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A Novel Method for Power Consumption Optimization In Manet

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ABSTRACT: *In MANET, there are two important factors to be solved. First, the power aware routing protocol should be fully distributed and adaptive to the current states of all mobile nodes. Secondly, links may be unpredictable due to asymmetric power configurations of neighboring nodes. In this manuscript, investigation has been done on the effect of change in number of nodes, mobility and pause time on packet delivery ratio and delay of reactive routing protocols. We propose efficient Power Aware Routing (EPAR), a new power aware routing protocol that increases the network lifetime of MANET. In contrast to conventional power aware algorithms, EPAR identifies the capacity of a node not just by its residual battery power, but also by the expected energy spent in reliably forwarding data packets over a specific link. Using a mini-max formulation, EPAR selects the path that has the largest packet capacity at the smallest residual packet transmission capacity. This protocol must be able to handle high mobility of the nodes which often cause changes in the network topology. This paper evaluates three ad hoc network routing protocols (EPAR, MTPR and DSR) in different network scales taking into consideration the power consumption. Indeed, our proposed scheme reduces for more than 20 % the total energy consumption and decreases the mean delay especially for high load networks while achieving a good packet delivery ratio.*

Keywords: *DSR, MTPR, network lifetime, power aware.*

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I. INTRODUCTION

MANET is an autonomous system of mobile routers connected by wireless links. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a stand-alone fashion, or may be connected to the larger Internet. Since the need to conserve energy so that battery life is maximized is important, it is obvious that energy efficient algorithms should be implemented in place of the conventional routing algorithm. In this paper we have proposed a new power efficient routing protocol which increases the network lifetime. In the conventional routing algorithm, connections between two nodes are established between nodes through the shortest path routes. It is unaware of energy budget and thus results in a quick depletion of the battery energy of the nodes along the most heavily used routes in the network. Therefore to conserve battery energy of the nodes, there are various routing algorithms and schemes designed to select alternative routes. Power aware routing schemes make routing decisions to optimize performance of power or energy related evaluation metric(s).

1.1. Routing Protocols

In MANET, routing protocols are classified into two types:

• Proactive or table-driven routing protocols
• Reactive or on-demand routing protocols.

a) On-Demand Routing Protocols (Reactive)

Reactive routing protocols [1], [2] try to utilize network bandwidth by creating routes only when desired by the source node. Once a route has been established, it is maintained by some route maintenance mechanism as long as it is needed by the source node. When a source node needs to send data packets to some destination, it checks its route table to determine whether it has a valid route. If no route exists, it performs a route discovery procedure to find a path to the destination. Hence, route discovery becomes on-demand. These routing approaches are well known as Reactive routing. Examples of reactive (also called on-demand) ad hoc network routing protocols include ad hoc on-demand distance vector (AODV), Temporally ordered routing algorithm (TORA), Dynamic source routing (DSR)[5].

b) Table Driven Routing Protocols (Proactive)

In proactive or table-driven routing protocols, each node continuously maintains up-to-date routes to every other node in the network. Routing information is periodically transmitted throughout the network in order to maintain routing table consistency. Thus, if a route has already existed before traffic arrives, transmission occurs without delay. Otherwise, traffic packets should wait in queue until the node receives routing information corresponding to its destination. However, for highly dynamic network topology, the proactive schemes require a significant amount of resources to keep routing information up-to-date and reliable. Certain proactive routing protocols are Destination-Sequenced Distance Vector (DSDV) [3], Wireless Routing Protocol (WRP) [4],[5],Global State Routing (GSR) [6] and Cluster head Gateway Switch Routing (CGSR) [7].The rest of this paper is organized as follows. Section 2 presents the preliminaries of this work.The analysis of the scheme is presented in Section 3. Section 4 describes the Design of the proposed protocol. Section 5 presents the simulation set up and result discussions. Finally ,Section 5 gives the conclusions.

