IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Survey on Postion based Routing Algorithms and Reliable Data Delivery in MANET

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Abstract

The vision of itinerant computing with its ubiquitous access has stimulated much attention in the Mobile Ad Hoc Networking (MANET) technology. Mobile Ad hoc Networks called as MANET is a self reliant system comprising of self organizing and self configuring nodes connected by wireless links. However, its promulgation sturdily depends on the availability of reliable routing mechanisms. In the open, collaborative MANET environment practically any node can maliciously or selfishly disrupt and deny communication of other nodes. An active research is going on to find reliable transmission techniques in the presence of dynamic topology. This paper helps the researcher by proving the survey about various routing algorithms involved in MANET.

Keywords: Data Delivery, MANET, Position Based Routing

Introduction

In recent years the widespread availability of wireless communication and handheld devices has stimulated research on self organizing network that do not require a pre established infrastructure. These ad hoc networks consist of autonomous nodes that collaborate in order to transport information. Based on the infrastructure the ad hoc networks can be classified into static and mobile. In static ad hoc networks the position of a node may not change. A Mobile Ad-hoc network (MANET) is consists of mobile routers connected wirelessly to each other where each node is free to move. This results in a continuously changing topology. Some examples of the possible uses of ad hoc networking include business associates sharing information during a meeting, soldiers relaying information for situational awareness on the battlefield and emergency disaster relief personnel coordinating efforts after a hurricane or earthquake.

Since mobile ad hoc networks change their topology frequently and without prior notice routing in such networks is a challenging task. The two different routing approached used are topology based and position based routing methods.

Topology based routing protocols use the information about the links that exist in the network to perform packet forwarding. They can be further classified as proactive, reactive and hybrid approaches.

Proactive algorithms employ classical routing strategies such as distance vector routing or link state routing (DSDV, OLSR and TBRPF). The main drawback of these approaches is that the maintenance of the unused paths may occupy a significant part of the available bandwidth if the topology of the network changes frequently. Reactive routing protocols (DSR, TORA, AODV…) maintain only the routers that are currently in use, thereby reducing the burden on the network when only a small subset of all available routes is in use at any time.

Hybrid ad hoc routing protocols such as ZRP combine local proactive routing and global reactive routing in order to achieve a higher level of efficiency and scalability.

Position based routing algorithms eliminate the limitations of topology based routing by adding some other extra information. The physical location of the nodes which is participating in the routing is made available by using GPS (Global Positioning System) service. A location service is used by the sender of a packet to determine the position of the destination and to include it in the packets destination address. In position based routing the need for route maintenance is null and the transmission of data in a geographical location is called as geocasting.

In recent years, position based routing algorithms have been extensively studied due to the popularity and availability of positioning services such as the global positioning system (GPS). Since position based routing does not require a route management process, it carries a low overhead compared to other routing schemes, such as proactive, reactive, and hybrid

ISSN: 2277-9655
Impact Factor: 1.852

topology based routing protocols. Position based routing protocols work on the assumption that every node is aware of its own position in the network; via mechanisms like GPS or distributed localization schemes and that the physical topology of the network is a good approximation of the network connectivity. The most significant difference between MANETs and traditional networks is the energy constraint. Some applications such as environment monitoring need MANETs to run for a long time. Therefore, extending the lifetime of MANETs is important for every MANET routing protocol. However, most position based routing algorithms take the shortest local path, depleting the energy of nodes on that path easily.

In this paper the various geographical based routing algorithms called as geo casting and a position based routing algorithms for mobile ad hoc networks are presented. Based on these two routing algorithms position based opportunistic routing algorithm [1] is also reviewed. Section II of this paper describes about the performance indicators for all routing algorithms. Section III describes the basic terminology of geocasting and the various geo casting algorithms. The Different position based routing algorithms are also discussed in section II. The recent position based opportunistic algorithm is presented in section III. The section IV gives the conclusion and guides the researcher in to various aspects of mobile ad hoc routing and creates a path for vehicular network routing.

