SHIV SHAKTI

International Journal of in Multidisciplinary and Academic Research (SSIJMAR)

Vol. 1, No. 2, July-August (ISSN 2278 – 5973)

Mobile Ad-hoc Network: A Special type of Wireless Ad-hoc Network

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Abstract

A wireless network is a technology that enables two or more entities to communicate without network cabling. Thus, reducing the costly process of introducing cables into a building or using cables as a connection between various equipments. The tremendous growth of personal computers and the handy usage of mobile computers demand the need to share the information. The enormous popularity of Internet services make more people enjoys and depends on the networking applications. In this paper a special type of wireless ad-hoc network termed as Mobile Ad-hoc Network (MANET) is discussed in detail. The working principle of MANET alongwith its characteristics and applications are presented.The hand held computers and other devices are simply required to be powered by some source of energy and having their existence within the specific ranges to makeup a network and commence communicating with each other's with no wires. The wireless networking provides attractive solution for emergency applications like

rescue missions and military communications. It is concluded that a MANET is of great importance in case of any disaster management and communication in a hostile environment like in case of military operations.

Introduction

The rapid advances in wireless communication technologies offer opportunities for increasingly use of small-size and high-performance computing and communication devices like personal digital assistants and laptops in our daily life. Presently wireless networking based communication becomes the new paradigm used for establishing communication between mobile users. This type of communication becomes more in style than ever before because of its easy deployment. Wireless service is mobile and can be deployed almost everywhere faster than the fixed service. The enormous popularity of Internet services make more people enjoys and depends on the networking applications. A wireless network is a technology that enables two or more entities to communicate without network cabling.The main element of a wireless network includes wireless hosts like PDA, laptop, mobile phones etc. Other components include base stations like towers or access points and wireless links for connecting various devices to base stations.There are two broad categories of wireless networks: infrastructure wireless network and infrastructure less wireless network also known as ad-hoc network [1].

In infrastructure wireless network, data sent between a wireless client and other wireless clients and nodes on the wired network segment is first sent to the wireless Access Points (APs) or Base Stations (BSs). The wireless AP or BS then forwards the data to the appropriate destination.Infrastructure less wireless network or Ad-hoc network does not require any fixed infrastructure. It is used to connect wireless clients directly together, without the need for a wireless AP or BS or a connection to an existing wired network. An Ad-hocnetwork consists of various wireless clients, which send their data directly to each other.In wireless network the carriers may be mobile [2] as a result there will be changes in the linking state between the carriers. If the carriers are cell phone, laptops or personal digital assistant (PDA) then this type of network is called “Mobile Ad-hoc Network” (MANET). So a MANET is a type of wireless ad-hoc network.If the carriers are moving vehicles [2] then this type of network is said to be “Vehicular Ad-Hoc

Network" i.e. (VANET) [10].VANETs are specially designed to provide road safety and comfort to the passengers. It is assumed that every vehicle is equipped with a GPS, digital maps or navigation system and an ad-hoc wireless communication device. Higher node mobility causes rapid changes in network topology [3].

Infrastructure-based Wireless Networks

The first type of wireless network is centrally coordinated which requires a pre-existing fixed infrastructure to be arranged before devices can establish communication with each other as shown in figure 1.

