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Stability Aware Routing in MANET

Parul Tomar

Assistant Professor, Department of Computer Engineering, YMCA University of Science & Technology, Faridabad, India

Abstract: An ad hoc wireless network is a collection of wireless mobile nodes that establish some kind of coordination among them to form a network. In ad hoc networks, all nodes share a single radio channel. Therefore, nodes that are within radio distance of other nodes can directly connect with each other [1]. Mobility increases the difficulty of communications among nodes due to variable radio channels and multi-path fading. While ad hoc networks have expanded and their technology has advanced considerably, there are still issues that need to be looked at more closely. These issues include throughput, delay, channel capacity, and power consumption. Power is a crucial factor especially in mobile ad hoc networks. In order to keep the network alive it is acting as fuel. Thus, power conservation helps in prolong network life. Here, in this paper we are presenting a new approach "Stability Aware Routing in MANET".

Keywords: Ad hoc, Power, Mobile, Stability, throughput.

I. INTRODUCTION

Mobile networks offer advantages for both the military and the civilian world. While they were originally meant for enhancing military communications in the battlefield or in areas hit by natural catastrophes, wireless networks have found their way into civilian life. Today People are using these networks in cafes, restaurants, malls, universities, and public Gatherings, such as conferences.

The advanced power management techniques employed in wireless devices on the operating system (OS) level give the OS direct control over the power management functionality of the wireless device. This allows the mobile nodes to take advantage of the power management features provided by the operating system and enhances the energy conservation process. Operating systems in mobile devices utilize new features found in the current generation of smart batteries. The aim of this paper is to extend the network lifetime by improving the power utilization of the routing mechanism in MANETs. This paper utilizes the ability of wireless network cards to dynamically change the transmission power, as well as the ability of wireless devices to read the remaining battery energy on which the device uses to determine how to route packets. Link stability is assigned according to the transmission power needed to reach the destination node, along with the battery status of the sending and intermediary nodes. The routes are chosen with lower uptime values on average, and with time, will lead to better utilization of the power sources of the communicating devices.

II. RELATED WORK

In a mobile ad hoc network nodes are often powered by batteries. The power level of a battery is finite and limits the lifetime of a node. Every message sent and every computation performed drains the battery [2,3]. The main goal of power awareness routing in an ad hoc network is to optimize the lifetime of the nodes and network[4]. In mobile ad hoc networking the power consumption of a node can be divided according to functionality into:

- The power utilized for the transmission of a message;
- The power utilized for the reception of a message;
- The power utilized while the system is idle.

This suggests two complementary levels at which power consumption can be optimized in wireless communication:

- Minimizing power consumption during the idle time by switching to sleep mode; this is Known as Power Management;
- Minimizing power consumption during communication, that is, while the system is transmitting and receiving messages; this is known as Power Control.

In power control routing protocols several metrics can be used to optimize power awareness routing [4] :

Minimize Energy consumed per packet: It is the most intuitive metric, however not optimal for maximum lifetime. This is one of the more obvious metrics. To conserve energy, we want to minimize the amount of energy consumed by all packets traversing from the source node to the destination node. That is, we want to know the total amount of energy the packets consumed when it travels from each and every node on the route to the next node. The energy consumed for one packet is thus given by the equation:

$$E = \sum_{i=1}^{k-1} T(n_i, n_{i+1})$$

Where, n_1 to n_k are nodes in the route while T denotes the energy consumed in transmitting and receiving a packet over one hop. Then we find the minimum E for all packets. However, this metric has a drawback and that is nodes will tend to have widely differing energy consumption profiles resulting in early death for some nodes.

Maximize Time to Network Partition: It is important for mission critical applications, hard to maintain low delay and high throughput simultaneously. For this metric, the basic criterion is that given a network topology, we can find a minimal set of nodes whereby the removal of it will cause the network to partition. A routing procedure must therefore divide the work among nodes to maximize the life of the network. However, optimizing this metric is extremely difficult as finding the nodes that will partition the network is non-trivial and the “load balancing” problem is known to be an NP-complete problem.

