FANET: A Review Study

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Abstract-*Large amount of research have been done in MANET in which new techniques have been developed for communication. From MANET then VANET and now FANET has been emerged. MANET is used for communication in mobile phones or laptops or such moveable devices. VANET is used in communication between vehicles with installed OBUs. Now FANET is flying ad hoc network. Here the concept of UAVs have been developed i.e Unmanned aerial vehicles has been produced which moves autonomously with any human personnel. We have discussed the models, protocols, applications ans the security issues regarding FANET in this paper.*

Keywords-MANET, VANET, FANET, UAV, OBU.

I. INTRODUCTION

With the advancement of technology, we have seen the changes from 2G to 4G and from MANET to FANET. Under ad hoc networks, we have MANET, VANET and FANET. MANET stands for Mobile Ad Hoc Networks, VANET is Vehicular Ad Hoc Networks and FANET is Flying Ad Hoc Networks. Ad Hoc Networks are the networks in which a temporary connection is made between two devices without any infrastructure requirement. In MANET the mobile nodes are communicating with each other like mobile phones. As the name indicates Mobile Ad hoc Network i.e it is the connection made between mobile nodes so that they can share information with each other. The connection is on ad hoc basis i.e temporary. In VANET mobile vehicles makes a connection with the help of which they get information about their surrounding and the traffic rush. In VANET vehicles have a device called OBU (On Board Unit) which connects with the road side units to share information about the surrounding. The information is related to either traffic or nearby restaurants, hotels, hospitals etc. Now in case of FANET, connectivity is made between the flying airplanes. FANET has more mobility as compare to other ad hoc networks. Now with the technology, UAV i.e unmanned aerial vehicles has been produced which moves autonomously with any human personnel [6].

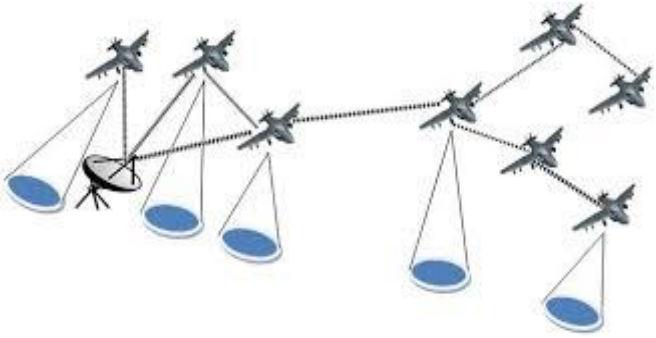

Fig:1

[11]As the UAVs are very flexible, versatile and have less installation expenses, thus have very promising applications in military and civilians.

In MANET i.e mobile ad hoc networks, the mobile nodes are connected with each other. Like we can connect our laptop with our mobile phones or can also make a direct connection between laptops or mobile phones. The mobility of nodes in this is very small as compared to VANET and FANET[5].

Fig:2

We can take the example of Bluetooth in which when one on its Bluetooth connection, all the nearby connection are shown in the mobile which comes under the range. This network formation by Bluetooth is known as piconet.

In VANET, mobile vehicles have been taken which contains the installed OBUs (On Board Units). When the vehicles having OBUs are moving, they receive signals from

RSUs (Road Side Units). OBU act as the interface which helps in the information sharing between RSU and the vehicle. With this information sharing, the mobile vehicle gets the whole information about their surrounding like the available restaurants, hotels, hospitals and also gets the information about the traffic flow on the road.

