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AN INVESTIGATION ON ENERGY EFFICIENT ROUTING PROTOCOLS FOR MANET IN VARIOUS MOBILITY MODELS

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ABSTRACT: Mobile ad hoc networks (MANET) represent distributed systems that consist of wireless mobile nodes that can freely organize it into temporary ad hoc network topologies. A mobile ad hoc network is a collection of nodes that is connected through a wireless medium forming dynamic topologies. If a node is used frequently for transmission or overhearing of data packets, more energy is consumed by that node and after certain amount of time the energy level may not be sufficient for data transmission resulting in link failure.

MANET's are generally battery-powered devices; the critical aspect is to reduce the energy consumption of nodes, so that the network lifetime can be extended. In mobile ad hoc networks (MANETs), nodes are mobile and have limited energy resource that can quickly deplete due to multi-hop routing activities, which may gradually lead to an un-operational network.

In the past decade, the hunt for a reliable and energy-efficient MANETs routing protocol has been extensively researched. This paper proposes the Ant Colony Energy Efficient Routing Protocols for MANET routing transformation. Other than that the various energy efficient routing protocols are also analyzed in this paper. This paper produces the proper investigation for energy efficient routing protocol for Mobile Ad Hoc Network.

Keywords: [Energy, Mobile, Routing, Protocols, Ant Colony, Mobility Models].

1. INTRODUCTION

Wireless Mobile Ad Hoc Networks (MANETs) have emerged as an advanced networking concept based on collaborative efforts among numerous self-organized wireless devices. MANET is a network where no fixed infrastructure exists. Such networks are expected to play vital role in future civilian and military settings, being useful to provide communication support where no fixed Infrastructure exists or the deployment of a fixed infrastructure is not economically profitable and movement of communicating parties is possible. The topology of MANETs is dynamic, because the link among the nodes may vary with time due to device mobility, new device arrivals, and the possibility of having mobile devices.

The routing protocol design must take into account the physical limitations and constraints imposed through the ad hoc atmosphere in order that the ensuing routing protocol does now not degrade process performances. Due to the fact that in MANET, there is no constant-infrastructure akin to base stations, cellular gadgets must function as routers with a view to maintain the know-how about the community connectivity, for that reason the traditional routing protocols are not able to be supported effectively by way of ad hoc networks. Several research experiences have been launched to be trained this hassle, these defined with the aid of the IETF MANET group can be classified into two classes: proactive protocols and reactive protocols. MANET's technology offers each new challenges and possibilities for many functions. The major challenges for ad hoc technology is cozy and efficient routing, due basically to MANET aspects (e.g., open medium, lack of centralized administration, nodes mobility).

A couple of techniques had been proposed to secure ad hoc routing. Some present options in Wi-Fi networks hire mechanisms used to guard routing protocols in wired networks that are centered on the presence of a centralized infrastructure. These options aren't correct for a decentralized ad hoc community. In mobile advert hoc networks, neighbor discovery is the procedure through which a node in a community determines the whole number and identification of different nodes in its vicinity.

1.1. Mobile Ad Hoc Network (MANET)

A MANET is a collection of cell nodes sharing a wireless channel with none centralized control or centered conversation spine. MANET has dynamic topology and each and every mobile node has restricted resources similar to battery, processing vigor and on-board reminiscence. This form of infrastructure-much less community is very priceless in quandary in which normal wired networks isn't possible like battlefields, average disasters and so forth. The nodes that are within the transmission range of each and every different communicate straight or else conversation is finished by means of intermediate nodes which can be inclined to forward packet therefore these networks are also known as multi-hop networks.

Figure 1.1- Mobile Ad Hoc Network

Ad-hoc network is clearly includes ad-hoc and network in which the word 'ad-hoc' is a Latin word specifies that means 'for this' or 'for this handiest' and the phrase community specifies a collection of computers and cellular nodes connected through wired or Wi-Fi link.