II. LITERATURE SURVEY:

Most of the previous work on routing in wireless ad-hoc networks deals with the problem of finding and maintaining correct routes to the destination during mobility and changing topology [8],[9]. In [10],[11]**,** the authors presented a simple implementable algorithm which guarantees strong connectivity and assumes limited node range. Shortest path algorithm **is** used in this strongly connected backbone network. However, the route may not be the minimum energy solution due to the possible omission of the optimal links at the time of the backbone connection network calculation. In [4]**,** the authors developed a dynamic routing algorithm for establishing and maintaining connection-oriented sessions which uses the idea of proactive to cope with the unpredictable topology changes. Some other routing algorithms in mobile wireless networks can be found in [6],[7],[8], which as the majority of routing protocols in MANETs do, uses shortest-path routing where the number of hops is the path length, The problem of minimum energy routing has been addressed before in [7],[12],[10]. The approach in those was to minimize the total energy consumed to reach the destination, which minimizes the energy consumed per unit flow or packet. If all the traffic is routed through the minimum energy path to the destination, the nodes in that path will be drained of energy quickly while other nodes, which perhaps will be more power hungry if traffic is forwarded through them, will remain intact.

III. PROPOSED PROTOCOL METHODOLOGY

Power aware routing schemes make routing decisions to optimize performance of power or energy related evaluation metric(s). The route selections are made solely with regards to performance requirement policies, independent of the underlying ad-hoc routing protocols deployed. Therefore the power-aware routing schemes are transferable from one underlying adhoc routing protocol to another, the observed relative merits and drawbacks remain valid. In DSR, because the route selection is done based on a shortest path finding algorithm (i.e., those with the minimum number of hops), only mobility of the nodes may cause a selected path to become invalid. In contrast, in PSR, both the node mobility and the node energy depletion may cause a path to become invalid. Since the route discovery and route maintenance in DSR are more complicated compared to their counterparts in our proposed protocol, these two steps will be described in detail. Also, since RER is derived from DSR, the PSR description will often be contrasted with that of DSR

3.1. Dynamic Source Routing (DSR)

DSR [4] is based on source routing where the source specifies the complete path to the destination in the packet header. All the intermediary nodes along the path simply forwards the packet to the next node as specified in the packet header [9],[10]. This means that intermediate nodes only need to keep track of their neighboring nodes to forward data packets. The source on the other hand, needs to know the complete hop sequence to the destination. In DSR, all nodes in a network cache the latest routing information. When more than one route to the destination is found, the nodes cache all the route information so that in case of a route failure, the source node can look up their cache for other possible routes to the destination. If an alternative route is found, the source node uses that route; else the source node will initiate route discovery operations to determine possible routes to the destination. During route discovery operation, the source node floods the network with query packets. Only the destination or a node which already knows the route to destination can reply to it, hence avoiding the further propagation of query packets from it. The disadvantages of DSR are two-fold. DSR is not scalable to large networks. The Internet Draft acknowledges that the protocol assumes the diameter of the network is no greater than 10 hops.

Additionally, DSR requires significantly more process resources than most other protocols. In order to obtain routing information, each node must spend much more time processing any control data it receives, even if that node is not the intended recipient. This is the ability of many network interfaces, to operate the network interface in "promiscuous" receive mode, including most current LAN hardware for broadcast media such as wireless. This mode causes the hardware to deliver every received packet to the network driver software without filtering, based on link layer destination address. The promiscuous mode increases bandwidth utilization of DSR by reducing the number of control messages being sent out, though the use of promiscuous modes may increase the power consumption of the network interface hardware.

3.2. Min-Max Battery Cost Routing (MMBCR)

MMBCR mechanism considers both the total transmission energy consumption [3],[9] of routes and the remaining power of nodes. When all nodes in some possible routes have sufficient remaining battery capacity, a route with minimum total transmission power among these routes is chosen. Since less total power is required to forward packets for each connection, the relaying load for most nodes must be reduced, and their lifetime will be extended. However, if all routes have nodes with low battery capacity (i.e., below the threshold), a route including nodes with the lowest battery capacity must be avoided to extend the lifetime of these nodes with MMBCR applied. Although MTPR can reduce the total power consumption of the overall net-work, it does not reflect directly on the lifetime of each host. In other words, the remaining battery capacity of each host is a more accurate metric to describe the lifetime of each host. Let ci(t) be the battery capacity of host ni at time t. We define fi(t) as a battery cost function of host ni. The less capacity it has, the more reluctant it is to forward packets; the proposed value is fi(t) = 1/ci(t). If only the summation of the values of battery cost function is considered, a route containing nodes with little remaining battery capacity may still be selected. Since MMBCR considers the weakest and crucial node over the path, a route with the best condition among paths impacted by each crucial node over each path is selected. However, in MMBCR, there is no guarantee that the total transmission power is minimized over a chosen route.

