GPS Enabled Energy Efficient Routing for Manet

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Abstract

In this paper, we propose an energy aware reactive approach by introducing energy and distance based threshold criteria. Cross Layer interaction is exploited the performance of physical layer which leads to significant improvement in the energy efficiency of a network.

Keywords: Ad Hoc Networks, AODV, Cross Layer Interaction, GPS.

1. INTRODUCTION

Ad Hoc Networks consist of mobile nodes that self configure to form a network without established infrastructure [7].Due to node mobility, network topology changes unpredictably, due to this host needs to determine the routes together nodes frequently. Ad-hoc On-Demand Distance Vector routing protocol proposed in [8] is one of the developed protocols that enable routing with continuously changing topologies. AODV establishes routes on demand basis. There have been several studies on AODV protocol and other on demand ad hoc routing protocols ([9], [10]). However, these schemes do not consider on-demand routing for mobile ad hoc networks. Different energy aware routing protocols use traditional protocols like AODV and DSR as base protocols. The selection of base protocol assumes importance for any kind of energy related proposal as the energy consumption pattern depends on this choice. One distinguish feature of power aware ad hoc routing protocol is its use of power status for each route entry. Given the choice between two routes to a destination, a requesting node is required to select one with better power status and more active.

Scalability of Ad Hoc Network can be improved by utilizing geographical information such as in GFG[13], LAR[14],GPSR[15].They use physical location information, typically from GPS(Global Positioning System).GPS enables a device to determine their position as in longitude, Latitude and Altitude by getting this information from the satellites. There has been significant effort in proposing energy efficient routing protocols, with a more recent effort on cross layer design solutions ([11, 12]).In this paper, a novel routing with better power feature using information of the nodes has been proposed and cross layer interaction is also exploited. The rest of the paper is organized as follows. Section 2 illustrates the power related issues of routing protocols in MANET. Section 3 emphasis the problems faced in the current existing protocols. New Protocols description and system methodology is presented in section 4.Conclusions are given in Section 5.

2. POWER RELATED ISSUES

The lack of a centralized authority complicates the problem of medium access control (MAC) in MANETs. The medium access regulation procedures have to be enforced in a distributed and hence collaborative, fashion by mobile nodes. In the shared broadcast medium transmission of packets from distinct mobile nodes are prone to collision. This contention based medium access results in retransmissions and appreciable delays. The performance of the MAC scheme affects the routing protocol adversely and consequently the energy consumption for packet transmission and reception increases.

On-demand routing consists of route discovery and route maintenance [16]. In route discovery, source uses flooding to find a route to its destination. The large number of packets generated by flooding consumes energy of nodes unnecessarily. The transit nodes, upon receiving a query, learn the path to the source and enter the route in their forwarding tables. The destination node responds using the path traversed by the query. Route maintenance is responsible for reacting to topological changes in the network, and its implementation differs from one algorithm to the other. On-demand protocols include the schemes like ad hoc on demand distance vector routing (AODV) [8] and dynamic source routing (DSR) [17]. In these protocols, route discovery and maintenance may become inefficient under heavy network load since intermediate nodes will have a higher probability of moving due to the delay in packet transmissions attributed to MAC contention. Routes have a higher probability of breaking as a result of mobility. The rediscovery or repair of routes wastes battery power. The flooding of route request and route reply packets in on-demand routing protocols may result in considerable energy drain. Every station that hears the route request broadcasts will consume an amount of energy proportional to the size of the broadcast packet. In addition, stations that hear a corrupted version of a broadcast packet will still consume some amount of energy [18].

In a multi-hop ad hoc network, nodes must always be ready and willing to receive traffic from their neighbors. All the nodes unnecessarily consume power due to reception of the transmissions of their neighbors. This wastes an extensive amount of the total consumed energy throughout the lifetime of a node. Much work in this direction has been carried out by Chiasserini et al. [19], Jayashree S. et al. [20] etc. The design objectives require selecting energy-efficient routes and minimizing the control messaging in acquiring the route information.

