Routing Protocols in MANET: A Survey

Swati Puri
M.Tech Student
CSE Department,SBSCET
Ferozepur, Punjab (INDIA)

Vishal Arora
Assistant Professor
CSE Department,SBSCET
Ferozepur, Punjab (INDIA)

ABSTRACT
Mobile means moving and ad hoc means temporary with no any fixed infrastructure so mobile ad hoc networks are a class of temporary networks in which nodes are moving without any fixed infrastructure or centralized management. Due to the various applications that use MANETs are such as battlefield, emergency services, and disaster discovery, MANETs suggest many advantages too many organizations that need wireless roaming. Routing in MANETs is a not easy task and has expected a large amount of attention from researchers around the world. To overcome this difficulty a number of routing protocols have been developed and the number is silent increasing day by day. It is rather hard to determine which of the protocols may complete well under a number of different network scenarios such as network size and topology etc. In this paper we present a review of the existing routing protocols with their characteristics and functionality. In future this will help out the researchers to get an overview of the existing protocols.

Keywords
Mobile Ad-hoc Network, Ad-Hoc routing table, Ad-Hoc routing protocol, Ad-Hoc Network.

1. INTRODUCTION
A mobile ad hoc network (MANET) consists of a set of mobile hosts that know how to communicate with each other without the help of base stations [1]. As shown in Fig. 1, the topology of a MANET can be extremely dynamic due to the mobility of mobile nodes [2]. The formation of mobile computing and communication devices (e.g., cell phones, laptops, personal digital assistants) is driving a new change in our information culture. Wireless networks consist of a number of nodes which communicate by each other over a wireless channel. There are now two variations of mobile wireless networks: infrastructure networks and infrastructure less networks. The infrastructure networks are the one, in which mobile devices communicate with base stations that are connected to fixed network infrastructure. Each node in the infrastructure networks is within the range of a fixed access point like base station [3]. Infrastructure less wireless networks is a major class of wireless networks that is greatest appropriate for scenarios where there is demand of temporary and localized telecommunication demand. Such networks consist of wireless devices that can form a network alone without the need for pre-deployed telecommunication infrastructures such as base-stations and access points [4].

Fig 1: MANET Network

2. RESEARCH AND DEVELOPMENT IN MANET
Mobile Ad hoc network characterized into first, second and third generation. The first generation of ad hoc network can be traced back to 1970's. In 1970's, these are called Packet Radio Network (PRNET).

The PRNET then evolved into the Survivable Adaptive Radio Network (SURAN) in the early 1980's. SURAN provided some profit by improving the radio performance.

In 1990's the performance group of MANET is born in Internet Engineering Task Force (IETF) who worked to regular routing protocols for MANET and gives rise to the development of various mobile devices like PDA's ,palmtops, notebooks, etc [5].

2.1 Characteristic in MOBILE AD-HOC NETWORKS

2.1.1 Dynamic Topologies
Nodes are free to go randomly with different speeds; therefore the network topology may change randomly and at irregular times.

2.1.2 Energy Constrained Operation
Some or all of the nodes in an ad hoc network may rely on batteries or other exhaustible means used for their energy. The mainly important system design optimization criteria can be energy conservation.

2.1.3 Limited Bandwidth
Wireless links continue to have much lower capacity than infrastructure networks. The realized throughput of wireless communication - after accounting for the effects of multiple access and interference conditions, etc, is often much less than a radio's maximum transmission rate.

2.1.4 Security Threats

Mobile wireless networks are generally more level to physical security threats than fixed-cable nets. The increased possibility of eavesdropping spoofing and minimization of denial-of-service type attacks should be carefully considered [6].

2.2 Issues in MANETS Networks

2.2.1Routing

Routing is one of the most complicated problems to solve as ad hoc networks have a correct connectivity to other devices in its neighborhoods. Because of multi hop routing no default route is available. Each node acts as a router and forwards each other's packets to allow in sequence sharing between mobile nodes.