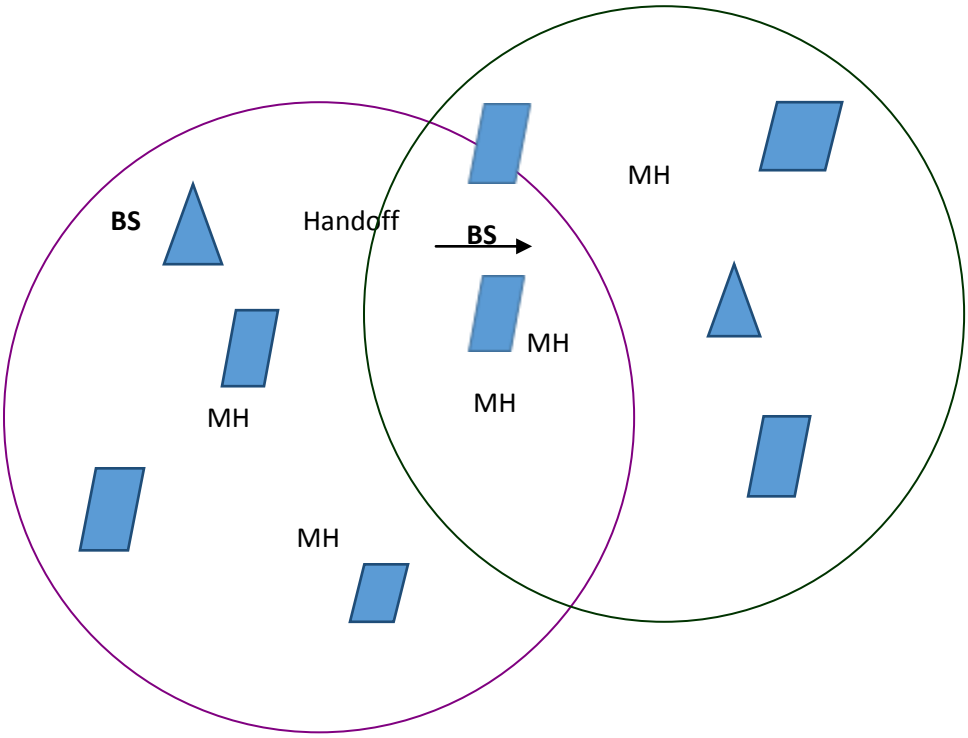

Figure 1: Infrastructure-based Network

All devices are connected to wireless network with the help of base stations (BSs) or Access Point (AP). The wireless centralized controller coordinates the activity of access point. The base stations are typically connected to wired network to form a fixed backbone. Cellular-phone networks are the best example of this class of wireless network built from public switched telephone network (PSTN) switches as backbone, mobile

switching centers (MSCs) ,base stations and mobile hosts where a phone connects to the base-station (BS) controlled by MSC. The wireless local area networks (WLANs) also fall in this category.Every mobile host operating in this category must be in transmission range of one or more base stations, which are responsible for buffering and forwarding traffic between hosts. Each base station serves a geographical area called cell.

A cell may contain many mobile hosts (MHs). A mobile host can communicate with other nodes in the system only through the base station of the cell in which it is present. The base stations are providing centralized control for various traffic management activities. A wireless link is used for communication between a mobile host and the base station. Mobile hosts can move from one cell to another during a communication session and keep the connection on the move. When the mobile host travels out of range of a base-station, "hand-off" taken place and the user switches to a new base-station within reach [1]. The wireless network can be easily expanded or reduced by adding or removing access points i.e. easily scalable as compared to the ad-hoc wireless networks. Infrastructure based networks offer the advantage of scalability and centralized security management. But these networks provide less flexibility due to their fixed base stations. One major issue with these networks is the concern of handoff, which tries to handle the situation when a connection should be smoothly handed over from one base station to another base station without noticeable delay or packet loss. Also deployment of such networks is limited to merely those places, where there exists such a cellular network infrastructure as well as every time it is not feasible to provide the infrastructure.

A VANET is a wireless network that is formed between vehicles as a result of integrating Ad-hocnetwork, wireless LAN (WLAN) and cellular technology. The nodes in the vehicular type of ad-hocnetwork use the wireless medium to communicate with other nodes within their radio range. Each vehicle has on- board unit (OBU) that connects the vehicle with roadside units via Dedicated Short-Range Communications (DSRC) [4] radio signals.Car manufacturers such as Ford, GM, and BMW have already announced their efforts to include significant computing power inside their cars [5, 6] and Chrysler

the third-largest U.S. automaker became the first car company to include in-car Internet access [7].

Infrastructure less Wireless Networks or Ad-hocNetworks

The second type of wireless network does not require a pre-existing fixed infrastructure or centralized control i.e. there are no fixed base stations or switching centers instead an Ad-hocnetwork is formed dynamically in an arbitrary manner by the cooperation of set of independent nodes wanting to communicate with each other. Figure 2 shows a simple Ad-hocnetwork.