Efficient battery management [21, 22], transmission power management [23, 24] and system power management [25, 26] are the major means of increasing the life of a node. These management schemes deal in the management of energy resources by controlling the early depletion of the battery, adjust the transmission power to decide the proper power level of a node and incorporate low power consumption strategies into the protocols. Typical metrics used to evaluate ad hoc routing protocols are shortest hop, shortest delay and locality stability [27]. However, these metrics may have a negative effect in MANETs because they result in the over use of energy resources of a small set of nodes, decreasing nodes and network lifetime. The energy efficiency of a node is defined by the number of packets delivered by a node in a certain amount of energy. Three Layers are involved in communications as

a) Physical layer

For Link maintaince, transmission power should be at minimum level and it should also allow adapting to changes in transmission environment. Excessive transmission power can cause interference to other hosts.

b) Data Link Layer

By using effective retransmission request schemes and sleep mode operation, energy conservation can be achieved. It is important to appropriately determine when and at what power level a mobile host should attempt retransmission. Node’s transceiver should be powered off when not in use.

c) Network Layer

In ad hoc network it is important that the routing algorithm should be selected on the basis of best path from the viewpoint of power constraints as part of route stability. Routing algorithm can evenly distribute packet-relaying loads to each node to prevent nodes from being overused. Three extensions to the traditional AODV protocol, named Local Energy Aware Routing (LEAR-

AODV), Power Aware Routing (PAR-AODV) and Lifetime Prediction Routing (LPR-AODV) have been proposed by Senouci et al. [28], for balanced energy consumption in MANETs.

3. RECENT WORK

In Much research has been done in GPS based routing. In [1], Network is divided into four quadrants and via GPS; position of each node is detected. Full flooding is used but due to shortest path routing, this can lead to blocked path and overhead and latency increases due to hello messages. In [2] extensive use of digital map database is done in order to make the routing decision effective. But shortest path is used in it due to which problem of route blockage can arise.

Much work has been done using cross layer approach to detect link breakage. Cross layer design concern with the interaction among different network layers to integrate channel and network characteristics and hence, promises to improve overall performance. In [3], MAC Layer inefficiencies have been eliminated in terms of achieved throughput. Routing assisted approach was used in which a node which initiates the communication, multicast the bandwidth reservation message to high power nodes. This, in turn leads to shortest path routes and consequently to improve performance but overhead occurred and there is increase of end to end delay also. In [4], cross layer design is used to improve route discovery by rejecting unidirectional links and supports usage of bi-directional links at routing layer but this protocol suffered from poor packet delivery .In [5] **,** energy efficiency and bandwidth is increased by exploiting cross layer interaction. Directional antennas are also used which caused latency.

The network layer can aid in the conservation of energy by reducing the power consumed for two main operations, namely, communication and computation. The communication power consumption is mainly due to transmission and reception of bits. Whenever a node remains active, it consumes power. Even when the node is not actively participating in communication, but is in the listening mode waiting for the packets, the battery keeps discharging. The computation power consumption refers to the power spent in calculations that take place in the nodes for routing and other decisions. In traditional routing algorithms, routes are constructed on the basis of shortest path but these protocols are not aware of the energy consumed for the path setup or maintenance. Shortest path algorithm may result in a quick depletion of the energy of nodes along the heavily used routes.

In this paper, a routing scheme with better power feature using geographical information of the nodes has been proposed. Routing is established using GRA [6]. It has been assumed that each node will get its geographical position from GPS [29]. Each routing table consists of all neighboring node. In traditional AODV, basic routing mechanism is when a source node S wants to send packets to Destination node D, it will broadcast RREQ to its neighbor. Then each intermediate node forwards their RREQ and also they record reverse routes back to Source S. In this way, route is established but the link quality between nodes is very unpredictable. Link quality depends on the signal to Interference Ratio (SIR)[6] .when this SIR drops below the system's SIR threshold Value, link is broken and route which has this broken link is disabled. By setting this Threshold value optimally, the mobile hosts are protected from draining their energy by transmitting data over a poor link. In this paper, an effort has been made to use cross layer interaction to overcome this problem.