IV. DESIGN CRITERIA

4.1. Concept of Proposed Protocol

PER protocol improves the lifetime of the network to some extent as compared to the existing power efficient protocols like on-demand DSR and MMBCR protocols. Reinitializing the route discovery process periodically at regular intervals to know the energy levels of nodes and change route accordingly results in increasing the routing overhead. Routing overhead though consumes very less amount of energy as compared to data packets, may contribute for delay and energy consumption. Thus, there is a need to overcome the routing overhead problem encountered in existing DSR protocol. To avoid unnecessary routing overhead, a new mechanism of route discovery is introduced in PER protocol. In this proposed protocol instead of reinitializing route discovery process periodically; route discovery is initialized only after transmission of an optimum number of data packets. If this number is less, i.e., if route discovery is initialized after transmitting say 100 data packets then the nodes are involved in this discovery process wherein their energy level is reduced. As a result node failure time is reduced that is nodes involved in this discovery mechanism die out quickly. If the number is more, i.e., if route discovery is initialized after transmitting say 100 packets then less frequently nodes are used up in the discovery process resulting in saving the energy of nodes. An optimum value of this number must be chosen carefully depending on the size of the network and the energy level of nodes to avoid routing overhead and maximize the lifetime of network.

4.2. Route Selection by PER Protocol

In DSR and MMBCR protocols, route discovery process is initialized periodically to know the power levels of nodes and change route accordingly. Due to continuous route discovery process, there is a chance of increasing the routing overhead. Hence the routing overhead, though consumes very less amount of energy as compared to data packets, may contribute for delay and energy consumption to some extent. To avoid unnecessary routing overhead a new mechanism is introduced such that the DSR and MMBCR protocols initiates the route discovery only after sending certain number of data packets. Due to less routing overhead, throughput and packet delivery ratio increases and is more for PER protocol compared to DSR and MMBCR protocols. Average delay increases with number of sources but is less for PER compared to DSR and MMBCR protocols. Residual energy decreases with increasing number of sources and with time but is comparatively more for PER as compared to DSR and MMBCR protocols. Normalized routing load is comparatively less for PER protocol resulting in increasing the network lifetime.

Algorithm in PER is as follows:

• Construct a new routing cost function as the judgment whether the route is valid or invalid. This routing cost function is the kernel of PER and it will immediately influence PER 's energy-saving effect;

• Inherit the common characteristic of on-demand routing protocols which initiate route discovery process just when needed;

• During the process of selecting routes, PER introduces power factor to consider together instead of just taking the count of hops as the judgment whether the route is valid or invalid;

• Use the idea of DSR and MMBCR for reference, adopt different routing strategies according to the nodes' different power consumption condition. PER expects to achieve power saving and improve the performance of the network lifetime;
• The modification of DSR should be as light as possible and we should try to improve it just based on the original protocol so as to get higher portability.

4.3. Designing of Power Consumption Model in PER Protocol:
The power consumption at a node in an ad hoc network can be divided into three categories: (i) energy utilized for transmitting a message, (ii) energy utilized for receiving a message and (iii) energy utilized in idle state. Energy consumption at a node would be dominated by the energy lost when the node is in idle state. Thus, in this paper, we do not consider the energy lost in the idle state and focus only on the energy consumed during the transmission and reception of messages and the energy consumed due to route discoveries. We model the energy consumed due to broadcast traffic and point-to-point traffic as linear functions of the packet transmission time, network density, transmission and reception powers per hop. For simulations without transmission power control, the fixed transmission power per hop is 1.6W. We modify the format of RREQ packet and RREP packet of the DSR. The RREQ of the DSR is tended as RREQ of the EPAR adding with two extra fields, one is cost field and another is Max-cost field is shown in table 1. It contains type field, source address field, destination field, unique identification number field, hop field, Max-cost field, cost (cumulative cost) field and path field. The PER protocol is the improvement of the DSR protocol. However it is un-avoid able to modify some important data structures of the original DSR protocol. The PER protocol adds power aware field and residual energy field into the RREQ messages and the RREP messages. They respectively denote the energy parameter of the current route and the minimum residual energy of its member nodes. So PER has to add power aware field and residual energy field, which respectively denote the route's energy parameter and its member node's minimum residual energy into every item of the route cache list, and their values equal to the value of power aware field and residual energy field respectively in the RREP message which is returned by the destination node in the route discovery process. Like the DSR protocol, such route cache is managed by the mechanism of overtime deletion.