Mobile ad hoc network nodes are furnished with wireless transmitters and receivers making use of antennas, which could also be totally directional (factor-to-factor), Omni directional (wide-forged), often steerable, or some mixture. At a given factor in time, depending on positions of nodes, their transmitter and receiver insurance plan patterns, conversation energy levels and co-channel interference levels, a wireless connectivity in the type of a random, multihop graph or Adhoc network exists among the many nodes. This ad hoc topology may regulate with time because the nodes move or adjust their transmission and reception parameters. The characteristics of these networks are summarized as follows:

- Conversation by way of wireless Networks
- Nodes can perform the roles of each hosts and routers.
- Bandwidth-restrained, variable ability hyperlinks.
- Limited physical security.

1.2. Major challenges in MANET

Regardless of the attractive applications, the points of MANET introduce a few challenges that need to be studied cautiously earlier than a large industrial deployment will also be anticipated. These include

- **Dynamic topologies**

Nodes are free to maneuver arbitrarily; hence, the network topology--which is typically multi hop, may change randomly and speedily at unpredictable times, and may include both bidirectional and unidirectional hyperlinks.

- **Routing**

The topology of the community is continuously changing; the limitation of routing packets between any pair of nodes turns into a challenging assignment. Most protocols will have to be based on reactive routing as a substitute of proactive.

- **Device discovery**

Identifying significant newly moved in nodes and informing about their existence need dynamic update to facilitate automatic finest route choice.

- **Bandwidth**

Constrained-variable potential hyperlinks: Wi-Fi hyperlinks will continue to have greatly scale down capability than their hardwired counterparts.

- **Multicast**

Multicast is fascinating to support multiparty wireless communications. Since the multicast tree is now not static, the multicast routing protocol ought to be in a position to cope with mobility including multicast membership dynamics (depart and join).

2. MANET ROUTING PROTOCOLS

Routing protocols define a set of rules which governs the trip of message packets from supply to vacation spot in a network. In MANET, there are exclusive varieties of routing protocols each of them is applied in keeping with the network instances.

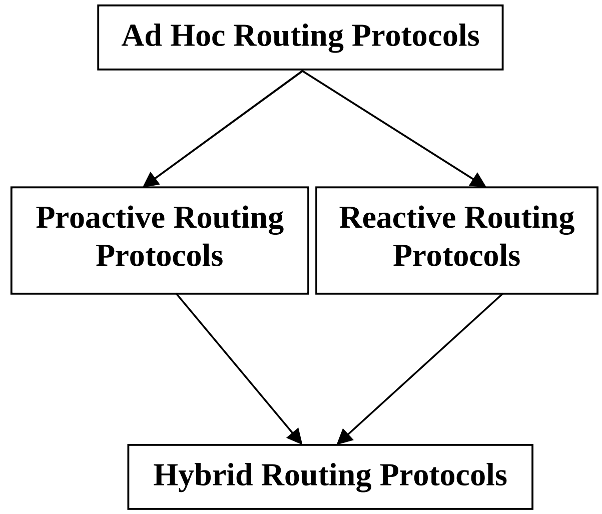

Figure 2.1 - MANET Routing Protocols

2.1. Proactive Routing Protocols

Proactive routing protocols are also referred to as as table driven routing protocols. In this each node hold routing table which includes knowledge about the network topology even without requiring it. This option although useful for datagram traffic, incurs great signaling traffic and power consumption. The routing tables are updated periodically whenever the network topology alterations. Proactive protocols aren't suitable for large networks as they ought to maintain node entries for each node in the routing desk of each node. These protocols preserve special number of routing tables various from protocol to protocol. There are various well known proactive routing protocols. Illustration: DSDV, OLSR, WRP and so on.

2.2. Reactive Routing Protocols

Reactive routing protocol is often referred to as on demand routing protocol. In this protocol route is discovered at any time when it is needed Nodes provoke route discovery on demand groundwork. Source node sees its route cache for the available route from source to destination if the route is just not on hand then it initiates route discovery method. The on- demand routing protocols have two major components route discovery, route protection.

