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A Review on Routing Protocols in Mobile Ad-hoc Networks

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Abstract - MANET (mobile ad-hoc network) is basically a temporary wireless network made up of mobile nodes, in which infrastructure is not present. Mobile ad-hoc networks have dynamic topology and it is self configurable network where the mobile nodes can move randomly. In MANET, Routing Protocols are used to establish communication within networks. These routing protocols help in finding different routes between nodes, in order to transfer data from source to sink. The main focus of routing protocol is on correct and efficient route establishment between nodes, so that messages can deliver within time. In this paper, we describe different types of routing protocols for mobile ad-hoc networks by presenting their characteristics and functionalities. Then, a comparison is provided based routing methodologies and at the end, discussion of their merits and demerits is done.

***Keywords* - MANET, Routing Protocol, DSDV, WRP, GSR, FSP, OLSR, TBRPF, DSR, AODV, TORA, ZRP.**

1. Introduction

MANET(Mobile Ad-hoc Network)is made up of three words i.e., Mobile which means 'moveable', Ad-hoc which means 'temporary' and Network which means 'collection of nodes'[1]. Thus MANET is infrastructure less network consisting of autonomous collection of mobile nodes that communicate with each other to exchange information. The topology of these networks keeps on changing due to movement of nodes. The networks are self organized and have limited bandwidth.

In MANETs, the router connectivity may change frequently, leading to the multi-hop communication paradigm that can allow communication without the use of Base Station/Access Point, and provide alternative connections inside hotspot cells [8]. In order to transfer data from source to destination Routing protocols are used.

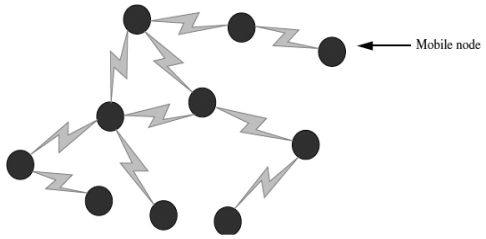
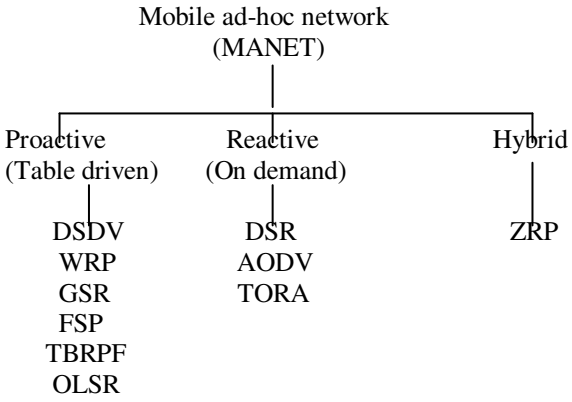


Fig 1.1 Manet Architecture

2. Routing in MANET

In an ad hoc network, all the nodes may not be within the transmission range of each other. So, nodes are required to forward network traffic on behalf of other nodes. The process of forwarding network traffic from source to destination is termed as routing [1]. In Ad-hoc networks require multi-hop routing and all nodes can potentially contribute in the routing protocols. Routing in MANETs is done by routing protocols. Routing Protocols are classified as:

- Proactive(Table driven) Routing Protocol
- Reactive(On demand) Routing Protocol
- Hybrid(Both reactive & proactive) Routing Protocol



2.1 Proactive Routing Protocol

In Proactive routing protocol, each node in the network maintains a routing table and the information in the routing tables are updated periodically. This routing information is used by every node to store the location information of other nodes in the network and this information is used to move data among different nodes in the network. When a source node has to send a packet to the destination node, the route to that destination is available immediately. This proactive routing protocol is also called table driven routing protocol. The various types of reactive routing protocols are as follow:

- Destination Sequenced Distance Vector Routing (DSDV).
- Wireless Routing Protocol (WRP).
- Global State Routing (GSR).
- Fisheye State Routing Protocol (FSP).
- Optimized Link State Routing Protocol (OLSR).
- Topology Dissemination Based on Reuse Path Forwarding (TBRPF).

