Mobile Ad Hoc Network

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INTRODUCTION

A mobile ad hoc network (MANET) is a temporary, self-organizing network of wireless mobile nodes without the support of any existing infrastructure that may be readily available on conventional networks. It allows various devices to form a network in areas where no communication infrastructure exists. Although there are many problems and challenges that need to be solved before the large-scale deployment of an MANET, small and medium-sized MANETs can be easily deployed.

The motivation and development of MANET was mainly triggered by Department of Defense (DoD)-sponsored research work for military applications (Freebersyser and Leiner, 2002). In addition, ad hoc applications for mobile and dynamic environments are also driving the growth of these networks (Illyas, 2003; Perkins, 2002; Toh, 2002). As the number of applications of wireless ad hoc networks grows, the size of the network varies greatly from a network of several mobile computers in a classroom to a network of hundreds of mobile units deployed in a battlefield, for example. The variability in the network size is also true for a particular network over the course of time; a network of a thousand nodes may be split into a number of smaller networks of a few hundred nodes or vice versa as the nodes dynamically move around a deployed area.

Ad hoc networks not only have the traditional problems of wireless communications like power management, security, and bandwidth optimization, but also the lack of any fixed infrastructure, and their multihop nature poses new research problems. For example, routing, topology maintenance, location management, and device discovery, to name a few, are important problems and are still active areas of research (Wu & Stojmenovic, 2004).

Characteristics of MANET

- Mobile: The nodes may not be static in space and time, resulting in a dynamic network topology.
- Wireless: MANET uses a wireless medium to transmit and receive data.
- Distributed: MANET has no centralized control.
- Self-organizing: It is self-organizing in nature.
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A message from the source node to destination node goes through multiple nodes because of the limited transmission radius.

- Scarce resources: Bandwidth and energy are scarce resources.
- Temporary: MANET is temporary in nature.
- Rapidly deployable: MANET has no base station and, thus, is rapidly deployable.
- Neighborhood awareness: Host connections in MANET are based on geographical distance.

SOME BUSINESS AND COMMERCIAL APPLICATIONS OF MANET

An ad hoc application is a self-organizing application consisting of mobile devices forming a peer-to-peer network where communications are possible because of the proximity of the devices within a physical distance. MANET can be used to form the basic infrastructure for ad hoc applications.

Some typical applications are as follows:

- **Personal-area and home networking:** Ad hoc networks are quite suitable for home as well as personal-area networking (PAN) applications. Mobile devices with Bluetooth or WLAN (wireless local-area network) cards can be easily configured to form an ad hoc network. With

Internet connectivity at home, these devices can easily be connected to the Internet. Hence, the use of these kinds of ad hoc networks has practical applications and usability.

- **Emergency services:** When the existing network infrastructure ceases to operate or is damaged due to some kind of disaster, ad hoc networks enables one to build a network and they provide solutions to emergency services.

- **Military applications:** On the battlefield, MANET can be deployed for communications among the soldiers in the field. Different military units are expected to communicate and cooperate with each other within a specified area. In these kinds of low-mobility environments, MANET is used for communications where virtually no network infrastructure is available. For example, a mesh network is an ad hoc peer-to-peer, multihop network with no infrastructure. The important features are its low cost, and nodes that are mobile, self-organized, self-balancing, and self-healing. It is easy to scale. A good example is SLICE (soldier-level integrated communications environment), a research project sponsored by DARPA (Defense Advanced Research Projects Agency) in this area for this need. The idea is that every soldier is equipped with a mobile PC (personal computer) with a headset and a microphone. SLICE is supposed to create mesh networks that handle voice communications while mapping whereabouts of soldiers and their companions.

- **Ubiquitous and embedded computing applications:** With the emergence of new generations of intelligent, portable mobile devices, ubiquitous computing is becoming a reality. As predicted by some researchers (Weiser, 1993), ubiquitous computers will be around us, always doing some tasks for us without our conscious effort. These machines will also react to changing environments and work accordingly. These mobile devices will form an ad hoc network and gather various localized information, sometimes informing the users automatically.

- **Location-based services:** MANET, when integrated with location-based information, provides useful services. GPS (Global Positioning System), a satellite-based radio navigation system, is a very effective tool to determine the physical location of a device. A mobile host in a MANET, when connected to a GPS receiver, will be able to determine its current physical location. A good example is that a group of tourists using PDAs (personal digital assistants) with wireless LAN cards installed in them along with GPS connectivity can form a MANET. These tourists can then exchange messages and locate each other using this MANET. Also, vehicles on a highway can form an ad hoc network to exchange traffic information.

- **Sensor network:** It is a special kind of hybrid ad hoc network. There is a growing number of practical applications of tiny sensors in various situations. These inexpensive devices, once deployed, can offer accurate information about temperature, detect chemicals and critical environment conditions (e.g., generate wild-fire alarms), monitor certain behavior patterns like the movements of some animals, and so forth. In addition, these devices can also be used for security applications. However, these sensors, once deployed, have limited battery power, and the lifetime of the battery may determine the sensor's lifetime. Recently, several government agencies (e.g., NSF [National Science Foundation]) have funded research projects on sensor networks.

MAC-LAYER PROTOCOLS FOR MANET

An ad hoc network can be implemented very easily using the IEEE 802.11 standard for WLAN. Since the mobile nodes in WLAN use a common transmission medium, the transmissions of the nodes have to be coordinated by the MAC (media-access control) protocol. Here we summarize the MAC-layer protocols.

- **Carrier-sense multiple access (CSMA):** Carrier-sense multiple-access protocols were proposed in the 1970s and have been used in a number of packet radio networks in the past. These protocols attempt to prevent a station from transmitting simultaneously with other stations within its transmitting range by requiring each station to listen to the channel before transmitting. Because of radio hardware char-

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