

Wireless Communication-Overview of MANET

Author: Poonam Suri¹; Priti Singh²

Abstract— The wireless arena has been experiencing exponential growth in the past decade. Great advances in network infrastructures, growing availability of wireless applications and emergence of omnipresent wireless all getting more powerful in their capabilities. A type of wireless network known as Mobile ad hoc network represent complex distributed systems that comprise wireless mobile nodes that can freely and dynamically self organize into arbitrary and temporary, topologies of "ad-hoc" network, allows people and devices to internetwork in areas with no pre existing communication infrastructure.

This paper attempts to provides comprehensive overview of Ad Hoc Network. The first section gives the overview of wireless communication and ad hoc network, Section second describes the characteristics of wireless communication, section third covers the type of wireless network, further it explains the evolution and application of ad hoc network, next the challenges of ad hoc network are described.

Index Terms— **Infrastructure less, MANET, SURAN, PRNet, Wireless communication.**

1. INTRODUCTION

The field of wireless and mobile communications has experienced an unprecedented growth during the past decade[3]. The distinguishing feature of wireless networks is that packets (segments) are transmitted with the presence of wireless links. Messages in a wireless network through a device is send via the wireless medium, air, to another devices provided that the receiver is within the transmission range of the sender device. This functionality adds flexibility to how a wireless network is formed and structured.

The presence of a fixed supporting structure limits the adaptability of wireless systems. Furthermore, the technology cannot work effectively in places where there is no fixed infrastructure. The Future generation wireless systems will require easy and quick deployment of wireless networks[1].Opposed to the infrastructure wireless networks where each user directly communicates with an access point or base station, a mobile ad hoc network[MANET] is a kind of wireless network.[2] It offer

quick and easy network deployment in situations where it is not possible.

Ad-hoc is a Latin word, which means "for this or for this only." Mobile adhoc network is an autonomous system of mobile nodes connected by wireless links; each node operates as an end system and a router for all other nodes in the network[1]. An Ad-hoc network is a collection of wireless mobile nodes which dynamically forming a temporary mobile network without the aid of any established infrastructure or centralized administration [1]. Furthermore ad hoc networks are usually such networks that are set up for one time occurrences such as conferences or military operations. This can be paraphrased into the following definition an ad hoc network is a flexible and adaptive network with no fixed infrastructure.

Ad hoc networks are envisioned as a key technology for ubiquitous/present networking. It is a suitable technology for embedded network devices in multiple environments such as vehicles, mobile telephones and personal appliances. As an *infrastructureless* technology, it will allow users to create their Personal Area Networks (PAN). The benefit of Ad hoc networks is that users can create the network automatically when needed and tear it down if it is not required anymore. The network can be created at any point in time for any communication purpose such as leisure, military or disaster situations. Ad hoc networks have an undefined lifetime since they can be up and running momentarily or permanently as long as there is a group of users that are willing to be part of the network. Nowadays, mobile computers and personalized applications are indispensable. Users demand connectivity at any time at any place, even where the appropriate infrastructure is not available. In this kind of scenarios, it is necessary that wireless devices learn how to communicate among themselves without routers, base stations or service providers. Ad hoc networks could be the solution to fulfil these user needs but they present new challenges that have not been primary concerns in fixed networks deployment until now.

2. Characteristics of Wireless communication

Wireless networking refers to the use of infrared or radio frequency signals to share information and resources

between devices. Many types of wireless devices mobile terminals, pocket size PCs, hand-held PCs, laptops, cellular phone, PDAs, wireless sensors, and satellite receivers are available today.

