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An Energy Efficient Communication Scheme by Estimating CAEN and Reducing Overhearing Probability in MANETs

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Abstract— Nodes in a mobile Ad-Hoc network are power constrained. It is thus crucial for these nodes with batteries to conserve energy for lasting long. Overhearing of data by the nodes in the mobile Ad-hoc network increases the network performance at the cost of excessive energy consumption. The balance between the extent of overhearing and energy consumption without compromising network performance is critical in such networks. This paper presents a mechanism which allows the sender to specify the desired level of overhearing and also enables the intermediate nodes to estimate the current average energy of the network to determine how to respond to the received route request packets. The proposed mechanism increases the network life time and reduces the energy consumption

Keywords— Mobile adhoc networks, overhear, routing, networks lifetime, overhearing.

I. INTRODUCTION

Mobile Ad-hoc Networks (MANETs) comprises of wireless mobile nodes that can freely and dynamically communicate without pre-existing communication infrastructure. Nodes in these networks are responsible for network control and routing activities. Communication between source and destination in MANETs involves intermediate nodes. These nodes obtain the routing information via overhearing .The energy consumed by overhearing nodes is almost equal to the nodes involved in actual routing. The nodes in MANETs depend on exhaustive energy sources (battery) and so the energy efficiency is a crucial design issue. The energy which is consumed by overhearing nodes not only involves reserving the battery of the nodes in routes but also the number of neighbours that these nodes interfere potentially.

Conventional routing protocols such as ad hoc on-demand routing protocol (AODV) and dynamic source routing protocol (DSR) intend to find the shortest route between the source and destination. Therefore using these protocols leads to extensive use of the nodes along the shortest path and drain their batteries quickly which causes reduced network lifetime and also network partitioning.

The main goal of this paper is to provide an energy saving mechanism which identifies and excludes the unnecessary communication activities. Over usage of particular set of nodes is avoided by using a method which enables every node to calculate the approximate average energy(AAEN) as a response to route request(RREQ) packet , Each node based on this value obtained decides whether to participate or not in the routing process

i) DSR protocol [1]

The Dynamic Source Routing protocol (DSR) is a routing protocol for use in wireless mesh and ad hoc networks. DSR doesn't require any pre-existing infrastructure and thus allows the network to be completely self-organized and self-configured. The protocol has two phases namely.

i) Route Discovery and ii) Route Maintenance. When a node has a data packet to send but does not know the routing path , the rout discovery procedure is initiated by broadcasting control packet called route request (RREQ) . when this packet reaches the destination, it replies through another packet known as route reply (RREP) to the source with complete route information. The source saves the route information in its local memory, called rout cache, for later use. In the event of link errors like link breakage the node sends another packet called as route error (RERR) to the source and deletes the state route information from its route cache. Overhearing improves the network performance by allowing nodes to collect more route information

DSR protocol has the following disadvantages i) Stale route problem in DSR due to unconditional overhearing: In the event of link error (RRER) is not propagated fast and wide, hence route caches often contain stale information. ii) Semantic discrepancy in DSR: where the nodes which employ 802.11 PSM, do not wake up to overhear unintended packets thus disrupting the normal operation of DSR.

ii) IEEE 802.11 Power saving Mechanism (PSM)

According to IEEE 802.11 standard[2] there are 2 medium access methods .i) Distributed Coordination function (DCF) and ii) Point coordination function .DCF uses contention algorithm based on principle of Carrier Sense Multiple access with Collision avoidance .PCF is optional method implemented on top of DCF

II. Existing Approaches

It presents the RandomCast protocol that is designed to employ the IEEE 802.11 PSM in multihop MANETs. Unlike previous approaches, where nodes need to switch between AM and PS mode, they consistently operate in the PS mode in RandomCast. In RandomCast, a transmitter can specify the desired level of overhearing to strike a balance between energy and throughput. More importantly, it helps avoid the semantic discrepancy found in most of MANET routing protocols. For example, in DSR, when a node transmits a unicast packet, it in fact expects that all of its neighbours overhear it as if it is a broadcast packet. This is not the case in the proposed RandomCast protocol. This mechanism shows that the problem of unconditional or unnecessary forwarding of broadcast packets can also be taken care of in the RandomCast framework

According to the simulation results, the proposed algorithm reduces the energy consumption as much as 50 percent and 31 percent compared to the original IEEE 802.11 PSM and ODPM, respectively. On the other hand, network performance such as its packet delivery ratio (PDR) could be at a disadvantage with RandomCast because nodes are not able to transmit or receive packets when they are in sleep state. In order to examine the performance trade-offs, we measure a combined metric, called energy goodput (Kbytes/Joule), which is defined as the number of bytes delivered per unit energy. RandomCast achieves as much as 64 percent and 63 percent higher energy goodput than 802.11 PSM and ODPM, respectively, which exhibits the overall benefit of Random Cast.

