# Performance Analysis of Flying Ad-Hoc Network with Different Antenna

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**ABSTRACT** *Flying Ad-hoc Networks (FANETs) consist of a collection of Unmanned Air Vehicle (UAVs) dynamically forming a temporary network without the use of any existing infrastructure or centralized administration. In this paper the impact of variation of different antenna with variation of speed of air vehicle is investigated. For this purpose Qualnet6.1 simulator has been used and the performance of FANET with different antenna using AODV with speed variation on key network performance metrices i.e. average delay, throughput, jitter, & paket delivery ratio.*

***Keywords***: *FANET, AODV, SPEED OF NODES, Qualnet6.1.*

## INTRODUCTION

FANETs (Flying Ad-hoc Networks) is a group of Unmanned Air Vehicle (Flying nodes) communicating with each other with no need to access point, but at least one of them must be connected to a ground base or satellite [1]. Flying nodes work without human help, like autopilot. This is because cheaper and small wireless communicating devices, the in recent years, many research fields from academia and industry make attention on FANETs. Now, FANETs are used in various applications such as military and civil applications [1], such as managing wildfire [2] and disaster monitoring [3]. As each type of network has its own specification and using the protocol depends on this specification, it is important to use a reliable protocol for this kind of networks and check their performance using simulation. Two factors affect protocol simulation: the first one is mobility model, and the second one is the communicating traffic pattern, among others. This paper focuses on the routing protocols and mobility models that have been used in the FANET network to solve communication, cooperation and collaboration problem between Flying nodes. FANET are a special case of mobile ad hoc networks (MANETs) [4]. FANET are a network with Flying nodes in the sky [1], which can automatically fly without human help. It consists of two parts, ad-hoc network and access point like a satellite or ground base to connect with the network in at least one of them, according to carry the data from one ground base to another. The network that its link is established between each Flying nodes and an access point is not specified as FANET network. Using multi- in the Flying nodes is network family reflects many advantages on this network.

### High Mobility

FANET nodes are highly mobile, with typical UAV speeds of 30-460 km/hr [1]. Such highly mobile UAVs cannot be served by conventional methods such as mobile Internet protocol (IP). Moreover, the efficiency of routing decisions and the quality of wireless links fluctuates due to the high speed of UAVs, leading to performance degradation. A media access control (MAC) layer addresses this issue by maintaining Quality of Service (QOS) for one hop transmission, whereas the routing layer ensures reliable end-to-end delivery. One potential solution to encountering the high mobility of UAVs has to predict the location and movement of UAVs using heuristic techniques. On the favorable side, when FANETs are used as relaying networks, the high mobility factor gives desired outcomes in the establishment of delay-tolerant links between geographically distant infrastructures.

## ROUTING PROTOCOLS USED IN FANETS

There are many routing protocols used in wireless and ad-hoc networks, such as flooding, dynamic source routing, and pre-computed routing. But due to the characteristics of UAVs like speed and rapid changes in links between nodes, these protocols need to be modified and the others will be established to adopt this network issues. Using the following protocols, FANETs network has the property of dynamic adding nodes and deleting nodes from the network due to their needs. These protocols can be viewed as four main classes.

## PROACTIVE ROUTING PROTOCOLS (PRP)

This technique of routing using a table contains all the information about all nodes in the network, thus each node knows all the things about each other in the network. This technique has one main advantage, the table for each node always has the latest information about the other nodes, but we take in our mind that this technique needs a bandwidth because the overhead of the updated messages for the tables, therefore PRP is not applicable for highly mobile or big networks FANETs-. Due to the control of bandwidth in FANETs network, some routing protocols in modified version can be used in order to change the topology for the nodes.

**REACTIVE ROUTING PROTOCOLS (RRP)**

Reactive routing protocols is also called on-demand routing protocol, which means that the path between nodes is established when there is a request RRP comes up to solve the overhead problem in PRP; there is no need to periodically calculate the paths for each node. In this technique, there are two types of messages which are Route Request and Route Reply. Route Request is sent from the source node to all neighboring nodes using flooding techniques to scan the path, and each node uses the same strategy until it reaches the destination. The second one is a message generated by the destination node and goes to the source using the unicast technique. In this case, each node saves the current using one path not all paths, and there is no need to refresh all tables in the network. Bandwidth efficiency is the main advantage to using this technique. On the other hand, it will be slower than PRP because of the time for finding the path.

**Ad-hoc On-demand Distance Vector (AODV)**

The combination of two algorithms i.e. DSDV and DSR result AODV Routing Protocol. Periodic becoming and sequence numbering procedure of DSDV and similar route discovery procedure as in DSR. AODV is reactive protocol based upon distance vector algorithm .The algorithm discovers and maintains links. When nodes want to find a route it forward the route request (RREQ) to all its neighboring and intermediate nodes until it reaches to destination through this an appropriate table is defined forwarding RREQ. Then the route is made available by uni-casting a RRER i.e. route reply back to the source. If a reply is sent, all hosts through that path may record the route to the destination through this packet. Because there may exist multiple exclusive path between two hosts, a mobile host can receive the same RREQ more than once. To stop the same request from being broadcast frequently, every request is alone identified by host ID, Broadcast ID couple. Every host keeps a record for the RREQs that have been processed .The main disadvantages of such algorithms are high latency time in finding routes and excessive flooding when traffic load is high.

