

Mobile Ad Hoc Network (MANET): Applications, Benefits and Performance Issues in a Global Positioning System

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Abstract - Mobile Ad Hoc network (MANET) is now a vital and important area for wireless networks' research and development as the Internet and its developments in wireless network technologies have in no little way, contributed to the precise creation of several mobile computing applications. MANET is attributed as a collection of two or more devices that have wireless capabilities that communicate and share resources without any fixed infrastructure. Each and every node in a MANET has the ability to freely compliment and move autonomously in whatever direction and will as a result vary its links to other devices frequently as they are outfitted and made operational with transmitters and receivers to communicate and relate with other nodes given to the fact that it is a stand-alone kind of network. This paper will analyze some distinctive uniqueness of wired networks, system applications and benefits of MANET, Performance issues in a Global Positioning System.

Key Words: MANET, Wireless Ad Hoc Networks, Global Positioning System, Mobile Ad Hoc Network Mobility, Mobile Computing.

1. INTRODUCTION

With the prevalent growth of computers and wireless communication modalities, mobile computing is now enviable in the field of computer communications. Mobile Ad Hoc Network (MANET) is absolutely a wireless connectivity that passes through nodes which are created by the activities of the network.

MANET is a self-configuring network of mobile routers and nodes connected by wireless links with no access point. Every mobile device in a network is autonomous. Mobile devices are bound to progress and move arbitrarily and arrange themselves subjectively. Nodes in the MANET share the wireless medium and the topology of the network changes erratically and dynamically [1].

In MANET, there is an often breaking of communication link because nodes are free to move everywhere and in any direction. The concentration of nodes and their numbers depend on the platform and applications that are being deployed. MANET has birthed several applications like the Tactical networks, Global Positioning System, Wireless Sensor Network, Data Networks, Device Networks, and etcetera. The foremost purpose of mobile ad hoc network is

to broaden mobility into the area of independent, mobile, and wireless domains, where a set of nodes may be collectively merged to form routers and hosts. This means that they are composed of the network routing arrangements in an ad hoc form. Mobility is an expression used to signify actions and roaming in different domains on the internet.

The mobile nodes are privileged to retain their individual IP addresses by not periodically changing it. This is called a Mobile IP technology. The work of Mobile IP nodes is saddled in the management of IP addresses with the assistance of the Foreign and Home Agents. Ad Hoc Network that is provided by a mobile IP node is a fully wireless system that is bound to utilize any mobile network infrastructure that has no base station. The nodes can be of any link arrangement and each node assumes responsibility for a router work with the Mobile IP with different levels of Mobility [2].

It is important to note that the swift growth of mobile phones is seen to support communication with one another anytime and anywhere and could access the latest information or share some basic information wherefore. MANET infrastructure has also supported the military as the dangers of the field environment are now reduced by the accurate node to node communication and mobility which helps in disaster management. The recent wireless LAN technology has also come to play and that Bluetooth has generated significant awareness as an improvement plan. Bluetooth's main responsibility is to assist wireless devices to contact and relate with one another in an Ad Hoc Network.



Fig -1: Mobile Ad Hoc Network

There are several security vulnerability concerns in wireless systems just like in MANET. MANET is more vulnerable than wired network due to mobile nodes, threats from compromised nodes inside the network, limited physical security, dynamic topology, scalability and lack of centralized management [3]. MANET is more prone to malicious attacks because of its vulnerability.

2. LITERATURE REVIEW

Information technology has been centered mainly on wireless technology sometime now; this does not say that the conventional mobile and other cellular networks are no longer useful.

It is true that Mobile Ad Hoc Network has expunged the limitations of other conventional networks in terms of their infrastructural needs like provisions for routers, base station, and etcetera. This limitation is removed as Ad Hoc Network is in no doubt the main answer to the progression of the wireless network and the Ad Hoc Network are characteristically balanced on equal nodes within communication over the wireless link without any known central control requirement.

It is also true that the Refining Technology (RT) and the Military Tactical Communication (MTC) are seen as the principal application for Ad Hoc Networks. The demands for Ad Hoc Networks applications continue to grow speedily such as rescue mission in a time of natural disasters, law enforcement operations, and other commercial activities are in high demand for Ad Hoc Networks. Mobile ad hoc network was developed by the American Defence Advanced Research Projects Agency (DARPA) in the early 1970s.

Radio system network known as the packet radio systems (PRNET) was developed to transmit the Advanced Research Projects Agency Network (ARPANET) within fixed and mobile nodes. A key focus in MANET has been the routing problem, and a large number of routing protocols have been proposed: Destination Sequenced Distance Vector routing (DSDV) [4], Dynamic Source Routing (DSR) [5], Ad Hoc On-Demand Distance Vector routing (AODV) [6], Ad Hoc On-Demand Multipath Distance Vector (AOMDV) [7] and NACK-Based AODV (N-AODV) [8]. The existence of some of these protocols is only in design.

