ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 2, Issue 3, March 2013

Position based Routing Protocols for Wireless Ad hoc Networks: A Critical Survey

Saba Khalid
M.Tech Student
Integral University
Lucknow, India

Shish Ahmad
CSE Deptt.
Integral University
Lucknow, India

Prof. Dr. Mohd Rizwan Beg
HOD CSE and IT Deptt.
Integral University
Lucknow, India

Abstract**—** A Mobile Ad-hoc Network is a collection of wireless nodes that cooperatively form a network in the absence of any infrastructure or administration. In this paper we present an overview of position based routing protocols that make forwarding decisions based on geographical position of packet destination. Position based routing protocols need to know only the destination address and the address of one hop neighbours in order to reach destination. In this paper recent location based routing protocols are discussed and qualitative comparison of the approaches is given**.**

Index Terms**— geographic routing protocols, location services, forwarding strategies, MANET**

I. Introduction

Mobile devices equipped with short range wireless communication interfaces (e.g., Wi-Fi, Bluetooth), and sometimes with a GPS receiver, are nowadays widespread and used daily by an increasing number of people. Netbooks, mobile internet devices or smartphones are some examples of such devices. Thanks to their short range wireless communication interfaces, these devices can spontaneously form a multi-hop disconnected mobile ad hoc network (DMANET). Designing a routing protocol supporting both service discovery and delivery in such kinds of networks is radically different than devising one for traditional infrastructure-based networks. Indeed due to the mobility of nodes and to the short communication range of wireless interfaces, the topology of DMANETs suffers from frequent and unpredictable changes, entailing an intermittent connectivity between nodes, therefore routing in MANET is a challenging task. We distinguish two different approaches: topology based and position based routing. Topology based routing protocols use the information about the links that exist in the network to perform packet forwarding. They can be further divided into proactive, reactive, and hybrid routing protocols.

Position-based protocols are currently being thoroughly studied due to their application potential in networks with demanding requirements. Their main characteristic is that they make use of location information for routing decisions. From all the position-based protocols, the geographic approach is the one which captures the attention mostly due to its numerous advantages. Geographic routing is an elegant way to forward packets from source to destination in very demanding environments without wasting network resources or creating any impediment in the network design. Therefore it is generally considered as an attractive routing method for both mobile wireless ad-hoc and sensor networks (ad-hoc and sensor networks). However, as all location based algorithms, it does not completely lack from drawbacks because it is based on localization, an intrinsic source of communication errors.

Geographic routing represents the algorithmic process of determining the paths on which to send traffic in a network, using position information/geographic location only about source, neighbours and destination. It is considered substantially better from an energetic point of view due to the use of solely local information in the routing process. As a result of very little routing information being needed, no energy is spent on route discovery, queries or replies, node memory requirements are decreased and traffic overhead and computation time are considerably reduced. Also, in this sense it is different from source routing in which the sender makes some or all the routing decisions by having mapped the network and specifying in the packet header the hops that the message has to go through. In geographic routing, the process is localized and distributed so that all nodes involved in the routing process contribute to making routing decisions by using localization methods and computing the best forwarding options.

The clear benefits of geographic protocols are not offered by all position-based routing protocols. Some position-based protocols make use of different types of routing which create unnecessary overhead and consume extra energy, unlike pure geographic routing. Their approaches sometimes clearly belong to a specific routing category, such as reactive and proactive routing or represent a hybrid. However, each protocol has it strengths and weaknesses and all of the position-based protocols present a novel idea or improve an old one. It is only fair to say that some of the non-geographic methods can be more attractive for specific network environments and scenarios.

The rest of the paper is organised as follows: Section II presents the basic principles and issues of position based routing protocols. Section III characterizes position based routing types and geographic routing in particular. Section IV details the routing parameters used in assessment of routing protocols and makes reference to the comparison table. Finally Section V concludes the paper and points out open issues and possible directions for future research.

II. PRINCIPLES OF POSITION BASED ROUTING PROTOCOLS

The philosophy of position based routing is that [1] it is necessary to determine the location of the destination before a packet can be sent.Generally a location service takes this responsibility. Existing location services can be classified according to how many mobile hosts(MH) have the service. This can be either some specific nodes or all the network nodes. Moreover each location server may maintain the position of some specific nodes or all the nodes in the network. Accordingly four possible combinations of location services exist: some for some, some for all, all for some ,and all for all.

