CHAPTER 1

INTRODUCTION TO MOBILE AD HOC NETWORK

1.1 GENERAL

The distinctive features of Mobile Ad Hoc Network (MANET) are Network connectivity variation, no existing infrastructure and no central mechanism. Rescue personnel in a disaster site or soldiers in a battlefield need to establish their own communication.

MANET is a possible solution in which mobile nodes through access points share routing information and permission to pass messages among source and destination.

Routing is a challenge due to regular updates for modifications in topologies and alive routes may be disconnected since mobile nodes move from one place to another. Mobility of the node leads to frequent link failures which cause route discovery. Hence routing overhead increases in the wireless networks, which degrades network performance.

Not like cellular wireless Networks, a collection of routers is present in the MANET and equipped with randomly moving wireless receiver/transmitters. Among the routers the communication link is a function of their locations, antenna patterns, transmission power levels and co-channel
intervention levels. The mobile node functions as mutually nodes and routers. The node mobility and instability of other connectivity leads to dynamic topology. Wireless links are more prone to congestion due to lower capacity than hardwired links.

Proactive routing protocols maintain the routing information in large number of tables and whenever there is a variation in the topology of the network, automatically updates the routing information in all the tables. Reactive routing protocols during the route discovery process creates the route only to the nodes it is going to communicate and until it is needed these routes are retained active.

Transport Layer protocol TCP maintains reliable path between sender and receiver and provides the mechanism of flow and congestion control. UDP is another Transport layer protocol, which is the connectionless and unreliable data transfer that sends packets as datagrams.

Each routing protocol has its own strengths in certain categorical application scenarios. Geographic routing appears as a promising approach for enhancing the routing efficiency in MANET.

Geographic routing protocol makes forwarding decisions based on the geographical location of the target node.

Generally, as per the basic design, each generated RREQ message, tries to send to all the nodes. It is not necessary for resolving a shortest path between sender and receiver. Because, only the nodes within a region are allowed to forward the RREQ message from the source and destination, then the overhead in the establishment of a stable, shortest path gets reduced very much.
Even though the earlier Location-aided routing (LAR) is working based on similar principles, it takes the hypothesis that all nodes in the network, identify the speed and location of the concerned receiver node. For that it assumes a location resolution mechanism using a location server. So, each node in the network should periodically send its location to a central node and other nodes raise query for the location of any nodes in the network.

The previous implementation of Geo_AODV does not mark the undertaking that each node recognizes the speed and locality of the receiver node, but it tries to find an issue position information to other nodes in the network so that it causes additional message overhead.

In the Quasi MANET scenario, the mobile nodes need not know the location of all other mobile nodes and only need to know the location of the static nodes which are situated at service providing locations. Hence, the proposed Geo routing algorithm conceptually performs better than the previous LAR as well as Geo-AODV.

If the routing message packets sent between one particular set of mobile nodes and a motionless node and also if the data packets sent between that particular set of movable node and a stationary node are handled only by a selected set of intermediate nodes over and near the line of sight, then the delay of communication and the routing overhead is minimized.

Network Simulator (NS2) is a discrete event simulator used in the networking research domain. NS2 offers extensive support for simulation of TCP, routing, unicast, multicast and Geo cast protocols over wireless networks. NS2 is the second version of Network Simulator. The NS2 project is supported over DARPA. Since the NS2 has lot of packages, it is widely used in academic research and by many non-benefit groups.
In this research work, the network simulator version NS2.35 is used in the Ubuntu Linux operating system for all the simulations.

1.2 CHARACTERISTICS OF MANET

- **Autonomous terminal:** Every mobile node is a self-governing node in a MANET acts as a host as well as a router.
- **Distributed operation:** In MANET there is no centralized server to perform network operations, the controlling the network operations are distributed among the mobile nodes. Every node acts as a relay node to forward the packets.
- **Dynamic network topology:** Due to the mobility of nodes, the network topology changes frequently and the connection among the mobile nodes vary rapidly. Based on the mobility model, the mobile nodes need to adapt to it. During the fly, the mobile nodes create its own network dynamically.
- **Energy-constrained operation:** Every mobile node needs energy for its network operations; however it relies on batteries.
- **Heterogeneity:** The opportunity of MANET requests indicates that the mobile nodes can vary from a limited number of nodes set up in a small area of the network to a number of nodes deployed in the large area of the network. Due to the variability in the size of the Network region, the battery power, energy consumption and the route request generated are varied from one another.
1.3 CHALLENGES ENCOUNTERED IN MANET

A MANET atmosphere has certain challenges of constraint and inadequacy:

- Naturally the wireless link individualities are time-varying. There are transmission barriers like interference, fading, blockage and path loss that leads to the prone behaviour of wireless channels.