2.3. Hybrid Routing Protocols

There's a trade-off between proactive and reactive protocols. Proactive protocols have big overhead and not more latency at the same time reactive protocols have less overhead and extra latency. So a Hybrid protocol is awarded to beat the shortcomings of each proactive and reactive routing protocol. Hybrid routing protocol is combination of both proactive and reactive routing protocol. It uses the route discovery mechanism of reactive protocol and the desk maintenance mechanism of proactive protocol so that you can hinder latency and overhead problems within the community. Hybrid protocol is suitable for huge networks where huge numbers of nodes are gift. On this enormous network is split into set of zones where routing inside the zone is carried out with the aid of making use of reactive strategy and outside the zone routing is finished utilizing reactive technique. There is quite a lot of popular hybrid routing protocols for MANET like ZRP, SHARP.

3. MANET MOBILITY MODELS

The movement of mobile users is represented by mobility models. In mobility modeling activity of user's movement can be described using analytical and simulation models. Analytical models may provide performance parameters and Simulation models can derive valuable solutions for more complex cases.

In MANET, mobility models describe the different mobility pattern of moving nodes. There are two major types of mobility models, Traces and Synthetic models. Traces are those mobility patterns that are observed in real life systems [13]. Traces comprise representation of real time movement of nodes in the network [1]. Synthetic models realistically represent node movement without using real network traces [1, 13]. Synthetic models are of two types, Entity and Group mobility models. In Entity Mobility Models mobile nodes move independently within the simulation area. They include Random Waypoint, Random Walk, Manhattan Grid, City, Gauss-Markov. In Group Mobility Models all the mobile nodes are arranged in a group and the mobility of nodes depends upon the movement pattern of the whole group i.e. all the nodes move together collectively. They include Reference Point, Nomadic and Pursue. Fig-3.1 shows all these types of mobility models for MANET.

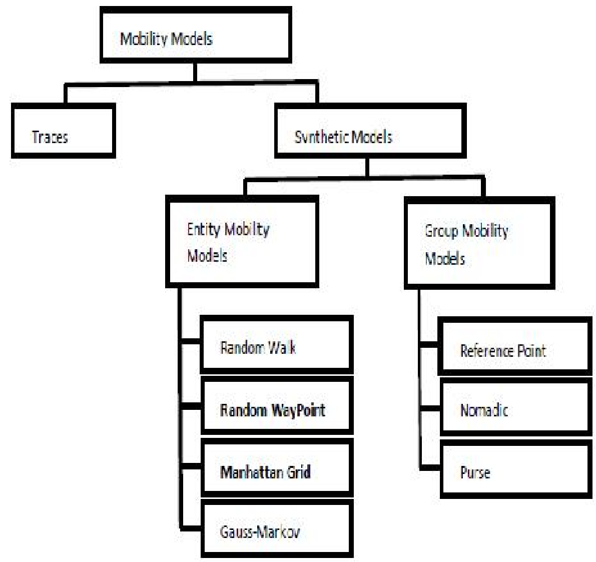

Figure 3.1- MANET Mobility Models

The performance of routing protocols can vary depending upon the type of mobility model exists for a specific application. In this paper the Random Way Point and Manhattan Grid mobility model are considered and routing protocol performance is evaluated.

4.1. Energy Efficient Routing Protocols

MANETs lack fixed infrastructure and nodes are typically powered by batteries with a limited energy supply wherein each node stops functioning when the battery drains. Energy efficiency is an important consideration in such an environment. Since nodes in MANETs rely on limited battery power for their energy, energy-saving techniques aimed at minimizing the total power consumption of all nodes in the group (minimize the number of nodes used to establish connectivity, minimize the control overhead and so on) and at maximizing the life span should be considered. As a result of the energy constraints placed on the network's nodes, designing energy efficient routing protocols is a crucial concern for MANETs, to maximize the lifetime of its nodes and thus of the network itself [11], [12].