Overhearing and redundant rebroadcast problems are controlled using ATIM window ATIM frame consists of frame control, destination address, source address, sequence control Subtype field in frame control helps to set the overhearing level.[3]

Subtype: 1001 for unconditional overhearing
1101 for probability based overhearing
1110 for no overhearing

Probability based overhearing method controls the level of overhearing and forwarding of broadcast messages. Sender is able to specify the level of overhearing.

Sender may choose no or unconditional or probability overhearing which is specified in ATIM frame control. Node is awakened if unconditional overhearing or probability overhearing is set or it is a destination node[3]. Each node maintains overhearing probability Po and rebroadcast probability Pr [2].

$Po=1/ n$ (1)

$Pr=cn/ N 2$ (2)

Where c is a constant , n is no. of neighbours and N is average no. of neighbour's neighbour.

$Ec = \Sigma(Ie – Re)/$ no. of packets sent (3)

where Ec is energy consumed, Ie is Initial energy and Re is residual energy. If a node's subtype is 1101, it generates a random number between 0 and 1 and compares it with Po. If it is greater than Po, node decides to overhear. If it is greater than Pr, node decides to rebroadcast. Po and Pr are decided based on number of neighbours.

Consider that node S transmits packets to node D via a pre-computed routing path with three intermediate nodes as shown in fig 2(a) no overhearing (b) and randomized overhearing(c). Comparing all the three diagrams it is seen that random cast reduces the number of overhearing nodes and hence overcomes the unnecessary energy utilization by overhearing nodes

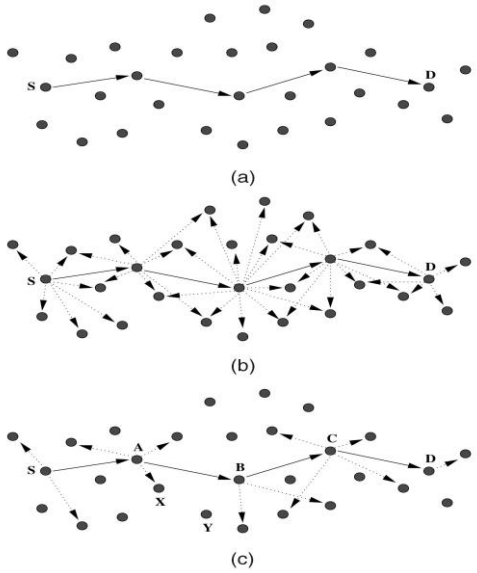

Fig. 1. Delivery of a unicast message with different overhearing mechanisms.

Energy Saving Ad-hoc On-demand Distance Vector (ESAODV[2]), is proposed for routing in MANETs. The scheme achieves the energy information exchange among neighbouring nodes through already-existed signalling packets in AODV and introduces a new network parameter as the comparison threshold, called current average energy of the network (CAEN), which can approximate the average energy of the network. In ESAODV, each intermediate node

determines whether to forward RREQ packet by comparing its remaining energy with CAEN. If the energy of the node is larger than the threshold, it will forward the RREQ packet immediately.

i) **Limitations of existing system.**

- Network performance such as its packet delivery ratio (PDR) could be at a disadvantage with Random Cast, because nodes are not able to transmit or receive packets when they are in sleep state. In order to examine the performance trade-offs, we measure a combined metric, called energy good put (Kbytes/Joule), which is defined as the number of bytes delivered per unit energy.
- Among the factors such as Sender ID ,Number of neighbors , Mobility ,Remaining battery energy, the existing algorithm is implemented based upon only the second factor that is the number of neighboring nodes but the other factors are not considered.
- The overhearing nodes are picked up random. So same node can be picked up multiple times resulting is loss of energy at a particular node, this will affect the life time of network. Since choice of node listening is random, some nodes will listen for packet and later find it is not useful

III. PROPOSED SYSTEM

We extend the Random Cast algorithm in following way .At each node the decision to overhear is based on the following factors Sender id Remaining energy of the node. Route is selected in which there is a maximum of minimum remaining energy and this field is added in RREQ as well as in the RREP

New field is added to the RREQ message which carries the collected remaining energy of nodes participating between source and the destination. In this, Destination node does not give an immediate reply to the request but waits for some time and in the mean time, calculate the mean energy of the network and is stored in each node.

