

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 6, Issue 10, October 2017

# Empirical Study of Flying Adhoc Networks and Comparison with Different Wireless Networks

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**ABSTRACT:** With the necessity of better availability and improved scope, synergistic systems are picking up a ton of ubiquity nowadays. From the last few years adhoc networks have attracted considerable attention in the research field as well as boosted up many different areas. The demand of Unmanned Aerial Vehicles (UAVs) is increasing day after day. In modern era, UAVs are being used in increasing number of civil applications, such as policing, fire-fighting, etc in addition to military applications. Despite of installing one large UAV, multiple UAVs are nowadays used for higher coverage network and accuracy. Henceforth, networking models are required to allow two or more UAV nodes to communicate directly or via relay node(s). Flying Ad-Hoc Networks (FANETs) are formed which is basically an ad hoc network for UAVs. This is relatively a new technology in network family where requirements are quite different from traditional networking model, such as Mobile Ad-hoc Networks and Vehicular Ad-hoc Networks. In this paper, Flying Ad-Hoc Networks are surveyed along with its challenges compared to traditional ad hoc networks. Our comparative analysis will help network engineers in choosing appropriate adhoc network based on the specific scenario.

**KEYWORDS:** FANET, Ad-hoc Network, Challenges, Comparison among different adhoc networks

### I. INTRODUCTION

Adhoc systems are decentralized sort of remote systems. They don't depend on a previous foundation, for example, access points in framework remote systems or switches in wired systems. Inferable from this decentralized nature of remote specially appointed systems, they are reasonable for an assortment of utilizations and may enhance the adaptability of systems when contrasted with wireless managed systems. Adhoc networks can be additionally grouped by their application into three general classifications:

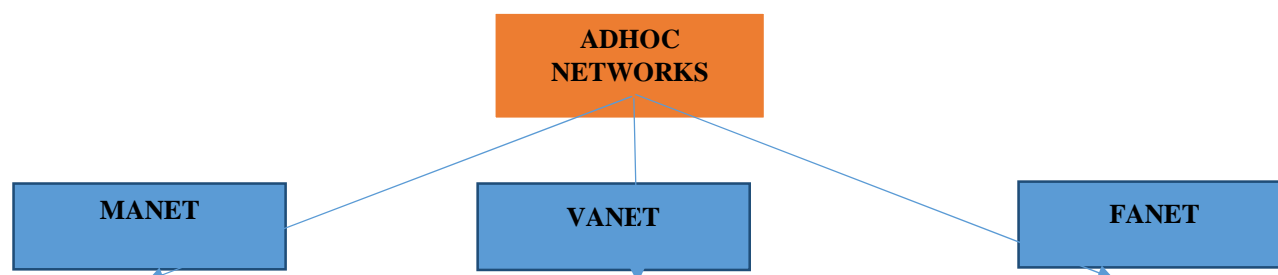


Fig 1. Various Ad-hoc Networks

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Figure 1 shows the classes of wireless adhoc network which are used for different purposes in various fields. First one is MANET which stands for MOBILE ADHOC NETWORK, second one is VANET, which is used for the communication among vehicles, and last one is FANET, which stands for FLYING ADHOC NETWORK. Adhoc networks are divided into three classes, which are as follows:

- **Mobile ad hoc networks (MANETs):**MANETs are self-organizing, temporary, infrastructure-free, multi hop, and dynamic topology wireless networks of mobile devices.
- **Vehicular ad hoc networks (VANETs):**VANETs are one of the popular ad-hoc network used for communication among vehicles as well as base stations.
- **Flying Ad-hoc Networks (FANETs):** The fanet mainly consists of a group of multi devices, in order to coordinate and collaborate, the different object must respect temporal and as well as spatial space of each other.[1]

## II. LITERATURE REVIEW

- Nanxiang Shi et. al.[2] In this paper authors investigated the results of novel routing protocol to address the issues of routing in UAV fleet networks, known as Cluster-Based Location - Aided Dynamic Source Routing (CBLADSR). It frames stable cluster architecture of UAV fleet as the basis and afterwards performs route discovery and route maintenance by utilizing the geographic location of UAVs. In their work they assessed and contrasted the performance of the proposed CBLADSR with DSR and GRP on OPNET Modeler.
- R.Suganthiet. al.[3] This paper examined the execution of DOFP protocol for UAANET. In their work they lessen the routing overhead and the likelihood of data loss. In their outcomes they compared DOFP algorithm with RGR and AODV. They used Network Simulator 2 (NS2) simulator for achieving the desired results.
- IlkerBekmezciet. al.[4] In this paper authors examined the performance of Flying Ad-hoc Network (FANET) with numerous applications. In their work they had taken several FANET application scenarios. They additionally talk about the different contrasts between FANET and other ad hoc network types in terms of mobility radio propagation model, power consumption, computational power, node density, topology change, and localization. For their simulation purpose, they used Test bed for Micro-Aerial Vehicle Swarm Experiment.
- Jean-Daniel Medjo Me Biomoet. al.[5] In this paper authors investigated many mobility models that influenced the performance of UAANET in simulations in order to get good results that provided a benchmark for future UAANET simulations. In their work they had used OPNET Modeler 16.0 for the simulation of the routing protocols.