Due to the differences found in the physical layer of these systems, wireless devices and networks show distinct characteristics from their wire line counterparts, specifically,

- 1) Higher interference results in lower reliability.
 - Infrared signals suffer interference from sunlight and heat sources, and can be shielded/absorbed by various objects and materials. Radio signals usually are less prone to being blocked; however, they can be interfered with by other electrical devices.
- 2) Low bandwidth availability and much lower transmission rates, typically much slower-speed compared to wireline networks, causing degraded quality of service, including higher jitter, delays, and longer connection setup times.
- 3) Highly variable network conditions:
 - Higher data loss rates due to interference
 - User movement causes frequent disconnection
 - Channel changes as users move around
 - Received power diminishes with distance
- 4) Limited computing and energy resources: limited computing power, memory, and disk size due to limited battery capacity, as well as limitation on device size, weight, and cost.
- 5) Limited service coverage. Due to device, distance, and network condition limitations, service implementation for wireless devices and networks faces many constraints and is more challenging compared to wired networks and elements.
- 6) Limited transmission resources:
 - Medium sharing
 - Limited availability of frequencies with restrictive regulations
 - Spectrum scarce and expensive
- 7) Device size limitation due to portability requirements results in limited user interfaces and displays.
- 8) Weaker security: because the radio interface is accessible to everyone, network security is more difficult to implement, as attackers can interface more easily.

3. Types of wireless network

Many types of wireless networks exist, and can be categorized in various ways depending on the criteria chosen for their classification. By network formation and architecture the wireless networks can be divided in following two categories:-

A. Infrastructure-based network

A network with pre constructed infrastructure that is made of fixed and wired network nodes and gateways, with, typically, network services delivered via these preconfigured

infrastructures. For example, cellular networks are infrastructure-based networks built from PSTN backbone switches, MSCs, base stations, and mobile hosts. Each node has its specific responsibility in the network, and connection establishment follows a strict signalling sequence among the nodes [2]. WLANs typically also fall into this category.

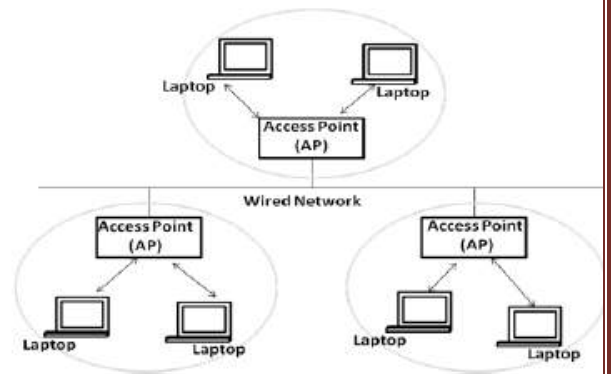


Figure 1: Infrastructure Wireless network

B. Infrastructure less (ad hoc) network

In this case a network is formed dynamically through the cooperation of an arbitrary set of independent nodes. There is no prearrangement regarding the specific role each node should assume. Instead, each node makes its decision independently, based on the network situation, without using a pre existing network infrastructure. For example, two PCs equipped with wireless adapter cards can set up an independent network whenever they are within range of one another. In mobile ad hoc networks, nodes are expected to behave as routers and take part in discovery and maintenance of routes to other nodes.

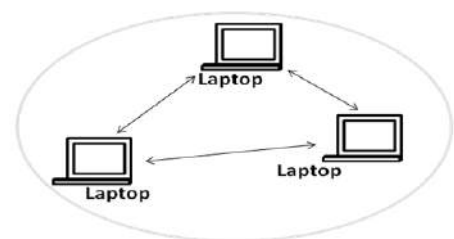


Figure 2: Infrastructure less network

4. AD HOC NETWORK

As described above Mobile ad hoc networks are infrastructure less networks since they do not require any fixed infrastructure such as a base station for their operation. In general, routes between nodes in an ad hoc network may include multiple hops and, hence, it is appropriate to call such networks “multi hop wireless ad hoc networks.” Figure 3 shows an example mobile ad hoc network and its communication topology.

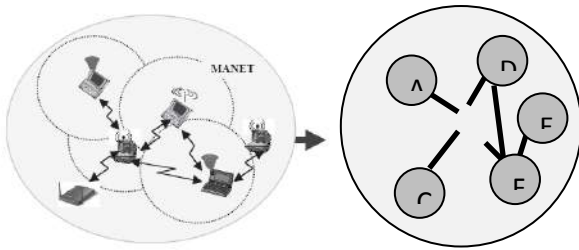


Figure:3 Mobile ad hoc network

As shown in Figure 3, an ad hoc network might consist of several home-computing devices, including notebooks, handheld PCs, and so on. Each node will be able to communicate directly with other nodes that reside within its transmission range. For communicating with nodes that reside beyond this range, the node needs to use intermediate nodes to relay messages hop by hop.

