An Enhanced Energy Efficient Multipath DSR Protocol for MANET

Deepika Thakral[1] Neha Dureja[2]
[1,2] Assistant Professor
[1,2] HGPI, KALA-AMB, H.P

Abstract— Routing in Wireless Ad-hoc networks is one of the main technical challenges due to the dynamic behavior of these networks [1]. A routing protocol is needed whenever a packet needs to be transmitted to a destination via number of nodes and numerous routing protocols have been proposed for such kind of ad hoc networks. Our Main objective in this paper is to develop Energy Efficient Power Aware Multipath Dynamic Source Routing based on DSR [2]. We analyze Minimum Battery Cost Routing (MBCR) to minimize the path battery cost so as to maximize the total remaining battery capacity. The cost function f in MBCR is defined such that the lower the remaining battery capacity c of a node i, the more reluctant the node is to receive and forward a packet. In this paper we proposed a new route discovery algorithm that considers the remaining energy for each node and uses a cost function to choose the best power saving route. And a new route maintenance algorithm that deals with the broken routes due to the nodal energy depletion and node mobility.

I. INTRODUCTION

The mobile ad-hoc networks are the infrastructure less networks. These are the temporary wireless networks [3]. All the routing information is managed by the node itself. If two mobile nodes are within each other's transmission range, they can communicate with each other directly; otherwise, the nodes in between have to forward the packets for them. In such a case, every mobile node has to function as a router to forward the packets for others. Thus, routing is a basic operation for the MANET [4]. Routing protocol can be divided into the categories [5]:

1) Proactive routing protocols.
2) Reactive routing protocols.
3) Hybrid routing protocols.

Proactive routing protocols are well suited for a small-scale, broad-band MANET with high mobility, while reactive routing protocols are well suited for a large-scale, narrow-band MANET with moderate or low mobility [6].

Proactive routing protocols are those in which periodic broadcast of network topology update is necessary to compute the shortest path from the source to every destination, which consumes a lot of bandwidth. Optimized Link State Routing Protocol (OLSR), Fish Eye Routing (FSR) [8].

Reactive protocols also known as on demand driven reactive protocols [5].These protocols setup routes when demanded [10]. When a node wants to communicate with another node in the network, and the source node does not have a route to the node it wants to communicate with, reactive routing protocols will establish a route for the source to destination node, AODV, Dynamic State Routing (DSR) [7].

Dynamic Source Routing (DSR) [9] protocol is a distance-vector routing protocol for MANETs. When a node generates a packet to a certain destination and it does not have a known route to that destination, this node starts a route discovery procedure. One advantage of DSR is that no periodic routing packets are required. DSR also has the capability to handle unidirectional links. Since DSR discovers routes on-demand, it may have poor performance in terms of control overhead in networks with high mobility and heavy traffic loads. Scalability is said to be another disadvantage of DSR [10], because DSR relies on blind broadcasts to discover routes. The multipath routing mechanisms are used to discover multiple paths under the nodes.

II. DYNAMIC SOURCE ROUTING (DSR)

Dynamic Source Routing (DSR) [9] protocol is a distance-vector routing protocol for MANETs.

A. Route Discovery

Route Discovery is the mechanism by which a node S (Source) wishing to send a packet to a destination node D obtains a source route to D. Route Discovery is used only when S attempts to send a packet to D and does not already know a route to D. The source first has to check in its "Route Cache" if it knows a suitable route for the destination. If no route is found, it will have to start a route discovery protocol to find a route to the destination. The route discovery itself consists on a chain of locally broadcasted Route Request (RREQ). The broadcasting occurs until one of the broadcasted RREQ reaches either the destination node or a node who knows a route to that destination. If a node receiving the RREQ has recently seen another RREQ message from this initiator bearing this same request identification and target address, or if this node's own address is already listed in the route record in the RREQ, this node discards the Request.

B. Route maintenance

Route Maintenance is the mechanism by which node S is able to detect, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a link along the route no longer works. When route maintenance indicates a source route is broken, Scan attempt to use any other route it happens to know to D, or can invoke Route Discovery again to find a new route for subsequent packets to D.

A link is considered to be broken when a node has been unable to verify the reachability of a next-hop node after reaching a maximum number of retransmission attempts [6]. The broken link is then removed from the cache of the former node, and a Route Error is sent to every node which use the broken link and which is in its Route Request Table.