4.1. Energy-Efficient Location Aided Routing Protocol (EELAR)

Energy Efficient Location Aided Routing (EELAR) Protocol [2] was developed on the basis of the Location Aided Routing (LAR) [13]. EELAR makes significant reduction in the energy consumption of the mobile node batteries by limiting the area of discovering a new route to a smaller zone. Thus, control packet overhead is significantly reduced. In EELAR, a reference wireless base station is used and the network's circular area centered at the base station is divided into six equal sub-areas. During route discovery, instead of flooding control packets to the whole network area, they are flooded to only the sub-area of the destination mobile node. The base station stores locations of the mobile nodes in a position table.

4.2. Power Aware Localized Routing Protocol (PALR)

The Power-aware Localized Routing (PLR) protocol [2] is a localized, fully distributed energy-aware routing algorithm but it assumes that a source node has the location information of its neighbors and the destination. PLR is equivalent to knowing the link costs from the source node to its neighbors, all the way to the destination. Based on this information, the source cannot find the optimal path but selects the next hop through which the overall transmission power to the destination is minimized [3].

4.3. Minimum Energy Routing Protocol (MER)

Minimum Energy Routing (MER) can be described as the routing of a data-packet on a route that consumes the minimum amount of energy to get the packet to the destination which requires the knowledge of the cost of a link in terms of the energy expanded to successfully transfer and receive data packet over the link, the energy to discover routes and the energy lost to maintain routes [10]. MER incurs higher routing overhead, but lower total energy and can bring down the energy consumed of the simulated network within range of the theoretical minimum the case of static and low mobility networks. However as the mobility increases, the minimum energy routing protocol's performance degrades although it still yields impressive reductions in energy as compared performance of minimum hop routing protocol [12].

4.4. Localized Energy Aware Routing Protocol (LEAR)

Local Energy-Aware Routing (LEAR) [24] simultaneously optimizes trade-off between balanced energy consumption and minimum routing delay and also avoids the blocking and route cache problems. LEAR accomplishes balanced energy consumption based only on local information, thus removes the blocking property. Based on the simplicity of LEAR, it can be easily be integrated into existing ad hoc routing algorithms without affecting other layers of communication protocols. Simulation results show that energy usage is better distributed with the LEAR algorithm as much as 35% better compared to the DSR algorithm. LEAR is the first protocol to explore balanced energy consumption in a pragmatic environment where routing algorithms, mobility and radio propagation models are all considered [3], [4].

4.5. Power Aware Multiple Access Protocol (PAMAS)

PAMAS [7] is an extension to the AODV protocol; it uses a new routing cost model to discourage the use of nodes running low on battery power. PAMAS also saves energy by turning off radios when the nodes are not in use. Results show that the lifetime of the network is improved significantly. There is a trivial negative effect on packet delivery fraction and delay, except at high traffic scenarios, where both actually improve due to reduced congestion. Routing load, however, is consistently high, more at low traffic scenarios. For the most part, PAMAS demonstrates significant benefits at high traffic and not-so-high mobility scenarios. Although, it was implemented on the AODV protocol, the technique used is very standard and can be used with any on-demand protocol. The energy-aware protocol works only in the routing layer and exploits only routing-specific information [5].

5. ANT COLONY BASED ENERGY CONTROL ROUTING PROTOCOL

The efficient foraging behavior of naturally occurring small-sized and energy-constrained ants is studied in the theory of ACO [1]. ACO uses the concept of artificial ants, which is analogous to the natural ants that behave as packets in MANETs. In ACO-based routing algorithms, pheromone content is used to choose the best paths out of a given network. It can be used to forward data stochastically.
Data for the same destination can be spread over multiple paths with more data transmitted on higher quality paths, which results in load balancing. ACO-based routing algorithms perform better in many ways due to their proactive and iterative behavior. These kinds of algorithms also reduce variability and errors in networks by choosing a trusted path which have behaved well for quite some time.

5.1. Why ACERP?

In this section, we propose an ant colony-based energy control routing protocol ACERP. In ACERP, when a source node wants to send a data packet to its destination, it checks its pheromone table and finds the next relay node in the path. If the pheromone table does not have next node to the destination node, the source node will start a path discovery process. The source node sends out a request packet, which is called F-ant (forward ant). When the node which F-ant has passed. Each node in networks forwards the F-ant packet until it reaches the destination.

