries, but infinite power sources [10, 11]. Therefore, these protocols do not account for power consumption of the routing process. However, ad hoc nodes generally run on limited battery power. In some extreme cases as sensor networks, a node is completely lost and wasted as soon as it depletes its energy supply. So, power awareness is an important aspect of ad hoc routing. One of the earliest efforts for this purpose is the Power Aware Routing (PAR) Protocol proposed in. PAR tries to relay the packets through the nodes with more left energy. Power aware routing advocates for minimizing the energy consumed per packet and minimizing the variances in node power levels and then maximizing the time before the network is partitioned.

A brief outline of the EPAB algorithm is presented in Figure 4.1 and operates as follows. On hearing a broadcast message m at node X, get degree of n node X and power field of each node then calculate average number of neighbors and average number of power field. Then the node rebroadcasts a message according to a high probability if the message is received for the first time, and the number of neighbors of node X is less than average number of neighbors typical of its surrounding environment. Hence, if node X has a low degree (in terms of the number of neighbors), retransmission should be likely. Otherwise, if X has a high degree its rebroadcast probability is set low. EDPB algorithm is a combination of the probabilistic and knowledge based approaches and EPAB algorithm is the combination of the efficient and dynamic probability based and power aware based approaches. It dynamically adjusts there- broadcast probability p at each mobile host according to the value of the local number of neighbors. The value of p changes when the host moves to a different neighborhood. Ina sparser area, the rebroadcast probability is larger and in denser area, the probability is lower. Compared with the probabilistic approach where p is fixed, EPAB algorithm achieves higher saved rebroadcast. Also, the decision to rebroadcast is made immediately after receiving a packet in our algorithm without any delay.

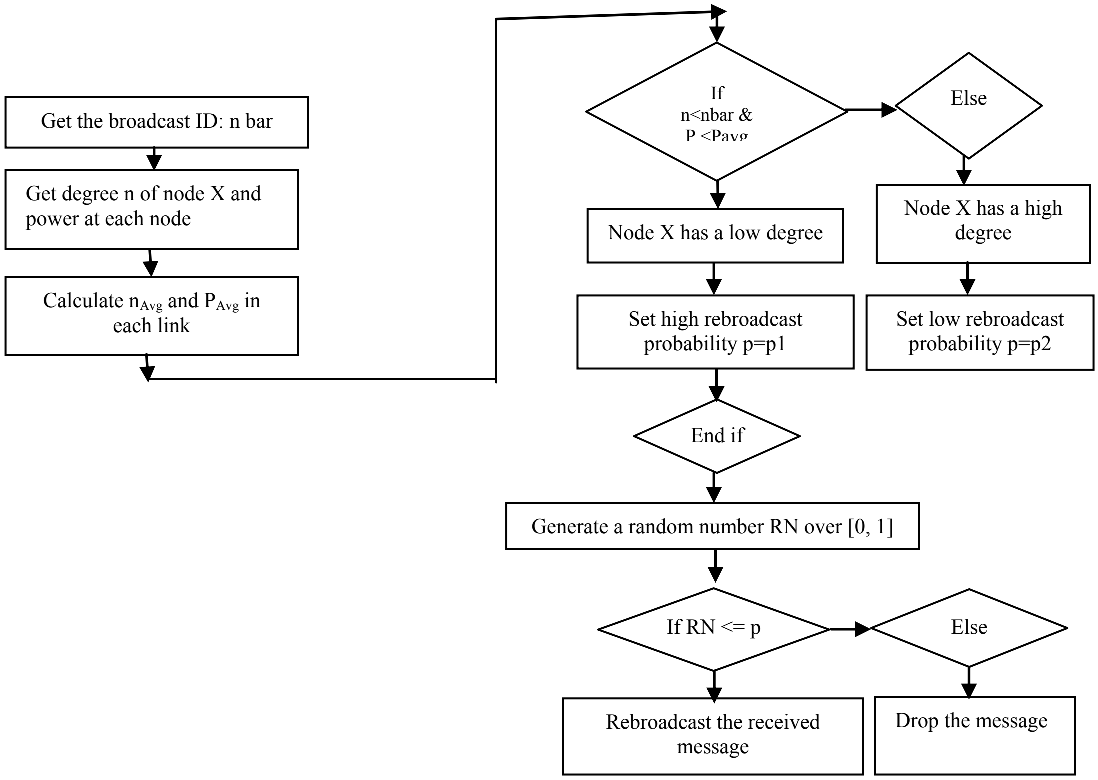

Fig 4.1: Efficient Power Aware Broadcasting Algorithm

5. Simulation Result

The Glomosim simulator is used to implement in this method and create simulation model to compare it with existing protocol. The simulated Ad Hoc network comprised of some mobile nodes in a 1000m x 1000m area. The number of nodes is 20. During the simulation, nodes move freely towards a random spot with a random speed which is distributed between 0 and maximum speed within this area. The maximum speeds value varies5m/s, 10m/s, 15m/s and 20m/s. The simulation time is 1000sec. The nodes which produce or receive the CBR data flow are selected randomly from all nodes and the CBR packet size is fixed at 512 bytes. To estimate the reliable of optimized power reactive routing protocol, the following shows the simulation key parameters:

