Cihan University-Erbil Scientific Journal (CUESJ)

Review Article

FANET Drone's Data Applications, Mobility Models, and Wi-Fi IEEE 802.11n Standards for Real and Non-real Time Traffic

Ghassan A. QasMarrogy[1], Areen J. Fadhil[2]

[1]Department of Communication and Computer Engineering, Cihan University-Erbil, Kurdistan Region, Iraq, [2]Department of Information System Engineering, Erbil Technical Engineering College, Erbil, Iraq

ABSTRACT

Data traffic is the most important data transmission between users inside every network. This data traffic can be videos, files, voice, pictures, and many more. It is divided into two types, real-time and non-real-time traffic. Most real-time traffic data have a low tolerance for delays during transmission, as they need to be quickly received between communication devices. In this paper, a comprehensive analysis was made to evaluate the two types of data transmitted through FANET drones, with different mobility models and two types of IEEE 802.11 2.4 GHz and 5 GHz using the optimized link state routing protocol. Metrics such as delay and throughput were measured. This paper gives an important overview of how real-time and non-real-time traffic will be handled during data transmission in FANET networks.

Keywords: FANET, Mobility models, IEEE 802.11n, Non-real time traffic, Real-time traffic

INTRODUCTION

In today's networks, most traffic transmitted between sender and receiver consists of different types of data, such as surfing the web, listening to music, making video calls, downloading files, watching YouTube, and many more. This data traffic can be divided into two types of data, real-time and non-real-time traffic. The total network traffic is the total amount of moving data between the sender and the receiver. Therefore, the bandwidth will be shared between both real-time and non-real-time applications. In today's network protocols, some priority will be given to real-time applications as they have a very low tolerance for delay during transmission.[1]

There are different types of ad hoc networks, such as MANET, VANET, UANET, and FANET. FANET is a group of flying drones that changes its topology frequently depending on the speed and attitude of the drones while communicating using routing protocols to send and receive data between them. The data traffic transmitted between them can be recorded video, voice, or exchange information about sites by transferring files, as shown in [Figure 1].[2]

Using different mobility models, the direction and speed of each drone will change depending on different criteria of the model chosen while exchanging data packets between the nodes, which can give different high and low performance as the routes between the drones will break due to high mobility.

Real-time traffic is very important to be analyzed and tested through different types of scenarios, as it is the most demanded traffic nowadays. This is the main purpose of this paper. While other non-real-time traffic will show how they can get priorities on the same link during transmission with real-time traffic.

The rest of the paper will be organized as follows: Section 2 will explain related work for various researchers; Section 3 will explain the methodology of the paper; Section 4 will give the results and analysis of the paper; and Section 5 will conclude the paper.

RELATED WORK

FANET is considered very popular these days as many researchers try to analyze its performance and enhance its ability for better properties. In[3] a survey was done for the critical points of FANET to show the performance of FANET architecture, communications, mobility models, characteristics,

Corresponding Author:
Ghassan A. QasMarrogy, Department of Communication and Computer Engineering, Cihan University-Erbil, Kurdistan Region, Iraq. E-mail: ghassan.qasmarrogy@cihanuniversity.edu.iq

Received: June 20, 2022
Accepted: August 07, 2022
Published: August 22, 2022

DOI: 10.24086/cuesj.v6n2y2022.pp76-80

and FANET design. It also shows all the recommendations to help the authors work on the same and enhance these parameters. The research lists most approaches that are used to give better results in FANET. In[4] the author evaluates FANET's different mobility models, real-time traffic, and frequency bands while measuring throughput and delay for best performance using two types of routing protocols. The result shows that 2.4 GHz gives a higher delay but more coverage than 5 GHz. In[5] a recent attempt was made to enhance and optimize the performance of video transmission in FANET with a 5 GHz frequency band while analyzing throughput, retransmission attempts, and delay. Their results show that changing some metrics in WLAN interface cards can give better performance to the transmission. Finally, in[6] the performance of optimized link state routing (OLSR) protocols was analyzed and investigated with four different data rates and scenarios while measuring the throughput, network delay, load, and retransmission attempts. The result shows that the OLSR protocol was improved and gives better performance than before.