In case of a new route, this Mean energy is then compared with the energy remaining in the node and if it is less, then RREQ message is delayed by some time and by this the entire lifetime is extended. Algorithm which selects the nodes on the basis of their energy status, which help in discovering alternate paths and to solve the problem of asymmetric links. In this, neighbouring nodes Backbone nodes) of active route having energy above than some threshold value are selected for route establishment between source and destination.

Battery status can be divided into 3 categories:

i) If (Battery Status < 20%) It is called Danger state.

ii) If (20% > Battery Status < 50%) it is Critical State

iii)If (Battery Status > 50%) It is Active mode

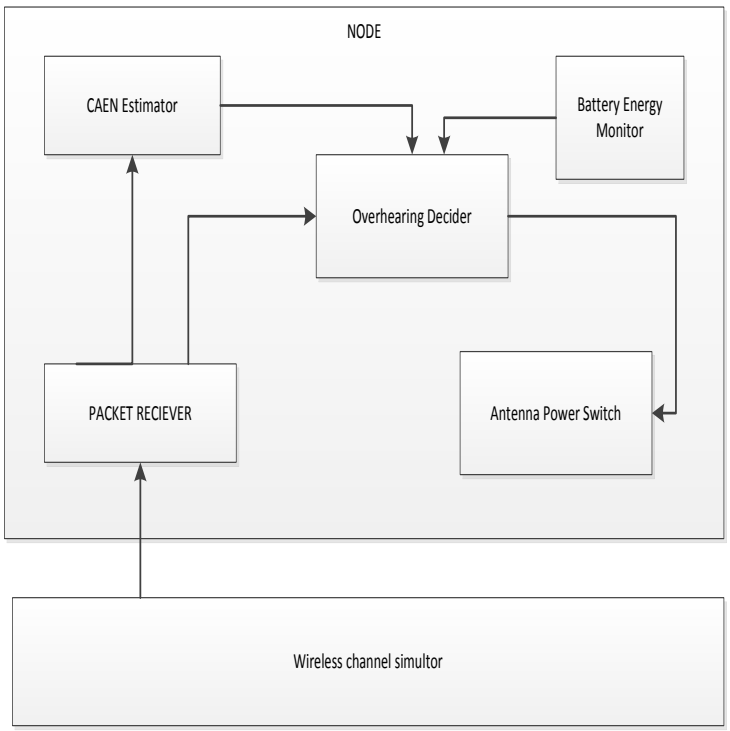

Fig 2:- System architecture for the proposed approach

Node communicates with each other using Wireless channel simulator. When a node receives any packet it is given to CAEN estimator to estimate the average energy of the network and also it is sent to overhearing decider. If the CAEN of the node is greater than or equal to the threshold value , then the node tries to overhear and the antenna power switch is turned on. Based on the packet type received, sender id , remaining energy of node , the decision is taken to keep the antenna switch on or off for the purpose of overhearing

ii) Steps for proposed system

Step1: Source initiates the routing process by broadcasting the packets and Ad hoc Traffic Indication Message window.
Step2: The intermediate nodes apply random cast overhearing. (for randomized overhearing)
Step3: The nodes which do not overhear will switch to Low power sleep state.
Step4: The nodes which actively participate in routing calculate current average energy estimation (CAEN) the node.
Step5: The nodes which have CAEN greater than threshold will participate in the process of routing