Once the position of destination is obtained using location service the packets are forwarded using three main packet forwarding strategies: greedy forwarding, restricted directional flooding, and hierarchical approaches. In greedy forwarding a node forwards a given packet to one or more one hop neighbour that are located closer to the destination than the forwarding node itself. Restricted directional flooding implies the packet is sent to all single hop neighbours towards the destination. The neighbours which receive the packet check whether they satisfy the criteria to forward the packet or whether they should drop it.From these neighbours, several of them participate in the forwarding, not just one, to increase the robustness of the algorithm. This flooding is used in Adaptive Location Aided Routing Protocol(ALARM). The third strategy combines forwarding strategies according to hierarchical network structures.Some use zone based routing and some combine geographic routing with forwarding packets based on a proactive routing vector or on greedy strategies.The location service and forwarding strategies together form the basic building blocks of position based routing.

TABLE I. BUILDING BLOCKS OF POSITION BASED ROUTING [1]

Buliding Blocks		
Serial No.	***Location Service***	***Forwarding Strategy***
1)	Some –for-Some	Greedy Forwarding
2)	Some- for- all	Restricted Directional Flooding
		-Next hop selection
		-Recovery Strategy
3)	All- for- some	Hierarchical approaches
4)	All- for- all	

III. ROUTING TYPES OF POSITION BASED PROTOCOL

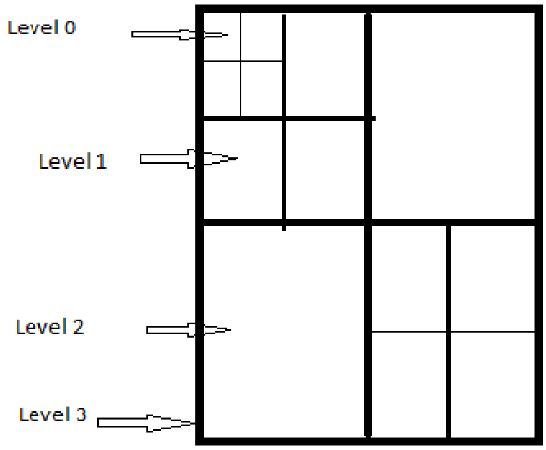
The work presented in [2] says that the position based routing protocols should not be made synonymous with geographic routing whose definition is more restrictive. The position based algorithms makes use of more location information than just that of source, destination and of the forwarding node. Such an example is the DREAM protocol which requires a position data base of all the nodes in the network. It can therefore be classified as an all-for-all approach.

A. Quorum Based Location Service

In[3]this service is employed for ad hoc networks. According to this scheme a set of MH is chosen to host position databases, information updates are sent to a subset of available nodes, and information requests are referred to a potentially different subset. The subsets are designed such that their intersection is nonempty hence an up-to-date version of the sought after information can always be found.

B. Grid Location Service

It is a location service specifically for geographic locations. It is simulated with simple geographic routing and GPSR. It breaks up the network area into a hierarchical system of squares forming a quad-tree as in Fig. 1, where each n-order squares contain four (n-1)-order squares. It makes use of location information and unique, permanent, random allocated node IPs, so each node stores a table of all nodes within the local first-order square. The use of periodic broadcasts as location updates increase with network size. The success rate degrades linearly so scalability is compromised when it comes to large networks



.
Figure 1. Hierarchical zones of the Grid Location Service

C. Homezone

Homezone approaches are all-for-some approaches and uses the concept of virtual directory where position information for a node is stored. In the Homezone location service, each node is assigned an area (the so called Homezone) in the ad-hoc network via a hash function. Location updates are sent to all the nodes in the homezone. Location requests are answered by one of the nodes in this area. A major disadvantage of this design is the single fixed homezone. Nodes are not limited in their movements. As a result, nodes may be far away from their homezone and their updates may have to travel long distances. Furthermore, even requests from nodes close to the target node must be forwarded all the way to the homezone. This can lead to high network load and latency.