Average End-to-End Delay of Data Packets: This is the average delay between the sending of the data packet by the CBR source and its receipt at the corresponding CBR receiver. This includes all the delays caused during route acquisition, buffering and processing at intermediate nodes, and retransmission delays at the MAC layer.
Packet Delivery Ratio: This is the fraction of the data packets generated by the CBR sources that are delivered to the destination. This evaluates the ability of the protocol to discover routes.
Throughput: This denotes the Average rate of successful messages delivered over the channel (bps).
Network lifetime: Network Lifetime is the time interval from the start of operation of the network till the death of the last node, beyond which the network not usable.
Power Consumption: The amount of energy spent by a normal node is to transmit a packet of unit length to reach the destination.

Performance Results: Figures 5.1 through 5.6 show the observed results for 20 node networks. Each data point is an average of 10 simulation runs with identical configuration but different randomly generated mobility patterns. As shown in Fig.5.1, the packet delivery fraction obtained using EPAB is 95% or higher in all scenarios and almost lesser to that obtained using EDPB. This suggests that EPAB is highly effective in discovering and maintaining routes for delivery of data packets, even with relatively high node mobility.

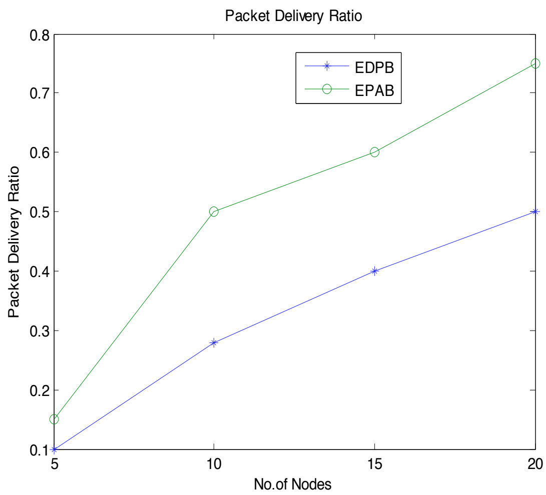

Fig. 5.1 Packet delivery ratio

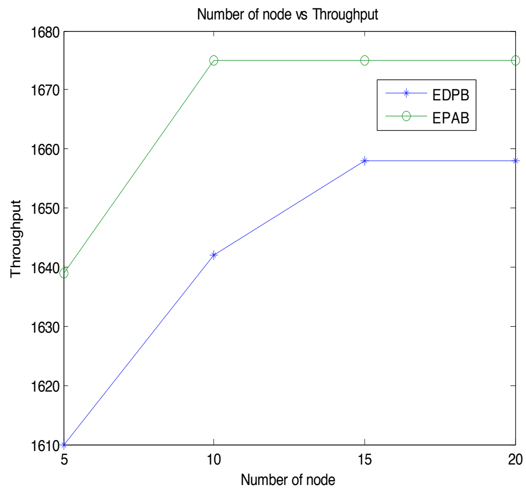

Fig. 5.2 Average path length Vs Node Speed

Fig 5.2 shows that the Throughput in EPAB is higher than EDPB. It means that EPAB achieve more data packet than EDPB. It should be noted, however, that in networks with significantly heavier data traffic loads, congestion could prevent by proposed technique. Fig 5.3 shows that by using a Power field related routing metric significantly reduces the power consumption in EPAB than EDPB. The performance is improved by finding the stability of node.