## III. AD-HOC NETWORKS WITH FLYING NODES

FANETs are a special case of mobile ad hoc networks (MANETs) [6]. FANET are a network with nodes –UAVs–flying in the sky [7], which can automatically fly without human involvement. It comprises of two sections, specially ad hoc system and access point like a satellite or ground base to associate with the system in no less than one of them, as indicated by convey the information starting with one ground base then onto the next. The network that its link is established between each UAV and an access point is not specified as FANET network. Using multi-UAVs in this network family reflects many advantages on this network [8]

- **Minimize the completion time for a request:** At the point when numerous UAVs forms a demand, it will be prepared quicker than one UAV.
- **Minimize the cost and the maintenance:** Utilizing little UAVs is less expensive than one major UAV, and the upkeep is lower also.

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- **Increase scalability:** It can augment the operations done by the system by adding more UAVs to the system powerfully as indicated by the demand needs.
- **Increase sustainability:** The system can work consistently regardless of the possibility that one UAV comes up short since different UAVs can play out the undertaking.

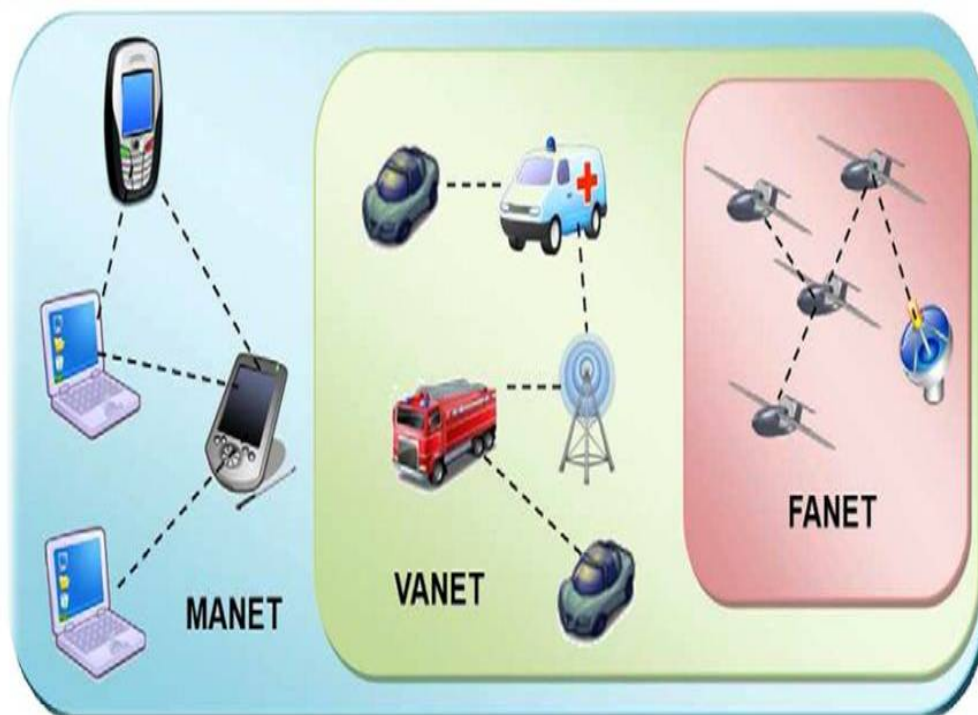


Fig2 Three types of networks

Figure 2 represents the way in which three types of wireless communicate with their respective devices. In this diagram, MANET is a superclass which further contains the VANET as well as FANET as subclasses. No doubt, VANET acts as superclass of FANET.

#### IV. COMPARISON OF FANET WITH MANET AND VANET

Wireless ad hoc networks are arranged regarding their utilization, communication, sending and mission points. By definition, FANET is a sort of MANET, and there are a few basic plan contemplations for FANET and MANET. In addition to this, FANET can likewise be sorted as a subset of VANET, which is further a subset of MANET. This relationship is appeared in Fig. 3. As a research zone, FANET imparts regular highlights to these systems, and it likewise has different interesting design issues. In this segment, the contrasts amongst FANET and the accessible wireless adhoc networks are portrayed detailedly.

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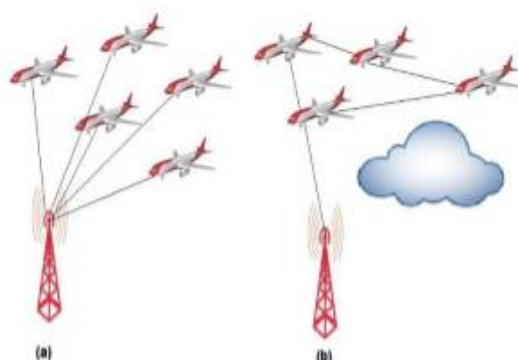


Fig 3 A FANET scenario

Figure 3 illustrates the FANET application scenario for reliable multi-UAV communication network. This type of connectivity characteristic increases the multi-UAV systems reliability.