2.2.2 Security

Clearly a wireless link is much more at risk than a wired link. The user can add false information into routing packets and cause routing loops, long time-outs and advertisements of false or old routing table updates. Security has few unsolved issues that are important to solve to make the ad hoc network into a good solution.

2.2.3 Quality of Service (QoS)

QoS is a complex task for the developers, because the topology of an ad hoc network will regularly change. Reserving resources and supporting a certain quality of service, while the network situation constantly changes, is very challenging [7].

2.3 Application in MANET

2.3.1 Military Battlefield

Ad-Hoc networking would agree to the military to receive advantage of routine network technology to keep an information network between the soldiers, vehicles, and military information head quarter.

2.3.2 Collaborative Work

For various business environments, the need for common computing might be more important outside office environments than inside and where people do need to have external meetings to assist and exchange information on a given project.

2.3.3 Local Level

Ad-Hoc networks can separately link an instant and short-term multimedia network using notebook computers to extend and share information with participants. E.g. conference or classroom.

2.3.4 Personal area network and Bluetooth

A personal area network is a little range, localized network here nodes are usually connected with a given person. Short - range MANET such as Bluetooth.

2.3.5 Commercial Sector

Ad hoc can be used in urgent situation operations for failure assistance efforts, e.g. in fire, flood, or earthquake. Emergency rescue operations must take position where non-existing or injured communications infrastructure and fast deployment of a communication network is required [8].

3. CATEGORIZATION OF PRESENT ROUTING PROTOCOLS IN (MANET)

In the ad hoc networks, every node should be capable to forward data for other nodes. So different routing schemes have been offered to supply enough performance of ad hoc networks. Ad hoc routing is classified into proactive routing and reactive routing and hybrid routing protocols [2]. As shown in Fig. 2.

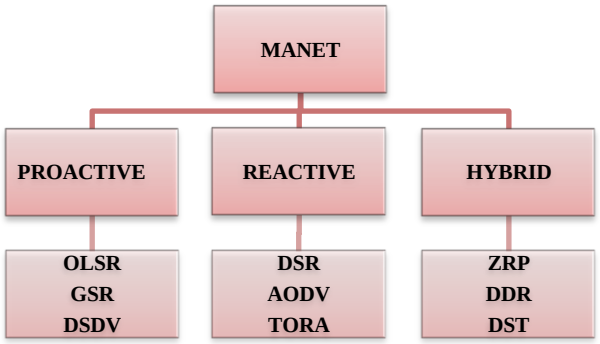

Fig 2: Routing Protocols for MANET

3.1 Proactive Routing Protocols/Table Driven

In table driven routing protocols, the protocols accepted and up-to-date routing in series to all nodes is maintained at each node where as in on-demand routing the routes are produced only when prefer by the source host [9]. Nodes sometimes look for routing information within a network. The fixed cost of these protocols is possible, because it is free to the traffic profiles and has a fixed upper bound. This is advantage of proactive routing protocols e.g. OLSR, GSR, DSDV [10].

3.1.1 Optimized Link State Routing (OLSR)

OLSR is an optimization of pure link state algorithm, uses the theory of Multi point Relays (MPR) for forwarding control traffic, proposed for distribution into the entire network. The MPR set is chosen such that it covers all nodes that are two hops away. OLSR works with a periodic replace of messages like Hello messages and Topology Control (TC) message only through its MPR. The parameters used by OLSR to control the protocol overheads are Hello-interval parameter, TC interval parameter, MPR reporting parameter and TC-redundancy parameter [11].

3.1.2 Global state routing (GSR)

The GSR protocol is based on the fixed Link State algorithm. GSR has enhanced the way in sequence is distributed in Link State algorithm by restricting the update messages among intermediate nodes only. In GSR, every node maintains a link state table based on the up-to-date information expected from neighboring nodes, and from time to time exchanges its link state information with neighboring nodes only. This has much reduced the number of control message transmitted during the network. The size of update messages is rather large, and as the size of the network grows they will get even larger [12].

