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Cluster Based Energy-Efficient Routing Algorithms for Mobile Ad-hoc Network Using OPTICS

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Abstract: MANET is a collection of wireless mobile nodes, which dynamically form a temporary network, without using any existing network infrastructure or centralized administration. These are often called infrastructure-less networking since the mobile nodes in the network dynamically establish routing paths between themselves. Current typical applications of a MANET include battlefield coordination and onsite disaster relief management. Each node participating in the network acts both as host and a router and must therefore is willing to forward packets for other nodes. For this a routing protocol is needed. An Ad hoc network has certain characteristics, which imposes new demands on the routing protocol. The design and analysis of routing protocols is an important issue in dynamic networks such as packet radio and ad-hoc wireless networks. Dynamic networks consist of mobile hosts, which can communicate with each other over the wireless links (direct or indirect) without any static network interaction. In such networks the mobile host has the capability to communicate directly with another mobile host in its vicinity. The mobile hosts also have the capability to forward (relay) packets. Examples of such networks are ad-hoc wireless local area networks and packet radio networks. Several proactive routing protocols have been proposed to improve the efficiency and power management in a MANET.
Keywords: Routing, Clustering, Optics, Energy efficiency.

I. INTRODUCTION

Mobile Ad-hoc networks (MANET) are distributed systems that consist of digital data terminals such as mobiles that communicate with each other without the help of any established networking infrastructure. These nodes are connected through a wireless medium forming dynamic topologies. Each device in a MANET is free to move independently and hence changes its links with other devices frequently. Since the nodes in a MANET are mobile, the efficiency and power consumptions are critical issues. Several proactive routing protocols have been proposed to improve the efficiency and power management in a MANET. Some of these protocols include destination sequenced distance vector routing, wireless routing, global state routing, fisheye state routing, hierarchical state routing, cluster gateway switch routing, source tree adaptive routing etc. The aim of this paper is to understand what is a MANET and the various techniques used in broadcasting data through a MANET. The important features and detailed working of each of these protocols are discussed. The results of various protocols are compared and summarized.

An Ad Hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any infrastructure or centralized administration mechanism [1]. Since it has no fixed infrastructure, it is characteristically different when compared to other wireless LANs. Each node in such a network can be used as a host and a router. And every node has similar features, responsibilities and capabilities hence this forms a symmetric network. Traditional routing protocols used in wired networks does not prove to be effective for Ad Hoc networks because of the intrinsic qualities of wireless media and the dynamic changing topology of the network since a node can join or leave the network at any point of time [3]. The fundamental goal of a routing protocol is to connect two nodes in a remote area successfully. There are several problems in establishing this connection since the nodes are not stationary. Therefore, an equally important goal is to conserve energy of the nodes for the survivability of the network as there is a possibility that the critical nodes exhaust their battery power and hence cannot be used for routing anymore. This leads to route breakage which affects routing protocol performances adversely. Mobile Ad Hoc networks can enhance the service area of access networks and provide wireless connectivity into areas with poor or previously no coverage connectivity. The essential features of Ad Hoc networks are easy connection to access networks, dynamic multi hop network structures, and direct peer-to-peer communication [2]. Routing protocols in MANETs are classified under two major fields of protocols: Proactive or table-driven and Reactive or on-demand. Some of the proactive or table-driven protocols are Dynamic Destination-Sequenced Distance-Vector Routing Protocol, Wireless routing protocol, Global state routing, fisheye State routing, Hierarchical State Routing, Zone-based Hierarchical link State Routing Protocol, Cluster head Gateway Switch Routing Protocol, On-Demand Routing Protocol. Some of the Reactive Protocols

are Cluster based Routing Protocol, Ad Hoc On-demand Distance Vector Routing, Dynamic Source Routing Protocol, Temporally Ordered Routing Algorithm, Associative Routing, Signal Stability Routing.

