CHAPTER – I

INTRODUCTION TO MOBILE AD HOC NETWORKS
AND ITS ROUTING

1.1 INTRODUCTION

Mobile Ad-hoc Networks are a collection of two or more devices equipped with wireless communications and networking capability. These devices can communicate with other nodes that are immediately within their radio range or one that is outside their radio range. For the latter, the nodes should deploy an intermediate node to be the router to route the packet from the source to the destination. The Wireless Ad-hoc Networks [1] do not have a gateway; every node can act as the gateway. Fig.1.1 shows the wireless mobile ad hoc network consists of mobile nodes that are interconnected by wireless-multi-hop communication paths.

These ad hoc wireless networks are self-creating, self-organizing, and self-administering. These mobile ad hoc networks offer unique benefits and versatility for certain environments and applications. With no prerequisites of fixed infrastructure or base stations, they can be created and used anytime, anywhere. Such networks could be intrinsically faulty-resilient, for they do not operate under the limitations of a fixed topology. Since all nodes are allowed to be mobile, the topology of such networks is necessarily time varying.
The set of applications for MANETs is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, MANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing. However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path (based on a given cost function) from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to MANETs. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes become relevant issues. The network should be able to adaptively alter the routing paths to alleviate any of these effects. Moreover, in a
military environment, preservation of security, latency, reliability, intentional jamming, and recovery from failure are significant concerns. Military networks are designed to maintain a low probability of intercept and/or a low probability of detection. Hence, nodes prefer to radiate as little power as necessary and transmit as infrequently as possible, thus decreasing the probability of detection or interception. A lapse in any of these requirements may degrade the performance and dependability of the network.

Recently a large volume of research has been conducted on the issue of energy efficiency for wireless networks. Since energy conservation is not an issue of one particular layer of the network protocol stack, many researchers have focused on cross layer designs to conserve energy more effectively. One such effort is to employ power control at the MAC layer and to design a power aware routing at the network layer.

Traditional routing protocols cannot be applied to ad hoc networks directly because ad hoc networks inherently have some special characteristics and unavoidable limitations such as dynamic topologies, bandwidth-constrained, variable capacity links, and energy-constrained operations compared with traditional networks. Consequently, research on routing protocols in ad hoc networks becomes a fundamental and challenging task.
Routing in MANETs

A routing is the mechanism by which user traffic is directed and transported through the network from the source node to the destination node. Objectives include maximizing network performance from the application point of view – application requirements- while minimizing the cost of the network itself in accordance with its capacity. The application requirements are hop count, delay, throughput, loss rate, stability, jitter, cost; and the network capacity is a function of available resources that reside at each node and number of nodes in the network as well as its density, frequency of end-to-end connection (i.e. Number of communication), and frequency of topology changes (mobility rate). The four core basic routing functionality for mobile ad hoc networks are:

- **Path generation**: which generates paths according to the assembled and distributed state information about the network and of the application; assembling and distributing network and user traffic state information.
- **Path selection**: which selects appropriate paths based on network and application state information.
- **Data Forwarding**: which forwards user traffic along the selection route forwarding user traffic along the selected route.
- **Path Maintenance**: which maintains the selected route.
Fig.1.2 An example of Routing in Ad hoc networks

Taking Fig.1.2 for example, path S-C-J-F is the shortest path with the minimum hop between source node A and destination F. Along this path, when node J relays packets, it needs to contend the channel with the other 6 nodes B, C, D, F, I and K, and this may generate additional packet delivery delay. Accordingly, the network delay will become very larger if the routing protocol keeps routing for other packets to pass through hotspot node J. On the contrary, if we select the path S-C-D-E-F with 4 hop counts, the relayed packets have a better chance to quickly reach the destination. Moreover, routing protocols with the minimum hop could not guarantee that the packet reaches the destination node using minimum energy consumption. In recent years, research on routing protocols based on delay and power control in ad hoc networks has received increasing attention from both researchers and applications, and many related routing protocols have been proposed. However, there is a common drawback in the following protocols that only consider network delay or power control. Literature integrates real-time and power control to achieve application specified
communication delays at low energy cost, but with different focuses and limitation.

Ad hoc routing protocols can be divided into two categories:

1. **Table-driven routing protocols**

   In table driven routing protocols, consistent and up-to-date routing information to all nodes is maintained at each node.

2. **On-demand routing protocols**

   In On-Demand routing protocols[1], the routes are created as and when required. When a source wants to send to a destination, it invokes the route discovery mechanism to find the path to the destination. In recent years, a variety of new routing protocols targeted specifically at this environment have been developed. There are four multi-hop wireless ad hoc network routing protocols that cover a range of design choices:

   1. Destination-Sequenced Distance-Vector (DSDV)
   2. Temporally Ordered Routing Algorithm (TORA)
   3. Dynamic Source Routing (DSR)[2]
   4. Ad Hoc On-Demand Distance Vector Routing (AODV).