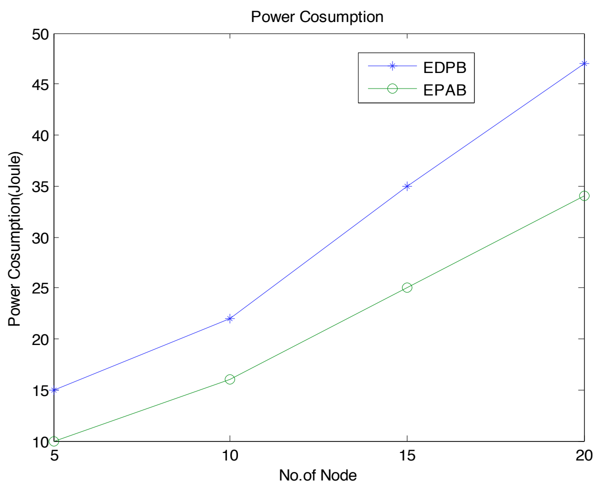

Fig. 5.3 Power Consumption

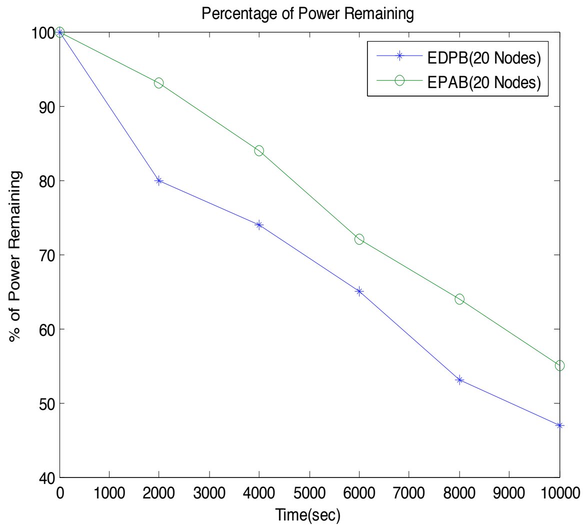

Fig .5.4 Percentage of Power Remaining

Fig.5.4 shows the remaining battery power in the nodes of the system as a function of time. Initially, both EDPB and EPAB show the same behaviour. Subsequently, when nodes still have enough power, PAR carries more packets because it has less operational overheads (RREQ, RREP and RERRs) than EPAB. It shows trade off between the Power savings in EPAB is less than EDPB protocol. The energy improvement is achieved by finding the average power level and the average probability.

As shown in Fig.5.5 EPAB has lesser route acquisition latency, the number of route discoveries performed is a small fraction of the number of data packets delivered. Hence the effect of the route acquisition latency on average end-to-end delay of data packets is less in EPAB than EDPB. With the increase in number of nodes for the same two dimensional regions (network density) average distance between the nodes reduces. Therefore, the transmitting power of the nodes reduces resulting in reduction of the total transmit power hence the lifetime (total number of transmissions) has to increase. This can be observed from Fig. 5.6.

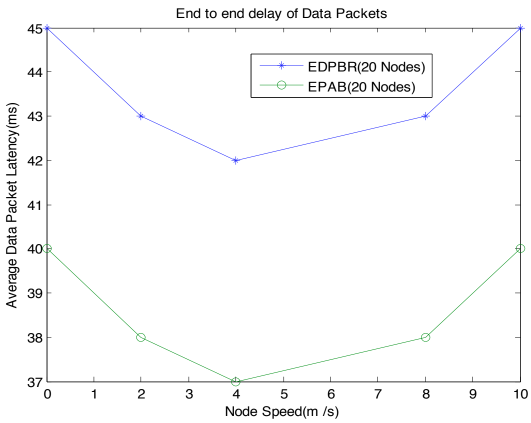

Fig.5.5 End to End Delay

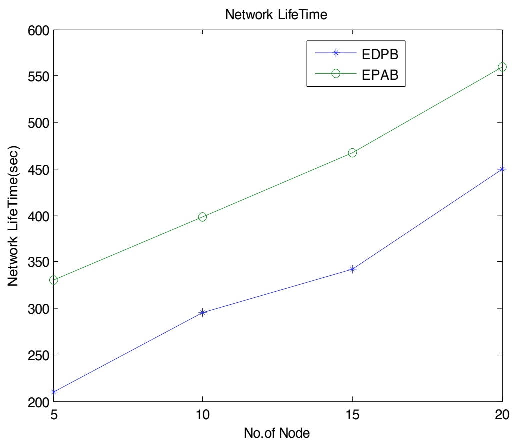

Fig. 5.6 Network Lifetime

6. Conclusion

The objective of the papers is to exist a new probabilistic hybrid-based algorithms to improve broadcasting in MANETs by reducing the number of redundant retransmissions while still guarantee that most of the nodes receive the broadcast packets without the use of any additional hardware devices. The aim of this research is to propose an efficient power aware broadcasting "EPAB" is presented and evaluated. It has presented a broadcasting technique to minimize the energy consumption as well as delay. EPAB will help in increasing the throughput by decreasing the packet loss due to non-availability of node having enough battery power to retransmit the data packet to next node. The proposed protocol is also helpful in finding out an optimal path without any loop.

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