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Energy Consumption Trade Off And Link Stability Issues For Wireless Sensor Network

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Abstract: MOBILE ad hoc networks (MANETs) have more popularity among mobile network devices and wireless communication technologies. A MANET is multihop mobile wireless network that have neither a fixed infrastructure nor a central server. Every node in a MANET will act as a router, and also communicates with each other. Wireless sensor networks are becoming increasingly important in recent years due to their ability to detect and convey real-time for many civilian. A Mobile Ad-Hoc Network (MANET) is special types of wireless sensor networks. In MANET, the topology of network is constantly changing as nodes move in and out of each other's range, breaking links. Energy efficiency is one of the main problems in MANET. Energy is an important resource that needs to be preserved in order to extend the lifetime of the network. The Nodes in a mobile ad-hoc network operate on batteries, and hence designing energy aware protocols to maximize the battery lifetime is important. Traditional routing protocols fail to address the energy issues present in these networks. Several energy aware routing protocols have been designed for mobile ad-hoc networks. Energy awareness for computation and protocol management is becoming a crucial factor in the design of protocols and algorithms. Often energy saving and path duration and stability can be two contrasting efforts and trying to satisfy both of them can be very difficult. In order to providing QoS guarantees in ad-hoc networks is to find a route to the desired destination that can, with high probability, survive for the duration of the session **.**

I. Introduction

Mobile ad hoc network (MANET) is an infrastructure-less multihop network where each node communicates with other nodes directly or indirectly through intermediate nodes. Thus, all nodes in a MANET basically function as mobile routers participating in some routing protocol required for deciding and maintaining the routes. Since MANETs are infrastructure-less, self-organizing, rapidly deployable wireless networks, they are highly suitable for applications involving special outdoor events, communications in regions with no wireless infrastructure, emergencies and natural disasters, and military operations . Energy efficiency is one of the main problem in MANET .Distributed power control improve the energy efficiency of routing algorithms in ad hoc networks. Each node in the network estimates the power necessary to reach its own neighbors, and this power estimate is used both for tuning the transmit power (thereby reducing interference and energy consumption) and as the link cost for minimum energy routing.

In the area of MANET, routing is one of the prominent issue which surfaces because of highly dynamic and distributed environment in MANET. The power efficiency in mobile ad hoc network has become is one of the critical design factors as the mobile node will be supported by battery with limited capacity. The failure or degradation of energy in mobile nodes will not only influence the node itself but it will also have impact into its potential to forward the packets on behalf of others and therefore influence the cumulative network lifetime. Hence, majority of the researchers has attempted for designing power aware routing algorithms for specific mobile ad hoc network scenario.

The routing protocols proposed for MANETs are generally categorized as table-driven and on-demand driven based on the timing of when the routes are updated. With table-driven routing protocols, each node attempts to maintain consistent, up-to-date routing information to every other node in the network. This is done in response to changes in the network by having each node update its routing table and propagate the updates to its neighbouring nodes. Thus, it is proactive in the sense that when a packet needs to be forwarded the route is already known and can be immediately used As is the case for wired networks, the routing table is constructed using either link-state or distance vector algorithms containing a list of all the destinations, the next hop, and the number of hops to each destination. Route discovery and route maintenance are two main procedures: The route discovery process involves sending route-request packets from a source to its neighbour nodes, which then forward the request to their neighbours, and so on. Once the route-request reaches the destination node, it responds by unicasting a route-reply packet back to the source node via the neighbour from which it first received the route-request. When the route-request reaches an intermediate node that has a sufficiently up-to-date route, it stops forwarding and sends a route-reply message back to the source. Once the route is established, some form of route maintenance process maintains it in each node's internal data structure called a route-cache until the destination becomes inaccessible along the route. Note that each node learns the routing paths as time passes not only as a source or an intermediate node but also as an overhearing neighbour node. In contrast to table-driven routing protocols, not all up-to-date routes are maintained at every node.