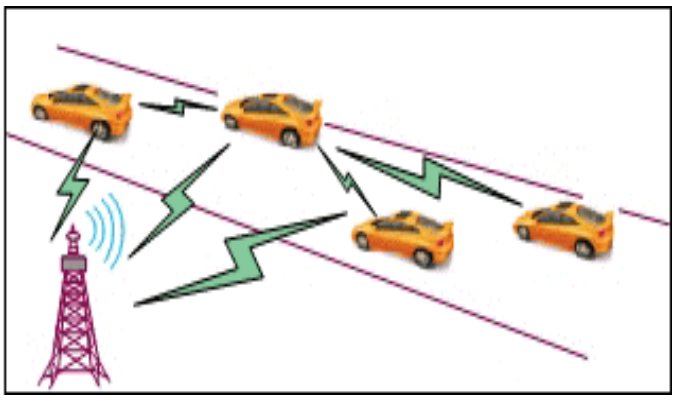

Fig:3

The mobility in case of VANET is more than MANET but less than FANET.

The vehicles can also make connection with each other. They share the information like their speeds, their lane, or any obstacle in the road.It helps in the smooth flow of traffic on the road.

In case of FANET, airplanes are used which are UAVs. The mobility of UAVs are very high as compared to MANET and FANET[8].

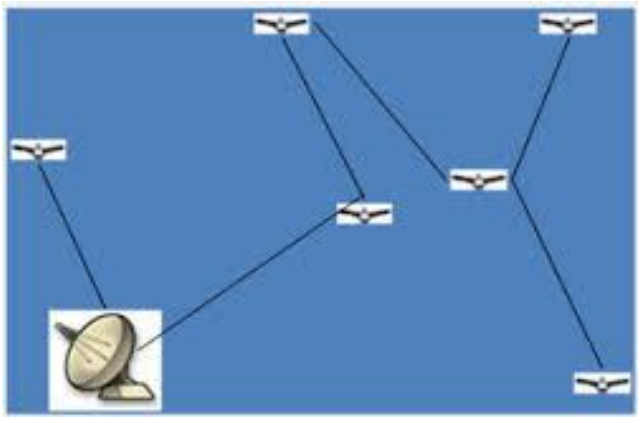

Fig:4

The UAVs can communicate with each other through satellite or ground stations. Mobility is the major concern in case of FANET and the biggest challenge. This high mobility may collide or delay the crucial data [4].

II. MOBILITY MODELS OF FANET

Mobility means the movement of the node and how their location and acceleration changes with time. There are four mobility models used in case of FANET [7].

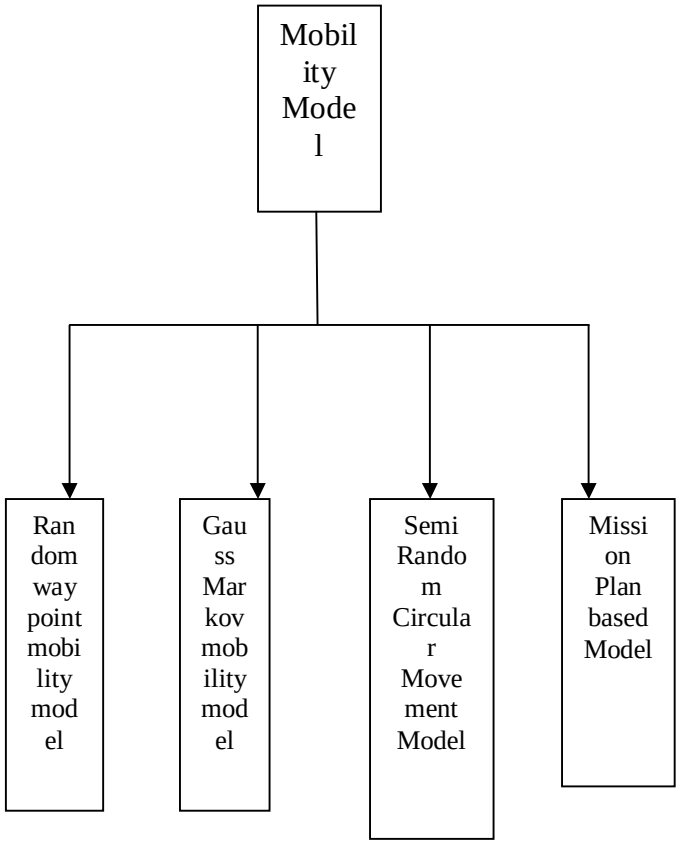

Fig: 5

Random way point mobility model: The random way point uses the pause time between the changes in speed/direction. The UAVs are set to move free independently and can select its destination, speed and direction independent of the neighbour nodes. This is not suitable for aircrafts as the aircrafts doesn't changes its speed and direction randomly and also cannot stay at same position. This mobility is based on three actions: going "straight", "left turn" and "right turn"[9].