The history of MANET can be discussed in first, second and third generations. The packet radio network (PRNET) came up within the first generation. This was built by the DARPA. PRNET was built with mobile battlefield elements; this is a platform without known infrastructure. PRNET is said to be reliable, vigorous, trustworthy and operational research network. SURAN (Survivable Adaptive Radio Networks) came within 1980's as a second-generation network. They were significantly improved in the areas of portability,

affordability and more efficient as the radios had a considerable enhancement.

SURAN birthed GloMo (Global Mobile Information System) and the NTDR (Near Term Digital Radio) The objective of GloMo was to present support for office environment Ethernet configured multimedia connectivity at any time. On the other hand, NTDR utilized some cluster link routing state which arranged itself into a distinctive two-tier Ad Hoc network. NTDR is wholly used in crude oil refining and also by the US Army. It is on record that NTDR is simply the only real and non-prototyping Ad-Hoc network that exists at the moment.

Finally, the third generation was developed in the 1990's which is seen as a commercial network that is in use with laptop computers. It also has open source software and based on Radio Frequency and Infrared techniques.

3. SYSTEM APPLICATION OF MANET

Mobile Ad Hoc network is now a reliable mobile network in the business commonplace. The progression in wireless communications and the rampant use of portable devices has given Ad Hoc networks the needed attention it befits.

MANET is now a dependable network in the military formation. The petroleum sector now relies on MANET for crude oil refining; business, public, and other private sectors can now integrate Ad Hoc networks in a commercial quantum. Irrespective of demography and immediacy, network users can now access and share information with the support of Mobile Ad-Hoc Networks.

There is no fixed infrastructure as MANET has dynamic connectivity and free to move to any position unlike other infrastructural networks like the Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Area Network (MAN) and etcetera. MANET assures flexibility, availability, and robustness. We will look at the essence of MANET in the following segments;

3.1 Military Segment

Ad Hoc networks now support the military to take lead in common places like the hostile environments (Sambisa Forest, Birni Gwari, Creeks in the Niger Delta regions, Ezilo Expressway, etc) in order to share information between the military infrastructure, soldiers and the movement of such bandits (Boko Haram, Militants). This will ensure support and maintain information between all the teams in the combatant both the aerial and surveillance sets. This includes the ground and tactical support groups. Information could be released directly from the Defence Headquarters and it will arrive at the intended destination and in a needed time without further requirement or provisions for fixed infrastructure that supports such information delivery.

3.2 Business Segment

Ad Hoc networks are prevalence in the emergency and rescue operations for disaster management like the time of water flooding, fire incidences, and hurricane situations. The rescue teams are capable of communicating using GPS in order to appropriately ventilate their productive energies into useful actions and to also ensure safety and interest. MANET is also most useful to the law enforcement agencies in cyber crime combating and other atrocious and heinous crimes. Taxi transport system like the famous Uber now uses Ad Hoc networks to monitor drivers and their exact mileage plied on each trip. Crude oil refining is made possible through MANET as there is little or no provisions for infrastructures and human presence in such operations.

3.3 Data Networks

A commercial application for MANET includes ubiquitous computing [9]. Data networks possibly will be unlimited and beyond the normal reach of fixed and installed infrastructure by permitting computer systems to send data to its users in a network. This will ensure that networks are readily available and easy to use.

3.4 Sensor Networks

Like in the Global Positioning Systems (GPS), there are some compositions of the mammoth figure of tiny sensors. It helps to identify the number or size of properties in a particular location. The figure below shows the distinctive qualities of an Ad Hoc network with regards to its utilization of infrastructure-less platforms, unlike other networks.