II. LITERATURE REVIEW

This section reviews the related state-of-heart literature with respect to routing algorithms in MANET. In [5], a partially distributed dynamic model for secure and reliable routing approach is presented for MANET. This work utilizes a partially distributed model on all sensor nodes and the misbehavior of the node is considered as additional information. This misbehavior based information is circulated among the nodes, while forming the routes. This work makes decision in a dynamic fashion by considering the level of node's misbehavior. A novel opportunistic routing protocol is proposed in [6]. This work enhances the energy efficiency of routing protocols by employing candidate selection and coordination phases. This work is claimed to perform better than BATMAN routing protocol, when dealing with multimedia data. In [7], a dynamic connectivity factor based routing protocol that relies on neighborhood nodes is presented for MANET. The protocol is named as neighbor based Dynamic Connectivity Factor routing Protocol (DCFP), which probes the status of the network by considering the network connectivity. The performance of the work is compared against AODV and proven to be better in terms of energy efficiency and packet delivery rate. A self-adaptive proactive routing scheme is presented for MANET in [8]. This work includes a special indicator to check the mobility of nodes, such that the current status of the network can be assessed. The routing metric is switched between the expected transmission count or mobility factor, which increases the routing performance. This work claims to attain better packet delivery rates. In [9], a smooth mobility and link reliability based optimized link state routing scheme is introduced for MANET. This work is based on markov smooth and complexity restricted mobility model, which aims to increase the reliability by selecting multi-point relay. This work claims that it can attain better lifetime with minimal control overhead. A dynamic cloudlet based energy saving routing mechanism is proposed for MANET in [10]. This work forms a temporary file that consists of node's identity and route information for a specific period of time. The cloudlets are the small data centres and by utilizing these cloudlets the mobile devices establish routes. A security framework for MANET is introduced in [11], which is named as Security Using Pre-Existing Routing (SUPERMAN). This protocol focuses on secure routing by enabling the network and the routing protocols to carry out the functionality and the security mechanisms such as node authentication and access control. In [12], an ant based multipath backbone routing scheme with load balancing is presented for MANET. In this work, when a source node requires transmitting data, multiple routes are selected with the help of swarm based ant colony optimization technique by considering the maximum path preference probability. The path preference probability is computed by the availability of hops, delay and bandwidth. The load of the network is balanced with the help of backbone node for equal traffic distribution. A multi-objective optimization model meant for presenting a secure routing scheme is proposed in [13]. This work presents a hybrid optimization algorithm based on Mlionwhale algorithm that incorporates both the lion and whale optimization algorithm by considering different quality of service parameters such as energy, distance, delay and so on. In [14], a new routing approach on the basis of fuzzy Petri nets and ant system is presented for MANET. This work computes the minimal investment with reasonable capacities for routing traffic. The routing model is computed by the fuzzy synchronized pertinent and the routing decision is made with the help of synchronized fuzzy transition approach. In [15], an attack pattern discovery based trusted routing scheme with pattern discovery is presented for MANET. This work analyses the sensitivity analysis of the routing scheme by varying the parameters with three different packet dropping attacks. An ACO look-ahead based approach is proposed for fault-tolerant routing in [16]. This work surveys different fault tolerant protocols and the ant colony based routing techniques for MANET. Additionally, a fault tolerant look-ahead routing algorithm that can detect suitable route and route pairs is presented. This technique helps in choosing the alternative path easily. An evolutionary self-cooperative trust scheme is provided to withstand the routing disruptions in MANETs in [17]. The evolutionary self-cooperative trust mimics the cognitive process of humans and the trust information of nodes is taken into account to deal with different attacks. The trust information collected from the sensor nodes are interchanged between them and are analyzed with the help of cognitive judgment. In [18], a secure routing model is proposed on the basis of game theory model for MANET. This work analyses the profile of normal and malicious nodes with the help of dynamic Bayesian signaling game and the best actions of every node is notified. The Perfect Bayesian Equilibrium (PBE) offers the solution to signal games and the players are given pay-off. This work minimizes the malicious nodes and the cooperation of nodes is stated to be improved by means of reputation system. A constructive relay based cooperative technique is proposed for MANET in [19].

III. PROPOSED METHOD FOR CLUSTER BASED ENERGY EFFICIENT ROUTING ALGORITHM

1. Routing Protocols For Manet's

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 neighboring 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. 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.

