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An Overview of Position Based Routing Protocols in Mobile Ad Hoc Networks

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Abstract
Mobile Ad-Hoc Network is wireless network consist of collection of mobile nodes that changes its topology very soon and communication between mobile nodes is based on the wireless links .since the MANET works in dynamic environment with no fixed infrastructure and topology, so routing the data packet between mobile nodes is challenging and crucial task. This paper focuses a brief overview of the routing protocols that uses position information to determine the location of destination node as well as its neighbor node. By the use of location services and forwarding strategies, it provides reliable as well as efficient routing for certain applications.

Keywords
Mobile Ad hoc Networks, Position Based Routing Protocol, LAR, DREAM.

I. Introduction

A Mobile Ad-Hoc Network is an autonomous collection of mobile node, that are communicated through wireless links. It is a temporary network without having any centralized access point, infrastructure, or centralized administration. It is wireless network that perform multi hop communication between mobile nodes, without the reliance on a fixed base station. It is a self configuring, self organizing, self administering wireless network whose topology changes dynamically. Each node acts as router and as a host. It works on five layers: Physical layer, Data link layer, Network layer, Transport layer, application layer. It is similar to the OSI Model, but the basic difference lies in the network layer. Network layer in MANET is divided into 2 parts i.e. network and ad hoc routing. IP protocol is used in network part and rest of the protocols like AODV, TORA, DSDV etc are used by ad hoc routing part.

Challenges in MANETs:

- Dynamic topology
- Network overhead
- Quality of service
- Security
- Efficient and Stable routing

These networks have various application areas, like disaster relief, military, emergency, conferencing, sensor applications.

II. Routing Protocols In Manet

To route the packet from one end to another end is the crucial task. The main goal of any routing protocol is to establish an optimal and efficient path between mobile nodes. There are several routing algorithm is proposed for efficient routing. Earlier routing protocol are based on the topological information, which consist of path establishment and path maintenance. It uses link information that exists in the network for packet forwarding. But now a day routing protocols are designed which utilizes position information to locate the exact locations of destination node as well as its neighbor node It uses position information to provide more reliable as well as efficient routing for certain applications.

A. Classification Of Routing Protocols In Manet

Routing protocols are divided into two categories: Topology based Routing and Position based Routing. Topology based Routing is further classified into Reactive or on- demand while others are proactive. In general, Proactive protocol always has to update its network topology. It finds routes in advance while a reactive protocol finds routes to the destination until it is demanded. It uses flooding technique to forward the packets. The major advantage of using this protocol is that it is designed to save the bandwidth space.

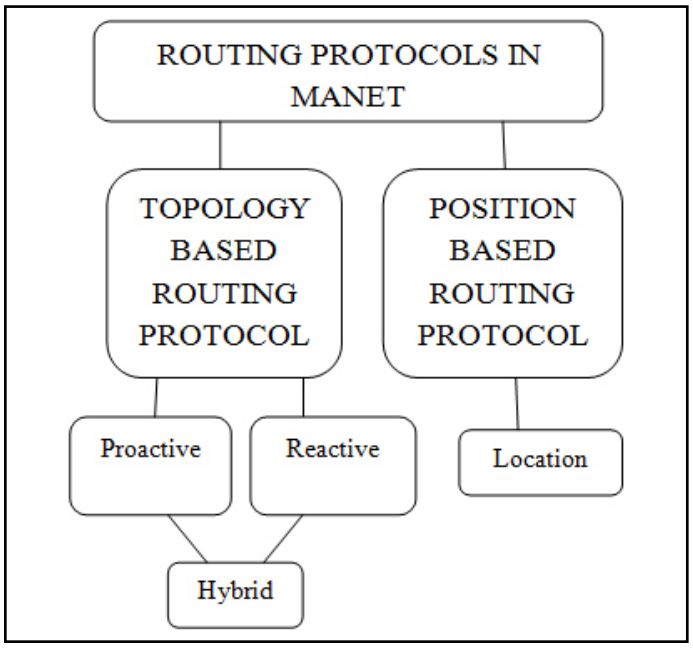

Fig: Classification of Routing Protocols in MANET

B. Reactive Routing Protocols

Reactive protocol can't find its routes to the destination until it is demanded. These routing protocols are more appropriate because they initiate a route discovery process only when data packets need to be routed. One advantage of reactive routing protocols is that it does not require periodic routing. Performance of the reactive routing protocol gets degraded in terms of control overhead with high mobility and heavy traffic loads. One disadvantage of this protocol is its Scalability because it depends on blind broadcasts to discover routes. It includes flooding for route determination and long route request delays [14].