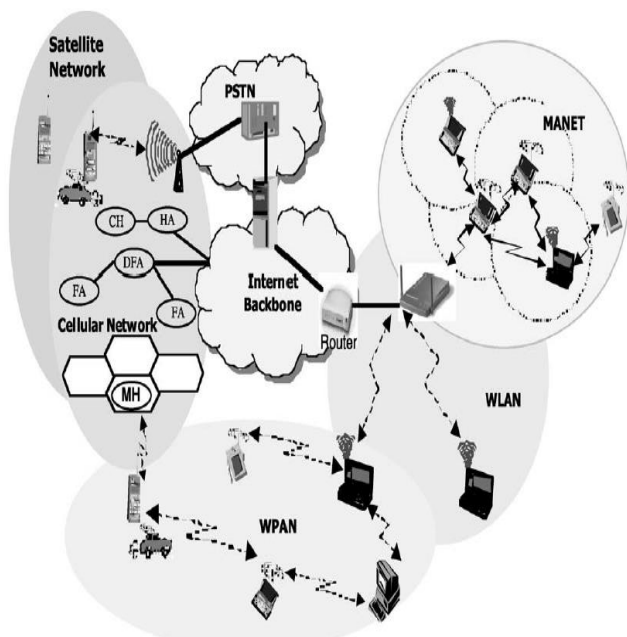


Fig -2: MANET and other Infrastructural Networks

4. BENEFITS OF AD HOC NETWORK ROUTING PROTOCOL

- Ad Hoc Networks are very useful especially in some situations in which the fixed infrastructural network is relatively expensive or not trustworthy.
- Installation of Ad Hoc Network is undemanding as it requires least possible human involvement as the planning of base stations and its installations are not required.
- Mobile Ad Hoc Networks has a built-in structure for the utilization of the 4G architecture and its resources. This provides the ready system environments that support different users to accomplish varying task and communication irrespective of their location or device in use.
- Ad hoc networks could be incorporated into the World Wide Web or the internet as a whole. This means that several devices are bound to interconnect and several users benefiting from the network provider.
- Capacity, range and energy arguments promote their use in tandem with existing cellular infrastructures as they can extend coverage and interconnectivity [10].

5. GLOBAL POSITIONING SYSTEM (GPS)

GPS is a Mobile Ad Hoc Networks Positioning system that uses radio navigation technique to explore devices or environments. GPS consists of 24 satellites within the six orbital planes that operate in a circular of 10,900 nautical miles (20,200 km) orbits with an inclination angle of 55 degrees and with a 12-hour period. GPS operates in an L-band frequency (1575.42 and 1226.6 MHz), and is useful in all the spheres of life both in the Agro business, the taxi cab system, crude oil refining, military, intelligence, and public sectors.

Orbital messages are transmitted from the satellites in the sky and this contains some elements, clocks, and statuses which are useful to the GPS receiver to trace its positioning and the speed rate in terms of velocity. Three satellites are required in deciding the latitude and longitude from the transceiver and also the receiver's height and elevation.

The exactness of some readings is supported by the provision of additional satellites. This will also ensure an adequate accuracy from the readings and to support ground station operations. To improve its accuracy, assistance from ground stations can be applied. Such systems, called *differential GPS* (DGPS), can reduce the error to less than a few meters [11].

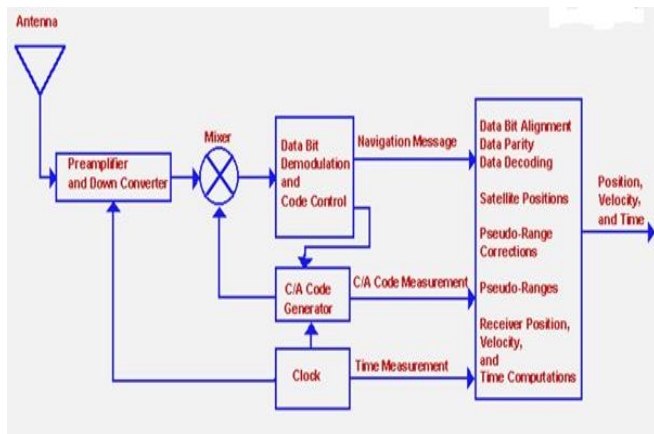


Fig -3: Block Diagram of a GPS Receiver

6. PERFORMANCE ISSUES

MANET and other traditional wired, fixed networks have many different characteristics. For the design of a suitable routing protocol for MANET operating environment, one must consider the different directions and the sub-qualitative and quantitative aspects of the design and implementation [12].

MANET has a handful of challenges as no network is completely efficient. Some of the drawbacks are enumerated as follows;

■ **Independence:** Given to the fact that the routing nodes are independently mobilized, there is no provision for a centralized administrator or server-side entity.

■ **Bandwidth Usage:** Wireless connections are boosted with some bandwidth optimizations but considerably lower than the wired links. The routing protocols in a wireless network system are bound to utilize bandwidth provisions in the most advantageous manner by ensuring that the overhead is kept as moderate as possible. The limited transmission range also imposes a constraint on routing protocols in maintaining the topological information. Especially in MANETS due to frequent changes in topology, maintaining the topological information at all nodes involves more control overhead which, in turn, results in more bandwidth wastage [13].

■ **Active topology:** Since nodes are mobile, they have connected actively in a random mode as links of the system's network are not static. The links are supported in a distance of a node to the other. The process of updating of information within nodes is challenging in a MANET system.

■ **Inadequate resources:** Mobile nodes are bound to rely on battery power only as it is a limited resource that could run down if there are no sufficient backup provisions. Storage space and power supply are also inadequate.

■ **Transmission quality and material security:** Mobility translates to a higher security menace and challenges just like in the peer-to-peer network architecture. The system is made available to several users as the legitimate network users and the malicious attackers abound. Snoopers, spoofing, and denial of service attacks ought to be considered. The resultant dreadful conditions of the received signal should be a concern.

