Applications of Mobile Ad Hoc Network (MANET): A Survey

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Abstract

With technological advancements, the network has also evolved to keep up with current tendencies. Mobile Ad hoc Network (MANET) is a technology that consists of a collection of mobile nodes. These nodes communicate with one another without the need for a central administrator. MANETs offer a varied range of applications in many domains such as education, sensor networks, disaster relief, and the military. The widespread of ad-hoc networking is due to the increase of wearable electronics and improvements in wireless communication. Ad-hoc networking can be used whenever there is a lack of or cumbersome usage of existing communication infrastructure. Ad hoc networking enables participants to maintain connectivity while easily adding as well as removing them from the network. MANET has a wide range of applications, from highly dynamic, mobile, and large-scale networks to static, tiny networks bound by power bases. This study used a systematic review strategy to acquire data from previously published studies from publishers, and these data were analyzed and evaluated as well. The study finds that there are numerous applications of MANET technology in various sectors. The magnitude of the dataset and the lack of quality attributes were two of the study's limitations.

Keywords: MANET, Mobile node, Mobile Ad hoc Network

I. INTRODUCTION

Smart transportation is an inevitable part of smart city development, where it is engaging with various emerging technologies considering the security of transportation (Kariapper *et al.*, 2019). This concept helps to track vehicles in real-time through smartphones (Mohamed Nafrees *et al.*, 2021), smart traffic systems (Nizzad *et al.*, 2021), etc. The architecture of Mobile Ad hoc Networks (MANETs) is seen in Figure 01. Enabling technologies, networking, application, and middleware are the three primary levels. The layer which allows technologies may be more separated into a Wireless Body Area Network (BAN), a Local Area Network (WLAN), and a Personal Area Network (PAN) depending on the coverage area (Ramphull *et al.*, 2021).

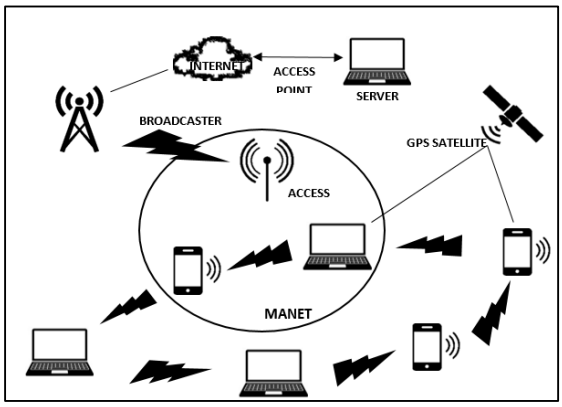

Figure 01: MANET Architecture

The MANET is a kind of wireless mobile communication network invented of mobile nodes with logical equivalency and wireless transceivers. It doesn't depend on any pre-existing infrastructure, but rather on cooperation among mobile nodes with restricted communication capabilities to preserve network connectivity as well as perform data transformations. It has the

following characteristics: multi-hop, Mobility, dynamic topology, self-organizing, wireless, distributed control, restricted connection bandwidth, as well as limited calculating capabilities, which are all features of the mobile network (Zhang *et al.*, 2019). MANETs can be used in a variety of fields, including education, sensor networks, disaster assistance, and the military (Ramphull *et al.*, 2021).

Because MANETS nodes have a limited transmission range, direct communication between the source and also destination is not possible when they are outside their transmission

zones. As a result, intermediate nodes participate in communication, and MANET's communication is divided into two types: "Single Hop Communication" and "Multiple Hop Communication." In the former, nodes within the radio range of each other interact directly, but in multi-hop communication, intermediary nodes assist in relaying messages to their destinations when the destination node is beyond the source node's radio range. Transaction data is not affected by their physical location or proximity to the foundation. In contrast to foundation structures, MANET hubs are all adaptable and their connections are dynamic. MANETS, unlike other flexible systems, do not require a solid basis. This gives the system a valuable decentralized aspect. The structure becomes more adaptive and stronger as a result of decentralization. The use of MANETS may be found in a variety of disciplines. Furthermore, ad-hoc planning is obtaining significance with the growing amount of far-reaching applications in the corporate, private sectors, and military thanks to the proliferation of mobile devices and advancements in remote correspondence. Clients can connect to Ad-Hoc Networks on the go.