III. RELATED WORK

Many research efforts have been devoted for developing power aware routing protocols [2]. Different approaches can be applied to achieve the target. Transmission power control and load distribution are two approaches to minimize the active communication energy, and sleep/power-down mode is used to minimize energy during inactivity. For efficient utilization of battery power, it is important to minimize the power consumption of the entire network (implying maximizing the lifetime of ad hoc networks). The power required by each mobile host can be classified into two categories [11]:

1) Communication-related power
2) Non-communication-related power

Currently, research has been done for hardware and circuit-level power optimization and management within a wireless device (e.g., low-power displays, low-power CPUs, power-efficient computing algorithms). Within a single wireless device, improved power efficiency may be achieved for conventional components (e.g., CPU and disk) by turning them off or slowing them down when not needed [11]. When a transmitter does not receive acknowledgments after packet transmissions, the retransmission request scheme senses that the channel is bad and ceases retransmitting to not waste power when the chances of successful reception are dim [11]. This scheme, therefore, reduces unnecessarily power wastage at the expense of transmission delay. Another solution is for the retransmission request scheme to increase the retransmission power. This reduces the possibility of transmission errors but increases the signal- to-interference ratio (SIR) of the network. Therefore, to appropriately determine when and at what power level a mobile host should attempt retransmission is an important issue for minimizing power incurred at the data link layer

Flow argumentation Routing (FAR) [12] which assumes a static network and finds the optimal routing path for a given source-destination pair that minimizes the sum of link costs along the path, Online Max-Min (OMM) [13] which achieves the same goal without knowing the data generation rate in advance. Power aware Localized Routing (PLR) is a localized, fully distributed energy aware routing algorithm but it assumes that a source node has the location information of its neighbours and the destination and Minimum Energy .Localized Energy Aware Routing (LEAR) Protocol [14] is based on DSR but modifies the route discovery procedure for balanced energy consumption. In LEAR, a node determines whether to forward the route-request message or not depending on its residual battery power. Conditional max-min battery capacity routing (CMMBCR) Protocol [15] uses the concept of a threshold to maximize the lifetime of each node and to use the battery fairly.

Examples of such multipath protocols include Temporally Ordered Routing Algorithm (TORA) and Split Multipath Routing (SMR). In TORA, the source node constructs multiple routes by flooding a query message followed by a set of update messages. However, TORA does not have any mechanisms to evaluate the quality of these multiple paths and this leads to its poor performance.

DSR multipath routing is significantly better than single path routing [15], the performance advantage is small beyond a few paths and for long path lengths. The source keeps all routes received no reply packets in its route cache. When the primary route breaks, the shortest remaining alternate route is used. This process continues until all routes break, when a fresh route discovery is initiated. The number of alternate routes used can be a selectable parameter of the protocol. This protocol equips only the source with alternate routes.

IV. PROPOSED WORK

In the proposed energy efficient Multipath DSR protocol each node will only use part of energy to transmit the data packets. This is done through a route discovery procedure. The new protocol uses a cost function to decide route selection instead of using the traditional shortest hop algorithm. As MBCR consider only total battery cost function it may happen that the route containing nodes with less remaining battery may still selected and thus decrease the network partition time.

In the existing DSR protocol, during route discovery the destination node after receiving first route request packet and replying to it, starts discarding other route request packets from the same source. The reason is that existing DSR is single path protocol and as soon as one route is discovered from source to destination, destination does not respond to other requests considering that a route is already successfully discovered and replied.

In the proposed work, the destination will accept at most first three route request packets from the same source for the same transmission (i.e. same ID). This gives the source, multiple paths from source to destination for transmission. It then utilizes all the discovered paths for data transmission. These multiple paths allow load balancing and faster delivery. These multiple paths are node disjoint as the original DSR protocol is itself does not allow loops.

In order to implement this concept, some changes are required in the protocol. They are:

Destination Node: allow more than one replies from different paths without looping. We need to maintain a counter for that, and store these paths into the table, with the preferable sequence.

Source Node: Record at most three routes in the route cache. Structure of route cache need some change in order to incorporate this.

Intermediate Node: As through overhearing they are in a position to get aware of new paths, they also need to change route cache structure.

The energy supply Es is the only part of remaining power. A node with high energy supply percent. In each transmission, the node uses only parts of the power to participate in the operation and leaves the remaining parts to participate in the future operations. By this method, the nodes avoid using too much energy at one time and this can guarantee that the node with more power will be used to transmit the large size packets and the node with the less power will be used to transmit the small size packets.

We define the energy demand E_d for sending packet with size *m* is:

E_d=b*m+c

Where, b and c are parameters.

We define the energy supply level Es for node I,

Es=Ei*(Ei/Eo)

Where, Ei is the current energy of node I, Eo is the initial energy of the node i.

We define the cost function C(r) of route r:

C(r) = Sum Ci

Where, node i is in route r, Ci=Eo/Es.

Energy Efficient Multipath DSR solves this problem by using route discovery algorithm based on cost function of routes. The route selection is controlled by the cost of the route .Our protocol prevent overuse of small set of nodes and reduce the energy level variance among nodes in the whole network.

V. SIMULATION

NS-2 simulator is used for performance evaluation. The network is a collection of 50 nodes deployed on square area of 1200mx1200m. Transmission range of each node is 250 m. For radio propagation model, a two-ray ground reflection model is used. In our simulations, we will use the RWP (Random waypoint) mobility model. Each node moves with a maximum speed randomly chosen from the interval 5 m/s and 15 m/s.

Communication between nodes is modelled by CBR (Constant Bit Rate) traffic over UDP. A source generates packets of 512 bytes with a rate of five packets per second. A total of 8 connections were generated. They start at a time randomly chosen from the interval [0s, 100s] and still active until the end of simulation.

