An Overview of MANET: Concepts, Architecture & Issues

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Abstract--A Mobile Ad Hoc Network (MANET) is a self organizing collection of wireless mobile nodes that form a temporary and dynamic wireless network without any infrastructure. The MANET technology truly supports pervasive computing because in many contexts information exchange between mobile units cannot rely on any fixed network infrastructure but on rapid configuration of a temporary wireless network. This is the main motivation behind MANET. In this paper we study what makes all this possible, what are the basic concepts, its architecture and issues to be considered when deploying MANET

Keywords-- MANET, pervasive computing, wireless network, architecture, issues

I. INTRODUCTION

A Mobile Ad Hoc Network (MANET) is a continuously self configuring, infrastructure-less network of mobile devices connected without wires. Ad Hoc is Latin & means "for this purpose" Each device in a MANET is free to move independently in any direction and will change its links to other devices frequently [1].

The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger internet. They may contain one or multiple & different transceivers between nodes. This results in a highly dynamic autonomous topology.
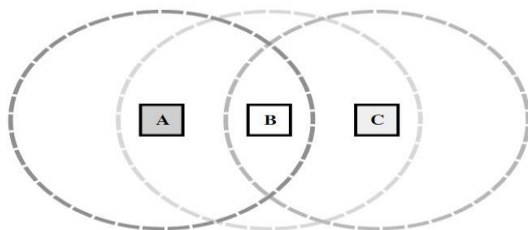

Fig.1. A mobile Ad hoc network of three nodes, where nodes A & C must discover the route through B in order to communicate.

The mobile Ad hoc networks are different from internet in two major ways. The first is that the hosts in this network are resource-constraint. They have only limited energy, computing power & memory. The second is that the hosts (and therefore the routers) of the network are mobile & the topology changes rapidly. These two features pose great challenges to the researchers working in the area [2].

MANET nodes are typically distinguished by their limited power, processing & memory resources as well as high degree of mobility. In such networks, the wireless nodes may dynamically enter the network as well as leave the network. Due to the limited transmission range of wireless network nodes, multiple hopes are usually needed for a node to exchange information with any other node in the network[3].

II. HISTORY

We can characterized the life cycle of mobile ad hoc network into first, second and third generation. Present ad hoc network are considered the third generation [4][5]. The first generation of ad hoc network can be traced back to 1970's. In 1970's, these are called Packet Radio Network (PRNET) [6]. The Defence Advanced Research Project Agency (DARPA) initiated research of using packet- switched radio communication to provide reliable communication between computers and urbanized PRNET. Basically PRNET uses the combination of Areal Location of Hazardous Atmospheres (ALOHA) and Carrier Sense Multiple Access (CSMA) for multiple access and distance vector routing [7][4][5].

The PRNET is then evolved into the Survivable Adaptive Radio Network (SURAN) in the early 1980's. SURAN provides some benefits by improving the radio performance (making them smaller, cheaper and power thrifty). This SURAN also provides resilience to electronic attacks.

Around the same time, United State Department of Defence (DOD) continued funding for programs such

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Globe Mobile Information System (GloMo) and Near Term Digital Radio (NTDR). GloMo make use of CSMA/CA and TDMA molds, and provides self-organizing and self-healing network (i.e. ATM over wireless, Satellite Communication Network). The NTDR make use of clustering and link state routing and organized an ad hoc network. NTDR is worn by US Army. This is the only "real" ad hoc network in use. By the growing interest in the ad hoc networks, a various other great developments takes place in 1990's. The functioning group of MANET is born in Internet Engineering Task Force (IETF) who worked to standardized routing protocols for MANET and gives rise to the development of various mobile devices like PDA's, palmtops, notebooks, etc. Meanwhile the Development of Standard IEEE 802.11 (i.e. WLAN's) benefited the Ad hoc network. Some other standards are also developed that provide benefits to the MANET like Bluetooth and HIPERLAN.

III. CHARACTERISTICS OF MANET

MANET has the following features [8]:

A. Autonomous Terminal:

In MANET, eachmobile terminal is an autonomous node,which may function as both a host and arouter. In other words, besides the basicprocessing ability as a host, the mobilenodes can also perform switching functionsas a router. So usually endpoints andswitches are indistinguishable in MANET.

B. Distributed operation:

There is no background network for the central control of the network operations and so the control and management of the network is distributed among the terminals. The nodes involved in a MANET should collaborate amongst themselves and each node acts as a relay as needed, to implement functions e.g.security and routing.

