A Review of Position Based Routing Protocol in Mobile Ad-Hoc Networks

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Abstract— **The Mobile Ad-hoc Network (MANET) is a collection of self-configuring formed with the wireless link mobile nodes where each node in MANETs is free to move independently with infrastructure less and decentralized network. The finding an efficient route between a source and a destination is crucial problem in Ad-Hoc networks. To justify introducing position based routing algorithms in mobile Ad-Hoc networks there is need for scalable and energy efficient protocols, along with the recent availability of small, inexpensive and low power positioning instruments. There are several protocols are used for wireless ad hoc networks such as reactive protocols proactive protocols for finding routes. Hybrid protocols are used which combines the advantages of both reactive and proactive protocols. The position based routing protocols are also the part of hybrid routing protocol. The position based routing protocols uses GPS to find the availability of routes. In this paper various protocols for position based routing in mobile ad hoc networks are discussed.**

Index Terms— *Mobile Ad-hoc Networks, Position Based Routing, Gps, Hybrid protocols.*

I. INTRODUCTION

The wireless mobile Ad-hoc network (MANET) is self-configuring mobile nodes connected through the wireless links with the decentralized networks where the nodes communicate with each other on the basis of mutual trust. Ad-Hoc networks are highly applicable in many fields, such as emergency deployments and community networking. A fundamental and challengeable task in Ad-Hoc wireless network is an efficient routing protocol since all the nodes in the network act as hosts as well as routers. The usage of physical positions of the nodes can considerably improve the efficiency of routing techniques for mobile ad hoc networks. This mainly leads to a much reduced routing overhead and an increased packet delivery rate. Position- Based Routing is possible through the availability of small inexpensive GPS receivers and techniques for finding the relative coordinates based on signal strengths.

II. TYPES OF ROUTING PROTOCOLS

There are different types of routing protocols for mobile ad hoc networks. Some of them are based on topology and other protocols are position based. Each protocol has its own significance depending upon the area of its application. Some of the protocols for mobile ad hoc networks are discussed in this paper. There are three main categories of routing protocols ie. proactive protocols, reactive protocols and hybrid protocols. The hybrid protocols combine the advantages of both reactive and proactive protocols. The position based routing protocols comes under hybrid routing protocols.

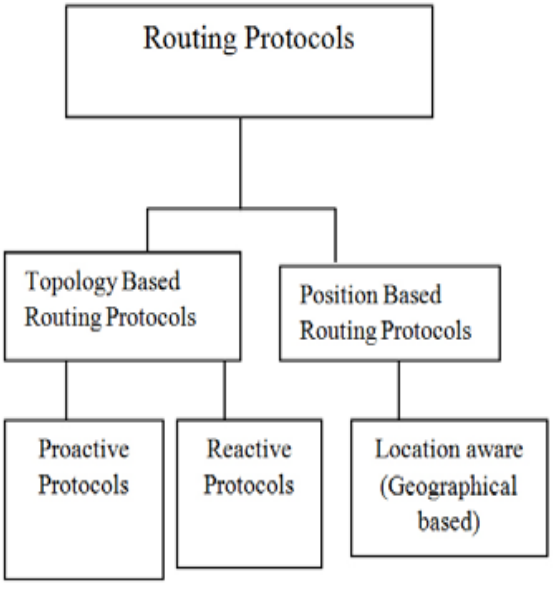

Fig1: Different Routing Protocols for Mobile Ad-Hoc Networks

A. Proactive Routing Protocols

In this type of routing protocol, each node in a network maintains one or more routing tables which are updated regularly. Each node sends a broadcast message to the entire network if there is a change in the network topology. However, it incurs additional overhead cost due to maintaining up-to-date information and as a result; throughput of the network may be affected but it provides the actual information to the availability of the network. Distance Vector (DV) protocol, Destination Sequenced Distance Vector (DSDV) protocol, are the examples of Proactive protocols.

B. Reactive Protocols

In this type of routing protocol, each node in a network discovers or maintains a route based on-demand. It floods a control message by global broadcast during discovering a route and when route is discovered then bandwidth is used for data transmission. The main advantage is that this protocol needs less touting information but the disadvantages are that it produces huge control packets due to route discovery during topology changes which occurs frequently in MANETs and it incurs higher latency. The examples of this type of protocol are Dynamic Source Routing (DSR), Ad-hoc On Demand Routing (AODV).