Further, the paper has been organized as section II grants the literature review for attaining the applications in MANET. Section III presents the methodology used for this article. Simulation results and discussion is particularized in Section IV and the article is concluded in Section V as well.

II. LITERATURE REVIEW

In a network, each mobile device is self-contained. Mobile gadgets are permitted to roam about as well as organize themselves in whatever way they like. In other words, an ad-hoc network is a wireless network that does not rely on any fixed infrastructure. Multi-hop pathways are used in MANET communications. The MANET's nodes share the wireless medium, as well as the network's architecture, which varies irregularly but also dynamically. Because nodes in a MANET (Muruganandam and Renjit, 2021) are allowed to relocate to any location, communication links are frequently broken. The number of nodes and their density is determined by the applications in which MANET is used (Kumar and Mishra, 2012).

Any of the proposed MANET protocols must be tested and evaluated to ensure their success in a real-world application. Researchers in this field can test their MANET protocols using one of three methods: test beds, simulation tools, and emulators. The simulation tool is an application that, when given a set of controlled inputs, behaves or works like a genuine system (Hortelano *et al.*, 2010). The scale of a wireless ad-hoc network changes dramatically as the number of applications develops, from a network of a few mobile computers in a classroom to a battlefield network of hundreds of mobile units. As nodes travel about a deployed region, a network of a thousand nodes might be broken into several smaller networks of a few hundred nodes (Dhar and Jose, 2005).

Ad-hoc networks of laptops mobile nodes or PDAs that are self-monitored and self-organized and utilized for quick communication during, military operations, information exchange, disaster relief, and emergencies. MANETs have several characteristics, including changeable limited physical security, topology, power limits, and energy. Vehicular Ad-hoc Networks (VANET) is a type of MANET that allows automobiles and permanent roadside devices to communicate with each other (Singh *et al.*, 2011).

Mobile Social Software (MoSoSo) and cluster-based applications for instance emergency/rescue operations or military are widespread on MANETs. An application topology is a group that is not taken into account by present techniques. To gather resource information, there must be any query for all members individually otherwise flood queries throughout the entire network. This produces needless traffic that increases the time it takes to receive the needed source information in cluster-based applications. The prior work suffers from increasing duplicate traffic if there are numerous groups (Kwak *et al.*, 2009). MANET allocates resources for multimedia applications by both agent-based and traditional approaches. Preemptive policies, pricing policies, failure, and congestion, multi-class services with alternate pathways, spatial resolution, bandwidth, load, resource reservation, real-time control, and multilayered-stream are all examples of classic bandwidth allocation techniques. For bandwidth allocation, certain agent-based approaches were suggested. It routes packets according to bandwidth as well as latency measurements (Varaprasad, Wahidabanu and Venkataram, 2008).

The MANETs have a vast area of applications, static networks, from mobile, highly dynamic networks to tiny, large-scale certain by power resources. Aside from legacy applications that migrate from old-style infrastructure to ad hoc environments, a large number of new services may and will be created for the new surroundings. Due to mobility nodes, risks from hacked nodes inside the network, changeable topology, scalability, partial physical security, as well as lack of central administration too. MANETs are more vulnerable to attacks than wired networks. MANET is more susceptible to malicious attacks as a result of these flaws (Goyal, Parmar and Rishi, 2011). Due to uninterrupted end-to-end video communication, Quality of Service (QoS) steering to support multimedia applications is critical over MANET. Nevertheless, traditional source and hop-by-hop routing protocols can't offer adequate QoS for multimedia applications due to the need to maintain state information at each node (Raji and Mohan Kumar, 2014).

The dynamic evaluation approach presented may be expanded to monitoring and assessing various distributed Trust Third Party (TTP) systems in MANET, since the dispersed Cryptographic Application (CA) is an example of the secret sharing application. This assessment methodology can assist administrators in mastering the network's dynamic security as well as taking measurements in real-time. It might be beneficial in actual network security design also construction (Mu and Changlun, 2010).