D. Geographic Routing Protocols

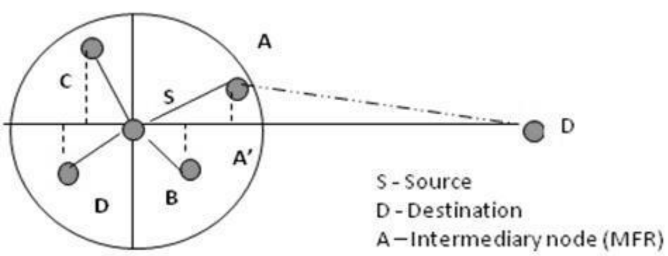
Geographic routing protocols are based solely on location information of nodes, which can be obtained via the GNSS, where this is available, or via other location services. The source node has to be aware of its own position, the position of nodes within its range of communication (neighbour nodes) and of the destination. Therefore, the required node memory is minimal reducing bandwidth consumption and conserving energy. Nodes use broadcasting (on demand or periodically) to let their one hop neighbours know their location, but discovery floods and state propagation are not needed. So geographic routing results in minimal overhead. Also, because of the localized forwarding process, the network reacts faster, avoiding delays and overall latency [4][5].

Because geographic routing is based on knowledge of node coordinates, it relies on idealized assumptions about radios and their capacity to accurately serve node communication [6]. Two such impractical assumptions are the nodes' fixed radio range described by unit disk graphs (UDG) and the accurate location information they posses. The communication area of nodes is not predictable and proximity does not suffice. Obstacles may prevent nodes from being within range result in voids in the physical network topology and eventually in the failure of the forwarding strategy.

1) Most Forward Within Radius (MFR)

It is a progress-based algorithm, in which data is forwarded to the neighbour with the greatest progress (node A in the Fig.2). Its objective is to maximize obtainable expectable progress in a certain direction. If no node is in the forward direction, within the range of the sender, the message is sent to the neighbour node with the least backward progress. This algorithm minimizes the number of hops, but doesn't minimize energy consumption. In inhomogeneous node density (for uniform Poisson distribution of nodes), it is recommended for short range transmission because of the low possibility of packet collision. In [7], another version is proposed (f-MFR), which uses flooding to guarantee delivery and eliminate looping.

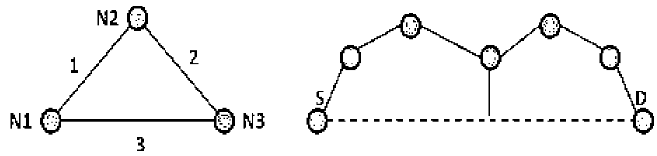
Figure 2 Example of progress with MFR



2) Face Routing

It is presented, as a method which guarantees delivery. Face routing proceeds along faces of planar graphs and along the line connecting the source and the destination, so the underlying network has to be a planar graph. It uses the Right Hand Rule and has to explore the complete boundary of faces (Fig. 3). It is unsatisfactory because the delivery of the message takes place in a number of steps equal to the number of network nodes, which is similar to flooding.

Figure 3Planar graph traversal for FACE



3) Compass Routing /Perimeter Routing Protocol

This algorithm uses the following method: the sending node uses the information it has about the destination to calculate the direction in which to forward the message. It is also named Compass routing because it minimizes the spatial distance a packet travels. Finally, it is possible to let the sender randomly select one of the nodes closer to the destination than itself and forward the packet to that node.This strategy minimizes the accuracy of information needed about the position of the neighbours and reduces the number of operations required to forward a packet.

4) SPAN

This protocol operates under the routing layer and above the MAC and physical layers and is designed to conserve energy and increase network lifetime. In [9] it is implemented with geographic forwarding. The technique relies on the following: each span node decides by itself whether to sleep or join the forwarding backbone, as coordinators, based on local topology information. When a void is encountered, packet is dropped. Loss rate is low both for mobile and static networks, lifetime is doubled and connectivity is preserved. It improves routing throughput and packet delivery latency. For mobility, the random waypoint model is used.

5) Location Aided Routing(LAR)

This protocol uses position information to enhance the route discovery phase of reactive ad hoc routing approaches.LAR uses this position information to restrict the flooding to a certain area. This is carried out similar to DREAM.