FANET PARAMETERS

This part will give a comprehensive explanation of all the FANET parameters calculated in this paper, such as mobility models, IEEE wireless protocols, routing protocols, and data traffic types as follows:

Mobility Models

Because FANET's topology changes as it moves, it requires a specific mobility model and routing protocols to guide packets between drones to their final destination.

Mobility models are very important in guiding and controlling the FAENT movement in specific areas, as they use a mobility formation to keep all the drones in the range for transmission with a fixed direction, height, and speed.[7]

The most commonly used type of mobility model is the Random Waypoint Mobility Model (RWPM). This model uses random value numbers and direction for moving and pausing, also uses random values for height and attitude. When the simulation starts, the drones start using the mobility model as these randomness values will be repeated until the end of the simulation. This model is considered very important as it simulates real-life scenarios of FANET drones moving for different life applications such as WSN wireless sensor networks, search and rescue missions, area scanning, and many more.[8]

While the second type is known as the Gauss–Markov GMM mobility model, in this model, a drone starts moving in a specific direction with a specified speed as it reaches the endpoint, then it chooses a different direction and speed than planned. These numbers are calculated with a specific equation that depends on FANET parameters, where each drone movement is not related to other drones in the same FANET topology. [Figure 2] shows the different mobility models used in this paper.[9]

IEEE WIFI and Routing Protocols Standards

The IEEE 802.11n is a wireless standard used to organize the movement of data wirelessly from the sender to the receiver, using multiple antennas to increase the data transfer rate. This protocol can support up to a 600 Mb/s speed rate while operating with two different types of frequencies, 2.4 GHz and 5 GHz.[10]

The multiple input/multiple output (MIMO) can transmit a larger number of data packets compared to the single antenna used with the previous version of wireless standards. Furthemore, MIMO uses spatial division multiplexing (SDM) technology, in which multiple streams of individual data are transmitted at the same time on one single spectral channel. The technology of MIMO SDM permits the bandwidth to be increased for each data stream, which helps to increase the overall speed rate. Still, each data stream requires one antenna to send and one to receive; therefore, this technology uses MIMO to adjust its transmission.[10]

In IEEE 802.11n, the 5GHz bandwidth gives more speed compared to the 2.4 GHz bandwidth as it has more non-overlapping channels that reduce the interference between the frequencies of broadcasted devices. Figure 3 shows the different types of channels between 2.4GHz and 5GHz.[11]

A routing protocol is needed to guide the packets from the source to the destination. The OLSR protocol is used as it gives better results in FANET scenarios to route the packets and helps them reach the destination.[12]

This protocol was optimized for the old link-state protocol used in MANET; [Figure 4] shows the different types of FANET routing protocols.

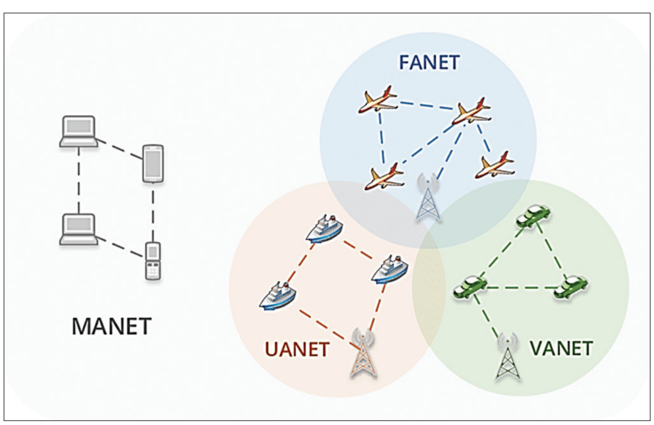

Figure 1: Different types of mobile ad hoc networks[2]

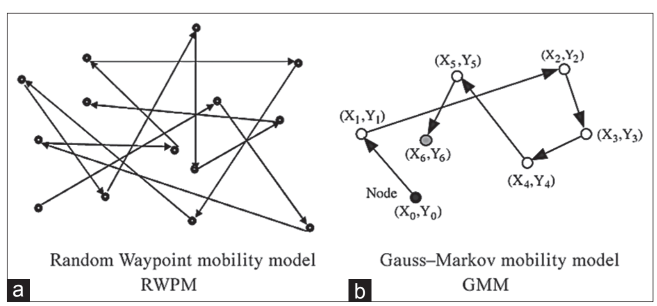

Figure 2: Different Mobility Models[8]