As the remaining energy level of a node decreases, the link cost of the node increases. This forces new routing decisions in the network by invalidating its own cache entries to various destinations. However, if a path was recently added to the cache table, the node will not force a new decision (route finding step) unless the node's remaining energy is depleted by a certain normalized amount due to messages passing through that path.

Battery status is divided into 3 categories:

1 If (Battery Status < 10%)

Then Set B_S = 1

2 If (10% <= Battery Status < 80%)

Then Set B_S = 2

3 If (Battery Status > 80%)

Then Set B_S = 3.

Parameters to Concern during Route Search

At the time of route discovery, a route request (RREQ) packet broadcasted by the source. The header of the RREQ packet includes <source-id, destination-id, T_B_S (Total Battery Status), WNs (number of weak nodes) and Node IDs.

Calculation of Total Battery Status (T_B_S)

Initially T_B_S = 0 and WN=0 at source node. As RREQ packet propagates along the path, T_B_S is updated at each intermediate node i as follows:

If (B_Si == 3)

Then T_B_S = T_B_S + 3

Else-if (B_Si == 2)

Then T_B_S = T_B_S + 1

Else-if (B_Si == 1)

WN= WN + 1

Here WN represents a weak node which has the energy less than 10%.

This is achieved by adding Battery_ cost () function to dsr_proto.cc.

We consider Random way point mobility (RWP) for mobility. We simulate the network at 50nodes. In order to find the best mobility model we fix the CBR connection and pause time of each node.

Simulation time	Dead Nodes In DSR	Percentage Of Dead Nodes In DSR	No Of Dead Nodes In DSR-PSR	Percentage Of Dead Node in DSR-PSR
400	17	34	3	6
450	19	38	3	6
500	21	42	3	6
550	23	46	4	8
600	25	50	4	8
650	27	54	4	8
700	29	58	5	10
750	32	64	5	10
800	34	68	5	10
850	36	72	6	12
900	38	76	6	12

Table. 1: number of dead nodes in both DSR and DSR-PSR protocol.

A. ANALYSIS

As the objective of this paper is to perform energy efficient routing and find a reliable data transmission method for mobile ad hoc networks by DSR. For analysis here, the first definition is adopted. Network lifetime of DSR and Energy Efficient Multipath DSR (DSR-PSR) are compared for the given scenario by using number of dead nodes.

1) Number of dead nodes

From the observation, whenever the node speed is fixed, the result presents two facts:

1) The time for the first node to die in network in DSR and DSR-PSR.
2) The number of dead node in DSR and DSR-PSR protocol.

The numbers of dead nodes are very less in case of our new protocol. The reason being in DSR-PSR source nodes will change the moving direction frequently. Then the previous path may not useful for the new destination.

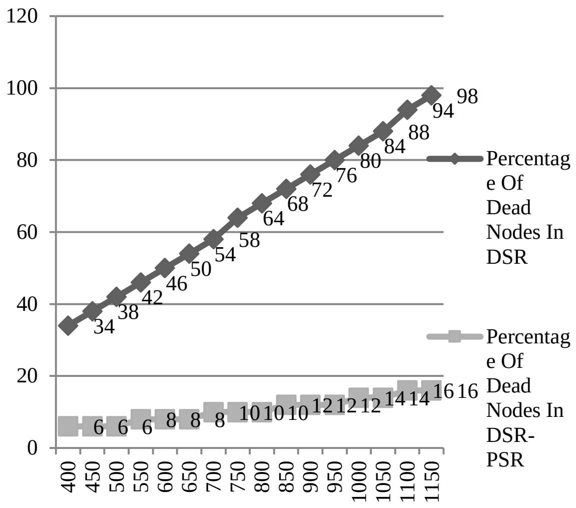

Fig. 1: Graph for percentage of dead nodes.

The simulations are carried out for network densities of 50 nodes respectively. The area considered is 1200m X 1200m for stationary nodes and nodes with mobility of 10mps. Simulations are configured for the first node dead and all node dead estimations of both routing protocols with the metrics like battery capacity & energy consumed at the destination for stationary and nodes with mobility of 10mps respectively. Comparison of routing protocols constant bit rate (CBR) traffic patterns is used. The network contains variable CBR traffic connections and packet size of 512 bytes.

VI. CONCLUSION

From our simulation results, we discover that if nodes in an ad hoc wireless network expend most of their power on communication-related applications, power aware routing protocols, like minimum battery cost and min-max battery cost schemes, can prevent nodes from being unwisely overused. This extends the time until the first node die and increases the operation time before the network is partitioned. However, these power-aware routing protocols tend to select a longer path, which increases the average relaying load for each node and therefore reduces the lifetime of most nodes.

In this paper I analyze Minimum Battery Cost Routing (MBCR) to develop Energy Efficient Power Aware Multipath Dynamic Source Routing based on DSR. I proposed a new route discovery algorithm that considers the remaining energy for each node and uses a cost function to choose the best power saving route. And a new route maintenance algorithm that deals with the broken routes due to the nodal energy depletion and node mobility.

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