**Antenna**

In general, an antenna is a device that is used for radiating/collecting electromagnetic energy (radio signals) into/from space. For the simulation scenario omni directional and three types of directional antenna has been used which is given as:

1. Omni directional antenna
2. Steerable antenna
3. Switched beam antenna
4. Pattern antenna

**Omni directional antenna:** One hypothetical Omni-directional antenna, called isotropic, is a point in space that radiates power in all directions equally. This ideal antenna is often taken as a reference model of practical antennas. A half-wave dipole is a practical Omni-directional antenna, which has a circular radiation pattern in the azimuth plane or in the elevation plane. As an Omni-directional antenna radiates radio signals in all directions, only a small percentage of them can reach the desired nodes and most of them are scattered into space. The scattered radio signals can cause interference with nodes within the coverage of the antenna. Besides, Omni-directional antennas have low efficiency in the frequency reuse as a number of channels are required to avoid interference.

**Steerable antenna**: Steerable antenna is additionally a kind of directional antenna that is used to reduce the interference. In an exceedingly network, once the source nodes cannot focus to a selected angle of the receiver node, a steerable antenna has capability to try and do this. Steerable antenna consists of every type of antenna elements in such a way that the beam is directed towards the receiver node at a selected angle. The antenna elements are placed in such a way that main lobe, side lobe and tail lobe do not create interference and thus interference is reduced.

**Switched beam antenna:** The antenna beam patterns are predetermined by shifting every antenna element's signal phase. Weights for antenna elements, which are used to produce the desired beam pattern, can be locally saved in memory and instantaneously switched.

**Pattern Antenna :** Antennas point RF energy in a specific direction for RF concentration within a targeted area. The gain is higher for that area or in that direction. The high gain pattern antenna are good for sites requiring a directed coverage in specific area or wireless back haul extensions where two wireless access points are connected with each other to extend the wireless network, rather than connected them to wired backbone.

**QOS Parameter**

The following QOS parameters are used for analyzing the performance of the network These parameters are described below:-

**Throughput**

Throughput is the average rate of all the successful data packet received by the destination from source. This is measured in bits/sec

Throughput = Total packet received/Total packet send.

**Average End to End Delay**

The difference in the calculation while transmitting , packets send time and received time is average end to end delay. Buffering during route discovery latency, retransmission delay. This is calculated by the formula

D = (TR-TS)

**Average Jitter**

Jitter is the variation of the packet arrival time jitter is simply the difference in packet delay .In other words, jitter is used to measure time difference in packet inter arrival.

**Packet Delivery Ratio** Packet delivery ratio is defined as the ratio of data packet by the destination to those generated by the source.

**Simulation Setup and Environment**

The simulation model was developed in the scalable and portable simulator qualnet 6.1 with the feature supporting different data rate and different speed of flying nodes. For the simulation setup 50 mobile nodes are randomly placed in terrain size of 1500mx1500m .The access point is put at the centre. The mobility model and the energy model used are random waypoint. The battery model and propagation model used is linear and Jitter, Packet delivery ratio End to End delay, Throughput. For the traffic generation, the traffic source used is CBR (constant bit rate) in which 512bytes of data at data rate of 2mbps rate is sent over the network. There are 5 CBR connection are done.

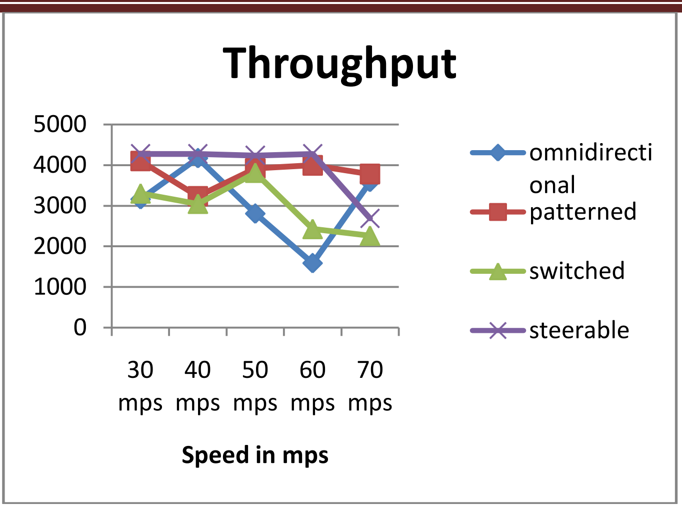
The design scenario of 50 nodes randomly placed in the defined terrain. The simulation parameters are summarized below in Table

