

## MOBILE AD-HOC NETWORK (MANET): A Review

Sangeeta Monga  
AP ,ECE Department,  
DAV University, Jalandhar

Puneet Jain  
A.P, ECE Department  
AIET, Faridkot

### ABSTRACT:

A mobile ad-hoc network is a collection of wireless mobile nodes frequently forming a network topology without the use of any existing network infrastructure or centralized administration. Data transmission between two nodes in MANET's, require multiple hops as nodes transmission range is limited. The mobility of different nodes makes the situation more complicated results in frequent changes of network topology making routing in MANET a challenging task. To overcome this difficulty various routing protocols in MANET which helps nodes to send and receive packets in different situations has been defined. This paper presents a comprehensive study of various MANET protocols such as AODV, DSR, ZRP etc., and their classification and selection criteria and conclude the applications and future scope of MANET.

**Keywords:** MANET, Routing Protocol, AODV, DSR, ZRP, OLSR, GRP

## 1. INTRODUCTION

A mobile ad-hoc network (MANET) [1] is a network of wireless mobile nodes (MNs) that communicate with each other without any centralized control or pre-established infrastructure such as access points. It is a self organized system of mobile nodes. These nodes like laptops, computers, PDA and wireless phones have a limited transmission range for direct transmission. If two such devices are located within transmission range of each other they can communicate directly otherwise they will use intermediate nodes. Thus a multihop scenario will occur in which mobile nodes allow communication among the nodes by hop to hop bases and forward packets to each other. Thus each node performs the function of a router. The success of communication depends upon cooperation of other nodes. Such a mobile adhoc network may have mobile features:

- Automatic self configuration and self maintenance
- Quick and inexpensive deployment.
- No need of centralized administration
- Highly dynamic topology as nodes is continuously into and out of the radio range so change in routing information is required.
- The wireless link between nodes is highly vulnerable to security attacks.
- Bandwidth is limited.
- MANET needs energy efficient operation because all nodes depend on battery power which is highly limited.

The task of specifying a routing protocol for a mobile wireless network is not an easy one. The main problem in mobile networking is the limited bandwidth, high rate of topology changes and link failure caused by node movement. Therefore Protocols in MANET plays an important role for data forwarding where each mobile node can act as relay in addition to

being a source or destination node. The rest of paper is organized as follows: section 2 describes the classification and selection criteria of protocols, in section 3 we discuss the various routing protocols and section 4 describes the various software used for MANET and section 5 summarizes the application and future scope.

## **2. Classification and selection criteria of protocols:**

### **2.1 Classification [2]:**

**2.1.1 Proactive v/s Reactive Routing:** Proactive scheme determines the routes to various nodes in the network in advance so that route is always present when ever needed. Route discovery overhead are large in such scheme as one has to discover all the routes. Reactive scheme determines the route when needed therefore they have smaller route discovery overheads.

**2.1.2 Single path v/s Multipath:** The overhead of route discovery in multipath routing is much more than that of single path routing. On the other hand frequency of route discovery is much less in a network which use a multipath routing since system can still operate even if one or a few of multiple paths between a source and destination fail.

**2.1.3 Table driven V/s Source Initiated:** In table driven routing protocols up to date routing information from each node to every other node in the network is maintained on each node of the network. The changes in the network topology are than propagated in the entire network by means of updates. The routing protocols classified under source initiated on demand routing, creates routes only when desired by source node.

**2.1.4 Periodic v/s Event Driven:** Periodic update protocols disseminate routing information periodically. It simplifies the protocol and maintains network stability and also enables new nodes to learn about the topology and state of the network.

**2.1.5 Flat v/s Hierarchical Structure:** In Flat Structure all nodes in the network are in the same level and have same routing functionality. It is simple and efficient for small networks but when network becomes large the volume of routing information will also become large and it will take a long time for routing information to arrive at the remote nodes. So for large networks hierarchical (cluster based) routing may be used to solve the problem

In this the nodes in the network are dynamically organized into partitions called clusters, and then the clusters are aggregated again into larger partition called super clusters and so on.

**Selection Criteria [3]:** The following points should keep in mind while selecting a protocol:

**Multicasting:** this is the ability to send packets to multiple nodes at ones. This is important as it takes less time to transfer data to multiple nodes.