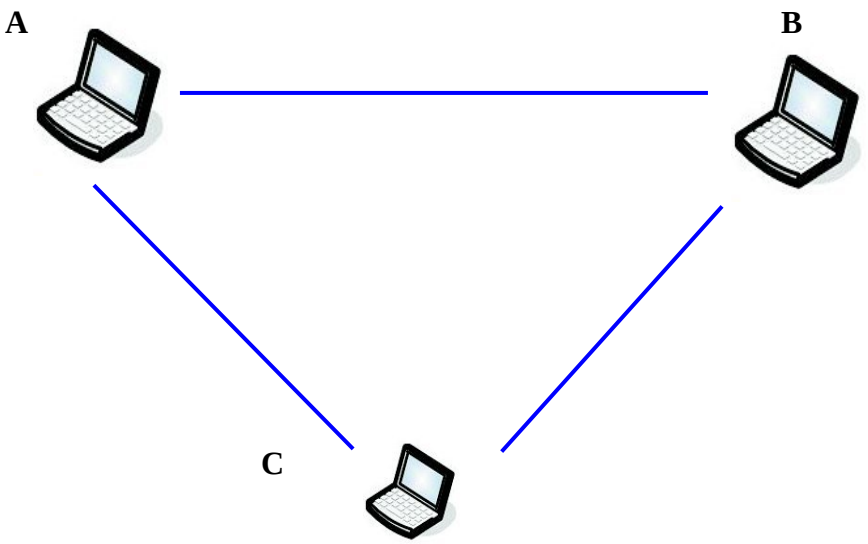

Figure 2: Infrastructure less or an Ad-Hoc network

Nodes communicate directly with all other nodes that are in wireless transmission range. Because there are no base stations to moderate communication, hosts must always be ready to receive traffic from their neighbors. This means that all users participating in the Ad-hocnetwork must be willing to forward data packets to make sure that the packets are delivered from source to destination. For example two computers equipped with wireless adapter cards can set up an independent network whenever they are in close proximity. Nodes of an Ad-hocnetwork are mobile hosts with similar transmission power and

computation capabilities. MHs that are within each other's link coverage communicate directly via wireless links. Otherwise, they communicate through multi-hop routing.

Due to high flexibility, Ad-hocnetworks are significant in situations where wireless access to a wired backbone is either not practicable or expensive. Because of independency from pre-established infrastructure these networks can be deployed in places with no infrastructure. Ad-hocnetworks works well in small environment. Because these do not need any additional access point (routers/switches), therefore it reduces the cost. This is helpful in battle fields, disaster recovery situations like flood, fire, tsunami, earthquakes etc. and places with non-existing or damaged communication infrastructure where communication network is needed to be deployed rapidly. Ad-hocnetworks can also be useful when it is required to be made for a short period of time like during conference meetings where people participating in the conference can form a temporary network without engaging the services of any pre-existing network. Furthermore, it is assumed that nodes have equivalent capabilities, which does not always happen in reality. Also due to decentralized environment Ad-hocnetworks require efficient routing protocols.

Mobile Ad-Hoc Networks

Mobile Ad-hoc networks (MANETs) [8] refer to self-organizing wireless networks that provide such kind of wireless communication in which the nodes are mobile, autonomous in nature, performs multi-hop communication and supporting no fixed infrastructure. There is no central controller thus each device in a MANET is free to move independently in any direction, and is dynamically connected in an arbitrary manner and will therefore change its links to other devices frequently. Each mobile node is equipped with transmitter/receiver and acts as an end-terminal (source or destination) as well as a router to relay the message throughout the whole network. The growth of laptops and Institute of Electrical and Electronics Engineers (IEEE) 802.11/Wi-Fi wireless networking have made MANETs a popular research topic since the mid-to late 1990s. Such networks may operate by themselves or may be connected to the larger Internet. In MANET no fixed network topology is used. Since the nodes in a MANET are mobile,

therefore, mobile nodes adopt any runtime topology due to their own dynamic behavior and the topology changes frequently. The rate of change in the topology depends on the velocity of the nodes and usually every node is able to communicate with every other node in its communication range.

Besides, the devices are small and the available transmission power is limited. The power limitations depress the range of radio transmission. Consequently, the radio coverage of a node is small. Each terminal owing to be a mobile router forwards data packets received from other nodes, as illustrated in figure 3. Therefore, communication over distances much larger than the transmission range of an individual node is possible without requiring any infrastructure such as dedicated routers or repeaters. For example, Nodes A and C in Figure 3 are able to communicate via Node B despite being separated by more than the transmission range. MANETs can easily be deployed in infrastructure-free environments, such as emergency rescue, military, airports, sports stadiums, campus, disaster management as well as sensor network. MANETs are characterizes by having limited energy as the nodes are battery operated and also limited bandwidth because of interference, noise and other hurdles in the atmosphere.Successful delivery of data among various nodes requires the routing protocols. Routing protocols for MANET is one of the challenging areas due to its dynamic and Ad-hocnature. Many routing protocols have been developed so far to contend with sudden changes that may arise due to nature of the networks.