- Inadequate range of wireless transmission – When compared to wired networks, wireless networks have reduced data rates due to limited radio band. Therefore, in order to keep the overhead low, the bandwidth should be used optimally.

- Packet loss – In MANETs due to hidden terminal problem, frequent link breakage results in higher packet loss and collision.

- Routing – Due to mobility, regular route changes and path breaks. The dynamic topology leads to frequent path breaks.

- Frequent network barriers - Intermediate nodes are affected due to the node mobility which leads to the partition of the network.

1.4 MOBILITY MODELS IN MANET

Mobility model is one of the simulation parameters to assess the MANET protocol performance. Mobility model refers to the mobile node design of movement and velocity change over in the timing. Camp et al. (2002) presented mobility models for MANET which are as follows:

**Random Waypoint Mobility Model:** This model design is built at the pause times among the moderation in destination besides velocity.

**Random Walk Mobility Model:** This model is the simplest one designed for the random direction and velocity.
Random Direction Mobility Model: This model is designed for the mobile nodes to reach to the end of the network area in advance due to which there is a variation in the direction and velocity.

Gauss-Markov Mobility Model: This model incorporates a single tuning parameter to alter the random direction and velocity.

A Boundless Simulation Area Mobility Model: This model changes the network area from two dimensional into torus-shaped.

City Section Mobility Model: This model views the network area as a city with streets.

1.5 PROTOCOL ARCHITECTURE OF MANET

Open System Interconnection (OSI) reference defines seven layers, namely Physical, Data Link, Network, Transport, Session, Presentation and Application layer as shown in Figure 1.1. OSI which is referred as a reference model, defines the various levels of networking protocols and their associations. Table 1.1 shows the seven layer description.

<table>
<thead>
<tr>
<th>OSI Layer</th>
<th>Functionalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Layer</td>
<td>Controls the transmission range and frequencies.</td>
</tr>
<tr>
<td>Data Link Layer</td>
<td>Using IEEE 802.11 MAC ensures the reliability of logical link control.</td>
</tr>
<tr>
<td>Network Layer</td>
<td>Routing and relaying between the mobile nodes in</td>
</tr>
<tr>
<td><strong>OSI Layer</strong></td>
<td><strong>Functionalities</strong></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>the network</td>
<td></td>
</tr>
<tr>
<td>Transport Layer</td>
<td>Ensures reliable completion of data transfer.</td>
</tr>
<tr>
<td>Session Layer</td>
<td>Managing the communication by initiating, and terminating sessions.</td>
</tr>
<tr>
<td>Presentation Layer</td>
<td>Controlling the incoming and outgoing packets in the presentation format.</td>
</tr>
<tr>
<td>Application Layer</td>
<td>Defines the services to applications such as authentication and availability.</td>
</tr>
</tbody>
</table>

**ENABLING TECHNOLOGIES:** Based on the coverage region the MANET are classified in to a Wide Area Network (WAN), Metropolitan Area Network (MAN), Personal Area Network (PAN). WAN and MAN are mobile multiple path wireless networks. PAN connects more than one mobile device.

**NETWORKING:** The networking protocols are used with the help of enabling technologies to provide reliable data transfer between source to destination. To create an end-to-end connection, the source needs to find the destination in the network area by dynamically mapping the logical address of the destination node to its present position in the network.