**Loop Free:** a path taken by a packet never transits the same intermediate node twice before it arrive the destination. So routing protocol should guarantee that the routes supplied are loop free. This also results in effective utilization of bandwidth.

**Multiple Routes:** if on route gets broken due to disaster, then the data could be send through some other route. So protocol should allow to create multiple routes.

**Distributed operation:** the protocol should, of course, be distributed. It should not be dependent on a centralized node.

**Reactive:** it should be reactive (on demand bases).

**Power conservation:** the nodes in an adhoc network can be laptops or PDA that are very limited in battery power and therefore use some sort of standby mode to save power. It is therefore important that routing protocol has support for these sleep modes.

Transmission delay of protocol should be minimum.

Some kind of compression may be provided by the protocol to waste less bandwidth. Some type of encryption may be provided to protect data.

Quality of service support is also required so that least packet drop can be obtained.

### 3. Various Types of MANET Protocols

An adhoc routing protocol is a convention, or standard that controls how the nodes decide the way to route packets between computing devices in mobile adhoc network. Performance of routing protocol varies with network and selection of accurate routing protocols according to the network will ultimately influences the efficiency of that network in magnificent way.

Various protocols are as follows –

#### 3.1 DSDV(Destination Sequence Distance Vector):

It is a table driven routing protocol in which each mobile node in the system maintain a routing table in the system in which all the possible destination and no. of hop to them in the network are recorded. A sequence no. is also associated with each route to the destination. The route labeled with highest sequence is always used. To minimize the traffic generated there are two types of packet in the system. One is known as full dump system which is packet that carries all the information about a change however at the time of occasional movement another type of packet called incremental will be used which will carry just the changes there by increasing the efficiency of the system. The data broadcast by each mobile node will contain the new sequence number, the destination address, the no. of hops to reach the destination and sequence no. of the information received regarding that destination. Each node advertises an increasing even sequence no. for itself. When node A determines that destination E is unreachable, it advertises the next odd sequence for the route that has failed with an infinite metric count. Any node that receives this infinite metric count updates its table for the matching route and waits until a greater sequence no. with non infinite metric count is received [2].

#### 3.2 OLSR (Optimized Link State Routing Algorithm):

It based on link state algorithm and it is proactive in nature OLSR is an optimization over a pure link state protocol as it squeezes the size of information send in the message and reduces the no. of retransmissions. Unlike, DSDV and AODV, OLSR reduces the size of control packet by declaring only a subset of links with its neighbors who are its multipoint relay selectors and only the multipoint relays of a node retransmit its broadcast messages. Hence the protocol does not generate extra control traffic in response to link failure and node join/leave events OLSR is a particularly suitable for large and dense networks. In OLSR each node uses the most recent information to route a packet. Each node in the network selects a

set of nodes in its neighbors which retransmits its packets. This set of selected neighbors is called the multipoint relay (MPR) of that node. The neighbors that do not belong to MPR set read and process the packet but do not retransmit the broadcast packet received from the node. For this purpose each node maintain a set of its neighbors which are called the MPR selectors of that node this set can change over time which is indicated by the selectors in their HELLO message. The path to the destination consists of sequence of hops through the multipoint relay from source to destination. In OLSR a HELLO message is broadcasted to all its neighbors containing information about its neighbor and their link status and received by nodes which are one hop away but they are not relayed to further nodes. On reception of HELLO messages each node would construct its MPR selected table Multipoint relays of a given node are declared in HELLO messages transmitted by this node [4].

### 3.3 GRP (Geographic Routing Protocol) –

GRP is a kind of position based protocol which belongs to proactive protocol It uses Global Positioning System (GRP) data to keep track of nodes in the network. The protocol creates grid in the geographical area and assigns one node in each area to be a gateway. When a gateway leaves its area it passes its route information to another in its area which then becomes a gateway. Because a protocol assigns leadership to just one in a grid, routing occurs in an orderly, grid by grid sequence with the gateway passing route discovery request and a data packets to neighboring grids [5].