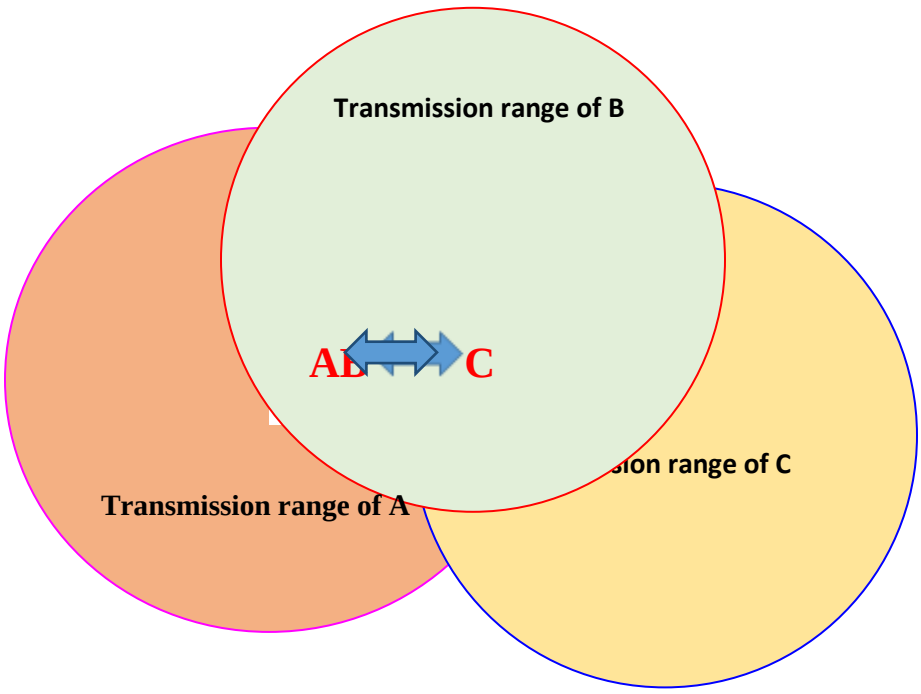

Figure 3: MANET with three nodes

Characteristics of MANET

- **Dynamic Structure:** In MANET no fixed network topology is used. Because the nodes are continuously moving in a random fashion the network topology is changing rapidly.
- **Multi-hop message passing:** The devices are small and the available transmission power is limited. The power limitations depress the range of radio transmission. Consequently, the radio coverage of a node is small. Due to this the nodes that cannot reach the destination node directly will need to relay their message through other nodes i.e. nodes that are within each other's link coverage communicate directly via wireless links. Otherwise, they communicate through multi-hop routing.
- **Distributed nature of network:** As a benefit, the control in MANETs provides additional robustness against the single point of failure as in centralized approaches.
- **Scalability:** InAd-hocnetworks scalability is much difficult than in wired networks. This is due to the random movement of nodes and having limited bandwidth and inadequate power.
- **Energy-constrained:** Almost all the nodes in a MANET are battery operated. For these nodes, the most important system design criteria for optimization may be energy conservation.
- **Limited Bandwidth:** Wireless links have lower capacity than wired links because available bandwidth is limited. As in this case the communication medium is air which can be effected by noise, interferences etc. in the atmosphere.
- **Susceptible to to Safetydangers:** Mobile wireless networks are generally more prone to physical security threats than are fixed cable networks. The increase possibility of eavesdropping, spoofing and denial of service attacks should be carefully considered.

MANET Applications

- **Disaster controlling:** Situations like flood, fire, tsunami, earthquakes etc. and places with non-existing or damaged communication infrastructure where this kind of network can rapidly deployed.
- **Military actions:** Communication in a hostile environment.
- **Infrequent events handling:** The communication network may be established for a very short period of time such as laptop meeting in a conference hall or car.
- **Remote search and rescue operations:** Rapid deployment of a communication network for searching in remote areas where it's not feasible to install the infrastructure.

Conclusion

Presently wireless networking based communication becomes the new paradigm used for establishing communication between mobile users. This type of communication becomes more in style than ever before because of its easy deployment. Wireless service is mobile and can be deployed almost everywhere faster than the fixed service.In this paper a special type of wireless ad-hoc network termed as Mobile Ad-hoc Network (MANET) is discussed in detail. Organization of a MANET including its features and applications are presented. It is concluded that a mobile ad-hoc network is of great importance in case of any emergency circumstances like military operations, disasters etc.

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