TABLE 1. Comparison of FANET with existing Ad-hoc Networks

Network Types Criteria	FANET	VANET	MANET
Node Mobility	High degree	Medium degree	Low degree
Mobility model	Usually Predetermined	Steady	Arbitrary
Node Density	Low	Medium	Low
Topology Change	Rapid and speedy	Average speed	Slow and steady
Power Consumption and network lifetime	Needed for mini UAVs, but not needed for small UAVs	Not needed	Need of energy efficient protocols
Computational power	Very big	Average	Limited
Localization	GPS,AGPS,DGPS,IMU	GPS,AGPS,DGPS	GPS

Table 1 shows the comparison between there wireless adhoc networks.Wireless ad hoc networks are categorized according to theirapplication, positioning, communication and topology are getting used.

### Challenges faced by FANET

- Due to the high mobility of the nodes, maintaining a communication link between the UAVs is a challenging task.
- The topology of these networks is more dynamic than MANET
- The existing routing protocols designed for & MANETs partly fail in tracking network topology changes"

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## V. FANET ROUTING PROTOCOLS

In FANET, there are categorized into four main classes of routing protocols:

- Static protocols have fixed routing tables and there is no need to refresh these tables again and again.
- Proactive protocols, or table driven protocols, have routing tables that need to be refreshed after some time.
- Reactive protocols, or on-demand protocols, these types of protocols work on demand and dynamically discover paths for messages.
- Hybrid protocols are a combination of proactive and reactive protocols.

## VI. COMMUNICATION PROTOCOLS FOR FANETS

In this section, the FANET communication protocols and the open research issues are described. We audit the available FANET protocols introduced for the physical layer, medium access control (MAC) layer, network layer, transport layer.

- Physical layer: The physical layer covers the fundamental flag transmission methods, i.e. flag or balance coding. Several data bit sequences can be shown with different waveforms by changing the amplitude, frequency and phase of a signal [5]. Absolutely, in the physical layer, the information bits are directed to sinusoidal waveforms and transmitted into the air by utilizing an antenna. The execution of MANET framework is profoundly in light of its physical layer, and the high versatility puts extra issues on FANET. For creating economical and strong information correspondence models for FANET, the physical layer circumstances must be all around characterized and surely knew. As of late, UAV-to-ground correspondence and UAV-to-UAV situations have been broadly contemplated in both real-time and simulation conditions. Antenna structures and Radio proliferation models are enquired as the key factors that influence FANET physical layer plan.
- Radio propagation model: Electromagnetic waves transmit from the transmitter to the recipient via wireless channels. The feature of radio wave propagation is represented as a mathematical function, which is known as radio propagation modeling [9]. FANET condition has numerous novel issues as far as radio propagation when contrasted with alternate sorts of remote systems.
- MAC layer: Though VANET, MANET and FANET have different issues and features, they have additionally numerous regular outline contemplations. For the most part, FANET is a specific subpart of VANET and MANET. In this way, the first FANET examples utilize IEEE 802.11 with omni-directional antennas [10][11], which is one of the most generally utilized MAC layers for MANETs. With the assistance of the clear-to-send (CTS) and demand-to-send (RTS) flag trade plot, IEEE 802.11 can cover the conceal node problem.
- Network layer: The beginning FANET investigations and studies are composed with the accessible MANET routing protocols. One of the principal fly experiments with FANET engineering is done in SRI International [9]. In this exploration, Topology Broadcast in view of Reverse-Path Forwarding (TBRPF) [9], which is for the most part a proactive protocol, is utilized as the system layer to decrease the overhead. The basic role to choose DSR is its reactive structure.
- Transport layer: The FANET designs achievement is firmly identified to the communication architecture reliability, and building up a reliable transport method is necessary, especially in a highly powerful dynamic environment.

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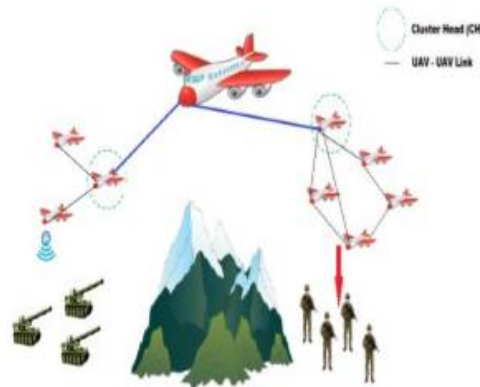


Fig. 4. Hierarchical routing in FANET

Figure 4 represents the FANET architecture in which unmanned Aerial Vehicles is communicating while making the clusters. The primary purpose is choosing the appropriate protocols to complete the process.

## VII. CONCLUSION

Communication is one of the most imperative design issues for multi-UAV systems. In this paper, ad hoc networks among UAVs are investigated as a separate network family i.e. Flying Ad-hoc Network (FANET). We define FANET and explain various FANET routing protocols as well as presents a comparison among three famous adhoc networks in terms of node density, mobility, configuration change. FANET design conditions are also enquired as scalability, adaptability and latency. We also talk about a comprehensive survey of the recent literature on FANETs and related challenges in a layered mechanism.

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