### 3.4 DSR (Dynamic Source Routing) –

It is also a reactive protocol. It is an on demand routing protocol that is based on concept of source routing. DSR used to update its route cache by finding new routes. It update its cache with new route discover or there exist a direct route between source and destination node. When a node wants to transmit data it defines a route for the transmission and then starts transmitting data through the defined route In the DSR protocol source node sends the routing request (RREQ) packets by means of flooding technology. Each RREQ packet includes source node address (Sid), destination address (Did) and the unique request sequence number (Request ID). An advantage of DSR is that nodes can store multiple routes in their route cache, which means that source node can check its route cache for a valid route before initiating route discovery. And if a valid route is found there is no need for route discovery. This is very beneficial in network with low mobility since route stored in the route cache will be valid longer. Another advantage of DSR is that it doesn't require any periodic beaconing (or HELLO messages exchanges) therefor nodes can enter sleep mode to conserve their power. This also saves a considerable amount of bandwidth in the network.

There are two processes for route discovery and maintenance which are described below [4]

**3.4.1 Route discovery process in DSR** – when a source node wants to start data transmission with a node in the network it checks its routing cache when there is no route available to destination in its cache or route is expired it broadcast RREQ. When destination is located or any intermediate route that has fresh enough route to the destination node, RREP is generated. When the source node receives the RREP it update its cache and the traffic is routed through the route [4].

**3.4.2 Route maintenance in DSR** – when the transmission of data started it is the responsibility of node that is transmitting data to confirm the next hop received the data along with the source route. The node generate the Route Error Message if it does not receive any conformation to the originator node. The originator node again performs new route discovery process [4].

### **3.5 AODV (Ad hoc on Demand distance Vector) –**

It is another routing algorithm which is based on DSDV and DSR. It shares DSR's on demand characteristics hence discovers routes whenever it is needed by a similar route discovery process and sequencing of DSDV. It is a reactive routing protocol in which the network generates routes at the start of communication. AODV arrange a route to a destination only when a node wants to send a packet to that destination. Routes are maintain as long as they are needed by the source. Sequence numbers shows the freshness of route and guarantee the loop free routing. AODV also provides topology for the nodes. AODV builds routes using a route request/route reply query cycle. When a source node desires a route to a destination for which it does not already have a route it broadcasts a route request (RREQ) packet across the network. Nodes receiving this packet update their information for the source node and setup backward pointers to the source node in route tables. In addition to the source nodes ip address, current sequence no., broadcast id the RREQ also contains the most recent sequence no. for the destination of which the source node is aware. A node receiving the RREQ may send a route reply (RREP) if it is either the destination or if it has a route to the destination with corresponding sequence no. greater than or equal to that contain in the RREQ. If this is the case is unicast a RREP back to the source otherwise it rebroadcasts the RREQ. If they receive a RREQ which they have already process they discard the RREQ and do not forward it. As the RREP spreads back to the source nodes setup forward pointers to the destination. Once the source node receives the RREP it may begin to forward data packets to destination. If the source later receives a RREP containing a greater sequence number or contains the same sequence number with a smaller hop count it may update its routing information for that destination and begin using the better route. As long as the routes remain active it will continue to be maintained. If a link break occurs while the route is active the node upstream of the break spreads a route the now unreachable destinations after receiving the RERR, if the source node still desires the route, it can reinitiate the route discovery [6].

### **3.6 ZRP (zone routing protocol) –**

It is a hybrid protocol which combines the advantage of both proactive and reactive schemes. Proactive routing protocol uses excess bandwidth to maintain a routing information while reactive protocols suffers from long route request delays and inefficient flooding the entire network for route determination. ZRP addresses these problems by combining the best properties of both approaches. Each node in ZRP proactively maintains routes to the destinations with in a local neighborhood which is referred as routing zone. However size of a routing zone depends on a parameter known as zone radius. In ZRP each node maintains the routing information of all nodes within its routing zone. Node learn the topology of its routing zone through a localized proactive scheme referred as an intra-zone routing protocol (IARP). The inter zone routing protocol (IERP) is responsible for reactively discovering routes to the destination beyond a nodes routing zone. This is used if the destination is not found with in the routing zone. The route request packet are transmitted to all border nodes. Which in turn forward the request if the destination node is not found within their routing

zone. IERP distinguish itself from standard flood search by implementing the concept called border casting provided by border cast resolution protocol (BRP). For detecting link failure and new neighbor nodes ZRP relies on protocol provided by MAC layer known as neighbor discovery node (NDP). NDP transmits hello beacons at regular intervals to advertise their presence after receiving a beacon neighbor table is updated if no beacon is receive from a neighbor with in a specified time the neighbor is considered as lost [7] .