Advantage:

Routes are discovered on demand basis.
Bandwidth efficient protocols

Less network communication overhead

Disadvantage:
Very high response time, as route is needed on demand.

C. Proactive Routing Protocols

Proactive protocol always has to update its network topology. It finds routes in advance. It periodically broadcast control message in order to have all node to know the current route to all destinations. This kind of routing uses very large amount of bandwidth to maintain routing. These routing protocols are less suitable for Mobile Ad-Hoc networks because it constantly consume power in the network, regardless of the activity of network [14].

Advantage:
Routes are readily available.
Quick response to application program

Disadvantage:
It has to maintain complete network graph in current state.
Consumes lot of network resource in order to maintain the network graph.

D. Hybrid Routing Protocols

These routing protocols combine the best of two approaches i.e reactive and proactive approaches. In general, topology-based are considered not to scale in networks with more than several hundred nodes. It is used to find the balance between both protocols. Proactive operations are restricted to small domain, whereas reactive protocols are used for outside those domains [14].

III. Position Based Routing Protocols In Manet

Position based routing protocol utilizes position information to locate the exact locations of destination node as well as its neighbor node It uses position information to provide more reliable as well as efficient routing for certain applications and this information is generally obtained via Global Positioning System (GPS) and location services. By the use of location services and forwarding strategies its performance is much better than topology based routing protocol. It exhibit better scalability, robustness against frequent topological changes. These routing protocols are designed to improve efficiency and performance of the network. Routing is done in a hop-by-hop fashion to forward the data packets. It is designed to handle networks that have many nodes. One advantage of this kind of routing is that it is totally based on local information to forward the data packet, rather than to keep the network wide information. This will lead to much reduced routing overhead and increase the packet delivery rate. Position information of each node is determined by the use Location Services and Forwarding strategies are used to forward the data packets. Several routing based algorithms have been presented including DREAM (Distance Routing Effect and Mobility), LAR (Location Aided Routing), GLS (Grid Location Service), GPSR (Greedy Perimeter Stateless Routing) [3, 14, 15].

Performance of Position Based Routing Protocol

The following performance of position based routing strategy of the protocol can be according to their important design parameters are:

- Loop Free
- Distributed Operation
- Path Strategy
- Packet Forwarding
- Path Selection Metric
- Memory (State)
- Guaranteed Message Delivery
- Scalability
- Overhead
- Adaptive to Mobility

Location services:
A location service should have the following characteristics are:

- It should efficiently and accurately provide a node with the location it needs to make routing decisions.
- It should be distributed, and should not rely on any special hardware or setup.
- It should be self-configuring.
- It should not introduce too much overhead.

Forwarding strategies:
There are three main packet-forwarding strategies used for position-based protocols: greedy forwarding, restricted directional flooding and hierarchical approaches [3].

Greedy forwarding:
protocols do not establish and maintain paths from source to the destination, instead, a source node includes the approximate position of the recipient in the data packet and selects the next hop depending on the optimization criteria of the algorithm; the closest neighbor to the destination for example. Similarly, each intermediate node selects a next hop node until the packet reaches the destination. In order for the nodes to be enable to do this, they periodically broadcast small packets. Greedy forwarding can lead into a dead end, where there is no neighbor closer to the destination.