2. Energy Efficient Manet Protocol Using Optics

In contrast to simply establishing correct and efficient routes between pair of nodes, one important goal of a routing protocol is to keep the network functioning as long as possible. As discussed in the Introduction, this goal can be accomplished by minimizing mobile nodes' energy not only during active communication but also when they are inactive. 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. Table I shows taxonomy of the energy efficient routing protocols. Before presenting protocols that belong to each of the three approaches in the following subsections (3.1, 3.2 and 3.3), energy-related metrics that have been used to determine energy efficient routing path instead of the shortest one are discussed. They are [4] energy consumed/packet; time to network partition; variance in node power levels; cost/packet; and maximum node cost. The first metric is useful to provide the min-power path through which the overall energy consumption for delivering a packet is minimized. Here, each wireless link is annotated with the link cost in terms of transmission energy over the link and the manpower path is the one that minimizes the sum of the link costs along the path. However, a routing algorithm using this metric may result in unbalanced energy spending among mobile nodes. When some particular mobile nodes are unfairly burdened to support many packet-relaying functions, they consume more battery energy and stop running earlier than other nodes disrupting the overall functionality of the ad hoc network. Thus, maximizing the network lifetime (the second metric shown above) is a more fundamental goal of an energy efficient routing algorithm: given alternative routing paths, select the one that will result in the longest network operation time.

3. Optical Routing Algorithm For Power Management

In this paper we propose the problem of network partition caused due to earlier death of some node caused by heavily utilization in network connectivity as compare to other nodes in network. By routing the packets through the shortest path some group of nodes are used rapidly. To eliminate this problem and make connectivity intact for a longer period of time we propose routing should be carried by distinct alternative paths and for its efficient operation.

It is controlled by clustering. The protocol environmental assumptions are described as follows:

1. We are considering two dimensional homogeneous networks where all the nodes have limited battery power and similar capabilities. Each node has its own ID and communicates through Omni directional antenna.
2. All nodes in network have same transmission range. The transmission medium is Let G= (V, E) represents a network where V is the set of mobile nodes and E is the set of connections between the nodes. Let Puv denotes the minimum power required for node u to communicate directly to node v. As the medium is symmetric so Puv = Pvu. In the dynamic network the cardinality of the nodes |V| remains constant but due to mobility nature of the nodes the cardinality of links |E| may varies. Proposed protocol consists of two phases, the first phase is path establishment phase, and second is clustering phase.

In path establishment phase we propose an algorithm to find the number of possible distinct alternative paths in a network. We assume that by running our algorithm more than one distinct alternative path can be found out. We limit the maximum number of paths to three, as more number of paths needs more control mechanism causing unnecessary energy consumption.

In the second phase we divide the network logically into number of clusters. Each cluster is having one cluster head which control the routing through alternative path so that overall traffic of network is shared and efficient network connectivity can be achieved. It also minimizes the total energy consumption in network by making the idle mode node to be in sleep state.

a. Path Establishment Phase:

Initially all the nodes are deployed in an area to establish network connectivity. In the first phase a node, randomly broadcast the hello message once using the power Pmax. It is the constant transmission power of each node. The initial energy level of all nodes is assumed to be same [15]. The node sends the hello message by appending its ID to the nodes present in its neighbor. The receiver collects all the information from the hello message of its neighbour. It collects all these information to make its adjacent list. This list contains the list of neighbour nodes of a particular node. For example in Fig. 1. node 1 sends the hello message as given in Table 1. The neighbour in its transmission range listens to this hello message. Node 1 collects the hello message from its neighbor nodes and prepares its adjacent list as given in Table 2.

Table1: Node sending message

MSG	1

Table2: Adjacent List

List	node
Adjacent	2,4,5,6,

Algorithm for finding path ( ):

1. Initialize all nodes of network to ready state (Status=1).
2. Put the source node in queue and change its status to waiting state (status=2).
3. Repeat step 4 to 6 until queue is empty or destination is reached.
4. Process front node N of queue and change its status=3. front=front+1
5. Add at rear end of queue all the neighbor's of N that are ready state and change their status to waiting state (status=2). rear=rear+1.

Don't add repeated nodes.

6. As neighbors are added keep track of their origin. End of step 3.
7. As destination is reached stop and find the path traversing from destination in a reverse order by tracking the origin till source node at origin is reached. Then switch off all nodes coming in the path to reduce energy conservation due to idle state.
8. Go to step 3 and process to front node.
9. Exit.

IV. CONCLUSION

The energy efficient routing an important issue in MANET. It is the need of hour for the effective communication in MANET. The various characteristics and issues in MANET are discussed in the paper. The shortcoming of several protocols is main focus of this paper. There is need of efficient protocol for addressing the issue of mobility with efficient energy utilization using optics.

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