The GPS technology has been used to find the position of mobile nodes in the network. The concept suggests that only those nodes whose energy is in active mode can take part in the network path. Link breakage is detected by physical layer. It has been shown in Fig. 1. If a node has SIR less than system Threshold value then information about this link breakage is given to network layer by the physical layer so that network layer will update the routing table. Here, transmission is unicast; an acknowledgement will be received if there is successful transmission. If an acknowledgement is not received then node will choose another neighboring node. In this way, any error in the routing table due to stale data won't adversely affect the performance of the protocol.

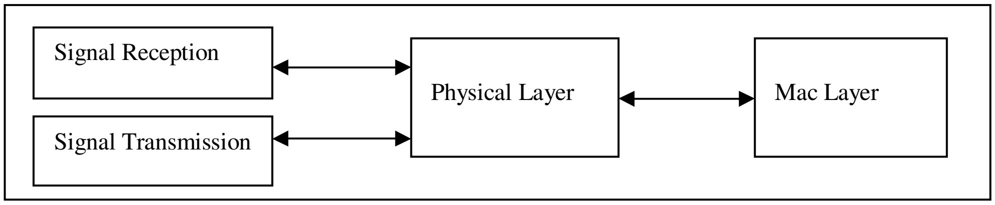

FIGURE 1: Information sharing in Cross Layer Design

4. PROPOSED ALGORITHM

The AODV has been extended in the route Construction Phase to accept the concept of GPS nodes and also Route tables have been modified to insert entry for Power factor. This scheme does not require any modification to the AODV's route request RREQ process. When a source wants to transmit data to a destination but does not have any route information, it searches a route by broadcasting the route request RREQ packet. Each RREQ packet has a unique identifier so that nodes can detect and drop duplicate packets if any. The destination node sends a route reply RREP via the selected route when it receives the first route request RREQ or subsequent RREQs that have traversed. Route is established. The change occurs when a link break

Route Repair:
When a link break in an active route occurs, the node upstream of that break may choose to repair the link locally. Here the proposed scheme makes changes.

Node to participate in route selection must be in active state. It can keep on transmission till it is in Active state and cannot participate if it moves in to danger state. In this case to efficiently apply power function routines cannot be made to turn nodes not participating in route to sleep mode to conserve energy as it to use GPS system. A node can be in idle state but not in sleep mode.
All nodes of the topology broadcast these entries after fixed intervals to all nodes and each node updates its routing table. To repair the link break, the node increments the sequence number for the destination and then broadcasts a REQ for that destination.
Two major factors have been considered for repair description. One is battery status and other is threshold value set for SIR. In first case battery status has been evaluated and two ranges have been set which can be categorized as in Equation-1.

If B_S >30%,then it is Active State else it is in Danger mode. --- 1

Where B_s is battery status and Percentage factor is for fully charged or decaying. 100% is fully charged battery range. For practical purposes, the battery decay rate is approximately 6 hours for decay from 100% to 30%.
The Signal to interference ratio has also been divided into two parametric evaluations based on Threshold value. Equation 2 generalizes the theory.

If SIR > Tv means SIR is good and message is transmitted to neighbor node
Else there may be link break. ---- 2

From these two parameters a new value called lifetime of a node is calculated as shown in equation 3.

Lifetime= B_S+SIR --- 3

This factor is transmitted as weight factor to all nodes to select best available path with maximum power. The entry is done in route table and transmitted along with hello packet. Thus, local repair attempts are often invisible to the originating node. The node initiating the repair waits for the discovery period to receive reply message in response to that request REQ. During local repair, data packets are buffered at local originator. The scheme has been described using Figures 2 and 3.