C. Hybrid Routing Protocols

Hybrid routing algorithms aim to use advantages of table driven and on demand algorithms and minimize their disadvantages. Position based routing algorithms that are classified in the hybrid routing algorithms category include the properties of table driven and on demand protocols and are usually interested in localized. Localization is realized by GPS that is used to determine geographical positions of nodes. Position changes which occur because of nodes mobility in MANET cause changes in routing tables of nodes. The GPSs, which are embedded in nodes, are used to update information in tables in position-based algorithms. That makes position-based algorithms different from the table driven and on demand algorithms. Multi Point Relaying (MPR) based algorithms, position based algorithms, Directional Routing Algorithm (DIR), most Geographic Distance Routing (GEDIR) are few examples of hybrid routing protocols [1].

D. Position Based Routing Protocols

Position-based routing algorithms eliminate some of the limitations of topology-based routing by using additional information. A location service is used by the sender of a packet to determine the position of the destination and to include it in the packet's destination address. Position-based routing thus does not require the establishment or maintenance of routes. Location services can be classified according to how many nodes host the service. The position information can be collected in different ways .It can be collected from the direction and strength of the received wireless signals and through interfacing with a low-power Global Positioning System (GPS) and a satellite updating the positions of the nodes by sending signals to this GPS device [2].

III. PACKET FORWDING STRATAGIES

There are three main packet-forwarding strategies used for position-based protocols.

- Greedy forwarding
- Restricted directional flooding
- Hierarchical approaches.

3.1. Greedy Forwarding

In this approach the protocols do not establish and retain paths from source to the destination instead; a source node includes the estimated position of the recipient in the data packet and selects the next hop depending on the optimization criteria of the algorithm i.e. the closest neighbor to the destination. 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 (called beacons) to announce their position .Such an approach is scalable and flexible as it does

not need route discovery and maintenance with the topology change. It has the disadvantage because the periodic beaconing creates lot of congestion in the network and consumes node's energy. The greedy routing may not always find the best possible route, even it may fail to find a path between source and destination when one exists. An example of this problem is shown in fig. 2. The circle around S shows the transmission range of S. Note that there is a valid path from S to D. The problem here is that S is closer to the destination D than any of the nodes in its transmission range; therefore greedy forwarding will reach a local maximum from which it cannot recover. Generally, greedy forwarding works well in dense networks, but in sparse networks it fails due to voids (regions without nodes).

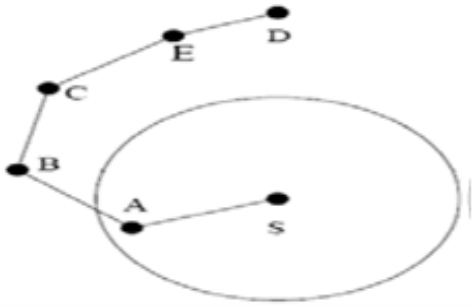

Fig. 2: Greedy Routing Failure Example

3.2. Restricted Directional Flooding

In restricted directional flooding, the sender broadcasts the packet (whether the data packet or route request packet) to all single hop neighbors towards the destination. The node which receives the packet, checks whether it is within the set of nodes that should forward the packet (according to the used criteria). If yes, it will retransmit the packet. Otherwise, the packet will be dropped. In restricted directional flooding, instead of selecting a single node as the next hop, several nodes participate in forwarding the packet in order to increase the probability of finding the shortest path and get robust against the failure of individual nodes and position inaccuracy.

3.3. Hierarchical Approaches

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. Others use the dominating set routing. Some others present a two level hierarchy within them; if the destination is close to the sender (in number of hops), packets will be routed based on a proactive distance vector. Greedy routing is used in long distance routing.

IV. OVERVIEW OF SSELECTED POSITION BASED ROUTING PROTOCOLS

In this section the selected protocols are described. For each protocol, we tried to summarize its main objectives, how it works and its advantages and disadvantages compared to other protocols.

4.1 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. 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 [3]. 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 [2].