6) SPAAR

It is a position based routing protocol which uses geographical information and improves the security of mobile ad-hoc networks. Every message sent in the network is signed with a private key and encrypted with the public key of a neighbour. A high level of security is achieved also through allowing nodes to receive routing messages only from one-hop neighbours. Each node which participates in the routing process has to have a private/public key pair, a certificate binding its identity to its public key and the public key of the certificate server. The assumption is that there is one single certificate server – possible point of failure. Routes to specific destinations are found by sources broadcasting a Route REQuest (RREQ) encrypted with a group encryption key. Intermediate nodes check if they or other neighbour nodes are closer to destination and forward the request towards the destination. Intermediate nodes also record in their route cache the address of the neighbour from which they receive the request, thereby establishing the route back. The destination uses the route back to send the Route REPly.

7) Reactive Geographic Routing Protocol(RGRP)

It is a hybrid routing algorithm which combines a reactive mechanism and geographic routing which aims to find the shortest path and reduce communication overhead. It is a reactive position-based protocol that aims to improve communication cost by not using beaconing or table maintenance and benefiting from two types of route discovery packets RREQ and RREP with multiple functions. They are broadcasted to one-hop neighbours only by the source and destination and forwarded by the rest of the nodes. The shortest path to destination is calculated by coordinator nodes in two steps, both in the forwarding of the RREQ and of the RREP. Each time a node receives a RREQ or the RREP, it compares the distance of the paths it has been received on and discards the one arrived on the longer path. Route information and neighbour tables are not kept for a long time as they are created every time a new message needs to be forwarded.

IV. Comparison Parameters

In this section we have compared several parameters for comparing different position based routing protocol. One key aspect of this comparison is how the individual approaches behave with an increasing number of nodes in the mobile ad hoc network. Ad hoc networks as well as sensor networks have varying size and are forecast to reach sizes of thousands of nodes in the near future. This is only possible if routing algorithms allow network growth, without influencing network performance when new nodes join. This property is called scalability. Because scalability is not measured in a particular way and it depends on the outcome of a certain algorithm or protocol simulation, stating that an algorithm is, or is not, scalable is rather subjective. Algorithm simulations can be run under ideal conditions and may not even take mobility into consideration, therefore what may seem a scalable algorithm under certain constrictions, can eventually prove otherwise. Here, scalability is classified as low, medium or high. Low ,when the network which uses the protocol in discussion cannot grow beyond a relatively small size. Medium, when the network does not perform well over a certain size threshold or when size is restricted by a certain condition (density or topology). High, when the network's performance is not influenced by size.

The next parameter is time complexity whose task is to lookup and update nodes in the network. Mode of operation field in the table1 depicts that network can operate in a centralized, decentralized or distributed manner. Packet forwarding field classifies routing algorithms into forwarding strategies which can be greedy, flooding and hierarchical.

The next parameter is Network recommendation. Geographic routing protocols were designed for a certain type of network, so a column has been dedicated to this specifically. Researchers have simulated these protocols and analyzed their performance under several network conditions (small/large number of nodes, sparse/dense networks, under static/mobile conditions). Thus, suggestions could be made for the type of network recommended for implementation, information which can support the application suggestions as well. The next column of table is robusteness which checks whether a given routing algorithm is able to handle failure of individual nodes and position inaccuracy. The work of this paper might not be enough for practical purposes because the behaviour of each protocol has been studied only under simulated theoretical network scenarios, sometimes unrealistic or insufficiently detailed to match the desired application. To be able to choose the most suitable protocol would therefore imply more study of the protocol itself. However, to be able to efficiently focus the research in the correct direction, one would need to know which of the existing protocols is more suitable, at least theoretically, to a certain area of application, from all the points of view expressed in this section.