Minimize Variance in node power levels: It is used for balance the power consumption for all the node in the network, i.e., all nodes in the network have the same importance; This metric ensures that all the nodes in the network remain up and running together for as long as possible. It achieves the objective by using a routing procedure where each node sends packets through a neighbour with the least amount of packets waiting to be transmitted. In this way, the traffic load of the network is shared among the nodes with each node relaying about equal number of packets. Therefore, each node spends about the same amount of power in transmission.

Minimize Cost per packets: It is used to maximize the life of all the nodes. For this metric, the idea is such that paths selected do not contain nodes with depleted energy reserves. In other words, this metric is a measurement of the amount of power or the level of battery capacity remaining in a node and that those nodes with a low value of this metric are not chosen (unnecessarily) for a route. This metric is defined as the total cost of sending one packet over the nodes, which in turn can be used to calculate the remaining power. It is given by the equation:

$$C = \sum_{i=1}^{k-1} f_i(x_i),$$

Where xi represents the total energy expended by node i so far and f is the function that denotes the cost. Then we find the minimum C for all packets.

Minimize Maximum Node Cost: It is used to reduced delay the node failures. The idea here is to find the minimum value from a list of costs of routing a packet through a node. The costs themselves are maximized value of the costs of routing a packet at a specific time. The equation for this metric is:

$$\boldsymbol{Minimize}\ \hat{C}(\boldsymbol{t}), \boldsymbol{for\ all\ t} > 0,$$

Where Ĉ(t) denote the maximum of the Ci(t)s and Ci(t) is the cost of routing a packet through node i at time t.

III. PROPOSED PROTOCOL

Route request phase in stability aware source routing

When a source node needs to send a data packet to a target node, it first searches its routing cache for any entry using the target node address as the key. An entry in the routing cache contains a list of stable routes to the target node. If a routing cache entry is found, then the source node picks a route. If no entry is found for the target node, then the source node initiates a route discovery for the target. The proposed protocol adds four new entry types to the RREQ packet format of standard DSR[6].

1. Link Uptime Vector $(\boldsymbol{t_i^{uptime}};\ \boldsymbol{i} \in (\mathbf{1}, \dots \dots, \boldsymbol{N} - \mathbf{1}))$ for the route,
2. Partial route Rij

$$= (V_i, V_{i+1}, V_{i+2}, \dots \dots \dots \dots V_k, V_{k+1}, \dots .. V_{j-1}, V_j)$$

3. Earliest Up-time of Last-upstream node (t_i^{up})
4. Threshold value (Th = T_{data} transmission time of each data packet)

The protocol allows intermediate nodes to forward multiple RREQ packets with the same <source address, request id> pair if the packets contain distinct source routes. During the RREQ lookup at intermediate nodes, the tuple <source address, request id, last upstream node address, partial route length> is checked with each entry in the recently seen requests list for possible match. If no match is found, then the RREQ contains a distinct source route and is eligible to be forwarded if the contained source route is predicted to be stable.

If intermediate node receive more than two RREQ packets. It does not forward these all RREQ packet to their neighbor node. Intermediate node performs the comparison between the received RREQ and the previous RREQ packet. If uptime of previous RREQ is greater than to the Received RREQ then discard the received RREQ and forward the previous RREQ uptime.

SourceAddress	**Source Sequence #**	**Destination Address**
Partial Route	**Link Uptime Vector**	
Earliest Up-time of Last Upstream Node	**Threshold value**	

Fig 1. Route Request (RREQ) packet in SAR

SAR predicts the route stability using a link by link stability prediction. Each intermediate node receives RREQ and predicts the stability of the link between itself and the last upstream node. All previous links in the source route are assumed to be stable, otherwise the previous upstream nodes would not have forwarded the RREQ packet. Thus the stability of the current link ensures the stability of the entire source route. For each received RREQ, intermediate node VK+1 calculates the uptime of the link between itself and the last upstream node recorded in the RREQ and appends it to the Link Uptime Vector in the RREQ.. If the uptime is less than Threshold, then the link will not be stable for the entire period of exchanges of the RREQ, the following RREP and then the data packet. Hence the intermediate node discards the RREQ.

