Optimization of Routing Protocol in MANET using GA

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Abstract: *Ad hoc mobile devices heavily depend on the performance of batteries. Optimizing the power consumption is a very crucial issue. To maximize the lifetime of mobile ad hoc network, the power consumption rate of each node must be reduced. In this paper we present a novel energy efficient routing algorithm based on mobile agents to deal with the routing mechanism in the energy-critical environments. A few mobile agents move in the network and communicate with each node. They collect the network information to build the global information matrix of nodes. The routing algorithm chooses a shortest path of all nodes in all possible routes. Additionally, we compare the performance of power-relation routing protocol DSR (Dynamic Source Routing) in simulation environment. The results show that the survivability of Ad Hoc network has been better because of less energy consumption when using our improved DSR as compare to standard DSR protocol.*

Keywords: Power Consumption, DSR, Improved DSR, Energy Comparison, MANET

1. Introduction

In the last few years, the widespread use of wireless communications has begun [1]. Currently, there is an increasing interest in wireless communications from both an academic and industrial perspective. The main feature that makes wireless networking so important is the ability to enable mobility. The great benefit of wireless networks is concentrated in the ability of users to communicate, cooperate, and access Internet services in an anytime and anywhere fashion. Wireless networks can be grouped into two categories: infrastructured networks and infrastructure-less networks [2]. The first type is a network with fixed and wired gateways. The second type is commonly known as wireless ad hoc networks and consists of a collection of geographically distributed nodes that communicate with one another over a wireless medium without the need of fixed routers [3]. Among the various network architectures, the design of *mobile ad hoc network (MANET)* has attracted a lot of attention recently. A MANET is one consisting of a set of mobile hosts which can communicate with one another and roam around at their will. No base stations are supported in such hosts may have to communicate with each other in a *multihop* fashion. Applications of MANETs occur in situations like battlefields, major disaster areas, and outdoor assemblies. It is also a prospective candidate to solve the "last-mile" problem for broadband Internet service providers [1]. One critical issue for almost all kinds of portable devices supported by battery powers is *power saving*. Without power, any mobile device will become useless. Battery power is a limited resource, and it is expected that battery technology is not likely to progress as fast as computing and communication technologies do. Hence, how to lengthen the lifetime of batteries is an important issue, especially for MANET, which is all supported by batteries.

2. Related Work

Routing protocols in ad hoc networks are categorized in two groups: *Proactive (Table Driven)* and *Reactive (On-Demand)* routing.

2.1 Proactive (Table-Driven) Routing Protocols
These routing protocols are similar to and come as a natural extension of those for the wired networks. In proactive routing, each node has one or more tables that contain the latest information of the routes to any node in the network. Various table-driven protocols differ in the way the information about a change in topology is propagated through all nodes in the network.

2.2 Reactive (On-Demand) Protocols
Reactive routing is also known as on-demand routing. These protocols take a lazy approach to routing. They do not maintain or constantly update their route tables with the latest route topology. Examples of reactive routing protocols are the dynamic source Routing (DSR) [3], ad hoc on-demand distance vector routing (AODV) .Our power-aware source routing algorithm belongs to this category of routing algorithms. Since our approach is an enhancement over DSR, a brief description of DSR is warranted. DSR is one of the more generally accepted reactive routing protocols. In DSR, when a node wishes to establish a route, it issues a route request (RREQ) to all of its neighbors. Each neighbor broadcasts this RREQ, adding its own address in the header of the packet. When the RREQ is received by the destination or by a node with a route to the destination, a route reply (RREP) is generated and sent back to the sender along with the addresses accumulated in the RREQ header. Since this process may consume a lot of bandwidth, DSR provides each node with a route cache to be used aggressively to reduce the number of control messages that must be sent. If a

node has a cache entry for the destination, when a route request for that destination is received at the node, it will use the cached copy rather than forwarding the request to the network. In addition, each node promiscuously listens to other control messages (RREQs and RREPs) for additional routing data to add to its cache.

3. Low Power Routing Protocols

The main focus of research on routing protocols in MANETs has been network performance. There has been some study on power aware routing protocols for MANETs. Presented below is a brief review of some of them.

3.1 Minimum Power Routing

Reference [8] proposes a routing algorithm based on minimizing the amount of power (or energy per bit) required to get a packet from source to destination. More precisely, the problem is stated as: *Minimize* $\sum P$ (*i*, *i* 1)(1) where $P(i,i+1)$ denotes the power expended for transmitting (and receiving) between two consecutive nodes, i and i+1(a.k.a. link cost), in the route. *P*. This link cost can be defined for two cases:· When the transmit power is fixed · When the transmit power is varied dynamically as a function of the distance between the transmitter and intended receiver. For the first case, energy for each operation (receive, transmit, broadcast, discard, etc.) on a packet is given by [7]: *E* (*packet*) = *b´ packet _ size + c* (2) where *b* and *c* are the appropriate coefficients for each operation. Coefficient *b* denotes the packet size-dependent energy consumption whereas *c* is a fixed cost that accounts for acquiring the channel and for MAC layer control negotiation. Route selection depends on the packet size; hence in case of variable packet size transmission many routes should be selected. The second case is more involved. Reference [7] proposes a local routing algorithm for this case. The authors assume that the power needed for transmission and reception is a linear function of *da* where *d* is distance between the two neighboring nodes and is a parameter that depends on the physical environment. They make use of the GPS position information to transmit packets with the minimum required transmit energy. The key requirement of this technique is that the relative positions of nodes are available to allnodes. However, this information may not be easy readily available. The GPS-based routing algorithm has two drawbacks. One is that GPS cannot provide the nodes much information about the physical environment and the second is the power dissipation overhead of the GPS device is additional.

