Review Article

Mobile Ad Hoc Network

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Abstract A mobile ad hoc network (MANET) is a network of wireless mobile devices. It consists of many free or autonomous nodes/devices equipped with antennas which can communicate among each other using a wireless communication technology such as Wi-Fi and Bluetooth. The topology is highly dynamic and the nodes share the same physical medium. The nodes can freely create and dynamically self-organize a temporary wireless network. The flexibility and easy deployment of MANET have attracted many applications such as military battlefield, vehicle communication, emergence rescue, and disaster recovery. This paper provides a brief introduction to MANET.

Introduction

Wireless technologies are invading our lives through the increasing use of smart phones and portable computers. It is common today to see people everywhere and at anytime use mobile telecommunications devices, such as cellular/mobile phones, Personal Digital Assistants (PDAs), or laptop. The proliferation of these mobile devices has led to the emergence of mobile computing and mobile ad hoc networks [1].

Mobile ad hoc network (or MANET) is an emerging type of wireless networking. It is a kind of wireless ad hoc network (WANET). It is a decentralized type of wireless network without fixed infrastructure. It is a wireless network composed of mobile nodes. It is ad hoc network because it is infrastructure-less and does not rely on a pre-existing infrastructure. It is a self-configuring and dynamic network in which nodes are free to move. This is a technology to support nomadic host "roaming." A typical MANET is shown in Figure 1 [2].

MANET was originally used in military projects, including in tactical networks and Defense Advanced Research Projects Agency (DARPA) projects. The earliest types of MANETs were called "packet radio networks," which were sponsored by DARPA in the early 1970s.
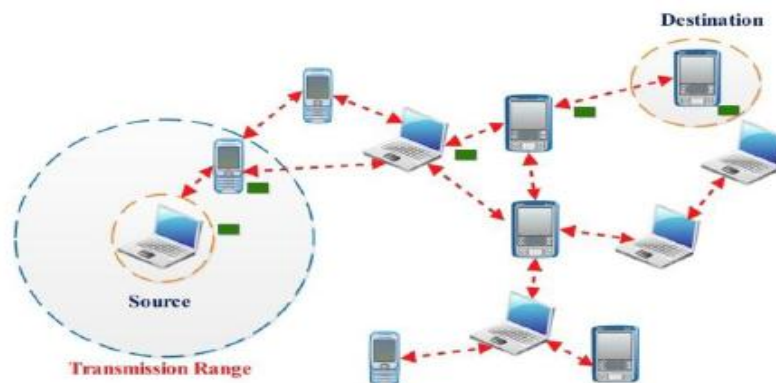

Figure 1   A typical MANET [2]

Characteristics of MANET

A MANET, also known as the packet radio network, is the group of nodes that share information with each other and move around freely. The mobile nodes communicate only through wireless medium. The key characteristic of a MANET is the mobility of the nodes. Each mobile node behaves as a router as they forward traffic to other nodes in the network. This requires that each node continuously maintain the information needed to properly route traffic. Nodes represent devices or gadgets such as cell phone, laptop, PDA, individual electronic devices, electric vehicles, and MP3 player.

Unlike traditional networks, a MANET lacks infrastructure or centralized administration and dedicated routers. Topology changes frequently due to the mobility of the nodes. The nodes are mainly battery-powered; therefore they are energy-constrained. A node can communicate directly with another node only if they are within each other's transmission range. Otherwise, the message may traverse several hops before reaching the destination node [3].

The characteristics of MANETs are summarized as follows [4]:

1. Self-organizing and self-managing
2. Most or all of the nodes are mobile
3. Dynamic network topology
4. Wireless
5. Node is both a host and a router
6. Multiple hop routing
7. Power-constrained operation
8. Variation in scale
9. Heterogeneity
10. Decentralization
11. Variable routing paths
12. Dynamic topology
13. No access point required
14. Distributed operation
15. Bandwidth-constrained and variable capacity links
16. Limited physical security.

Types of MANET

Mobile ad-hoc networks can be classified by their usage [5]:

- Vehicular ad hoc networks (VANETs) are used for communication between vehicles and roadside equipment.
- Smart phone ad hoc networks (SPANs) use commercially available smart phones to create peer-to-peer networks without relying on cellular carrier networks.
- Internet-based mobile ad-hoc networks (iMANETs) is a type of wireless ad hoc network that supports Internet protocols such as TCP/UDP and IP.
- Hub-Spoke MANET – Multiple sub-MANETs may be connected in a classic Hub-Spoke VPN to create a geographically distributed MANET.
- Military or tactical MANETs are used by military units with emphasis on data rate, real-time requirement, fast re-routing during mobility, data security, radio range, and integration with existing systems.
- Flying ad hoc networks (FANETs) are composed of unmanned aerial vehicles, allowing great mobility and providing connectivity to remote areas.

Applications

The decentralized nature of mobile ad-hoc networks makes them suitable for a variety of applications. The simplicity of their infrastructure makes them quick for deployment and therefore suitable for emergency

situations like natural disasters. With recent performance advancements in computer and wireless communications technologies, MANET is expected to see increasingly widespread use and application.

MANETs can be used in wide range of applications such as road safety, home, health, air/land/navy defense, weapons, monitoring pollution, disaster recovery, heavy construction, mining, transportation, education, entertainment, sensor data collection, file sharing, vehicle-to-vehicle communications, battlefield communications, and emergency communications for rescue operations. These applications are summarized as follows [6]:

- Personal area networking – cell phone, laptop, ear phone, wrist watch
- Military environments – soldiers, tanks, planes
- Civilian environments – taxi cab network, meeting rooms, sports stadiums, boats, small aircraft
- Emergency operations – search-and-rescue, policing, and fire fighting

MANET continues to provide only a fraction of its potential capacity due to scarcity of spectrum, lack of stable infrastructure, and non-commercial requirements such as mission-critical systems. Its applications need to bring value to users, while providing business incentives for corporate participation.

Advantages and Disadvantages

The advantages and disadvantages of MANET can be briefly summarized as follows [7].

Advantages

- More robust than centralized networks
- Highly performing network
- No expensive infrastructure must be installed
- Use of unlicensed frequency spectrum
- Quick distribution of information around sender
- No single point of failure
- Separation from central network administration

Disadvantages

- All network entities may be mobile ⇒ very dynamic topology
- Network functions must have high degree of adaptability
- No central entities ⇒ operation in completely distributed manner
- High mobility, causing links to be frequently broken and reestablished
- Lack of network access control, leaving these networks vulnerable
- Physical security is limited due to the wireless transmission

Challenges

Despite the applications of MANET, there are still some design issues and challenges to overcome [8]. Security concerns are an impediment to deploying MANETs in hostile environments. It is the most serious issue impacting performance of the network. Lack of address privacy is undesirable in both military and civilian MANETs [9]. Another challenge is that radio links can easily be impaired due to interference and jamming. Due to the mobility of the nodes and the constraints linked to a wireless multihop, routing in MANETs is a complex and challenging task. Other challenges are the sparse resources and frequent mobility. Energy saving in MANET devices is crucial to maintaining network services.

Conclusion

Mobile ad-hoc network is an infrastructure less wireless network of autonomous collection of mobile nodes/devices. It is a wireless network without any infrastructure. As the popularity of mobile device and wireless networks rapidly increases over the years, MANET has become an active field of communication and networks. Internet-based MANET is an emerging technology that supports self-organizing, mobile networking infrastructures, and is one which appears well-suited for use in future commercial and military applications [10]. More information about MANET is available in books in [11-14] and other books available at Amazon.com.

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