OSPF uses a group of selected multipoint relays (MPRs) that forward the received broadcast messages through the flooding process. Therefore, using this technique, the overhead of the network will be decreased substantially, as every drone will retransmit the received message when it receives the first message from the main source. [Figure 5] shows the OLSR MPR's node.[13]

The main three optimizations on OLSR can be summarized as follows:

1. The information link status will only be generated by the selected MPR nodes
2. The number of control messages forwarded will decrease as only the selected MPRs will broadcast the generated traffic
3. Each MPR node can choose to report the main active link connected between them.

Therefore, these enhancements made OLSR provide optimal routes between the sender and the destination, with the lowest delay and higher throughput. Furthermore, made it very suitable for large and dense networks with a dynamic number of nodes.[13]

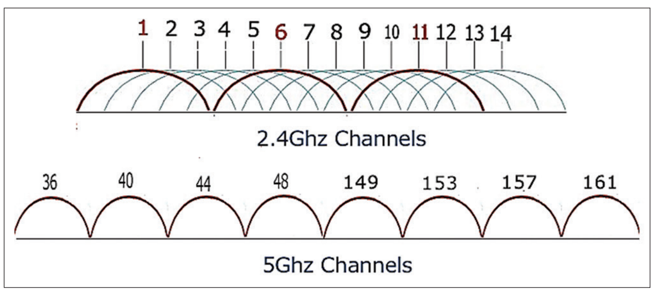

Figure 3: Different types of channels of 2.4 GHz and 5 GHz[11]

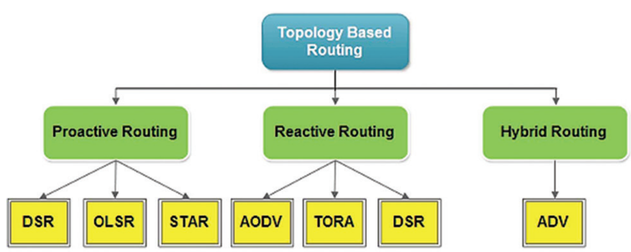

Figure 4: FANET routing protocols[12]

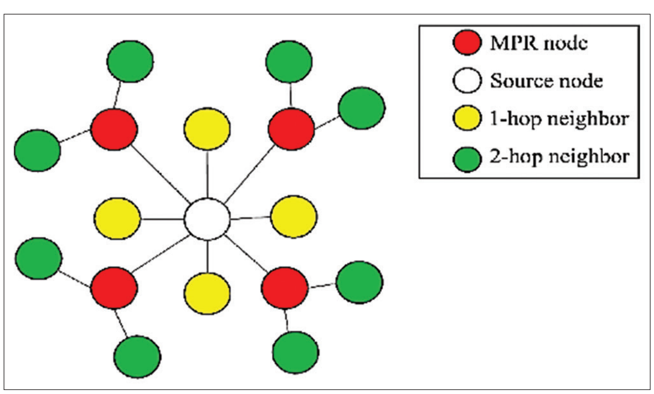

Figure 5: MPR's nodes of OLSR routing protocol[13]

Network Traffic

There are two types of network traffic: Real-time and non-real-time traffic. Real-time traffic demands are transmitted or delivered on time without any delay and with the highest quality as possible, such as videoconferencing, VoIP, and web browsing.[14]

While non-real-time traffic has lower priority than real-time traffic, which can tolerate delays and some packet dropping, such as emails and web publishing, [Figure 6] depicts the various types of data traffic transmitted in the network.