3.1.3 Destination Sequenced Distance Vector (DSDV)

In DSDV protocol every node maintains routing in sequence for all known destinations. The routing information is updated from time to time. Each node maintains a table, which contains information for all existing destinations, the next node to arrive at the destination, number of hops to reach the

destination and sequence number. The nodes from time to time send this table to all neighbors to maintain the topology, which adds to the network overhead. Each entrance in the routing table is marked with an order number assigned by the destination node. The series numbers allow the mobile nodes to distinguish stale routes from new ones, so avoiding the structure of routing loops [13]. The summary of above discussion is shown in Table 1.

Table 1. Proactive routing protocols/table driven

Protocol	Routing Protocol Class	Routing Structure	Multiple Routes	Route Metric Method	Route Maintenance	Advantage/ Disadvantage
Optimized link state routing (OLSR)	Proactive Routing Protocol	Flat	No	Periodic	Reduces control overhead using Multipoint Relay	Reduced control overhead and contention / 2-hop neighbor knowledge required
Global state routing (GSR)	Proactive Routing Protocol	Flat	No	Periodic and local	Localized updates	Localized updates / High memory overhead
Destination-sequenced distance vector (DSDV)	Proactive Routing Protocol	Flat	No	Periodic and as required	Loop free	Loop free / High overhead

3.2 Reactive Routing Protocols

The on demand routing protocols, ”on demand” means that it builds routes between nodes only as preferred by source nodes. It maintains these routes as long as they are required by the sources [9].The reactive (on-demand) routing protocols describe the perfect nature of ad hoc network, which is much more dynamic than infra structured networks. In its place of from time to time updating the routing information, the reactive routing protocols update routing information when a routing need is presented, thus reducing the control overhead, mainly in high mobility networks where the periodical update will guide to significant useless overhead e.g. AODV, DSR, TORA [14].

3.2.1 Ad Hoc On-Demand Distance Vector (AODV)

AODV is a mixture of on-demand and distance vector i.e. hop-to-hop routing methodology. When a node wants to know a route to a particular destination it creates a ROUTE REQUEST. Then the route request is forwarded by intermediate nodes which also produce a reverse route for itself to destination. When the demand reaches a node with route to destination it creates again a REPLY which contains the number of hops that are need to reach the destination. All nodes that play a part in forwarding this reply to the source node create a forward route to destination. This route produced from each node from source to destination is a hop-by-hop state and not the complete route as in source routing [11].

3.2.2 Dynamic Source Routing Protocol (DSR)

In Dynamic Source Routing, beginning node generates Route Request (RREQ), which is sent over data packet and It specifies source node as well as destination. Afterwards, the packet sends by flooding algorithm in MANET. Each node receives RREQ packet and does not know about the route to the destination so combine its name on the list which is placed on packet’s header then broadcast packet. If each node cannot transmit the data packet to other nodes in the MANET, then a Route Error (RERR) data packet is generated and retransmitted it on the route [15].

3.2.3 Temporally Ordered Routing Algorithm (TORA)

Temporarily ordered routing algorithm (TORA) is highly adaptive, loop-free, distributed routing algorithm based on the idea of link exchange. It uses directed acyclic graphs (DAG) to explain the Routes both as upstream or downstream. TORA involves four major functions: creating, maintaining, erasing and optimizing routes. As every node must have a height, some node which does not have a height is considered as an erased node and its height is considered as null. Sometimes the nodes are certain new heights to get better the linking structure. This purpose is called optimization of routes [16].The summary of above discussion is shown in Table 2.

Table 2. Reactive routing protocols

Protocol	Routing Protocol Class	Routing Structure	Multiple Routes	Route Metric Method	Route Maintenance	Advantage/Disadvantage
Ad hoc on-demand distance vector (AODV)	Reactive Routing Protocol	Flat	No	Freshest and shortest path	Route Table	Adaptable to highly dynamic Topologies / Scalability problems, large delays, hello messages
Dynamic source routing (DSR)	Reactive Routing Protocol	Flat	Yes	Shortest path, or next available in route cache	Route Cache	Multiple routes, Promiscuous Overhearing / Scalability problems due to source routing and flooding, large delays
Temporally ordered routing algorithm (TORA)	Reactive Routing Protocol	Flat	Yes	Shortest path, or next available	Route Table	Multiple routes / Temporary routing loops

3.3 Hybrid Routing Protocols

The hybrid routing protocols that have the advantage of both proactive and reactive routing protocols to balance the delay and control overhead (in terms of organize packages). Hybrid routing protocols try to maximize the profit of proactive routing and reactive routing by utilizing proactive routing in small networks (in order to decrease delay), and reactive routing in large scale networks (in order to decrease control overhead) e.g. ZRP,DST, DDR [14].