2.1.1 Destination Sequenced Distance Vector Routing Protocol (DSDV)

The destination sequenced distance vector routing protocol (DSDV) is an extension of classical bellman ford routing mechanism. DSDV maintains consistent network view via periodic routing updates. Routing information is stored inside routing tables maintained by each node. New route broadcasts contain the address of the destination, the number of hops to reach destination, the sequence number of the destination and a new sequence number unique to broadcast. A route with a recent sequence number is considered as a fresh route. If sequence numbers are found to be the same than the route with better metric will be selected [3].

2.1.2 Wireless Routing Protocol (WRP)

The Wireless Routing Protocol is a table-based protocol similar to DSDV that inherits the properties of Bellman-Ford Algorithm. The main goal is maintaining routing information among all nodes in the network regarding the shortest distance to every destination. Wireless routing protocols (WRP) is a loop free routing protocol. WRP is a path-finding algorithm with the exception of avoiding the count-to-infinity problem by forcing each node to perform consistency checks of predecessor information reported by all its neighbors [2]. Each node in the network uses a set of four tables to maintain more accurate information:

- Distance table (DT)
- Routing table (RT)
- Link-cost table (LCT)
- Message retransmission list (MRL) table.

In case of link failure between two nodes, the nodes send update messages to their neighbors.

2.1.3 Global State Routing (GSR)

Global State Routing (GSR) is based on link state routing protocol. In this each node exchanges link state information with its neighbor nodes. Based on link state information, a global knowledge of the network topology is maintained. GSR is similar to DSDV but it avoids flooding of routing messages.

2.1.4 Fisheye State Routing (FSP)

Fisheye State Routing Protocol (FSP) is an improvement of GSR. It reduces the traffic of transmitting update messages. Each node has accurate information about its neighbor nodes. This is so because the transmitted update messages contain the information of the nearer nodes rather the information about all nodes in the network.

2.1.5 Topology Dissemination Based on Reuse Path Forwarding (TBRPF)

It is a link state proactive routing protocol. On the basis of partial topology in the topology table, each node in the network maintains a source tree to each destination. The source tree is also called as shortest path tree [1]. To reduce overheads only a part of source tree is broadcasted to the neighbors. The partial source tree is called a reportable tree. TBRPF is best suited for dense networks.

2.1.6 Optimized Link State Routing (OLSR)

Optimized Link State Routing is another proactive link state protocol which is claimed to work best in large dense network [3].OLSAR each node selects a set of Multipoint Relays (MRP) from its neighbors. The radio range of the MRP set such that it should cover all two hops neighbors. Each node has the knowledge as to for which node it acts as a MRP. Thus OLSR requires bidirectional links. OLSR utilizes UDP to distribute routing packets. Each routing packet contains one or more OLSR messages. Messages exist for neighbor by the same originator as the route and send its reply via the reversed hop list in the received request.

2.2 Reactive Routing Protocols

Reactive Protocols use a route discovery process to flood the network with route query requests when a packet needs

to be routed using source routing or distance vector routing. Source Routing uses data packet header containing routing information meaning nodes don't need routing tables; however this has high network overhead. Distance vector routing uses next hop and destination addresses to route packets, this requires nodes to store active routes information until no longer required or an active route timeout occurs, this prevents stale routes [2].

2.2.1 Dynamic Source Routing (DSR)

The Dynamic Source Routing protocol (DSR) is an on demand routing protocol. DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. Using DSR, the network is completely self-organizing and self-configuring, requiring no existing network infrastructure or administration. The DSR protocol is composed of two main mechanisms that work together to allow the discovery and maintenance of source routes in the ad hoc network [4]:

- Route Discovery is the mechanism by which a node S wishing to send a packet to a destination node D obtains a source route to D.
- Route Discovery is used only when S attempts to send a packet to D and does not already know a route to D.
- Route Maintenance is the mechanism by which node S is able to detect, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a link along the route no longer works. When Route Maintenance indicates a source route is broken, S can attempt to use any other route it happens to know to D, or it can invoke Route Discovery again to find a new route for subsequent packets to D. Route Maintenance for this route is used only when S is actually sending packets to D [4].