The topology of such an ad hoc network is dynamic in nature due to constant movement of the participating nodes, causing the intercommunication patterns among nodes to change continuously. Ad hoc wireless networks eliminate the constraints of infrastructure and enable devices to create and join networks on the fly any time, anywhere for virtually any application.

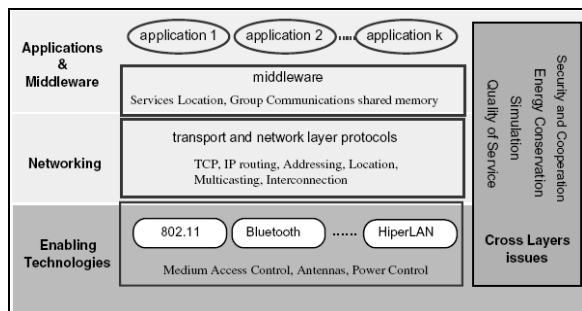


Figure2: Simple MANET Architecture

4.1 EVOLUTION OF MANET

Historically, mobile ad hoc networks have primarily been used for tactical network related applications to improve battlefield communications/ survivability. The dynamic nature of military operations means that military cannot rely on access to a fixed pre-placed communication infrastructure in battlefield. Pure wireless communication also has limitation in that radio signals are subject to interference and radio frequency higher than 100 MHz rarely propagate beyond line of sight (LOS) [6]. Mobile ad hoc network creates a suitable framework to address these issues by providing a multi-hop wireless network without pre-placed infrastructure and connectivity beyond LOS. Early ad hoc networking applications can be traced back to the DARPA Packet Radio Network (PRNet) project in 1972 [6], which was primarily inspired by the efficiency of the packet switching technology, such as bandwidth sharing and store-and-forward routing, and its possible application in

mobile wireless environment. PRNet features a distributed architecture consisting of network of broadcast radios with minimal central control; a combination of Aloha and CSMA channel access protocols are used to support the dynamic sharing of the broadcast radio channel. In addition, by using multi-hop store-and-forward routing techniques, the radio coverage limitation is removed, which effectively enables multi-user communication within a very large geographic area. Survivable Radio Networks (SURAN) were developed by DARPA in 1983 to address main issues in PRNet, in the areas of network scalability, security, processing capability and energy management. The main objectives were to develop network algorithms to support a network that can scale to tens of thousands of nodes and withstand security attacks, as well as use small, low-cost, low-power radios that could support sophisticated packet radio protocols [6]. This effort results in the design of Low-cost Packet Radio (LPR) technology in 1987 which features a digitally controlled DS spread-spectrum radio with an integrated Intel 8086 microprocessor-based packet switch. In addition, a family of advanced network management protocols was developed, and hierarchical network topology based on dynamic clustering is used to support network scalability. Other improvements in radio adaptability, security and increased capacity are achieved through management of spreading keys [8]. Towards late 1980s and early 1990s, the growth of the Internet infrastructure and the microcomputer revolution made the initial packet radio network ideas more applicable and feasible [6]. To leverage the global information infrastructure into the mobile wireless environment, DoD initiated DARPA Global Mobile (GloMo) Information Systems program in 1994 [7], which aimed to support Ethernet-type multimedia connectivity any time, anywhere among wireless devices. Several networking designs were explored; for example Wireless Internet Gateways (WINGs) at UCSC deploys a flat peer-to-peer network architecture, while Multimedia Mobile Wireless Network (MMWN) project from GTE Internetworking uses a hierarchical network architecture that is based on clustering techniques. Tactical Internet (TI) implemented by US Army at 1997 is by far the largest-scale implementation of mobile wireless multi-hop packet radio network [6]. Direct-sequence spread-spectrum, time division multiple access radio is used with data rates in the tens of kilobits per second ranges, while modified commercial Internet protocols are used for networking among nodes. It reinforces the perception that commercial wire line protocols were not good at coping with topology changes, as well as low data rate, and high bit error rate wireless links. In 1999, Extending the Littoral Battle-space Advanced Concept Technology Demonstration (ELB ACTD) was another MANET deployment exploration to demonstrate the feasibility of Marine Corps war fighting concepts that require over the horizon (OTH) communications from ships at sea to Marines on land via an aerial relay. Approximately 20 nodes were configured for the network, Lucent's WaveLAN and VRC-99A were used to build the access and backbone network