Gauss Markov mobility model: In this model, each node is initialized with fixed speed and direction. After a fixed interval of time, the speed and time of the node is updated. The value of nth interval is calculated based on the n-1th position. This scenario is based upon the swarm criteria.

Semi Random Circular Movement model: This model is designed for the curved movement of the UAVs. It gathers the information at the time when the UAV take a turn around a specific position.

Mission Plan Based Mobility Model: The airplanes moves on the predirected path i.e they already knows the path and position of the potential target location information. The

mobility files are created and updated after certain period of time. For each aircraft, starting and ending points are randomly selected while velocity and flight time are given. If an aircraft reaches the destination before the flight time, it takes turn to the starting point and continuous flight as round trip.

III. APPLICATION SCENARIOS

Application of FANET is explained in this section

3.1 Scalable multi UAV communication network

If a UAV cannot communicate with the infrastructure, it cannot operate. On the other hand, FANET is based on the UAV-to-UAV data associations instead of UAV-to-infrastructure data links, and it can extend the coverage of the operation. Even if a FANET node cannot establish a communication link with the infrastructure, it can still operate by communicating through the other UAVs. If a multi-UAV communication network is recognized fully based on an infrastructure, such as a satellite or a ground base, the operation area is restricted to the communication coverage of the infrastructure[1].

3.2 Decrease Payload in FANET

By using FANET, only a subset of UAVs use UAV-to-infrastructure communication link, and the other UAVs can work with FANET, which require lighter communication hardware in many cases. In this way, the endurance of the multi-UAV system can be extended by FANET. The difficulty in payload capacity is not valid only for small UAVs but also High Altitude Low Endurance (HALE) UAVs must consider payload weights. The lighter payload means the higher altitude and the longer endurance If the communication architecture of a multi-UAV system is fully based on UAV-to-infrastructure communication links, each UAV must carry relatively heavier communication hardware.

3.3 Reliable and Consistent UAV Communication

Multi-UAV systems run in a highly dynamic environment. The conditions at the establishment of a mission may change during the operation. If there is no chance to establish an ad hoc network, all UAVs must be connected to an infrastructure. However, during the operation, because of the weather condition changes, some of the UAVs may be disconnected. If the multi-UAV system can support FANET architecture, it can maintain the connectivity through the other UAVs. This connectivity feature enhances the reliability and consistency of the multi-UAV systems.

IV. NETWORKING MODELS IN FANET

FANET can be categorized in 3 main routing classes i.e. Proactive routing protocol, Reactive routing protocol and Hybrid routing protocol[2].

4.1 Proactive routing protocols (PRP)

The main advantage of proactive routing is that it contains the latest information of the routes; therefore, it is easy to select a path from the sender to the receiver, and there is no need to wait. It use tables to store all the routing information of each other's node or nodes of a specific region in the network. Various table-driven protocols can be used in FANET, and they differ in the way of update mechanism of the routing table when the topology changes. Two main protocols are widely used in VANETs: Optimized Link State Routing (OLSR) and Destination- Sequenced Distance Vector (DSDV) protocols.