**APPLICATION & MIDDLEWARE:** There is a quick development in MANET Research, resulting in technologies such as WiFi, Bluetooth, IEEE802.11 which help in deploying the MANET for applications like Disaster recovery scenario, battle fields and emergency services.
Routing protocol avails the intermediate nodes to forward a packet when the mobile nodes are not in the same transmission range. Routing protocol has its own strengths in certain categorical application scenarios. Geographic routing appears as a promising approach for enhancing the routing efficiency in MANET.
Catastrophe hit areas lacking a communication infrastructure for the deployment of a Quasi MANET to provide support for communication between rescue teams and avail communication between the rescue teams and other emergency accommodations. In this scenario, there are certain static wireless nodes at special service providing locations such as a medical camps or helipads and the other mobile nodes such as mobile equipment carried by a rescue personal or any transport vehicle. To make such applications possible, it is indispensable to design networking protocols that can surmount pertinent quandaries that arise from MANET environments.

In real life, the mobile nodes need to communicate with certain static nodes that are kept at a specific physical location in the shortest lifetime of the overall network. Hence, Quasi MANET has unnecessary overhead due to the location sharing needs in their design. The increase in node density and the mobility reduces the performance of any routing protocol under Quasi MANET. The aim of this thesis is to propose a Location based Geographic Routing approach so as to minimize the number of neighbours (Node Density) and to avoid the high Mobility Nodes so as to reduce the routing overhead.

### 1.7 CHARACTERISTICS OF GEOGRAPHIC ROUTING

Topological routing accomplishes packet forwarding by using routing table information. Geographic routing decides to forward packets with the help of neighbouring location information and self location awareness. In geographic routing, using GPS (Global Positioning System) provides location information which enhances the performance of message delivery.

LAR is a mechanism using AODV routing protocol in which through limited flooding only the part of a network which has destination
route in performing routing process in order to reduce control message overhead. LAR uses GPS to find the destination node location.

Geo_AODV is a distinction of the AODV protocol which attempts to dynamically learn and distribute location information among the nodes in the network. The main drawback of the existing system is that in several ways position updates are expensive.

In the MAC layer each update raises the threat of packet collision, affecting the routing performance due to packet loss through packet collision. A lost data packet retransmission increases the end-to-end delay.

LAR algorithm is proposed in existing Ad Hoc wireless networks in which the computation of forwarding zone was addressed. A modified-LAR algorithm is proposed in which the request zone extensions if route discovery failed was addressed. Simulation results show improvement in control overhead.

LACBER is a variant of Location aided routing with lower hop-count and improved energy efficiency to GPS scarce network was addressed. For the better utilization of bandwidth and to conserve energy the GPS enabled nodes periodically wakes up to listen for the changes and goes back to sleep mode.

1.8 QUASI MANET

MANET can be generally of two kinds: Mobile and Quasi-static. In a Quasi-static network nodes may be static or dynamic. Technical challenge in a MANET is to design an efficient routing protocol to manage with the topology changes. This work addresses MANET as a Quasi MANET
where all the nodes are neither in mobility nor in static condition. Hence a Quasi MANET contains where some nodes are partly mobile and partly static throughout the period of operation.

In a Quasi MANET scenario in every day application having some restricted predefined functionality and usage. In real life the mobile nodes need to be communicating with some static nodes that were kept at some specific physical location through the short lifetime of the overall network. Hence Quasi MANET has unnecessary overhead due to the location sharing needs in their design. The increase in node density and reduce the mobility performance of any routing protocol under Quasi MANET.

The problem in Geographic Routing is to minimize the No. of neighbours (Node Density) and to avoid the high Mobility Nodes.

1.9 OBJECTIVE OF THE RESEARCH

The objectives of the present investigations are

I. To design and implement a location aware geographical routing method for the Quasi MANET environment in a disaster recovery scenario.

II. To conduct an evaluation on the performance of Routing protocols AODV, DSDV and DSR with transport protocols TCP and UDP for Quasi MANET in a Disaster Recovery Scenario.

III. To develop Location based Geographic Routing approach namely Region based Route Request Processing AODV algorithm (RRRP_AODV) based on Node Density to reduce routing overhead for Quasi MANET in a Disaster recovery Scenario and to evaluate the performance of RRRP_AODV by comparing with the Routing protocols AODV, DSDV and DSR with transport protocols TCP and UDP in terms of total sent data
packets, total received data packets, routing load, MAC load, routing overhead, packet delivery fraction, throughput, total dropped packets and consumed battery energy.