C. Multihop routing:

Basic types of ad hoc routing algorithms can be single-hop and multi-hop, based on different link layer attributes and routing protocols. Single-hop MANET is simpler than multi-hop in termsof structure and implementation, with the cost of lesser functionality and applicability. When delivering data packets from a source to its destination out of the direct wireless transmission range, the packets should be forwarded via one or more intermediate nodes.

D. Dynamic network topology:

Since the nodesare mobile, the network topology may change rapidly and unpredictably and theconnectivity among the terminals varies withtime. MANET should adapt to the traffic andpropagation conditions as well as themobility patterns of the mobile networknodes. The mobile nodes in the networkdynamically establish connectivity amongthemselves as they move about, formingtheir own network on the fly. Moreover, auser in the MANET may not only operatewithin the ad hoc network, but mat requireaccess to a public fixed network (e.g. Internet)

E. Fluctuating link capacity:

The nature ofhigh bit-error rates of wireless connectionmight are more profound in a MANET. Oneend-to-end path can be shared by severalsessions. The channel over which theterminals communicate is subject to noise, fading, and interference, and has lessbandwidth than a wired network. In somescenarios, the path between any pair of userscan traverse multiple wireless links and thelink themselves can be heterogeneous.

F. Light-weight terminals:

In most cases, theMANET nodes are mobile devices with lessCPU processing capability, small memorysize, and low power storage. Such devicesneed optimized algorithms and mechanismsthat implement the computing andcommunicating functions.

IV. MANET ARCHITECTURE

The architecture ofMobile Ad-hoc Network (MANET) is shown in figure 2. The network architecture isgrouped intomain three categories:

• Enabling technologies;
• Networking;
• Middleware and applications

A. Enabling Technology:

Depending on their coverage area, these technologies are classified into severalclasses:
Body (BAN), Personal (PAN), Local (LAN), Metropolitan (MAN) and Wide (WAN) area networks [9].

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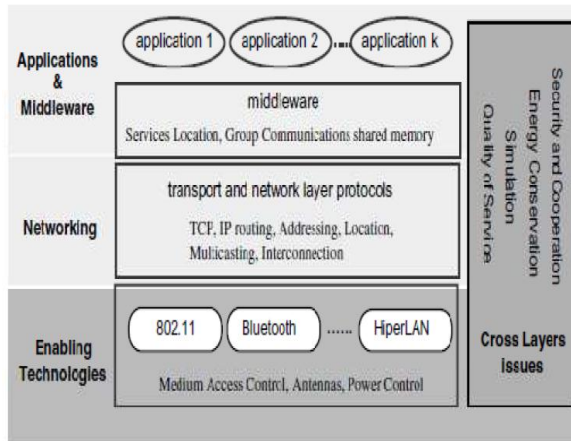Vol. 3, No. 2, April 2015
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Fig. 2.   A simple MANET architecture

A body area network (BAN) is strongly connected with wearable computers. A wearable computer distributes on thebody its components like as head mounteddisplays, microphones, earphones, etc., and the BAN provides the connectivityamong these devices. With respect to the human body range, t he communicating range of a BAN is 1–2 m.

The Personal area networks (PAN) connect the mobile devices which are carried by users to other mobile and stationarydevices. A PAN communicating range is typically up to 10 m.

Wireless LANs (WLANs) support 100–500 mcommunication range for a single building, or a cluster of buildings.Wide- and Metropolitan-area (WAN-MAN) ad hoc networks are mobile multi-hop wireless networks that face manychallenges which are still to be solved (e.g., addressing, routing, location management, security, etc.), and their availabilityis not on immediate horizon
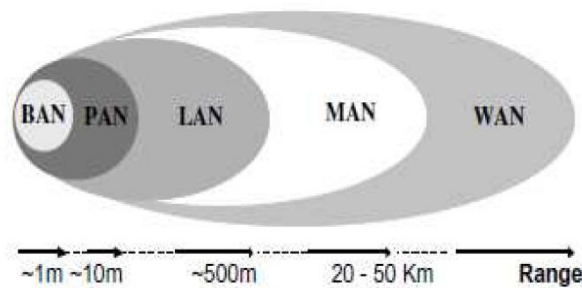

Fig. 3.   Ad hoc networks Taxonomy

B.   Networking

In MANET, most of the main functionalities of the Networking protocols need to be re- designed for the self organizing, dynamic, volatile, peer-to-peer communication environment. The main target of networking protocols is to use the one-hop transmission services which are provided by the enabling technologies to construct end-to-end (reliable) delivery services, from a sender to one (or more) receiver(s). In case of establish an end-to-end communication; the sender needs to locate the receiver within the network. The main aim of a location service is to dynamically map the logical address of the (receiver) device to its current location in the network.