2.2.2 Ad-hoc on Demand Distance Vector (AODV)

AODV stand for Ad-hoc On-Demand Distance Vector Routing .AODV is meaning that it establishes a route to a destination only on demand. AODV is capable of both Unicast, broadcast and multicast routing. AODV have some join feature of DSR and AODV.AODV avoids the counting- to-infinity problem of other distance-vector protocols by using sequence numbers on route updates. AODV reacts relatively quickly to the topological changes in the network and updating only the hosts that may be affected by the change, using the RREQ message. Hello messages, be dependable for the route maintenance, are also imperfect so that they do not create unnecessary overhead in the network. The RREQ and RREP messages are responsible for the route discovery [5].

2.2.3 Temporary Ordered Routing Protocol (TORA)

In TORA is a distributed highly adaptive routing protocol designed to operate in a dynamic multi-hop network. TORA has four basic functions:

- Route discovery
- Route maintenance
- Route erasing
- Route optimization

TORA uses an arbitrary height parameter to determine the direction of link between any two nodes for a given destination. Consequently, multiple routes often exist for a given destination but none of them are necessarily the shortest route. To initiate a route, the node broadcasts a QUERY packet to its neighbors. This QUERY is rebroadcasted through the network until it reaches the destination or an intermediate node that has a route to the destination. The recipient of the QUERY packet then broadcasts the UPDATE packet which lists its height with respect to the destination. When this packet propagates in the network, each node that receives the UPDATE packet sets its height to a value greater than the height of the neighbor from which the UPDATE was received. This has the effect of creating a series of directed links from the original sender of the QUERY packet to the node that initially generated the UPDATE packet [6].

2.3 Hybrid Routing Protocol

Often reactive or proactive feature of a particular routing protocol might not be enough; instead a mixture might yield better solution. Hence, in the recent days, several hybrid protocols are also proposed**.**

2.3.1 Zone Routing Protocol (ZRP)

In ZRP, the nodes have a routing zone, which defines a range (in hops) that each node is required to maintain network connectivity proactively. This means that for nodes within the routing zone, routes are kept in a table and therefore are immediately available. For the outside nodes, routes are discovered on-demand (reactively) and any on-demand routing protocol can be used to find a route to the destination. It can be seen that, the control overhead is much less than pure proactive routing protocols. The delay for discovering routes is also improved with respect to pure reactive protocols such as DSR by allowing routes to be discovered faster. This is due to the fact that the boundary node of a routing zone

will have the information of required destination proactively. So, the route request will only have to travel to a boundary node of the destination's zone [7].

3. Comparison of Protocols

In this section we have presented a comparison between existing routing protocols. Table below provides an overall comparison of the three categories of routing protocols. The comparisons basically consider the characteristic properties of routing protocols in high load networks. In order to make flat addressing more efficient, the number of routing overheads introduced in the networks must be reduced. . The hybrid routing protocols employ both reactive and proactive properties by maintaining intra-zone information proactively and inter-zone information reactively.

Table 1: Comparison of Protocols

Parame-ters	proactive	reactive	Hybrid
Storage requirement	Higher	Depend on no. of routes maintained	Depends On size of each zone or cluster
Route availability	Always available	Computed as per need	Depend on lacation of destination
Periodic route updates	Required always	Not required	Used inside each zone
Delay	Low	High	Low for local de-stinations & high for interzone
Scalability	100 nodes	>100	>1000
Control traffic	High	Low	Lower than other two types
Routing information	Keep stored in table	Doesn't store	Depends on require-ment
Routing philosphy	Mostly flat	Flat	Hierarch-ical

4. Conclusion

In this paper, we have presented and discussed the taxonomy of routing protocols in mobile ad hoc networks and provided comparisons between them. The protocols are divided into three main categories: (i) source-initiated (reactive or on-demand), (ii) table-driven (pro-active), (iii) hybrid protocols. For each of these classes, we reviewed and compared several representative protocols in the form of table. There are various challenges that need to be met, so these networks are going to have widespread use in the future.

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