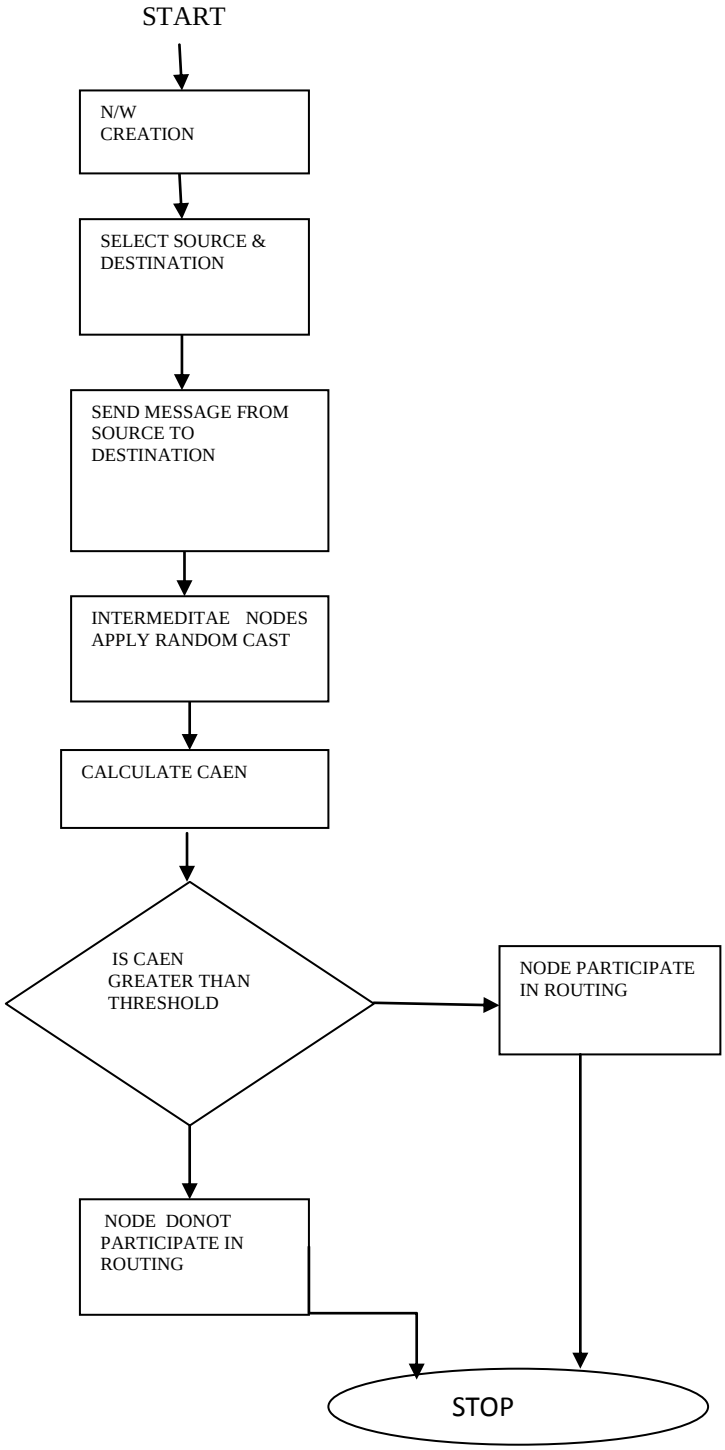

Fig 3:- flow diagram for the proposed method

IV. SIMULATION RESULTS

The simulation of the proposed scheme is carried out in the JProwler simulator. The proposed method can provide additional energy saving by providing the combined feature of two approaches 1) probability based overhearing 2) estimation of current average energy of the node . The following graph shows the improvement in the Packet delivery ratio(PDR) in the proposed approach.

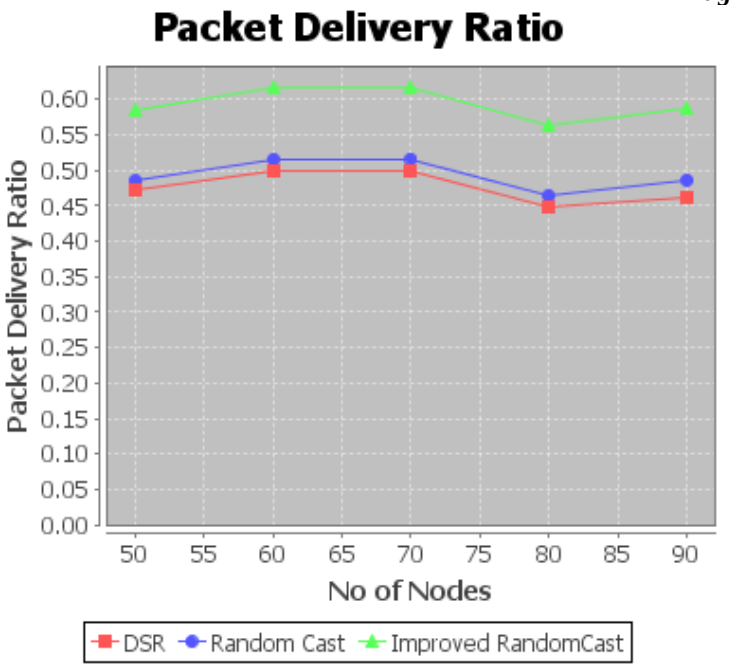

Figure 4: simulation results

VI. Conclusions and Future Work

An effort has been made to combine the advantages of 802.11 PSM with multihop routing protocols such DSR.The approach called random cast is followed to obtain randomized overhearing .The proposed mechanism follows and additional energy saving mechanism by setting a threshold value at each node . The nodes whose energy is greater than the threshold value can participate in routing. The proposed mechanism is implemented by considering the parameter as number of neighbours and remaining battery energy. This work can be extended by considering other factors such as, sender ID, and node Mobility.

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