Ad-hoc networking is becoming increasingly widespread, with a growing number of applications, thanks to the increase of portable devices and improvements in wireless communication. When the current communication structure is unavailable or problematic to utilize, Adhoc networking might be employed. Ad hoc networking allows devices to keep their network connections while deleting and adding them from the network quickly and conveniently. From large-scale, mobile, and highly dynamic networks to microscopic, static networks constrained by power sources, MANET offers a wide range of applications (Bang and Ramteke, 2019). Through hardware enhancement, energy-efficient apps running in a MANET setup are tested, concentrating on issues as well as methods that are furthermost related to a decentralized ad-hoc context. When the participants' Mobile Devices (MDs) aren't conducting any meaningful action, the extreme energy spent in MANET is equal to their idle time (Taneja, Taneja and Kumar, 2016). A fundamental challenge with MANET is arranging an acceptable amount of resources and reserving them for a lengthy period of time. Formulating techniques to support Quality of Service for individual applications is complicated. A protocol for MANETs that assigns channel resources in chronological order so that data transmission between a source and a target across a path can be and without interruption and easily. QoS can be improved to a larger extent by sharing network information across various tiers. Improved QoS has been achieved by merging network and MAC layer functionalities (Rath, Pattanayak and Pati, 2016).

III. METHODOLOGY

This study was written utilizing a qualitative method known as systematic review, which involved reviewing previously published research and review articles. Where the acquired data was examined using a qualitative manner to investigate MANET technology applications.

A. Article Selection Criteria

To shortlist the downloaded publications from publishers such as IEEE, Springer, Emerald, Inderscience, and Researchgate, the following important factors were evaluated. Figure 02 also shows a flowchart of the systematic literature review classification method.

i. Considered only full-length articles.
ii. Articles having a high index in citation databases.
iii. Open-accesses articles
iv. Application of MANET technology (sensor networks, disaster management, commercial segment, education etc.)
v. Published in English

B. Research Question

i. What is defined by Mobile Ad hoc Network?

What are the applications of MANET technology?

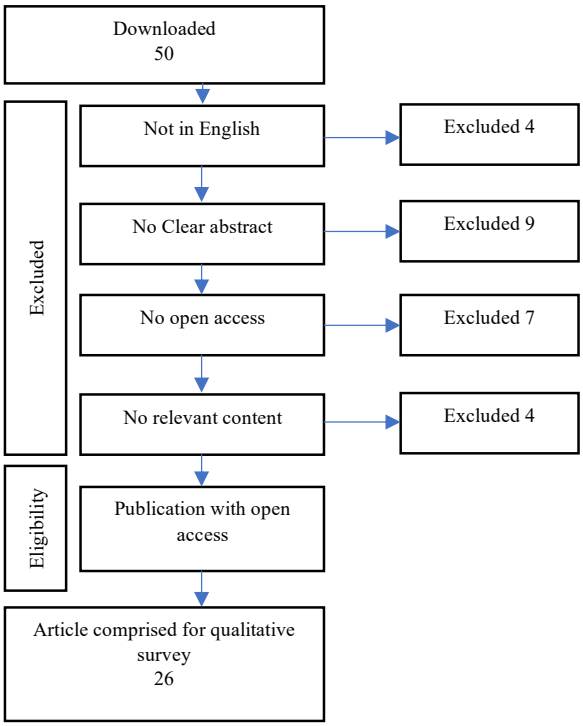

Figure 02: Arrangements of Research studies

IV. RESULTS AND DISCUSSION

Ad-hoc networking is becoming more important as a result of the rise in portable devices and advancements in wireless communication, as well as the rising number of widely used applications. Wherever there is little to no communication infrastructure, or if the infrastructure that does exist is either expensive to maintain or unpleasant to use, ad-hoc networking can be used. Ad hoc networking enables the devices to quickly add and remove devices from the network as well as retain connections to it. MANET may be used for a wide variety of applications, from tiny, static networks that are limited by power sources to big, mobile, highly dynamic networks. In a network, each mobile device is self-contained. Mobile gadgets are permitted to roam about as well as organize themselves in whatever way they like.