Restricted Directional Flooding

In restricted directional flooding, the sender broadcasts the packet (whether the data packet or route request packet) to its neighbors towards the destination ends. The node which receives the packet, checks whether it is within the restricted boundary that should forward the packet. If, yes it will transmit the packet. Otherwise, the packet will be discarded. In this kind of flooding, several nodes participate in order to forward the packet. It will not only increase the probability of finding the shortest path but also it is robust against the failure of individual nodes and position inaccuracy.

Hierarchical Routing

The third forwarding strategy is to form a hierarchy in order to scale to a large number of mobile nodes. Some strategies combine the nodes location and hierarchical network structures by using the zone based routing.

A. Location-aided Routing Protocol (LAR)

This protocol is based on the use of location information about the mobile nodes by using location services like GPS and many more to reduce the route discovery overhead, the two regions are defined i.e. Request zone and Expected zone. Request zone is the area in which the node forwards the route request only when the node is inside the zone. When the nodes does not belongs to request zone then it simply discards the message. Expected zone is the area in

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which there is the maximum probability of finding the destination nodes. Since the destination node is mobile, We can calculate its probabilistic position by assuming its average velocity multiplied by difference in time interval. We assume the expected zone to be circular with the radius v (t_1-t_0). Difference between at time t_0 the location of destination node and at time t_1 the location of destination node multiplied by its average velocity [1].

B. Distance Routing Effect Algorithm for Mobility Protocol (DREAM)

DREAM protocol is proposed by Basagni et al., in which node location information is determined from GPS systems for communication. It is the combination of proactive and reactive protocol where the source node sends the data packet to the destination node by selective flooding. The sender will broadcast the packet towards nodes in a limited sector of the network; to all single hop neighbours towards the destination. DREAM algorithm is a proactive protocol that uses a limited flooding of location update messages Since DREAM uses the restricted directional flooding. to forward data packets themselves, there will be multiple copies of each packet at the same time. This increases the probability of using the optimal path; however, it decreases its scalability to large networks with a high volume of data transmissions and makes it more suitable for applications that require a high reliability and fast message delivery for infrequent data transmissions [4].

C. Adaptive Location-aided Mobile ad hoc Network Routing Protocol (ALARM)

This protocol uses feedback for adaption and location information for improvement the performance. It is a hybrid, adaptive to mobility protocol 'which uses LAR and directed flooding. It introduces the number of hops to be flooded past the mobility hot spot by the flood horizon. It uses the link the duration of the feedback at each node to determine the appropriate forwarding method and it adapts the operation on the current network mobility conditions and it will increases the mobility of the packet overhead [6].

D. Greedy Perimeter Stateless Routing Protocol (GPSR)

This protocol uses the location of the node to selectively a forwarded the packets based on the distance. The node closest to the destination by forwarding is carried out on the basis by selecting the greedy approach. This process will continue until the destination is reached. This protocol uses two methods for data forwarding: greedy forwarding and perimeter forwarding. A node sends the packet to its neighbor nodes closed to its region of perimeter. In the route discovery the states are collected and cached in the nodes after the region of perimeter forwarding. For the study of mobility, we used a random waypoint model [5].

E. Grid or Geographic Location Service Protocol (GLS)

It is based a location service for the geographic locations. We can be simulated with the simple geographic routing and the GPSR. It breaks up the network area into a hierarchical forming of the system of squares a quad-tree, where each n-order squares contain four (n-1) order squares. It will make use of the location information and it can be a unique, permanent and random allocated node IPs, the local first order square that each node stores a table of all nodes. it use of the periodic broadcasts as the location which updates increase with the network size [7].

Table 1: Comparison of Position Based Routing Protocols in Mobile Ad hoc Networks

Protocol	Path Strategy	Path Selection	Scalability
LAR	Multipath	Hop Count	Medium
ALARM	Multipath	Link duration	High
DREAM	Multipath	Hop Count	Medium
GLS	Single Path	Hop Count	Medium
GPSR	Single Path	Hop Count	Medium

F. Dynamic Route Maintenance for Geographic Forwarding (DRM):

Chou et al. propose a dynamic beaconing scheme to be used in geographic forwarding algorithms in MANETs. In beacon based protocols, each mobile node transmits periodic beacons to its neighbors to update and maintain its routing table. The beacons are generally forwarded at fixed intervals of time. During low mobility, a longer interval would be the best as it would reduce control overhead while providing accurate location information. However, in cases of higher mobility, determining an appropriate beacon interval is rather difficult. In DRM, beacon interval and route information are carried out dynamically. Based on the node's mobility information, its beacon interval is computed while the route management function updates the routing table entries. The DRM algorithm is applied to GPSR forwarding algorithm [10].