Network Performance Measurements

Performance Indicators

The performance of position-based routing algorithms [7] can be judged according to the provision they offer for important design parameters. Problems may appear during routing such as packet cycling around the network without reaching their destination, packets being dropped and never being retransmitted due to node failure, package copies being transmitted in the network redundantly, consuming energy unnecessarily. Routing performance can be rated by the way protocols handle network challenges such as these. The performance factors are listed below

1. Loop Free – Occasionally the data in the network articulates to the same network again and again and consumes energy and bandwidth considerably. The routing proctocol used should be free from such loops.
2. Distributed Operation - Network can be able to operate in centralized, de centralized, or distributed manner.
3. Path Strategy – It can be either single path strategy or multi path strategy. But single path strategy ensures the effective use of network resources.
4. Packet forwarding – The main forwarding mechanisms are a) Greedy b) Flooding c) Hierarchal . Selection of forwarding techniques depends on any one of the network metric such as hop count, delay geographic distance, power etc…
5. Path Selection Metric – It is very important to meet the goal of routing algorithm. The most frequently used metric is hop count.
6. Scalability – the routing algorithm should be able to do well when the network size grows also.
7. Guaranteed Message Delivery - Its very important factor. The expected delivery ratio is 100%
8. Mobility Support – The MANET should freely support the movement of nodes while maintaining the same performance level.
9. Overhead Handling – Network should be able to handle excess traffic and also bandwidth in an efficient manner.
10. Status of Memory – The network should be able to remember the current status of nodes either locally or globally.

Above routing parameters are necessary to characterize and compare the performance of geographic routing protocols.

Position Based Routing Algorithms and Geocasting

The table given below shows the survey of various routing algorithms in position based approach. Some of the benchmark algorithms [18] are given a brief overview.

ISSN: 2277-9655
Impact Factor: 1.852

MFR - Most Forward within Radius (1984)
DREAM - Distance Routing Effect Algorithm for Mobility(1998)
GFG - Greedy Face Greedy (1999)
Face Routing - also known as Compass Routing II or perimeter routing (1999)
DIR - Compass Routing Method/Perimeter Routing (1999)
MECN - Minimum Energy Communication Network (1999)
LAR - Location-Aided Routing protocol (2000)
GLS - Grid or Geographic Location Service (2000)
GPSR - Greedy Perimeter Stateless Routing (2000)
SMECN - Small Minimum Energy Communication Network (2001)
GRUPI - Geographic Routing Using Partial Information (2001)
GEDIR - Geographic Distance Routing (2001)
GEAR - Geographic and Energy Aware Routing (2001)
GAF - Geographic Adaptive Fidelity - Geography Informed Energy Conservation for Ad-hoc Routing (2001)
SPAN - An Energy Efficient Algorithm for topology Maintenance (2001)
TMNR (Terminode Routing) (2002)
SPAAR - Secure Position Aided Ad-hoc Routing(2002)
SPEED - A Real-Time Routing Protocol for Sensor Networks(2002)
GOAFR - Greedy Other Adaptive Face Routing – It was created after investigating and improving face routing. Face routing was extended through: BFR (Bounded Face Routing) and AFR (Adaptive Face Routing). Other related algorithms are OFR (Other Face Routing), BOFR (Bounded Other Face Routing), OAFR (Other Adaptive Face Routing), GAFR (Greedy Adaptive Face Routing) and GOAFR, all mentioned in the same paper. GOAFR is the most efficient. GOAFR has been improved through consecutive versions: GOAFR+, GOAFR++ and GOAFR PLUS-ABC. (2003)
LABAR - Location Area Based Ad-Hoc Routing for GPS-Scarce Wide-Area Networks (2003)
CBF - Contention-Based Forwarding (2003)
IGF - Implicit Geographic Forwarding (2003)
GRWLI - Geographic Routing Without Location Information (2003)
ARRIVE - Algorithm for Robust Routing in Volatile Environments(2003)
TBF - Trajectory Based Forwarding (2003)
ALARM - Adaptive Location Aided Routing Protocol-Mines(2004)
BLR - Beacon-less Routing (2004)
DSAP - Directional Source Aware Routing Protocol (2004)
EEFS - Energy Efficient Forwarding Strategies for Geographic Routing (2004)
TTDD - Two-Tier Data Dissemination (2005)
I-PBBLR - Improved progress Position Based BeaconLess Routing (2005)
BGR - Blind Geographic Routing (2005)
SWING - Small World Iterative Navigation Greedy Protocol (2006)
AODPR - Anonymous On-Demand Position-based Routing in Mobile Ad-hoc Networks (2006)
LOSR - Local Optimal Source Routing) (2007)
GREES - Geographic Routing with Environmental Energy Supply (2007)
SWING+ (2008)
EEGR - Energy Efficient Geographic Routing (2008)
MDSAP - Modified Directional Source Aware Routing Protocol (2008)
MACQP - Multiple Ant Colonies Query Protocol (2008)
LED - Least expected distance (2009)
EGR - Energy-Aware Geographic Routing (2009)
ORF - Optimal Range Forward (2009)
OFEB - Optimal Forward with Energy Balance (2009)
RGRP - Reactive Geographic Routing Protocol (2010)
EBGR - Energy-efficient Beaconless Geographic Routing (2010)
EAGPR-Energy Aware Geographic Routing Protocol (2010)
AeroRP - Aeronautical Routing Protocol(2011)
POR – Position based Opportunistic Routing Algorithm (2012)

MFR - Most forward within Radius [1]

It is a progress-based algorithm, in which data is forwarded to the neighbor with the greatest progress (node A in the Figure 7). 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 neighbor node with the least backward progress.