3.2 Battery-Cost-Aware Routing

The main disadvantage of the problem formulation of the previous approach is that it always selects the least-power cost routes. As a result, nodes along these routes tend to "die" soon because of the battery energy exhaustion. This is doubly harmful since the nodes that die early are precisely the ones that are needed most to maintain the network connectivity (and hence useful service life). Therefore, it is better to use a higher power cost route if it avoids using nodes that have a small amount of remaining battery energy. This observation has given rise to a number of "*battery cost-aware routing*" algorithms as described next.

1. Minimum battery cost routing algorithm that minimizes the total cost of the route. It minimizes the summation of inverse of remaining battery capacity for all nodes on
2. Min-Max battery cost routing algorithm is a modification of minimum battery cost routing. This metric always tries to avoid the route with nodes having the least battery capacity among all nodes in all possible routes. Thereby, it results in fair use of the battery of each node.
3. Conditional Max-Min battery capacity routing algorithm proposed in [8]. This algorithm chooses the route with minimal total transmission power if all nodes in the route have remaining battery capacities higher than a threshold otherwise routes including nodes with the lowest remaining battery capabilities are avoided the routing path [9]. Several experiments have been done in [10] to compare different battery cost-aware routing in terms of the network lifetime. The result showed that the first node in "Shortest Path routing" metric died sooner than all the battery -cost-aware routing but most of the other nodes had longer expiration time. In that result Minimum battery cost routing showed better performance than Min-Max routing in terms of expiration time of all nodes. Conditional Max-Min routing showed different behavior that depended on the value of chosen threshold.

4. Route Discovery

In DSR, activity begins with the source node flooding the network with RREQ packets when it has data to send. An intermediate node broadcasts the RREQ unless It gets a path to the destination from its cache, or it has previously broadcast the same RREQ packet. This fact is known from the sequence number of the RREQ and the sender ID. Consequently, intermediate nodes forward only the first received RREQ packet. The destination node only replies to the first arrived RREQ since that packet tends to take the shortest path.

5. The Proposed Technique

The proposed Genetic based algorithms for the route discovery is as follows: The mobile nodes will be aware of their neighbor's position in the network. We generate random population P of n chromosomes (suitable paths). Next, we evaluate each chromosome x in the current population P according to the fitness function f(x). In each iteration of the algorithm, we sequentially perform three basic genetic operations:

• Selection - this operation selects chromosomes from a population according to their fitness.
• Crossover - this operation with a crossover probability cross over two parents chromosomes and forms off springs,
• Mutation - this operation with a mutation probability mutates a new offspringat each locus (position in chromosome).

Then, the two children replace two members of the current population P. Next, we again compute the fitness f(x) of each chromosome x in the population. The process is

repeated for 1000 times. If the algorithm stops, we return the best solution (chromosome) in the current population P.

Fitness function

The fitness describes how well a chromosome solves a specified problem. In this case it is the distance of node in network. The above mentioned Genetic Algorithm technique is then used in standard DSR protocol to find the best path to transfer the data. Here best path denotes the optimal path in terms of distance. This new Enhanced protocol is called the "IMPROVED DSR PROTOCOL".

6. Simulation Environment

NS-2 Simulator version 2.35 has been used for simulating the energy consumption of Improved DSR and DSR protocol the simulation parameters for analyzing the performance of Improved DSR and DSR for various metrics are as given in table.

Table 1. Simulation Environment Specifications

NS-2 Simulator Version	NS 2.35
Topology size 500 X 500	620 X 620
Mac Layer	802.11
propagation model	Radio Propagation
Number of Nodes 50	5,10,15,20,25,30
Protocols under test	Improved DSR, DSR
Simulation Duration	100 sec
Initial Energy allocated to each nodes	10 Joules
Mobility Model	Random
Channel	Wireless

With the given criteria both the protocol are simulated and run for every given number of nodes. Then the average battery consumption by nodes in all condition is calculated

7. Simulation Result

The average energy consumption of nodes is evaluated for nodes ranging 5 to 30 for both the protocol. The following graph shows the result of simulation. The X-axis shows the no. nodes and Y-axis shows the Energy consumed in joules.
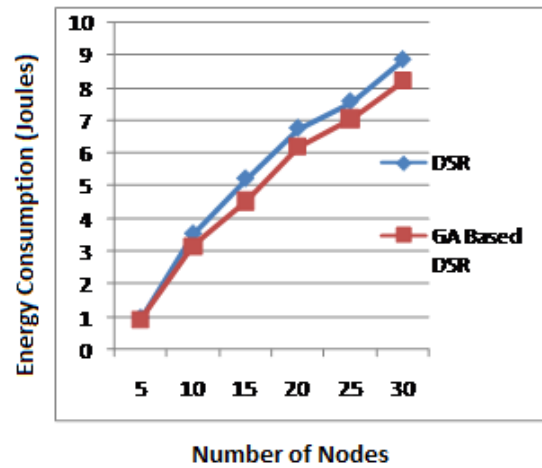

Figure 1. Energy Consumption graph

From the above graph it is clear that the Improved DSR Protocol has the advantage of less battery consumption over Standard DSR Protocol.

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