4.2. Location-Aided Routing (LAR)

Ko and Vaidya presents the LAR protocol which utilizes location information to minimize the search space for route discovery towards the destination node [1]. LAR aims to reduce the routing overhead for the route discovery and it

uses the Global Positioning System (GPS) to obtain the location information of a node. LAR essentially describes how location information such as GPS can be used to reduce the routing overhead in an ad hoc network and ensure maximum connectivity. Location-Aided Routing is an example of restricted directional flooding routing protocols; however, partial flooding is used in LAR for path discovery purpose. Hence, LAR proposes the use of position information to enhance the route discovery phase of reactive Ad-Hoc routing approaches

4.3. DREAM

Distance Routing Effect Algorithm for Mobility (DREAM) [4] is an example of restricted directional flooding routing protocols, that within them, the sender will broadcast the packet towards nodes in a limited sector of the network; to all single hop neighbors towards the destination. DREAM algorithm is a proactive protocol that uses a limited flooding of location update messages [3]. In DREAM, each node maintains a position database that stores position information about all other nodes in the network. Its location service can therefore be classified as an all for all approach. Thus, each node regularly floods packets to update the position information maintained by the other nodes. The higher the speed of a node the more the frequency with which it sends position updates. Also, the distance that a position update may travel before it is discarded provides accurate position information in the direct neighborhood of a node and less accurate information at nodes farther away, but this does not cause a problem since intermediate hops are able to update the position information contained in the data packet.

4.4. AODPR

In [5] *Anonymous On-Demand Position based Routing in Mobile Ad-Hoc Networks (AODPR)* was proposed while these two problems in mind. It keeps routing nodes anonymous, thereby preventing possible traffic analysis. A time variant Temporary Identifier (Temp ID) is computed from time and position of a node and used for keeping the node anonymous. Moreover, AODPR uses the concept of Virtual Home Regions (VHR) [6] which is a geographical region around a fixed center. In this scheme each node stays in one of the VHRs and nodes within a VHR obtain their own geographic position through GPS and report their position information to the Position Servers (PS). PSs are trusted Ad-Hoc nodes distributed in the network. The PS keeps the position information of the nodes securely. When a node joins the network, it makes its registration to the PS and gets a common key and a pair of public and private keys from the PS [5].

4.5 I-PBBLR

Most position-based routing protocols use forwarding strategies based on distance, progress or direction. *Improved progress Position Based Beacon Less Routing algorithm (I-PBBLR)* [1] combines the traditional progress with the direction metric to form the improved progress definition. I-PBBLR tries to eliminate the beaconing drawbacks by using a beaconless protocol. In beaconless protocols the sender makes non-deterministic routing decisions, implicitly allowing opportune receiving nodes to determine a packet's next-hop through contention at transmission time. In I-PBBLR, if a source node has a data packet to send, it first determines the position of the destination, stores these geographical coordinates along with its own current position in the header of the packet, and broadcast the packet to all neighboring nodes.

4.6 GRID

In *GRID* algorithm [8] the dominating set concept is applied. A set is dominating if all the nodes in the system are either in the set or neighbors of nodes in the set. Routing based on a connected dominating set is a promising approach, since the searching space for a route is reduced to nodes in the set. GRID tries to exploit location information in route discovery, packet relay and route maintenance. In GRID the geographic area is partitioned into a number of squares called grids. In each grid, one mobile host (the one nearest to the physical center of the grid) will be elected as the leader of the grid. Routing is then performed in a grid-by-grid manner through grid leaders, and non-leaders have no such responsibility. Hence, the number of packets related to route search is insensitive to the network density. On the contrary the cost

slightly goes down as the host density increases, since routes are becoming more stable with denser hosts.

4.7 TERMINODES

TERMINODES [9] is an example of hierarchical routing protocols. TERMINODES presents a two level hierarchy within which, if the destination is close to the sender (in terms of number of hops), packets will be routed base on a proactive distance vector. Greedy routing is used in long distance routing. TERMINODES addresses the following objectives: scalability (both in terms of the number of nodes and geographical coverage), robustness, collaboration and simplicity of the nodes [3]. This routing scheme is a combination of two protocols called Terminode Local Routing (*TLR*) and Terminode Remote Routing (*TRR*). *TLR* is a mechanism that allows to reaching destinations in the vicinity of a terminode and does not use location information for making packet forwarding decisions. *TRR* is used to send data to remote destinations and uses geographic information; it is the key element for achieving scalability and reduced dependence on intermediate systems.