Energy is an important resource that needs to be preserved in order to extend the lifetime of the network; on the other hand, the link and path stability among nodes allows the reduction of control overhead and can offer some benefits also in terms of energy saving over ad hoc networks. However, as will be shown in this contribution, the selection of more stable routes under nodes mobility can lead to the selection of shorter routes This is not always suitable in terms of energy consumption. On the other hand, sometimes, trying to optimize the energy can lead to the selection of more fragile routes. Thus, it is evident that both the aforementioned parameters (i.e., link stability associated with the nodes mobility and energy consumption) should be considered in designing routing protocols, which allow right trade off between route stability and minimum energy consumption to be achieved. The main aim of this work is to propose an optimization routing model within a MANET. The model attempts to minimize simultaneously the energy consumption of the mobile nodes and maximize the link stability of the transmissions, when choosing paths for individual transmissions. The idea of considering, at the same time, energy consumption and link stability is motivated by the observation that most routing protocols tend to select shorter routes, in this way high efficiency in using wireless bandwidth and increase path stability are ensured. However, such routes may suffer from higher energy consumption, since higher transmission ranges are needed.

II. Literature Review

2.1 Mobility:

Induced error on Geography Routing in MANET In Geographic routing, the packet forwarding technique was solely based on the location information of neighbours. Geographic routing in GPRS consist of two forwarding modes.1.Greedy packet forwarding, 2.perimeter forwarding. Initially the packet was forwarded by greed forwarding in which all the nodes were identified the location based on the neighbour nodes. The packet forwarding mode has been changed in to perimeter forwarding mode when the node was found out the maximum location Final Stage.

2.2 Routing Protocols

In the MANET the nodes can construct a path in the network using the routing capacity of the intermediate nodes. The communication was established in wireless multi-hop fashion. In other words the communication is established in a wireless multi-hop fashion. The node can also have other characteristics such as small size and battery powered, making the node not only mobile but also portable. As a result MANET can operate in places and situations where traditional networks cannot work properly, such us in disaster recovery areas, rural zones, and third world countries.

The authors introduce Rumour Routing as a logical compromise between query and event flooding. With Rumour Routing paths (possibly multiple and non optimal) are created leading to each event. Whenever a query is generated it is sent on a random walk until it crosses one of the paths leading to the event of interest. It is possible that the query will never cross such a path, in which case query flooding can be used as a last resort. The authors use the heuristic of two lines intersecting in a bounded rectangular region to indicate the plausibility of their solution. The main focus of this paper is the method for setting up paths to an event. The algorithm uses a set of long-lived agents (packets that move between nodes) that create paths (state in every node) toward the events they encounter. Whenever a node witnesses an event it probabilistically generates an agent which travels the network and is initialized with the node's event forwarding table (distance and next hop for events that the node knows about directly or that it can route queries to). As the agent travels, it synchronizes its event table with each node it visits. As a result, it propagates path information and learns about new events that it can propagate further. The agent employs a straightening algorithm to determine its next hop and avoid loops. Due the broadcast nature of the medium, the agent leaves a fairly thick path as it travels, since nodes close to the agent's path can update their own event tables as well. Any node can generate an agent, but it makes more sense for nodes which have observed events to do so, so that useful information can be disseminated immediately. Whenever a query is generated, if the node has an entry for the event in its event table it routes the query to the next hop. Otherwise, it picks randomly a next hop in the hope that it will cross a path to the event. Forwarding queries along a straight path seems to yield better results. It is possible that a query will reach its TTL before crossing a path toward the event, in which case it can perform query flooding. The goal of the algorithm is for the latter case to be rare.