RESULTS AND ANALYSIS

This paper examines by analyzing two types of transmission data, real and non-real-time traffic in the FANET network using a simulation area of 2000 × 2000 square meters with a 25-flying drone at a speed of 15 m/s and a height of 15 m with two types of mobility models (Random Waypoint mobility, or RWPM, and Gauss–Markov GMM). These drones will broadcast the data using WIFI IEEE 802.11n standards, 2 GHz and 5 GHz, with the support of the OLSR routing protocol. The simulated environment was repeated 5 times while calculating the average for optimal values to calculate both throughput and end-to-end delay for both types of traffic. Finally, the OPNET simulator model was used to simulate the entire scenario, which is considered one of the best simulators on the market for FANET simulations. Table 1 shows the simulation parameters used in this paper.

The main comparison between 2.4 GHz and 5 GHz wireless protocols is about speed, bandwidth, and interference, as 2.4 GHz gives lower interference and a higher range, while 5 GHz gives more speed and bandwidth with less range coverage.

In [Figure 7], the throughput of both 2.4 GHz and 5 GHz traffic is shown with both real and non-real-time traffic using the OLSR routing protocol, where the highest throughput was shown for video and voice as they have a lower tolerance for delay, while both HTTP and FTP have a higher delay tolerance as they can be sent with more delay.

The 5 GHz wireless protocol shows more throughput for both real and non-real-time traffic as it has higher bandwidth, but due to its lowest coverage range, its performance decreases

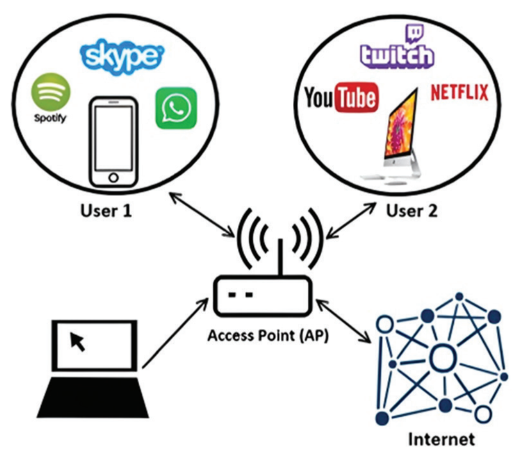

Figure 6: Different types of data traffic[14]

Table 1: Simulation parameters

Parameters	Values
Traffic Type	Video, Voice, HTTP, FTP
Area Size	2000×2000 m^2
FANET Routing Protocols	OLSR
FANET Number	25 Drone
Mobility Models	RWPM, GMM
Simulation Time	5 min
Node Speed, Height	15 m/s, 15 m
WIFI IEEE 802.11n	2.4 GHz, 5 GHz

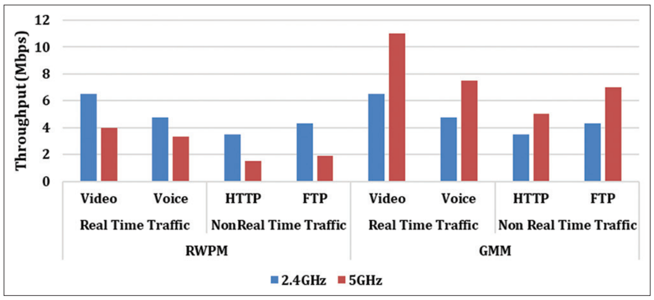

Figure 7: Average throughput for real-time and non-real-time traffic

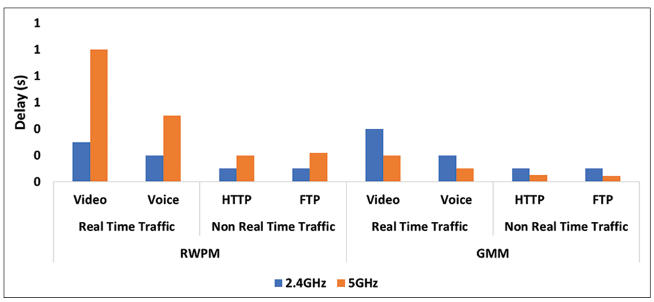

Figure 8: Average delay for real-time and non-real-time traffic

in throughput for the RWPM model as many links break and more nodes randomly fly away from each other, which makes them out of range coverage. The GMM model gives better performance as the nodes move in the same direction or next to each other inside the same coverage area.