Route reply phase in stability aware source routing

When the RREQ reaches the target, the route is predicted to be stable. The target node sends an RREP packet back to the source along the reverse path recorded in the RREQ. In this proposed protocol the routing table is maintained at the destination node. At the destination node the all stable route store in the routing table in increasing order of the Route uptime factor .In the route reply phase the destination node only send the one RREP packet which contain the first entry of the routing table Hence it leads to reduce the total transmission time between source to destination. Fig. 2 shown the route reply process in the given example

The proposed protocol adds three new entry types to the standard DSR RREP packet format:

1. source route Rij $= (V_i, V_{i+1}, V_{i+2}, \ldots\ldots\ldots\ldots V_k, V_{k+1}, \ldots..V_{j-1}, V_j)$
2. Link uptime vector $(t_i^{uptime}\ ;\ i \in (1, \ldots\ldots, N -$ ⍰ $1))$
3. Earliest up time. The minimum of all the Link Uptime Vector elements.
4. Estimated Transmission Time

Source Route	**Link Uptime Vector**
Earliest Up Time	**Estimated Transmission Time**

Fig 2. Route Reply (RREP) packet Format in SAR

Route selection phase at the destination node

At the destination node the all stable route store in the routing table in increasing order of the Route uptime factor .In the route reply phase the destination node only send the one RREP packet which contain the first entry of the routing table Hence it leads to reduce the total transmission time between source to destination

Destination Address	**Source Route**	**Earliest up Time**

Fig 3. Routing table Entry in SAR

Steps to identify the stable path:

1. Source Node initiates the Data Transmission Request.
2. Check for the destination node in route cache. If found then forward the data packet to destination.
3. If destination node is node found in route cache then broadcast the route request Packet (RREQ) to their neighbor node.
4. Calculate the link uptime value t_i^{uptime} between the node V_i to V_{i+1}

$$t_i^{uptime} = \text{average}(t_i^{up}\ , t_{i+1}^{up})$$

5. If t_i^{uptime} > th (Threshold) then add in to the link uptime vector

Lij $= \left(t_i^{uptime}, t_{i+1}^{uptime}, t_{i+2}^{uptime}, \ldots..., t_k^{uptime}, t_{k+1}^{uptime}, \ldots..., t_{j-1}^{uptime}\right)$

and forward the packet to the next node.

6. If the intermediate node receive more than two RREQ packet then if T_k^{uptime}.previous RREQ > T_k^{uptime}.latest RREQ then forward previous RREQ and discard latest RREQ otherwise forward latest RREQ.
7. Repeat step 3 to step 6 till destination is found.
8. If destination found then store all route in to the routing table in increasing order of Route Uptime Factor RUFij = min(t_i^{uptime}, $V_i \in V$, $t_i^{uptime} \in$ Lij) and send RREP to the first entry of routing table.

IV. CONCLUSION

Previous work on routing in MANETs has resulted in numerous routing protocols that aim at satisfying constraints such as minimum hop or low energy. Existing routing protocols often fail to discover stable routes between source and sink when route availability is transient, i.e., due to mobile devices switching their network cards into low-power sleep modes whenever no communication is taking place. This paper introduce a new approach stability aware source routing protocol that is capable of predicting the stability (i.e., expiration time) of multiple routes. Proposed protocol selects the route that minimizes hop count while staying available for the expected duration of packet transmission. The stability aware routing indicates a significant increase in route discovery success rate with comparable route establishment and maintenance overheads.

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