2.3 Energy:

Mobile nodes are powered by batteries with limited capacity. Power failures of a mobile node not only affect the node alone, it will affect the entire network life time. The routing protocols were proposed in MANETs are table-driven and on-demand driven routing. Routing in MANET includes new generation of on demand routing schemes. Proactive routing schemes (OSPF, RIP) compute global routes in the background. The Benefit of proactive routing includes low latency access, alternative paths for effective call acceptance control. These protocols concentrate on the energy properties scheme of applications. This paper focuses on the major energy efficiency issues in ad-hoc networks (not only sensor networks) which are defined as infrastructure less networks that require multiple hops for connecting all the nodes to each other. Vertical layer integration and criticality of energy consumption are the two main characteristics of ad-hoc networks that drive their design. The separation of network functions into layers is characterized as the (original sin) in networking. For any wireless node there are three major modes of operation: transmitting, receiving and listening. When the node is in listening mode the energy expenditure is minimal. However, if the node spends most of the time listening then this mode is responsible for a large portion of the consumed energy (as is the case in sensor networks). In multihop wireless networks it is energy efficient to choose long paths along a series of short hops rather than short paths along a series of long hops. However, even though energy efficiency is our paramount interest it is not the only one. Communication performance is also very important. By choosing many short hops we may lower the energy expenditure, but only to a certain degree, since delay increases, processing energy increases and control overhead increases. Therefore, the choice of how to incorporate energy is not as clear as it seems. A useful distinction presented in the paper refers to whether energy is treated as a cost function or as a hard constraint. In the former case, the objective of the designer is to minimize the amount of energy per communication task, treating energy as an expensive but inexhaustible resource. However, when energy is a hard constraint, the designer must keep in mind that it is a limited resource that will be exhausted. In this case, the designer's task is more complicated since he has to satisfy conflicting objectives: maximizing the longevity of the network vs communication performance (throughput, total data delivered, etc).

III. Minimum Energy Mobile Wireless Networks:

Position based algorithm is used to maintain the minimum energy between the user. Each user will be denoted by nodes over two dimensional planes. Each mobile node has a portable transmission set, reception, processing capabilities. This distributed protocol will find the minimum power topology in the Ad hoc networks.

IV. Existing Protocol

4.1 PERRA:

In mobile ad hoc networks, each node acts as both host and router and performs all the routing and state maintenance. Due to the unpredictable movement of mobile nodes, the network topology of a mobile ad hoc network changes frequently. It will directly cause the more power-efficient and reliable routing protocols are needed. PEAODV (Power Efficient Ad-hoc On-demand Distance Vector for mobile Ad-hoc networks), providing power- efficient and reliable packet transmission. PEAODV uses a new cost function to select the optimum path based on considering the minimum residual energy of the nodes on a path, and the path’s stability in accordance with the rate mobility of node and the available bandwidth and the radio frequency. After comparing PEAODV protocol with the well-known Ad hoc On-Demand Distance Vector (AODV) protocol, the PEAODV increases the throughput.

4.2 GPSR and E-GPSR:

Greedy Perimeter Stateless Routing (GPSR), a novel routing protocol for wireless datagram networks that uses the positions of routers and a packet’s destination to make packet forwarding decisions. GPSR makes greedy forwarding decisions using only information about a router’s immediate neighbours in the network topology. When a packet reaches a region where greedy forwarding is impossible, the algorithm recovers by routing around the perimeter of the region. By keeping state only about the local topology, GPSR scales better in per-router state than shortest-path and ad-hoc routing protocols as the number of network destinations increases. Under mobility’s frequent topology changes, GPSR can use local topology information to find correct new routes quickly. We describe the GPSR protocol, and use extensive simulation of mobile wireless networks to compare its performance with that of Dynamic Source Routing. GPSR’s works scalability on densely deployed wireless networks.

E-GPSR can Calculation of future position of neighbour nodes on the basis of a prediction technique. Selection of the next node to reach the destination based on the ellipsoid algorithm. Through this approach is selected the neighbour node that minimizes the difference distance between current total distance and the future total distance from current node to destination node.