■ **Distribution operation:** This is a qualitative characteristic because of the existence of MANET in the areas that do not have the requirements for the creation of the basic network, routing here may not depend on a particular node to function.

■ **Loop-freedom:** This ensures that the routing protocol ought to be reliable with its distinctiveness given that an appropriate effort should be done to ensure avoidance of wastage of bandwidth.

■ **Demand-based operation:** In order to reduce the burden on each node, if the link is not so much enhanced, demand should be considered when using On-demand approach to the establishment of a pathway and it is only when the need for a particular path queries the establishment of that path [14]

7. CONCLUSION

There is a paradigm shift in the growth and development of mobile technology as wireless alternatives for communications abound. These feat, savages the mobile devices the ability to self-create, self-administration, self-organization, and self-configuration. This is termed a Mobile Ad Hoc Network. Mobile Ad Hoc Network has its own challenges as it is vulnerable mostly at the receiving end, unlike the fixed wired networks. No doubt, vulnerability is a serious security concern in mobile technology. This paper has explained the various principles of MANET which supports thrill seekers and researchers to understand the inherent flexibility, deployment, collaboration and configuration in a wireless network system and other sensor networks like the Global Positioning System.

REFERENCES

- 1) M. Raja and C. Baboo, "An Overview of MANET: Applications, Attacks and Challenges," International Journal of Computer Science and Mobile Computing, Vol.3 Issue.1, Jan. 2014, pg. 409.
- 2) A. Saleh, K. Al-Omari and P. Sumari, "An Overview of Mobile Ad Hoc Networks for the Existing Protocols and Applications," International Journal on Application of Graph Theory in Wireless Ad Hoc and Sensor Networks (Graph - Hoc), Vol. 02, Mar 2010, pg. 87.

- 3) A. Kumar, "Security Attacks in Manet - A Review," National Workshop-Cum-Conference on Recent Trends in Mathematics and Computing (RTMC) 2011, Proceedings published in International Journal of Computer Applications® (IJCA), Apr 2011, pg. 1.
- 4) C. Perkins, and P. Bhagwat, "Highly dynamic Destination-Sequenced Distance- Vector routing (DSDV) for mobile computers," In Proceedings of the conference on Communications Architectures, Protocols and Applications (SIGCOMM '94), London, UK, Aug 31-Sep 1994, ACM: New York, NY, USA, 1994; pp. 234-244.
- 5) D. Johnson, and D. Maltz, "Dynamic Source Routing in Ad Hoc Networks. In Mobile Computing," Kluwer Academic Publisher: Dordrecht, the Netherlands, 1996, pp. 153-181.
- 6) C. Perkins, E. Royer "Ad-hoc On-Demand Distance Vector Routing," In Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications, New Orleans, LA, USA, 25-26 February 1999.
- 7) B. Singh, S. Baghla, and H. Monga, "Mobility models based performance evaluation of AOMDV routing protocol of MANET," International Journal Application Research, 2017, pp. 3, 82-86.
- 8) A. Bianchi, S. Pizzutilo and G. Vessio, "Preliminary description of NACK-based ad-hoc On-demand Distance Vector routing protocol for MANETs," In Proceedings of the 2014 9th International Conference on Software Engineering and Applications (ICSOFT-EA), Vienna, Austria, 29-31 August 2014.
- 9) M. Raja, and C. Baboo, "An Overview of MANET: Applications, Attacks and Challenges," International Journal of Computer Science and Mobile Computing, Vol.3 Issue.1, Jan. 2014, pp. 408-417.
- 10) N. Raza, M. Aftab, M. Akbar, O. Ashraf, and M. Irfan, "Mobile Ad-Hoc Networks Applications and Its Challenges," Communications and Network, Aug 2016, pp. 131-136.
<http://dx.doi.org/10.4236/cn.2016.83013>
- 11) A. Krikelis, "Location-dependent multimedia computing," IEEE Concurrency Vol. 7 Issue 2, April-June 1999 pp. 13-15.
- 12) A. Saleh, K. Al-Omari and P. Sumari, "An Overview of Mobile Ad Hoc Networks for the Existing Protocols and Applications," International Journal on Application of Graph Theory in Wireless Ad Hoc and Sensor Networks (Graph - Hoc), Vol. 02, March 2010, page 94.
- 13) M. Raja, and C. Baboo, "An Overview of MANET: Applications, Attacks and Challenges," International Journal of Computer Science and Mobile Computing, Vol.3 Issue.1, January 2014, pg. 415.
- 14) A. Saleh, K. Al-Omari and P. Sumari, "An Overview of Mobile Ad Hoc Networks for the Existing Protocols and Applications," International Journal on Application of Graph Theory in Wireless Ad Hoc and Sensor Networks (Graph - Hoc), Vol. 02, March 2010, page 94.