C.   Middleware & Applications

In the previous year the military oriented, non-military applications of MANET have also grown substantially since then. Especially in the past few years, with the rapid development in mobile ad hoc networking research, mobile ad hoc networks have attracted considerable attention and interests from commercial business industry, as well as the standards community. The introduction ofnew technologies like as the WiFi, Bluetooth, IEEE 802.11, WiMAX and HyperLAN greatly facilitates the deployment of ad hoc technology, and new ad hoc networking applications appeared mainly in specialized fields such as emergency services, disaster recovery and environment monitoring. In addition, MANET flexibility makes this technology attractive for several applicative scenarios like, for example, in personal area networking, home networking, law enforcement operation, search and- rescue operations, commercial and educational applications,sensor networks. Mobile ad hoc systems currently developed adopt the approach of not having a middleware, but rather rely on each application to handle all the services it needs.

I.   ADVANTAGES OF MANET

The advantages of an Ad-hoc network include the following:
- They provide access to information and services regardless of geographic position.
- Independence from central network administration. Self-configuring network, nodes are also act as routers. Less expensive as compared to wired network.
- Scalable—accommodates the addition of more nodes.
- Improved Flexiblibility
- Robust due to decentralize administration.
- The network can be set up at any place and time.

V. ISSUES TO BE CONSIDERED WHEN DEPLOYING MANET

Following are some of the main routing issues to be considered when deploying MANET's [10]

A.   Unpredictability of Environment

Ad   hoc   networks   may   be   deployed   in unknownterrains, hazardous conditions, and even

hostile environments where tampering or theactual destruction of a node may be imminent. Depending on the environment, nodefailures may occur frequently.

B. Unreliability of Wireless Medium

Communication through the wireless medium isunreliable and subject to errors. Also, due to varying environmental conditions suchas high levels of electro-magnetic interference (EMI) or inclement weather, thequality of the wireless link may be unpredictable.

C. Resource-Constrained Nodes

Nodes in a MANET are typically battery powered aswell as limited in storage and processing capabilities. Moreover, they may be situatedin areas where it is not possible to re- charge and thus have limited lifetimes. Becauseof these limitations, they must have algorithms which are energy efficient as well asoperating with limited processing and memory resources. The available bandwidth of the wireless medium may also be limited because nodes may not be able to sacrificethe energy consumed by operating at full link speed.

D. Dynamic Topology

The topology in an Ad hoc network may change constantly dueto the mobility of nodes. As nodes move in and out of range of each other, some linksbreak while new links between nodes are created.

As a result of these issues, MANETs are prone to numerous types of faults including the following:

1) *Transmission Errors:*The unreliability of the wireless medium and theunpredictability of the environment may lead to transmitted packets being garbled and
thus received packet errors.

2)*Node Failures:*Nodes may fail at any time due to different types of hazardousconditions in the environment. They may also drop out of the network eithervoluntarily or when their energy supply is depleted.

3) *Link Failures:*Node failures as well as changing environmental conditions (e.g.increased levels of EMI) may cause links between nodes to break. Link failures causethe source node to discover new routes through other links.

4) *Route Breakages:*When the network topology changes due to node/link failuresand/or node/link

additions to the network, routes become out-of-date and thusincorrect. Depending upon the network transport protocol, packets forwarded throughstale routes may either eventually be dropped or be delayed.

5) *Congested Nodes or Links:*Due to the topology of the network and the nature of therouting protocol, certain nodes or links may become over utilized, i.e., congested.

This will lead to either larger delays or packet loss.

VI. CONCLUSION

In this paper we have discussed a new wave in the field of information technology: MANET. We have seen the advancement in the field of internet due to wireless networking technologies. It gives rise to many new applications. In the past few decades, we have seen the advancement in wireless networks. The emerging capabilities of mobile devices have given a new direction to the internet, which decreases the cost and allow us to use infrastructure wireless networks and infrastructure less wireless networks (i.e. Mobile Ad hoc Wireless Network). We have also described its architecture, advantages and some issues. There is no doubt that MANET is development trend for the future.

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