GPSR – Greedy Perimeter Stateless Routing [4]

Each node of the network maintains a neighbor table, periodically updated through beacon messages – this results in a lot of data traffic; source's location is piggybacked on all data packets; it is tested in flat (2-D) topologies; it uses 2 methods for forwarding data: greedy forwarding and perimeter forwarding (right hand rule).

GOAFR – Greedy Other Adaptive Face Routing [14]

It is a combination of greedy forwarding and Other Adaptive Face Routing and makes use of a distance-bounded face traversal; the face is traversed on both sides using the left and right hand rule, for a bounded distance; if the condition to return to greedy mode is not satisfied, it increases the bound. It is considered worst-case optimal and average-case efficient.

ARRIVE - Algorithm for Robust Routing in Volatile Environments [13]

It is a probabilistic algorithm which uses localized information and leverages high node density and the broadcast medium to achieve robust routing. One of its goals is secure message transmission. It is based on a tree-like topology, with the sink as a root. It uses a breadth first search beaconing algorithm to initialize levels, parents and neighbor state information.

I-PBBLR - Improved progress Position Based BeaconLess Routing [15]

This algorithm uses a beaconless approach, in which sender nodes make non-deterministic routing decisions, based on an improved progress metric (the product between traditional progress and the cosine of the angle). Assumptions are made about the availability of a positioning system, the UDG communication graph, bidirectional links and omni-directional antennas. For mobility, the random waypoint model is used. Regarding the routing, the nodes determine the next hop through contention at transmission time, knowing location information only about the destination and the prior sender. If nodes are in the forwarding area, they apply Dynamic Forwarding Delay (DFD) prior to relaying the packet. If they are not, they drop the packet. The node which computes the shortest DFD, based on the positions of current and previous sender nodes and of destination, broadcasts the packet to all its neighbours. The rest of the nodes in the forwarding area cancel their scheduled transmissions of the same packet. It inherits the properties of greedy forwarding, but improves the performance in sparse networks.

BGR – Blind Geographic Routing [16]

It is a beacon-less geographic routing algorithm which forwards packets towards the destination in a certain forwarding area, while nodes in the network compete through timers to become the next hop. The node whose timer stops first continues the forwarding process. Simultaneous forwarding is prevented through a novel strategy called Avoidance of Simultaneous Forwarding (ASF) which uses the stored number of hops in the packet header to compare it with the number of hops stored in the node. Depending on this comparison, the nodes in the forwarding area cancel or continue their timing. The algorithm also implements a recovery strategy by changing the forwarding area (60 degrees left or right). The forwarding area is an implementation-dependent choice.

EEGR - Energy Efficient Geogrpahic Routing [9]

This geographic routing algorithm takes into account sensor position error, but does make some assumptions for simulation purposes: of an ideal, lossless and collision-free MAC and of uniformly distributed nodes with a randomly positioned base station with no location error. Nodes' location is estimated with a certain error ε. Node A for example can be located within any of the three surfaces S1, S2 and S3, in which communication is possible, probable and impossible (as in Figure 1). So depending on these cases, the communication probability is calculated based on the location error. The algorithm uses a metric which defines communication costs between neighbors. It sends messages along paths having the best trade-off between communication probability, progress and energy consumption. Shortest path, from sensor to base station, can be computed with Dijkstra algorithm. In low density consumes less than 30% of additional energy, in high density, less than 20%, thus optimizing energy consumption in networks in which sensors are inaccurately located.