   While DSDV is a table-driven routing protocol, TORA, DSR and AODV, fall under the On-demand routing protocols category. The existing popular routing protocols in ad hoc networks such as Dynamic Source Routing (DSR)[2], Destination Sequenced Distance
Vector (DSDV)[4] and Ad hoc On demand Distance Vector (AODV)[5] are all the shortest paths, that is, the minimum hop count routings.

1.2 CHALLENGES IN WIRELESS ADHOC NETWORKS

Since Wireless Ad-hoc Networks are inherently different from the well-known wired networks, it is an absolutely new architecture. Thus, some challenges arise from the two key aspects namely self-organization and wireless transport of information. The major challenges in ad hoc networks are given as follows:

Node Deployment

First of all, the nodes in a Wireless Ad-hoc Network are free to move arbitrarily at any time. So the network topology of MANET may change randomly and rapidly at unpredictable times. This makes routing difficult because the topology is constantly changing and nodes cannot be assumed to have persistent data storage. In the worst case, we do not even know whether the node will still remain next minute, because the node will leave the network at any minute.

Bandwidth Constrained

Bandwidth constraint is also a big challenge. Wireless links have significantly lower capacity than their hardwired counterparts. Also, due to multiple access, fading, noise, and interference conditions, etc., the wireless links have low throughput.
**Energy Constrained**

Some or all of the nodes in a MANET may rely on batteries. In this scenario, the most important system design criteria for optimization may be energy conservation[3].

**Limited Physical Security**

Mobile networks are generally more prone to physical security threats than are fixed cable networks. There are increased possibility of dropping, spoofing and denial-of-service attacks in these networks.

Ad hoc wireless networks inherit the traditional problems of wireless communications and wireless networking:

- The wireless medium has neither absolute, nor readily observable boundaries outside of which stations are known to be unable to receive network frames;
- The channel is unprotected from outside signals;
- The wireless medium is significantly less reliable than wired media;
- The channel has time-varying and asymmetric propagation properties;
- Hidden-terminal and exposed-terminal phenomena may occur.
- Thus, main challenges in Mobile ad hoc networks are Dynamic Topologies, Bandwidth-constrained, variable

1.3 TARGET OF THE THESIS

We describe routing by three approaches such as power controlled routing, energy efficient routing and QOS aware routing. The first method targets a detailed history about new power control routing which applies to wireless ad hoc networks, because applying power control into routing protocols has become a hot research issue. This also explains that our research work not only reduces network energy consumption, but also improves network throughput, Packet Delivery Ratio and other performances of ad hoc networks. This report focuses on an on-demand routing algorithm based on power control termed as Power Control Ad hoc On-Demand Distance Vector (PC-AODV).

This work represents that the routing algorithm builds different routing entries according to the node power levels on demand, and selects the minimum power level routing for data delivery. This PC-AODV uses different power control policies to transmit data packets, as well as control packets of network layers and MAC layer. Finally this thesis shows that the simulation results of our algorithm not only reduce the average communication energy consumption, thus prolong the network lifetime, but also improve average end-to-end delay and packet delivery ratio. The second approach is concerned with adaptive
routing in ad hoc networks using modified aodv and compared with aodv using the parameters aggregate interface queue length and node remaining energy. Differently from exciting approaches, we made changes in the aodv routing protocol in such a way that the only destination node can respond to a route request. This greatly reduces the control data packets sent on the network. We also evaluated the performance of the modified aodv based on metrics like average end-to-end delay, throughput and energy consumption.

In the third approach we describe an extended version of StAC termed as StAC-backup, which exploits the knowledge of alternative or backup routes to a source’s destination in order to improve the robustness of throughput-QOS assurances in the face of route failures.

1.4 THESIS OUTLINE

The dissertation is organized as follows:

1. In Chapter 2, we present the Literature Review where the previous works are studied in Power aware routing in Ad hoc networks for making an adaptive Power aware Routing in MANETs as well as the studies over AODV, load balanced routing protocols and StAC Protocols. The existing algorithms are identified and discussed.

2. In Chapter 3, we describe our work named Power controlled ad hoc on-demand distance vector (PC-AODV), where the proposed protocol is implemented using NS-2.34 and its
performance is analyzed with AODV and Cluster Power AODV.

3. In Chapter 4, we propose an Energy efficient routing in MANETs and performance metrics are compared with AODV.

4. In Chapter 5, we illustrate QOS aware routing in MANETs. The StAC backup and StAC multirate Protocols are combined and the performances are evaluated.

5. In Chapter 6, we analyze the performance comparision of proposed protocols with AODV as well as StAC protocols with DSR.

6. Finally in Chapter 7, we summarize our work and conclude the thesis.