#### 4. Software for MANET –

Criteria to select a software depends upon flexibility, user friendly, and portability, and performance, hardware and software compatibility. There are various software for MANET which are used by various researchers. Some of these software are:

##### 4.1 NS-2 –

The general process of creating a simulation can be divided into several steps [8]:

- 1) Topology definition: to ease the creation of basic facilities and define their interrelationships, ns-3 has a system of containers and helpers that facilitates this process.
- 2) Model usage: models are added to simulation (for example, UDP, IPv4, point-to-point devices and links, applications); most of the time this is done using helpers.
- 3) Node and link configuration: models set their default values (for example, the size of packets sent by an application or MTU of a point-to-point link); most of the time this is done using the attribute system.
- 4) Execution: simulation facilities generate events, data requested by the user is logged.
- 5) Performance analysis: after the simulation is finished and data is available as a time-stamped event trace. This data can then be statistically analyzed with tools like R to draw conclusions.
- 6) Graphical Visualization: raw or processed data collected in a simulation can be graphed using tools like Gnuplot, matplotlib or XGRAPH.

##### 4.2 OMNet++

OMNeT++ is an extensible, modular, component-based C++ simulation library and framework, primarily for building network simulators. Network in this case is meant in a broader sense that includes wired and wireless communication networks, on-chip networks, and queuing networks.

OMNeT++ provides a component architecture for models. Components (modules) are programmed in C++, then assembled into larger components and models using a high-level language (NED) [9].

##### 4.3 Opnet

OPNET modeler provides a comprehensive development environment supporting the modeling of communication network and distributed systems. OPNET modeler provides better environment for simulation, data collection and data analysis [10].

## **5. Applications and Future Scope**

With the increase of portable devices as well as progress in wireless communication, ad hoc networking is gaining importance with the increasing number of widespread applications. Ad hoc networking can be applied anywhere where there is little or no communication infrastructure or the existing infrastructure is expensive or inconvenient to use. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices to and from the network. The set of applications for MANET is diverse, ranging from large scale, mobile, highly dynamic networks, to small, static networks that are constrained by power sources. Besides the legacy applications that move from traditional infrastructure environment into the ad hoc context, a great deal of new services can and will be generated for the new environment. Typical applications include [11, 12,]

### **5.1 Military Battlefield:**

Military equipment now routinely contains some sort of computer equipment. Ad hoc networking would allow the military to take advantage of commonplace network technology to maintain an information network between the soldiers, vehicles, and military information headquarters. The basic techniques of ad hoc network came from this field.

### **5.2 Commercial Sector**

Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. Emergency rescue operations must take place where none existing or damaged communications infrastructure and rapid deployment of a communication network is needed. Information is relayed from one rescue team member to another over a small handheld. Other commercial scenarios include e.g. ship-to-ship ad hoc mobile communication, law enforcement, etc.

### **5.3 Local Level**

Ad hoc networks can autonomously link an instant and temporary multimedia network using notebook Computers or palmtop computers to spread and share information among participants at e.g. conference or classroom. Another appropriate local level application might be in home networks where devices can communicate directly to exchange information. Similarly in other civilian environments like taxicab, sports stadium, boat and small aircraft, mobile ad hoc communications will have many applications.

### **5.4 Personal Area Network (PAN):**

Short-range MANET can simplify the intercommunication between various mobile devices (such as a PDA, a laptop, and a cellular phone). Tedious wired cables are replaced with wireless connections. Such an ad hoc network can also extend the access to the Internet or other networks by mechanisms e.g. Wireless LAN (WLAN), GPRS, and UMTS. The PAN is potentially a promising application field of MANET in the future pervasive computing context.

The future of MANET is very bright because it provides anywhere and anytime cheap communication without using any centralized authority. As it is used in different fields as mentioned above so a lot of research can be done on MANET.

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