Chapter 1

INTRODUCTION

1.1 Wireless Networks

The mobile computation represents a new computational paradigm that has the objective to provide to the users permanent network access independent of their location. This access can be made through portable computational devices like laptops, palmtops, computers and cellular telephones etc. The past decade has seen increased popularity of wireless networks in many areas due to reduction in the cost of the devices and increase in their capacity.

Wireless technology is being used because of its suitability to mobile applications. The mobile wireless networks are broadly classified into two categories.

1.2 Types of Wireless Networks

The IEEE (Institute of Electrical and Electronic Engineers) study group 802.11 (Ref 1) classified wireless networks into two groups:

a. Wireless Networks with infrastructure

b. Wireless networks without infrastructure (Ref 2).
1.2(a) Wireless networks with Infrastructure

Infrastructured networks (Ref: 4) are those in which the mobile nodes are in direct contact with a base station or Mobility Support Station (MSS) in the fixed network. The MSS is normally linked to a fixed network of high speed, which forms a backbone network.

In the infrastructured network there are fixed and wired gateways, with the bridges or access points for these networks known as base stations (or MSS).

Figure 1: Communication model in an infrastructure network
In this type of wireless network all the communication is performed by the base station. The functioning of infrastructured wireless network is similar to the **Cellular Telephone**, where all communication must necessarily pass through the base station. Even if the cellular telephones are near by they cannot communicate directly between themselves, they can communicate only through base stations.

1.2(b) Wireless networks without infrastructure

Another type of wireless network is the mobile wireless network without any infrastructure. It is also called as adhoc network (Ref: 2) or Mobile adhoc network (MANET)(Ref: 2). It's a collection of wireless mobile nodes dynamically forming a network without the use of any existing network infrastructure.

![Figure 2: Communication between MANET Computers](image_url)
The mobile nodes are not bound to any centralized control like base stations or mobility support stations (MSS) (Ref: 11). This offers unrestricted mobility and connectivity to the users but the total responsibility of network management is now on the nodes that form the network. Due to limited transmission range of wireless network interfaces, multiple hops may be needed for one node to exchange data with another across the network (Ref: 12). It is necessary for one mobile host to enlist the aid of others in forwarding a packet to its destination, due to the limited propagation range of each mobile node. As shown in figure 2, transmission from A to D goes through B and C. The mobile nodes such as notebook computers, feature powerful CPUs, large memory, multimedia capabilities and color displays.

In the adhoc networks each mobile node operates not only as a host but also as a router, forwarding packets for other mobile nodes in the network, that is not within the direct range of wireless transmission. Each node participates in an adhoc routing protocol that allows it to discover multi hop paths through the network to any other node. These infrastructureless networks are mobile nodes that establish their own networks on the fly and perform their own routing.

Adhoc networks consist of mobile nodes which can move around freely. The system may operate in isolation or can have gateways to interface with a fixed network, and operates as a stub network connected to a fixed Internet-work. Stub networks carry traffic originating at and/or destined for its
internal nodes, but do not permit external traffic to transit through the stub network.

The nodes have wireless transmitters and receivers. The antenna's used differ depending on application. Omni directional antennas are used for broadcast communication. Highly directional and possibly steerable antennas are used for point-to-point communication. At a given point in time a wireless connectivity in the form of random multi hop graph or "adhoc" network exists between nodes.

1.3 Applications of Adhoc Networks

The main advantages of adhoc networks are

1. Ease of deployment.
2. Decreased dependence on Infrastructure.
3. Fast installation in places even without previous infrastructure.
4. Fault tolerance.
5. Direct connectivity.

Adhoc networks are mainly indicated for situations in which it cannot, or do not make sense, to install a fixed network.

The range of applications include military, industrial and commercial applications (Ref: 13).
Military networking requirements like robust, mobile, and highly dynamic autonomous topology may be solved by wireless mobile communication network like adhoc networks. In future if MANET technology is properly combined with satellite based information delivery, the developing technologies of computing and communication provide many applications for these networks.

They are extremely flexible and can provide rapidly deployable communications for disaster management's like earthquake, fire, safety, and rescue. Sensor networks, that consists of several small low powered nodes with sensing capabilities will be one of the futuristic applications of adhoc networks for remote data collection.

The bad functioning or the disconnection of a station, can be easily overcome with the dynamic reconfiguration of a network. In contrast, in a fixed network when a router fails the traffic redirection is a complex operation. If a MSS fails all the dependent nodes of that MSS will be without communication.

If two stations are within the communication range of the wireless link then they can have a direct communication channel between them. Whereas in an infra-structured networks nodes can communicate only through MSS.
1.4 Characteristics and challenges of adhoc networks

Adhoc networks consists of mobile nodes which can move around freely, so we have dynamic topologies.

Nodes are free to move arbitrarily. Thus the network topology which is typically multi hop, may change randomly and rapidly at unpredictable times, and may consist of both bi-directional and unidirectional links.

One reason for unidirectional links is due to differences in transmission range.

![Diagram showing communication between nodes of different transmission ranges](image)

**Figure 3: Communication between nodes of Different Transmission Ranges**

Node 1 has a large enough range to transmit packets directly to node 3. Where as the node 3 has a smaller range and must enlist the help of node 2 to return packets to node 1.
Wireless links have limited bandwidth (Ref: 18) than the wired counter parts. For wireless environment the bandwidth is typically less than 2 Mbps whereas wired optic fibers have bandwidth of one Gbps.

The errors in wireless link are also more at one in $10^4$ or $10^6$ transmitted bits while in a wired transmission like LAN it is typically one in $10^{14}$ transmitted bits (Ref 3). And also there are problems like fading, noise and interference conditions. Congestion is typically a norm than exception if the applications are like multi media computing where the bandwidth requirements are more. The mobile devices run on batteries which have limited energy (Ref: 14). So an important design criteria for optimization is energy conservation. The security threats are also more as the communication medium is wireless and can be easily received by any one within the range of transmission.