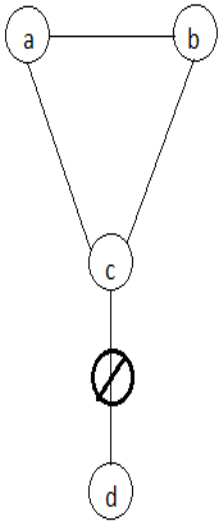

Fig 4.1 DSDV Routing Protocol

4.2 Reactive Routing Protocols

In this, There are two different type of messages *Route Request* message and *Route Reply* message. Route request messages are produced by source node and route reply messages are produced by destination node. It is known as the on demand routing protocol which means if there is no any communication between the nodes then there is no need to store the route between the two. Examples are DSR and AODV[3].

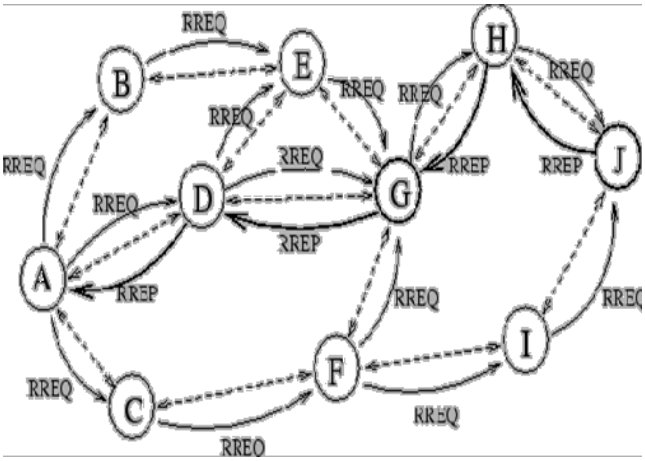

Fig 4.2: AODV Routing Protocol

4.3 Hybrid Routing Protocols

Hybrid routing protocol (HRP) is a combination of previous both protocols, and is presented to overcome their shortcomings. By using HRP, the large latency of the initial route discovery process in reactive routing protocols can be decreased and the overhead of control messages in proactive routing protocols can be reduced. Examples are ZRP and TORA.

V. SECURITY ISSUES AND CHALLENGES IN FANET

There are many challenges related to security purposes in FANET. Some of them are as explained below[10].

5.1 National Regulations

UAVs increasingly become a part of each country's national airspace system, most of countries current air regulations do not allow controlled UAV operations in civil airspace. This can be seen as the biggest current barrier to the development of UASs in civilian areas. Therefore, there is a serious need to define distinctive rules and regulations to integrate UAV flights into the national airspace.

5.2 Quality of Service (QoS)

Defining a comprehensive frame work for QoS enabled middleware is a crucial challenge that should be overcome due to the highly mobile and dynamic structure of FANET. It can transport different types of data, which include GPS locations, streaming video/voice, images, simple text messages, etc. FANET need to support some service qualities to satisfy a set of predetermined service performance constraints like delay, bandwidth, jitter, packet loss, etc[4].

5.3 Routing

In a FANET, due to the fast movement of UAVs, network topology can change quickly. Data routing between UAVs faces a serious challenge, which is different from low mobility environment. The routing protocols should be able to update routing tables dynamically according to topology changes .Most of previous routing algorithms in MANET are partly fail to provide a reliable communication between UAVs. Therefore, there is a need of developing new routing algorithms and networking model for constructing a flexible and responsive integration model.

VI. COMPARISON BETWEEN MANET VANET AND FANET

Table 6.1

	MANET	VANET	FANET
Node Mobility	Low	High	Very High
Mobility Model	Random	Regular	Regular
Node Density	Low	High	Very Low
Localization	GPS	GPS, AGPS,DGPS	GPS,AGPS,DGPS,IMU
Topology Change	Slow	Fast	Fast

VII. CONCLUSION

In this paper we describe about the Flying Ad-hoc Network (FANET). We described the most challenging task i.e. communication between the multi- UAV's. We formally define FANET and present several FANET application scenarios. We also discuss the differences between FANET,MANET and VANET and also other ad-hoc network types in terms of mobility, node density, topology change, radio propagation model, power consumption, computational power and localization. For the future work a new routing protocol is needed to implement and update existing protocols which will be more reliable to other routing protocols.

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