4.4 Route Discovery Mechanism in PER Protocol
When source node S begins to communicate with destination node D, it will search its route cache to find routes to destination node D. If no route exists, route discovery process will be initiated. Source node S generates a RREQ message first, fills its IP address, destination node's IP address etc. in the corresponding fields of the RREQ message, sets the pa field to the maximum value of power aware field MAX_POWER_ AWARE and the re field to node's initial energy INITIAL_ENERGY, and then broadcasts the RREQ message in the network. After destination node receives the RREQ message, it generates a RREP message first and sets the pa field and the re field respectively. Because it has been supposed that the PER protocol is just applicable to duplex links, the destination node just needs to reverse the “route record" of the RREQ message to be the route from the destination node to the source node, copy this reversed route to the “source route" field of the RREP message and then send it to the source node.

V. SIMULATION RESULT AND PERFORMANCE METRIC STUDY

In this paper, we have studied effect of mobility and varying number of mobile nodes of packet delivery ratio, average end to end delay and network lifetime metrics. NS-2 simulator is used in this simulation. We modified the reactive DSR protocol. 100 mobile nodes are used and area of ad hoc network is 1000 X 1000. We run all simulations for 1000 seconds. When we consider node movement, random waypoint model is used with two factors: (a) maximum speed and (b)

Signal Processing Model	Two – ray ground
Network Size	1000x1000
Number of Mobile Nodes	100
Network Simulator	NS-2.33 Version
Transmission range	250m
Data Packet size	512 bytes
Routing Protocols	DSR, MMBCR and PER
Traffic Model	CBR,UDP

5 .1. Packet Delivery Ratio (PDR)

Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. This performance metric gives us an idea of how well the protocol is performing in terms of packet delivery at different speeds using different traffic models. Packet delivery ratio for PER, MMBCR and DSR protocols is shown in fig.1, where speed of mobility taken into account is up to 100 meters/second with a pause time of 100 seconds. At low speeds of nodes, all three protocols demonstrate higher throughput. However, higher speeds may lead to frequent changes in links and probable link failures, ultimately reducing throughput. It can be observed from fig.1, that packet delivery ratio in PER is 95%, MMBCR is 86% and DSR performs 76% for high mobility up to 100 m/s. Packet delivery ratio with respect to number of nodes for different mobile speeds is represented. for mobile speed of 25 m/s, PER shows 65% improvement over DRS and MMBCR protocols. Please note that in the simulation, number of nodes is set up to 100. As number speed of mobility increases, packet delivery ration decreases. But PER maintains little bit constant packet delivery ration than DSR&MMBCR.

5.2 Node Lifetime:

In MANET, nodes may happen to die out. Fig.3 shows the number of nodes which die at some time instants using PER, MMBCR and DSR protocols. It can be clearly noticed that nodes in DRS die earlier than PER and MMBCR. It happens during forwarding of the query packet, when the power level of an intermediate node is found to be less than that mentioned in the power aware extension for power in the query packet. As data packet and time increases, due to lack of battery power number of mobile nodes dies.

5.3. Average End-to-End Delay:

This is the time taken to start from source node to destination node for successful delivery of data Packets DSR had

higher end-to-end delay than the MMBCR and PER because DSR had a longer routing path from the source node to the destination node. However, PER can found the more stable path. This is because our reliable path scheme will increase the end-to-end delay.

VI. CONCLUSION

DSR shows the least improvement in network lifetime and PER and MMBCR show a relatively larger improvement in network lifetime as we move from scenarios of no power control and no on-demand recharging towards scenarios of power control and on-demand recharging. This can be attributed to the power-aware nature of MMBCR. The gain in network lifetime with the introduction of the energy-efficient techniques is relatively low in the case of DRS and MMBCR. Simulation results show that PER allows the connections to live longer. In MANET, all three protocols perform in same way. When mobility increases, PER outperforms than MMBCR and DSR routing protocols. Poor performances of DSR routing protocol, when mobility or load are increased, are the consequence of aggressive use of caching and lack of any mechanism to expire stale routes or determine the freshness of routes when multiple choices are available.

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