A. Sensor Networks

A high number of small sensors are frequently used in this sort of network. Sensors of this sort can be used to gather data from the environment, such as pressure, temperature, gas emissions, as well as pollutants. Each sensor has a finite amount of data to relay to a central computer; thus, it must rely on others. Such sensors have limited processing ability also are disposed to lose or fail too. Mobile ad-hoc sensor networks might be the key to future home security (Nafrees, Sujah and Mansoor, 2021). Sensor networks have grown in popularity as technology such as Artificial Intelligence (AI) and the Internet of Things (IoT) has advanced. Many sensors are scattered around the environment, and each one must interact with its neighbors. As more sensors join the network, the topology changes (Ramphull *et al.*, 2021). Biological animal movement, Health monitoring, weather monitoring, and other uses (Singh and Prakash, 2020).

The network in this technology is made up of numerous tiny sensors. Sensors may be used to identify a vast range of area features. Pressure, temperature, pollution, poisons, and other variables are all checked via sensor networks. Every sensor's abilities are strictly constrained, and it should rely on others to provide data to a central computer. Single sensors have limited computational power and are susceptible to failure and loss. Future homeland security may rely on mobile ad-hoc sensor networks (Chouksey, 2016).

B. Disaster Management

Whenever rescue missions or crises, MANETs are deployed. Rescuers must be able to speak with one another to assist victims. Using inexpensive and readily available technological equipment, rescuers may construct ad hoc networks on the fly. The other organizations and government are developing reply response plans with ad hoc networks in mind, which might give rescuers relevant life-saving information as well as real-time. Disaster-related information may also be found on social media sites like Twitter and Facebook. Currently available data storage systems are unique and lack integration capabilities. To make the most of accessible data, a reliable and scalable storage system that allows for integration, reuse sharing and analysis is necessary (Ramphull *et al.*, 2021).

C. Military or Army

Ad-hoc networking permits the military to leverage the site's shared network structure to create an information network for transferring military information between troops, headquarters, and vehicles. Warfare in the future will be defined by the Network-Centric Warfare (NCW) concept. The armed community is always growing. The power of the communication network and the sharing of knowledge are increasingly appreciated in this concept. The

ideology emphasizes the need of achieving Internet-like capabilities in operating areas as well as retaining admission to an always-on network for communication (Ramphull *et al.*, 2021). There are computer devices attached to military equipment nowadays. Ad-hoc networking would enable the military to use the conventional network to maintain an information network between soldiers, military information headquarters, and vehicles (Chouksey, 2016).
PC technology is increasingly often seen in military equipment. A military might benefit from standard organized innovation by using specifically designated systems administration to maintain a data network among military headquarters, vehicles, and fighters. This sector is where the tactics of particularly assigned systems started (Chouksey, 2016).

D. Personal Area Network and Bluetooth

A personal area network (PAN) is a localized, small network in which nodes are often interconnected to individual devices. A short-range MANET, like Bluetooth, can shorten the connection with numerous moving devices, for example, laptops or mobile phones. For highly big and thick populations, a low-power operation is essential. It's critical to make the most of the device's CPU wireless bandwidth, cycles, battery capacity, and size (Ramphull *et al.*, 2021).
An Ad-hoc system can self-organize and link a temporary mixed media setup using scratch pad PCs or palmtop PCs to distribute and share data among meeting participants. Another suitable local-level use may be in home systems, where devices can connect especially to interchange data (Kumar and Mishra, 2012).

Short-extend MANET can help cell phone users communicate more effectively (for example, cell phone, tablets, and wearable computers). Remote associations replace traditional wired connections. MANET may also connect to the Internet or other systems through devices such as routers (Kumar and Mishra, 2012). Short-range MANETs can make interconnectivity between mobile devices easier. Wireless connections replace cumbersome wired connections. GPRS, UMTS, and Wireless LAN (WLAN) are examples of methods that may be used to expand access to networks or the Internet. In the future ubiquitous computing environment, the PAN might be a promising MANET application sector (Bang and Ramteke, 2019).

E. Local Level

The Ad hoc networks can connect a quick and temporary multimedia network employing palmtop computers or notebook computers to distribute and share information among classroom attendees or sessions. Another local-level use may be in home networks, where gadgets can talk straight to share data. MANET communications will have various applications in different neutral situations such as sports stadiums, taxicabs minor airplanes, and boats (Bang and Ramteke, 2019).