**Table 1.Simulation parameters**

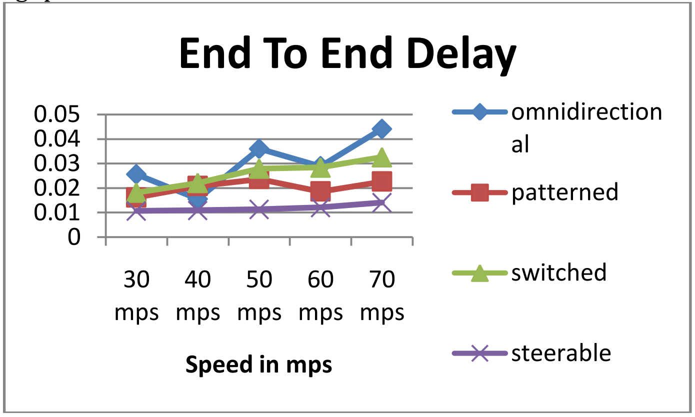
| Parameters | Values |
|---|---|
| Simulator | Qualnet6.1 |
| Terrain size | 1500m X 1500m X 300m |
| No. of nodes | 50 |
| Network protocol | AOVD |
| Data size | 512 Bytes |
| Data rates | 2(mbps) |
| Mobility model | Random waypoint |
| Antenna model | Omni directional, patterned, switched, steerable |
| Channel frequency | 2.4GHZ |
| Speed of nodes | 30, 40, 50, 60, 70 mps |
| Traffic source | CBR |
| Simulation time | 300sec |
| Routing protocol | AODV |

**Simulation Results**

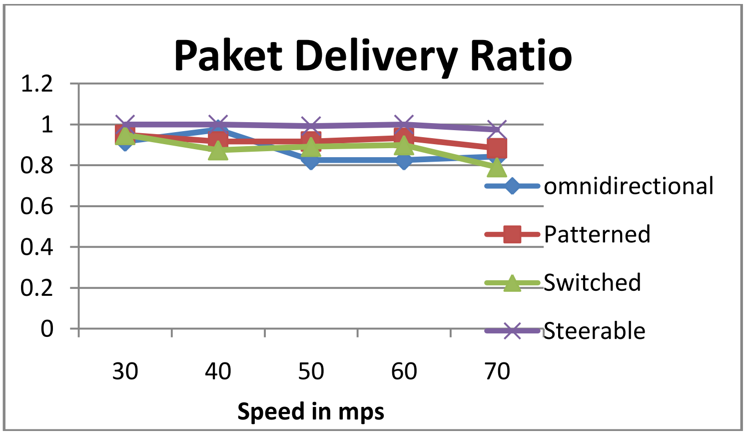
In this paper three scenarios are simulated. In the first scenario, all 50 nodes are equipped. The main purpose of above simulation is to compare various QOS parameters like average Throughput, average end to end delay, average jitter, packet delivery ratio in wireless FANET for different antenna with varying speed of air vehicle.



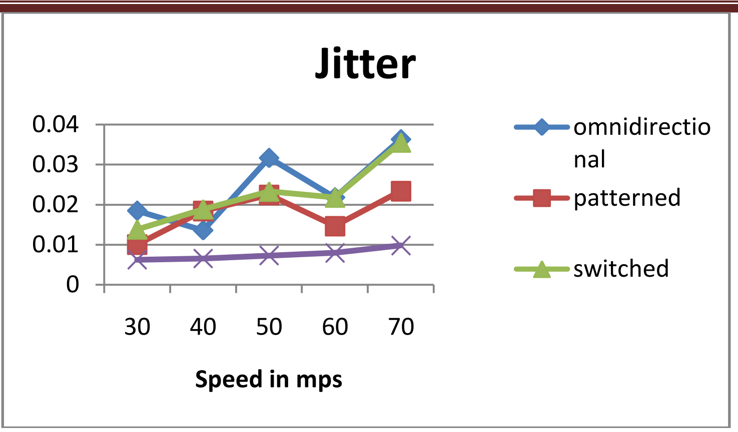

As the speed of flying nodes increases throughput for different antenna's decreases but steerable antenna has better throughput than other antenna.




As the speed of air vehicle nodes increases from 30 to 40 mps end to end delay for omni-directional antenna decreases then it increase for high speed of nodes. For switched and patterened antenna as the speed increases end to end delay increases. For steerable antenna end to end delay is minimum from other antenna.




As the speed of flying air vehicle increases pdr for steerable antenna is better than from other antenna. As speed increases pdr for FANET decreases for different antenna.




As the speed of flying nodes increases jitter for different antenna increases but steerable antenna jitter is better than other antenna's.

## Conclusion

From the above results, it can be seen that in FANET, the steerable antenna produces higher throughput than other antenna's. In the speed varying environment, for getting the higher throughput only steerable beam antenna should be used. And in case of Average End to End delay and Average jitter, the delay and Jitter is high in case of Omni directional antenna, switched antenna and patterned antenna as compared with steerable antenna. Directional antennas like steerable and switched beam are more efficient in sending packets correctly at the destination because from the above results the Packet Delivery Ratio is 95% and 96% in case of directional antennas whereas only 85% in case of Omni directional antenna.

So from the above results, it can be conclude that in varying speed environment, by using steerable antennas the Quality of Service (QOS) parameters can be improved and enhanced but there is always some limitation and challenges in the MAC layer and Physical layer which affect the performance of the antennas.

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