IV. To develop Location based Geographic Routing approach namely Region and Mobility based Route Request Processing AODV algorithm (RMRRP_AODV) for reducing the routing overhead based on Node mobility using RRRP_AODV for Quasi MANET in a Disaster recovery Scenario and to evaluate the performance of the RMRRP_AODV with transport protocols TCP and UDP in terms of total sent data packets, total received data packets, routing load, MAC load, routing overhead, packet delivery fraction, throughput, total dropped packets and consumed battery energy.

1.10 CONTRIBUTIONS OF THE RESEARCH

- An Elaborate survey of Geographic routing schemes and procedures for MANET has been presented

- An Extensive study and evaluation on the performance of reactive routing protocols (AODV and DSR) and proactive routing protocol (DSDV) with the transport protocols TCP and UDP to identify the better protocol suitable for Quasi MANET in a Disaster Recovery Scenario has been made and the results are presented.

- A new method Location based Geographic Routing approach, namely Region based Route Request Processing AODV algorithm (RRRP_AODV) based on Node density to reduce the routing overhead for Quasi MANET in a Disaster recovery Scenario has been presented. The performance of the RRRP_AODV algorithm is compared with the
Routing protocols AODV, DSDV and DSR with transport protocols TCP and UDP.

- Second new method Location based Geographic Routing approach, namely Region and Mobility based Route Request Processing AODV algorithm (RMRRP_AODV) for reducing the routing overhead based on Node mobility in AODV using RRRP_AODV for Quasi MANET in a Disaster recovery Scenario. The performance of the proposed method is compared with the RRRP_AODV and existing protocols and presented the results of the evaluation. The simulation results reveal that the new approach RMRRP_AODV improves the network performance by reducing the node density and avoiding the high Node Mobility with respect to total sent data packets, total received data packets, routing load, Medium Access Control (MAC) load, routing overhead, the total dropped packets, throughput, packet delivery fraction, and consumed battery energy.

1.11 ORGANIZATION OF THE THESIS

This thesis has been arranged in seven chapters. A brief description of each chapter is given below.

Chapter 1 provides an introduction to the Mobile Ad Hoc Networks, disputes in MANET, problem definition, characteristics of geographic routing, restrictions on existing system, software description, objective of the thesis, the contributions of the thesis, characteristics and thesis organization.

Chapter 2 discusses the various Geographic routing schemes and procedures devised by various researchers in the literature survey.
Chapter 3 presents the analysis of the impact of Node Density and Node Mobility in reactive routing protocols (AODV and DSR) and proactive routing protocol (DSDV) on network performance.

Chapter 4 provides an insight on the results of an evaluation of Routing protocols AODV, DSDV and DSR with transport protocols TCP and UDP for Quasi MANET in a Disaster Recovery Scenario.

Chapter 5 presents a proposed method Location based Geographic Routing approach, namely Region based Route Request Processing AODV algorithm (RRRP_AODV) based on Node Density to reduce routing overhead for Quasi MANET in a Disaster recovery Scenario. The performance of the RRRP_AODV algorithm is compared with the Routing protocols AODV, DSDV and DSR with transport protocols TCP and UDP.

Chapter 6 presents a second proposed method Location based Geographic Routing approach, namely Region and Mobility based Route Request Processing AODV algorithm (RMRRP_AODV) for reducing the routing overhead based on Node mobility in AODV using RRRP_AODV for Quasi MANET in a Disaster recovery Scenario. The performance of the proposed method is compared with the RRRP_AODV as well as existing protocols and the results of the evaluation are presented.

Chapter 7 concludes the results presented in this thesis and discusses some possible region based approaches for future research.
1.12 SUMMARY

The chapter deals with the fundamentals of MANEt al. along with its Challenges, Mobility Models, Protocol Architecture. The Quasi MANET followed of the characteristics of geographic routing are also discussed. The main objective and the contributions of the research are deliberated. In this chapter, the descriptions of proactive and reactive routing protocols are described. On-demand routing protocols are designed to reduce the overheads by preserving information for active routes only. This means the routes are determined and preserved for nodes that require sending data to a particular destination. In proactive routing, each node has one or more tables that contain the latest updates of the routes to any node in the network. The scope is to attain the improvement in the network performance by minimizing the number of neighbours (Node Density) and to avoid the high Mobility Nodes so as to reduce the routing overhead. The forthcoming chapter provides a detailed description of the contribution of different researchers for Geographic Routing and different Routing Protocols.