F. Education

The subject of education encompasses a wide range of applications based on MANET civilizations that can enhance their activities and create outcomes that benefit communication, learning, and teaching. Ad-Hoc networks allow users to create a real-time and temporary multimedia network on their device to distribute also share facts. MANETs are used in a variety of educational environments, including virtual conference rooms (Kariapper *et al.*, 2021), classrooms, and university campus wireless signals (Kariapper *et al.*, 2020). Wireless networks can expand their coverage area by communicating with a network that expands as well as mobilizes to meet the user's needs, without having to install additional access points, because the persistent link between the MANET and the wireless internet is generally sufficient. Campus networks can improve their coverage by cooperating and connecting a huge number of mobile devices (Ramphull *et al.*, 2021).

G. Commercial Segment

Ad hoc can be used in frequent cataclysms relief efforts, such as fire, surge, or seismic tremor, as part of crisis/safety operations. Where a non-existing or damaged interchanges framework, as well as speedy sending of a correspondence system, are necessary, protective actions must take place. Starting with one protected coworker, data is passed on to the next (Kumar and Mishra, 2012). During calamities, Ad-hoc Networks can be applied for emergency operations or rescue. To assist the people, rescuers must be capable of communicating. The process is made easier by immediately creating a data network with the communication tools that the rescuers previously have. Ship-to-ship ad-hoc business scenarios law enforcement, and mobile communication, are instances (Chouksey, 2016). An Ad hoc can be utilized in disaster relief energies, such as in the

event of an earthquake, flood, and fire. Where there is no damaged communications infrastructure, emergency rescue operations as well as the fast development of a communication network are required. A tiny hand-carried device is used to send information from one rescue team associate to another. Ship-to-ship ad hoc mobile communication, law enforcement, and other business scenarios are examples (Bang and Ramteke, 2019).

H. MANET-VoVoN

To allow audio streaming and user location via the JXTA virtual overlay network, a MANET-enabled version of the JXTA (Goyal, Parmar, and Rishi, 2011) peer-to-peer, modular, open platform is employed. A client can utilize MANET-JXTA to search asynchronously for a user and a call setup until a way to contact the user is provided. The program employs a proprietary signaling system based on XML messages sent across MANET-JXTA channels of communication (Bang and Ramteke, 2019).

I. Mobile Conferencing

Business customers that need to collaborate outside of their office but don't have access to a network can utilize ad hoc networks to do so. There is an increasing need for mobile computing environments in which project participants must cooperate on development and design. Documents must be shared, data must be uploaded and downloaded, and ideas must be exchanged (Dhar and Jose, 2005).

J. Other Sector

i. Entertainment: Virtual \classrooms, university campuses and Organizations, Meetings with wireless communications (Singh and Prakash, 2020)
ii. Emergency Services: In support of hospital administration (Mohamed Nafrees *et al.*, 2022), it is used for firefighting, policing, disaster management, and search and rescue operations, (Singh and Prakash, 2020).
iii. Tactical networks: Weapons management on the battlefield, use for military applications (Singh and Prakash, 2020)
iv. Coverage extensive: For cellular network access scalability, using the internet of things (IoT) to connect the human body to the actual world (Singh and Prakash, 2020).
v. Tourism: Smart technologies and smart transportation highly increase customer satisfaction and attraction (Razeeth *et al.*, 2020; Nafrees and Shibly, 2021).

V. CONCLUSION

Mobile nodes in a robust and challenging MANET network scenario are autonomous with self-configurable capacity due to the high frequency of topology changes and irregular rearrangement of network components through data transfer. Ad hoc mobile networks are widely employed in the business, government, and private sectors. Customers can use Mobile Ad-hoc Networks to access and exchange information regardless of where they are about infrastructure. In contrast to infrastructure networks, MANETs feature mobile, dynamically connected nodes throughout.

Moreover, there are several applications are available in MANET technology. These applications are used in several aspects as well. The study focused on the most relevant applications in Mobile Ad hoc networks such as commercial, military, education, mobile conferencing, Bluetooth, personal area network, local area, disaster management, sensor network, MANET-VoVoN, entertainment, tactical networks, coverage extensive as well as emergency services. The magnitude of the dataset and the lack of quality attributes were two of the study's limitations.

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