V. Related Work

5.1 Path Stability Aware Metrics:

Protocols In the literature, many metrics focusing on the link or path stability have been defined. Among them, some have been based on the definition of the route breakage probability and some others on the link duration distribution. However, most of them have considered some parameters associated with the specific mobility model in order to estimate the stability metric. In statistical prediction based on the node movement, a link stability probability has been defined on the basis of the random mobility model. A formal model to predict the lifetime of a routing path, based on the random walk mobility and on the prediction technique and considers a probability model derived through the subdivision into cells of the area where mobile nodes move and on the observations of node movements in these cells. Transition probabilities are calculated and a state-based model of the movement among the cells is considered. Each connection between a mobile node in a cell and the other mobile nodes among its neighbour cells is considered as the state of the wireless link. In this way, the wireless link dynamic is determined between a mobile node and its neighbours, permitting the calculation of the link lifetime. After this, through the assumption of independent link failure, the route breakage probability is derived. The link stability probability is determined by considering the signal stability. However, this approach cannot be suitable because it assumes that the signal strength can be affected by environmental conditions and its value can change a lot also for the same nodes distance. This determines many fluctuations in the radio signal measurement, producing erroneous considerations on the link stability. Other techniques rely on the use of special devices, such as the Global Positioning System (GPS), to detect the exact position of the mobile nodes. Each node can calculate its position and a protocol is applied, which disseminates or requests the position for the other nodes. This approach is also criticized, because in some environments, such as indoors or where the mobile nodes are greatly limited in energy, the GPS is not functional. Some enhanced versions of GPSR where some movement prediction is applied in order to reduce the effect of bad location information; however, these fully location-based routing schemes do not account jointly for other metrics such as energy and stability. Five different metrics, for stable path selection, have been proposed in the literature: the first technique is based on the local choice of the oldest link as the most stable link; the second class of metrics concerns the selection of the youngest links, because they are considered more resilient to breakage; the third criterion is based on the selection of the link with the highest average residual lifetime value; the fourth one makes selection of the link with the highest persistence probability; finally, the fifth metric focuses on the connection failure probability. The latter approach has been shown to be robust because it is based on the monitoring of the links lifetime of the mobile nodes in the wireless network, in the past and in the present, to predict its behaviour, in the future without considering directly parameters depending by underlying mobility model such as node speed or direction. The path stability, in terms of the number of route transitions a routing protocol incurs to continue the data exchange.

End-to-end delay of a source destination session is another considered performance metric, particularly for real-time applications. In this work, the idea of stability-delay tradeoff (SDT), as a measure of the efficiency of an MANET routing protocol, was introduced. The authors propose a prediction location-based routing scheme in order to increase the delivery ratio of GPSR and select the more stable route. However, such as for the previous listed contributions, energy is not considered in the packet forwarding.

5. 2 Energy Aware Metrics:

Energy saving mechanisms based only on metrics related to the remaining energy cannot be used to establish the best route between source and destination nodes. If a node is willing to accept all route requests only because it currently has enough residual battery capacity, much traffic load will be injected through that node. In this sense, the actual drain rate of energy consumption of the node will tend to be high, resulting in a sharp reduction of battery energy. As a consequence, it could exhaust the node energy supply very quickly, causing the node soon to halt. To mitigate this problem, other metrics, based on the traffic load characteristics, could be employed. To this end, techniques to measure accurately traffic load at nodes should be devised.

5.3 Energy-Based Routing Protocols:

A distributed power control has been designed as a way to improve the energy efficiency of routing algorithms in ad hoc networks. Each node in the network estimates the power necessary to reach its own neighbours, and this power estimate is used for tuning the transmission power (thereby reducing interference and energy consumption). In an approach energy efficient Optimization Link State Routing is based on the proactive info management and on the selection of Multipoint Relay (MPR) based on energy metrics, such as MMBCR and MDR. The authors proposed an on-demand protocol based on the MDR metric and using a route discovery mechanism. A Life-time Prediction-based Routing (LPR), focused on the minimization of the variances of the nodes remaining energies in the network. In this protocol, each node tries to predict the future energy expenditure, but its estimation depends on many factor such as node distances, residual power, hop count, and node mobility.