3.3.1 Zone Routing Protocol (ZRP)

In ZRP the nodes control a routing zone, which defines a collection that each node is required to maintain network connectivity proactively. Consequently, for nodes inside the routing zone, routes are immediately accessible. For nodes that lie outer the routing zone, routes are determined on-demand (i.e. reactively), and it can use any on-demand routing protocol to verify a route to the required destination [12].

3.3.2 Distributed Spanning Tree (DST)

The nodes in the network are grouped into a number of trees. Each tree has two types of nodes; route node, and internal node. The root controls the collection of the tree and whether the tree can combine with a new tree, and the rest of the nodes within each tree are the regular nodes. All node can be in one three different states; router, merge and configure depending on the category of task that it trying to perform. DST proposes two strategies to terminate a route between a source and a destination pair: Hybrid Tree Flooding (HTF), Distributed Spanning Tree (DST) shuttling [16].

3.3.3 Distributed Dynamic Routing (DDR)

Planed a tree based routing protocol without the required of a root node. The trees are constructed using constant beaconing messages, which are exchanged by nearest nodes only. The DDR algorithm include the following six phases: (i) preferred neighbor election; (ii) intra-tree clustering; (iii) inter-tree clustering; (iv) forest construction; (v) zone naming; and (vi) zone partitioning [17].The summary of above discussion is shown in Table 3.

Table 3. Hybrid routing protocols

Protocol	Routing Protocol Class	Routing Structure	Multiple Routes	Route Metric Method	Route Maintenance	Advantage/Disadvantage
Zone routing protocol (ZRP)	Hybrid Routing Protocol	Flat	No	Shortest path	Intrazone and interzone tables	Reduce retransmissions / Overlapping zones
Distributed spanning trees based routing protocol (DST)	Hybrid Routing Protocol	Hierarchical	Yes, if available	Forwarding using the tree neighbors' and the bridges using shuttling	Route tables	Reduce retransmissions / Root node
Distributed dynamic routing (DDR)	Hybrid Routing Protocol	Hierarchical	Yes, it alternate Gateway nodes are available	Stable routing	Intrazone and interzone table	No zone map or zone coordinator / Preferred neighbours may become bottlenecks

4. COMPARISON OF ROUTING PROTOCOL

Table 4 shows the comparison of three routing protocols (Proactive, Reactive, and Hybrid).

Table 4. Comparison of routing protocols

Parameters	Proactive	Reactive	Hybrid
Storage Requirement	Higher	Dependent on no. of Routes maintained or needed	Depends on size of each zone or cluster
Routing Schema	On demand	Table driven	Combination of both
Mobility Support	Route Maintenance	Periodical updates	Combination of both
Routing Overhead	Low	High	Medium
Routing Information	Keep stored in table	Doesn't store	Depends on requirement
Storage Capacity	Low generally	High ,due to the routing tables	Depends on the size of Zone

Routing Philosophy	Mostly flat	Flat	Hierarchical
Delay	Low	High	Low for local destinations and high for Inter-zone

5. CONCLUSION

In this paper, we have presented the classification of routing protocols in mobile ad hoc networks and provided comparisons table among them. The protocols are divided into three main categories: (i) pro-active (table-driven), (ii) reactive (on-demand), (iii) hybrid protocols. For every these module, the representative we reviewed and compared some things about protocols. A relationship of three protocols, along with advantages and disadvantages has been presented in the form of table. There are different advantages and disadvantages in different routing protocols. In future work this can be helpful to get an overview of the existing protocols.

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