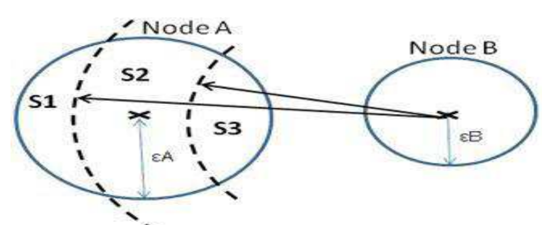


Figure 1. EEGR forwarding cases for the communication probability calculation

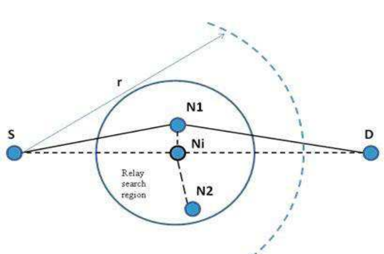
ISSN: 2277-9655
Impact Factor: 1.852

LED – Least Expected Distance [17]

This algorithm takes into account the inevitable presence of location errors in the localization process inherent to geographic routing. By incorporating location errors into the routing objective function, the algorithm maximizes the probability to achieve minimum power consumption from source to destination. By determining the optimal next forwarding position which optimizes the energy consumption over a single hop, the optimization of the energy over the total path is achieved. As a downside, the algorithm is not fully developed to the level of a protocol hence its study is theoretical based on assumptions of a static, stable uniform random network without obstacles and having nodes with accurate symmetric radio ranges. Nonetheless, the algorithm's consideration for location errors makes it very valuable for further research.

EBGR – Energy efficient Beconless Geogrphic Routing [5]

It is designed for highly dynamic scenarios with changing topology in which location information is known. The algorithm aims to provide loop-free, energy-efficient sensor to sink routing at low communication overhead. The forwarding process avoids beacons, but uses the RTS/CTS handshaking mechanism and calculates the ideal next-hop relay position (Ni in Figure 14) on the straight line between source and destination based on an energy-optimal forwarding distance. Each forwarding node chooses as next hop the neighbor closest to the ideal next hop relay position (in the figure node N1) within a predefined relay search region. In the recovery mode beaconless angular relaying is employed with two phases: selection and protest. The selection is based on RTS/CTS between source and neighbors in counter clock order, while in the protest phase, the first node that protests is selected as the next hop relay. The algorithm also tries to provide energy efficient routing in the presence of unreliable communication links by employing blacklisting and a discrete delay function. The performance is analyzed in three scenarios: a mobile scenario (in which a random walk mobility model is used for simulation), a random sleeping scenario (static case) and a high variant link quality scenario (for a static, active network with changing link quality



Position based Opportunistic Routing

POR [11] is constructed based on the ground of geographic routing and opportunistic forwarding. The nods in the network are aware of its own location and also the direct neighbor's location. To get neighborhood location one hop beacon or piggy backing is used. For location registration or look up service is employed. The principal routing set up of POR can be simply exemplified in Fig. 1. In customary circumstances without link break, the packet is accelerated by the next hop node (e.g., nodes A, E) and the accelerating aspirant (e.g., nodes B, C; nodes F, G) will be censored (i.e., the same packet in the Packet List will be dropped) by the next hop node's transmission. In case node A fails to deliver the packet (e.g., node A has moved out and cannot receive the packet), node B, the forwarding candidate with the highest priority, will relay the packet and suppress the lower priority candidate's forwarding (e.g., node C) as well as node S. By using the feedback from MAC layer, node S will remove node A from the neighbor list and select a new next hop node for the subsequent packets. The packets in the interface queue taking node A as the next hop will be given a second chance to reroute. For the packet pulled back from the MAC layer, it will not be rerouted as long as node S overhears node B's forwarding.

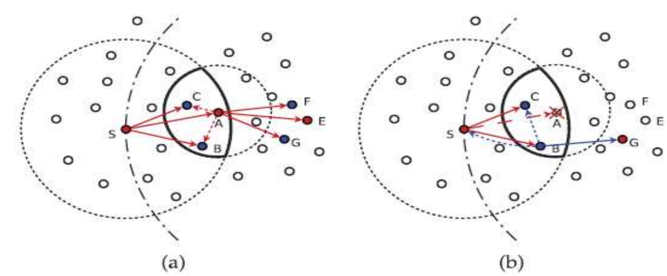


Fig. 1. (a) Normal situation. (b) When the next hop fails to receive the packet.

Conclusion

Written with the objective to shed light on existing geographic routing potentials and to lend a hand in the draft progression of mobile ad-hoc networks, this survey suggests which protocols are most suitable for certain applications. It also helps in understanding the steps made in the design of position-based routing protocols for highly demanding network applications and which aspects still require a lot of attention. While some protocols guarantee delivery, have excellent delivery ratio, look promising from the mobility point of view or seem satisfactory regarding memory availability, they still need a lot of improvement in other areas. Geographic routing also leaves room for further research and progress, but its benefits for future network design look very promising.

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