5.4 Link Stability and Energy Aware Routing Protocols:

There are few multiple metrics aware routing protocols, over distributed wireless systems, in the literature. In the context of novel distributed wireless systems and multimedia applications, where the system complexity is increasing, the chance of controlling and evaluating more network parameters becomes an important issue. Multiple metrics plays a crucial role. To the best of our knowledge, only two published works consider simultaneously link stability and energy consumption for path selection, which is the focus of this study. Specifically, a routing protocol called Power Efficient Reliable Routing protocol for mobile Ad hoc networks. This algorithm applies the following three metrics for path selection: 1) the estimated total energy to transmit and process a data packet; 2) the residual energy; 3) the path stability. Route maintenance and route discovery procedures are similar to the DSR protocol, but with the route selection based on the three aforementioned metrics. They consider the energy consumption of the protocols in order to see the best candidate from an energetic point of view. The path selection is performed by considering only the route stability metric. The neighbour nodes maximize (minimize) the joined link-stability energy metric. This local criterion permits a high scalability to be offered to the routing algorithm in terms of state info storage and control packets transmission sent by any underlying routing protocol to maintain the network state knowledge.

VI. Proposed System

The challenging task is to minimize the energy and maximize the link stability in the MANET, but concentrate on these factors will be more difficult. At the same time we have to identify the self node, because these nodes will provide the wrong information about the resent data access and require little energy for transmission. The self node can be identified by the self replica allocation method. Selfish replica allocation is based on the concepts of self-centered friendship tree and it is used to achieve high data accessibility with low communication cost in the presence of selfish nodes.

6.1 Develop the MANET Network:

A wireless network is simulated, with minimum of 25 nodes moving in defined area. Figure 1 shows the node scenario

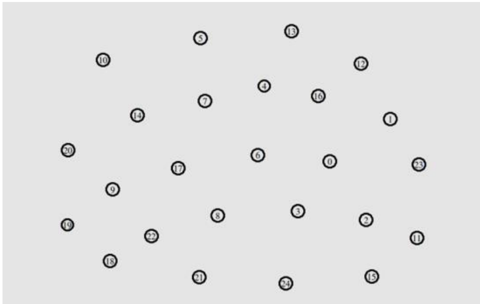


Figure 1: Node Scenario1

Every node has a back up energy through the battery. Each node moves randomly in this area, with a speed selected in a range of 250m. The duration of each simulation is 150 seconds. The maximum speed of node is set to 10 m/sec. To have detailed energy-related information over a simulation, the ns-2 code was modified to obtain the amount of energy consumed (energy spent in transmitting, receiving) over time. In multihop WSN, the data is transmitted from one node to another node. The data is transmitted in the form of packet only and the link is form between them as shown in figure 2.

Figure 2: Node Scenario 2

6.2. Simulation Setup

We have used network simulator (NS-2) for our work. NS2 is a discrete event driven simulator, developed at the University of Berkeley and the Virtual Inter Network Tested (VINT) project 1997. NS2 is suitable for designing new protocols, comparing different protocols and traffic evaluations. It is an object oriented simulation written in C++, with OTCL interpreter as a frontend. The parameters used for carrying out simulation are summarized in table1.

Table.1 Simulation parameters

Parameter	Value
Routing Protocols	LAER, PERRA, GPSR
MAC Layer	802.11
No. of Nodes	25
Packet Size	512B
Initial Energy	10J
Rx Power Consumption	0.3W
Tx Power Consumption	0.6W
Simulation Time	150s
Traffic Source	CBR
Terrain Size	500m*500m

The goal of our simulation is to evaluate the stable link and provide efficient energy.