Mobile Ad Hoc Network Applications	
Application	Possible Scenarios/ services
Tactical networks	Military Communication, automated Battle fields
Sensor Network	Remote weathers for sensors, earth activities
Emergency Services	Disaster recovery, earthquakes, crowd control and commando operations
Educational Applications	Setup virtual class & conference rooms
Entertainment	Multi-user games, robotics pets.
Location Aware Services	Automatic Call forwarding, advertise location specific services, Location-dependent travel guide.

connections. The ELB ACTD was successful in demonstrating the use of aerial relays for connecting users beyond LOS. In the middle of 1990, with the definition of standards (e.g., IEEE 802.11) commercial radio technologies have begun to appear on the market, and the wireless research community became aware of the great commercial potential and advantages of mobile ad hoc networking outside the military domain. Most of the

existing ad hoc networks outside the military arena have been developed in the academic environment, but recently commercially oriented solutions started to appear (see, e.g., Mesh Networks 1 and SPANworks).

In brief the evolution of MANTES:-

- In 1970, Norman Abramson and his fellow researchers at the University of Hawaii invented ALOHAnet.
- In 1972 DARPA Packet Radio Network (PRNet)
- In 1980 Survivable Radio Networks (SURAN).
- During 1980 emergence of Internet Emerging Task Force (IETF), termed the mobile ad hoc networking group.
- In 1994 emergence of Bluetooth by Ericsson.

4.2 AD-HOC APPLICATIONS

5. Challenges in ad hoc network

Despite the long history of ad hoc networking, there are still quite a number of problems that are open. Particularly among ad hoc networks designed for the military, scalability is one of the most important open problems. Scalability in ad hoc networks can be broadly defined as whether the network is able to provide an acceptable level of service to packets even in the presence of a large number of nodes in the network. As in wired networks, this capability is closely related as to how quickly network protocol control overhead increases as a function of an increase in the number of nodes and link changes. Some of the challenges in Ad hoc networks are:

- Changing the network topology over time
- Host is no longer an end system - can also be an acting intermediate system
- Potentially frequent network partitions
- Every node can be mobile
- Limited power capacity
- Limited wireless bandwidth
- Presence of varying channel quality

Furthermore, all network protocol developments are need to integrate smoothly with traditional networks and should take into account possible security

6. Conclusion

The rapid evolution in the field of mobile computing is driving a new alternative way for mobile communication, in which mobile devices form a self-creating, self-organising and self-administering wireless network, known as mobile ad hoc network. Its intrinsic flexibility, lack of infrastructure, ease of deployment, auto-configuration, low cost and potential applications make it an essential part of future pervasive computing environments. Mobile ad hoc networks (MANETs) are envisioned to become key components in the 4G architecture, and ad hoc networking capabilities are expected to become an important part of overall next-generation wireless network functionalities. From a technological point of view, the realization of this vision still requires a large number of challenges to be solved related to devices, protocols, applications and services. The concise discussion in this paper shows that, despite the large efforts of the MANET research community and the rapid progress made during the last years, a lot of challenging technical issues remain unanswered. From an economical point of view, this network has open up new business opportunities for telecom operators and service providers. To this end, appropriate business scenarios, applications and economical models need to be identified, together with technological advances, making a transition of ad hoc networks to the commercial world viable.

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