Packets are to be transferred from source S to Destination D. Nodes have been shown in different colors. Here, Blue nodes stand for Active State and Red nodes stand for Danger State. Position of each node is detected by GPS.

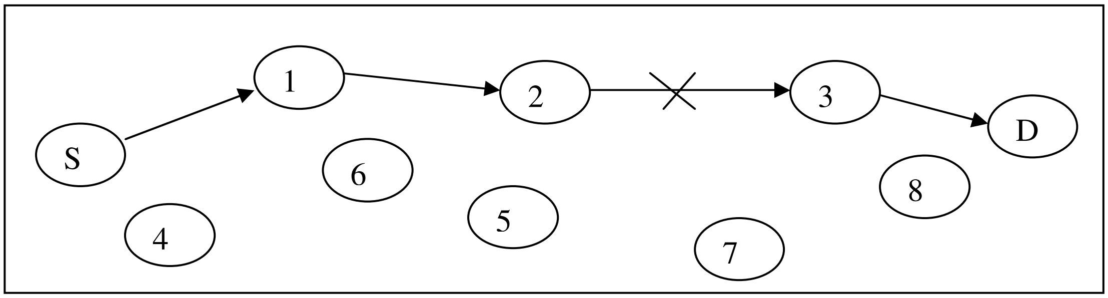

FIGURE 2: Link break between node 2 and node 3.

Path selected originally using RREQ is shown as {S-1-2-3-D} .When a link break occurs as shown in figure 2. A new path is to be created. Here local repair scheme proposed is adopted. Weight factor is calculated, this factor is transmitted to all nodes. The normal selection would have been {2-6-3}, but as per proposed scheme, new path selected is {2-5-8-3} which is longer one. This is much stable path for rest of the transmission. Node 6 has not been included as it is already in danger state and can cause link failure again. The concept has been described in Figure -3.

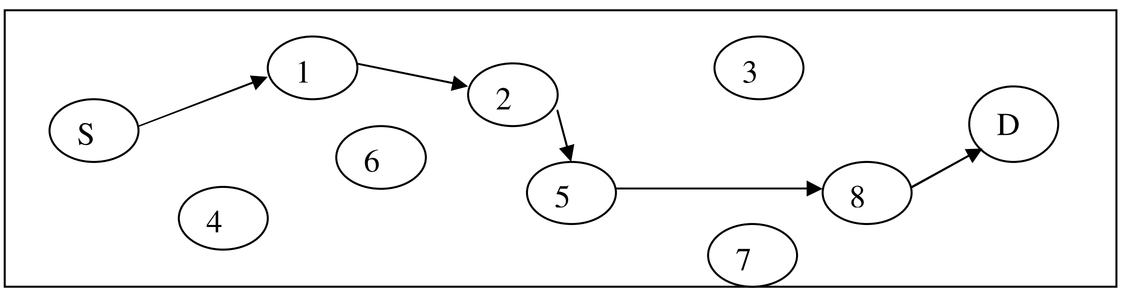

FIGURE -3 : Local repair scheme

5. CONCLUSION

A new scheme has been proposed that works on a reactive approach and utilizes alternate paths by satisfying a set of energy and distance based threshold criteria. The scheme can be incorporated into any ad hoc on-demand routing protocol to reduce frequent route discoveries.
Theoretical study indicates that the proposed scheme will behave better than the existing protocols. Efforts are on to simulate it using NS2. Modifications have been made in NS2 to accept GPS addresses. The scheme is still under progress and results are expected very soon. It is forecasted that the proposed scheme will provide robustness to mobility and will enhance protocol performance.

The delay may increase as it requires more calculation initially for setting route and GPS may take some time initially. The proposed scheme selects the nodes based on their energy status, which may also help in solving the problem of asymmetric links. Precision of GPS will also be considered.

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Type Flag Hop count
REQ ID DEST IP SRC IP
Power Status GPS Node Address

Type	N	Reserved	Dest Count
Unreachable Destination IP Address			
GPS Neighbor Node , Power status			

Route Repair Format