6.3. Simulation Results:

We have created a network scenario of 25 nodes. Initially the node sending data in packet form and node 0 is the source and node 24 is the destination. As the number of nodes increases some nodes will be dead and the dead nodes shown in red colour nodes. The yellow nodes show the ideal energy node and the ideal energy is 0.001. The nodes scenario is shown below in linear and in random form.

Figure 3: Snapshot of nodes in Linear Form

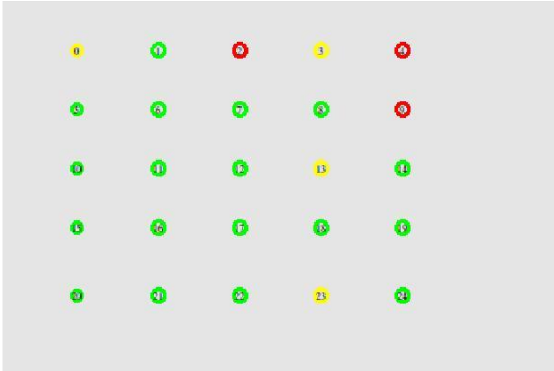


Figure 4: Snapshot of nodes in Metrics Form

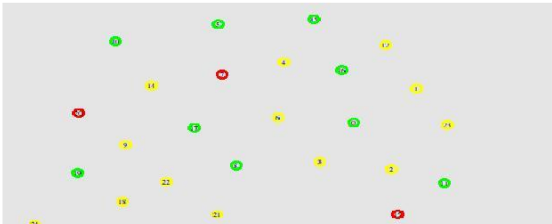
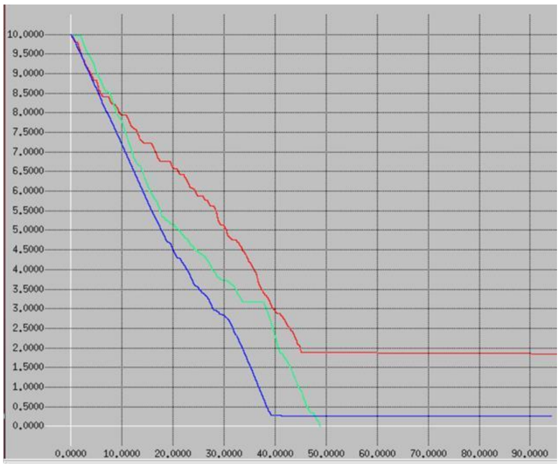


Figure 5: Snapshot of Nodes in Random Form

In the linear nodes the energy and link stability is better than in matrics or in random. This can be shown in the graph shown below. Red colour for linear, Green for Metrics and Blue for random.



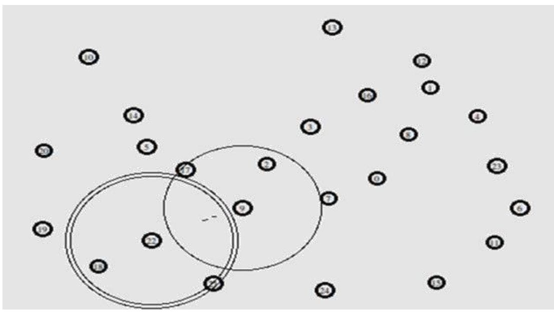


Figure 6: Time vs Energy Graph

VII. Conclusion

LAER is based on Joint Metric of link stability and Energy Aware Routing and is a scalable routing protocol which has been implemented. It makes use of a greedy technique and based on the local topology knowledge. The self node identification based on risk factor can also used to improve the data accessibility. This approach will minimize the energy consumption. By applying the notation of credit risk the self node will be detected. Each node will calculate the risk factor on other connected nodes individually to measure the self node. The removal of drawbacks such as self node can be overcome in the further work.

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