G. A Region-Based Routing Protocol For Wireless Mobile ad hoc Networks (REGR):

The REGR protocol, proposed by Liu et al., dynamically creates a pre-routing region between the source and the destination, hence control the flooding of route request packets within this region. The correct selection of the region, which should not be too small, is important for the discovery of the optimal routes [11].

H. Location aided Knowledge Extraction Routing for Mobile ad hoc Networks (LAKER):

The LAKER protocol minimizes the network overhead during the route discovery process by decreasing the zonal area in which route request packets are forwarded. During this process, LAKER extracts knowledge of the nodal density distribution of the network and remember a series of ''important'' locations on the path to the destination. These locations are named ''guiding routes'' and with the help of these guiding routes the route discovery process is narrowed down [12].

I. Most Forward within Distance (MFR):

Some greedy position-based routing protocols, such as Most Forward within distance R (MFR), try to minimize the number of hops by selecting the node with the largest progress from the neighbors, where progress is defined as the projection of the distance of the next hop from the sender on the straight line between the sender and the destination. As other greedy forwarding protocols, MFR has the shortcomings of either not guaranteeing to find a path to the destination or finding a path which is much longer than the shortest path. Moreover nodes periodically should broadcast beacons to announce their positions and enable other nodes maintain a one-hop neighbor table.MFR is the only progress-based algorithm competitive in terms of hop count .However, choosing the node with the largest progress as the next hop will increase the probability that the two nodes disconnected from each other before the packet reaches the next hop. So, the packet drop rate

increases greatly, especially in highly mobile environments. Such a situation is very common due to neighbor table inconsistency.

J. Secure Position Aided Ad-Hoc Routing (SPAAR):

It uses position information in order to improve the efficiency and security of mobile Ad-Hoc networks. It was designed for protecting position information in managed hostile environment where security is a primary concern uses geographical information to make forwarding decisions, resulting in a significant reduction in the number of routing messages. It uses asymmetric cryptography to protect against malicious nodes (unauthorized nodes that attempt to disrupt the network) and attempts to minimize the potential for damage of attacks from compromised nodes (authorized nodes those have been overtaken by an adversary) [13].

K. Sociological Orbit Aware Location Approximation Routing (SOLAR):

Ghosh et al. first proposed a macro level mobility framework termed orbit. It was a deterministic orbital movement pattern of mobile users along specific places called hubs. The movement pattern was based on the fact that most mobile nodes are not truly random in their movements but actually move around in an orbit from hub to hub. Each hub may be a rectangle and movement may take place either inside a hub or in between hubs. Example orbital models discussed are random orbit, uniform orbit, restricted orbit, and overlaid orbit [9].

IV. Conclusions

This paper mainly focuses on a brief overview of various position based routing protocols in MANET. Under what condition they are supposed to forward the packet is also described here. In this paper, the position based routing protocols can be classified into a location service, geographic and hierarchical. The routing protocol must be efficient to improve the performance of the network. The position based algorithms for both ad-hoc and wireless sensor networks, works in both dynamic and static scenarios. This paper shows that the task of routing packets from a source to destination can be divided into the two distinct ways: First to discover the position of the destination & its neighbor node by the use of location service and another way is the packet forwarding strategies. The common goal of any kind of routing protocol is to reduce the control packet overhead, maximize throughput and minimize the end-to-end delay. The main factor to differentiate between different protocols is the way of finding and maintaining the routes between the source and the destination pairs. We hope that the taken taxonomy of the protocol presented in this paper will be helpful in choosing the best routing protocol.

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