When F-ant arrives the destination node, it will create a new packet which is called B-ant (backward ant). The destination will send the B-ant back to the source node along the reverse route.

In order to explain the proposed ACERP protocol, an example network topology is shown in Fig. 5.1. There are 11 nodes in the network; each node has its energy. We assume that node 1 is the source and node 10 is the destination.

When source 1 broadcasts a F-ant packet to find the route paths, there are many return ants from destination 10, when B-ants arrive at source 1, many paths are discovered with pheromone to the path listed at node 1 in Table 5. According to Table 5, a route table and route selection probability can be obtained by using Recv-B-ant. Procedure and probability calculation formula as shown in Table 5.1. The multiple paths can be used to forward a data packet according to selected probability.

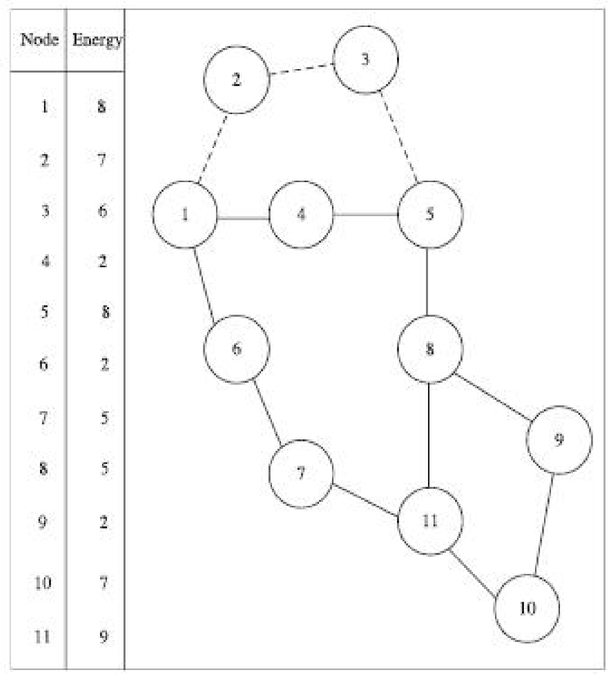

Figure 5.1- Network Topology & Energy distribution

Paths	Pheromone
1-2-3-5-8-9-10	14.3
1-2-3-5-8-11-10	14.7
1-6-7-11-10	15.5
1-4-5-8-9-10	2.1
1-4-5-8-11-10	2.6

Table 5.1- Discovered Path

When routes are discovered, the data packets can be sent through one of them. When a node i receives a data packet for a destination d, node i sends the data packet to a neighbor j, which is selected with probability Pi(j). If i has no pheromone for the destination d in its pheromone table, i sends the data packet to a neighbor j, which is selected randomly. If node i has no neighbor, the data packet is discarded. In order to maintain the path and keep alive, the ACERP should update pheromone value dynamically.

CONCLUSIONS

A mobile ad hoc network (MANET) consists of autonomous mobile nodes, each of which communicates directly with the nodes within its wireless range or indirectly with other nodes in a network. In order to facilitate secure and reliable communication within a MANET, an efficient routing protocol is required to discover routes between mobile nodes. The field of MANETs is rapidly growing due to the many advantages and different application areas. Energy efficiency and security are some challenges faced in MANETs, especially in designing a routing protocol. In this paper, we surveyed a number of energy efficient routing protocols and secure routing protocols. In many cases, it is difficult to compare these protocols with each other directly since each protocol has a different goal with different assumptions and employs mechanisms to achieve the goal. According to the study, these protocols have different strengths and drawbacks.

Here, we propose an ant colony-based energy control routing protocol ACERP and evaluate the affect of different mobility models to the performance of ant colony-based energy control routing protocols in MANETs. In ACERP, the routing protocol will find the better route which has more energy than other routes through the analysis of average energy and the minimum energy of paths.

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