Table 1 Comparison of different position based routing protocol

Protocol	**Mode of Operation**	**Type**	**Network Recommendation**	**Forwarding method**	**Robustness**	**Scalability**	**Time Complexity (update and lookup)**
Distance Routing Effect Algorithm for Mobility(DREAM)	Localized	All for all location service	Small/medium MANET	Restricted Directional Flooding(RDF)	High	Medium	Low
Quorum System	Centralized	Some for some location service	Small/medium MANET	Virtual backbone nodes	Medium	Medium	High
Grid Location Service	Localized	All for same location service	Medium VANET	Hierarchical strategy	Medium	Medium	Medium
Home zone	Localized	All for some location service	Small/Medium MANET	Position and hash function based	Medium	High	Low
Face routing, Greedy face Greedy(GFG)	Localized	Recovery strategy	Large MANET	Greedy	Medium	High	Medium
Most Forward Within Radius(MFR),Compass Routing Method(DIR)	Localized	RDF	Small/medium MANET	Greedy	Low	High	Low
Location Aided Routing Protocol (LAR)	Localized	Greedy Forwarding	Medium MANET	Flooding	Low	Medium	Medium
SPAN An energy efficient algorithm for topology maintenance	Localized	Greedy Forwarding	Dense/Static Ad hoc network	Hierarchical /Greedy	High	High	High
Secure Position Aided d hoc Routing(SPAAR)	Localized	RDF	Tactical network MANET	RDF for route discovery	High	Medium	High
Reactive Geographic Routing Protocol(RGRP)	Localized	Greedy Forwarding	Static Wireless Sensor Network	Greedy with route discovery	Medium	High	Low
Relative Distance Micro Discovery Ad hoc Routing	Localized/ Centralized	RDF	Large mobile network	Flooding mechanism	Medium	Medium	Medium

V. CONCLUSION

In this paper we present a survey on position based routing for mobile ad hoc networks. We provide a qualitative evaluation of different position and geographic routing protocols. Based on this evaluation we identified a number of research opportunities that could lead to further improvements such as: The behavior of GLS in a dynamic environment and in the presence of node failures is difficult to control than that of homezone[1].It is a very challenging task in GLS to ensure that the hashing works properly in the face of dynamic networks[2].The GLS approach works by hashing the ID of a node in the IDs of so called location servers. These location servers are updated by the destination node with regard to its own position and queried by the source nodes that want to contact the destination node. There is one very important aspect of location services that is not considered by any existing approach the problem of ensuring anonymity i.e; location privacy is hard to achieve. The next research opportunity is that since ad hoc networks are very common today, it is likely that connectivity among the individual adhoc networks, as well as connectivity of any given adhoc network and global internet wil be desired.This will require hierarchial structure as in GLS and the needed for global addressing.

REFERENCES

[1] Martin Mauve and Jorg Widmer, "A survey on Position based routing in Mobile Adhoc Networks", IEEE Network,2001

[2] L. K. Qabajeh, L. M. Hiah, M. M. Qabajeh, A qualitative comparison of position-based routing protocols for ad-hoc networks, February, 2009

[3] Z.J.Haas and B.Liang,"Ad hoc Mobility Management with Uniform Quorum Systems," IEEE/ACM Trans.Net.,Vol.7, no.2, Apr. 1999 pp.228-40

[4] Ivan Stojmenovic, "Position Based Routing in Ad hoc Networks, IEEE Communications 2002.

[5] K. Seada, A. Helmy, An overview of geographic protocols in ad-hoc and sensor networks, IEEE Journal, 2005

[6] Y. Kim, R. Govindan, B. Karp and S. Shenker, Geographic routing made practical, 2nd Symposium on Networked Systems Design and Implementation (NSDI), pp. 217-230, Boston, MA, USA, 2-5 May, 2005

[7] I. Stojmenovic, X. Lin, Loop-free hybrid single-path/flooding routing algorithms with guaranteed delivery for wireless networks, IEEE Transactions on Parallel and Distribution Systems, vol. 12, issue 10, 2001, pp.1023-1032

[8] Ana Maria Popescu, Ion Gabriel Tudorache,and A.H.Kemp, "Surveying Position based routing protocols for wireless sensor and Ad hoc networks," in *IJCNIS* vol. IV, No. 1,April 2012, pp.41-65.

[9] Chinmay Shete, Salil Sawhney, Supriya Herwadkar, Varun Mehandru, Ahmed Helmy, "Analysis of the Effects of Mobility on the Grid Location Service in Ad Hoc Networks", IEEE Communication Society 2012

[10] Shengbo Yang, Feng Zhong, Chai Kiat Yeo and Bu Sung Lee "Positionbased Opportunistic Routing for Robust Data Delivery in MANETs,"IEEE Globecom 2009 proc.

[11] Nicolas Le Sommer and Salma Ben Sassi, "Location-based Service Discovery and Delivery in Opportunistic Networks"*IEEE 2011, International Conference on Networks.*