4.8 LABAR

Location Area Based Ad-Hoc Routing for GPS-Scarce Wide-Area Ad-Hoc Networks **(***LABAR)* [10] is a hybrid virtual backbone and geographical location area based Ad-Hoc routing. Authors outlined that using GPS can increase the cost and power consumption of small mobile nodes. Thus, LABAR requires only a subset of nodes (G-nodes) to know their exact location forming location areas around them. G-nodes are interconnected into a virtual backbone structure to enable efficient exchange of information for the mapping of IP addresses to locations. Nodes that are not enabled with GPS equipment are called S-nodes. LABAR is a combination of proactive and reactive protocols, since a virtual backbone structure is used to update location information between Gnodes (in a proactive manner), while user packets are relayed using directional routing towards the direction zone of the destination. One of the most important advantages of LABAR is the reduction of cost and power consumption by the relaxation of the GPS-equipment requirement in each node.

4.9 SPAAR

Secure Position Aided Ad-Hoc Routing (SPAAR) [7] and *Anonymous On-Demand Position-based Routing in Mobile Ad-Hoc Networks (AODPR)* [5]. 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 concerned 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).

V. COMPARISONS OF VARIOUS ROUTING PROTOCOLS

Table.1 summarizes the discussed protocols together with the evaluation criteria used.

Here is the comparison of different routing protocols. Mobility (DREAM) DREAM is a multi-path, location-aware routing protocol. In DREAM, each node knows its geographical coordinates through a Global Positioning System (GPS). The coordinates are periodically exchanged between each node and stored in a routing table. The advantage of exchanging location information results in less bandwidth consumption resulting in good scalability of this protocol. Location Aided

Routing (LAR) is an improvement to flooding algorithms to reduce overhead due to flooding. The aim of LAR is to send the route requests only to a particular are expected to include the destination thereby decreasing overhead. MFR has the shortcomings of either not guaranteeing to find a path to the destination or finding a path which is much long than the shortest path. LABAR does not require all nodes in the ad hoc network to be precisely aware of their geographical location, i.e.to be equipped with GPS receivers, it is sufficient if only a subset of the nodes is enabled to determine their location. SPAAR is a routing protocol designed for a high risk MANET environment. In particular, SPAAR satisfies the security requirements of the managed hostile environment by using protected position information to reduce routing overhead and increase the security of routing. AODPR protocol ensures the anonymity of both route and nodes and the robustness against the target-oriented attack and several others. This protocol is applicable to networks with any density of node.

Metric	*Type*	*Robustness*	*Implement complexity*	*Scalability*	*Packet overhead*
MFR	Greedy (Progress)	Medium	Low	High	Low
I-PBLR	Greedy (Progress-direction)	Medium	Low	High	Low
DREAM	Restricted Directional Flooding	High	Low	Medium	Low
LAR	Restricted Directional Flooding	Low	Low	Medium	Low
Grid	Hierarchical	Medium	Medium	High	Low
TERMINODES	Hierarchical	Medium	Medium	High	Low
LABAR	Hierarchical	High	Medium	High	Low
SPAAR	Restricted Directional Flooding	Low	High	Medium	High
AODPR	Restricted Directional Flooding	Low	Medium	Medium	Medium

Table1: Comparisons of different routing protocols

VI. CONCLUSION

This paper has presented the various types of position based Ad-Hoc routing protocol with their type, robustness, scalability, implement complexity and packet overhead. Position based routing has several advantages over the earlier protocols and some disadvantages like the problem of designing location update schemes to provide accurate destination information As many protocols have been proposed, with greater throughput and performance still there is a need for the development of an efficient routing protocol. One of the most important functions in Ad-Hoc wireless networks is efficient routing among a set of mobile hosts. In the ad hoc networks because of the use of position based routing protocols, the ad-hoc networks can become more robust and efficient.

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