Figure 8 shows the delay for the same scenario of the FANET network, where 5 GHz shows lower delay in GMM as it has more bandwidth, which makes the traffic packet transmitted faster than the 2.4 GHz wireless protocol. However, the RWPM model gives higher delay as most of the links break and packet drops due to the low coverage range of the 5 GHz protocol.

Moreover, non-real-time traffic shows higher delays than real-time traffic as they have a longer tolerance to delays than real-time traffic for 2.4 GHz

CONCLUSION

FANET is a special type of mobile ad hoc network that flies for different types of functions, such as military functions, recording, transmitting data, and many more. This data can be real-time data that has a low tolerance for delay and non-real-time data that has a higher tolerance for delay.

In this paper, an evaluation has been done to measure the performance of both types of traffic using the OLSR routing protocol with two types of mobility models, RWPM and GMM, that are transmitted using IEEE 802.11n 2.4 GHz and 5 GHz wireless protocols.

In conclusion, real-time traffic has higher throughput and the lowest delay compared to non-real-time traffic. While during retransmission attempts, the 5 GHz wireless protocol gives the best result as it covers only a short distance, while the movement of FANET drones makes the links between the nodes break more frequently and only if these nodes are close to each other. As a result, 5 GHz gives decreased performance in the RWPM model as more nodes fly away from each other, which makes them out of the coverage area.

For the future work, it is recommended that more mobility models be used and more recent wireless protocols that support more bandwidth and higher speed rates, as well as more traffic.

REFERENCES

1. H. J. Alqaysi and G. A. QasMarrogy. Performance analysis of video streaming application over MANETs routing protocols. *International Journal of Research in Computer Applications and Robotics*, vol. 3, pp. 22-28, 2015.
2. D. Ramphull, A. Mungur, S. Armoogum and S. Pudaruth. A review of mobile ad hoc NETwork (MANET) protocols and their applications. In: *2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS)*. IEEE, pp. 204-211, 2021
3. A. Srivastava and J. Prakash. Future FANET with application and enabling techniques: Anatomization and sustainability issues. *Computer Science Review*, vol. 39, pp. 100359, 2021.
4. G. QasMarrogy. Evaluation of flying Ad Hoc network topologies, mobility models, and IEEE standards for different video applications. *Aro-the Scientific Journal of Koya University*, vol. 9, no. 1, pp.77-88, 2021.
5. K. Y. Tsao, T. Girdler and V. G. Vassilakis. A survey of cyber security threats and solutions for UAV communications and flying ad-hoc networks. *Ad Hoc Networks*, vol. 133, no. 1, p.102894, 2022.
6. M. M. S. Ibrahim and P. Shanmugaraja. Optimized link state routing protocol performance in flying ad-hoc networks for various data rates of un manned aerial network. *Materials Today Proceedings*, vol. 37, pp.3561-3568, 2021.
7. P. K. Sharma and D. I. Kim. Random 3D mobile UAV networks: Mobility modeling and coverage probability. *IEEE Transactions on Wireless Communications*, vol. 18, no. 5, pp.2527-2538, 2019.
8. K. Nabar and G. Kadambi. Affinity propagation-driven distributed clustering approach to tackle greedy heuristics in mobile Ad-hoc networks. *Computers and Electrical Engineering*, vol. 71, pp. 988-1011, 2018.
9. A. Chinmay and H. K. Pati. VoWiFi cell capacity evaluation using IEEE 802.11 ac for VBR traffic. In: *2021 3rd International Conference on Computer Communication and the Internet (ICCCI)*. IEEE, pp. 141-145, 2021.
10. S. Rajbhandari, A. V. Jalajakumari, H. Chun, G. Faulkner, K. Cameron, R. Henderson, D. Tsonev, H. Haas, E. Xie, J. J. McKendry, R. Ferreira, E. Gu, M. D. Dawson, D. O'Brienand and J. Herrnsdorf. A multigigabit per second integrated multiple-input multiple-output VLC demonstrator. *Journal of Lightwave*

Technology, vol. 35, no. 20, pp.4358-4365, 2017.
11. I. Dolińska, M. Jakubowski and A. Masiukiewicz. Interference comparison in wi-fi 2.4 ghz and 5 ghz bands. In: *2017 International Conference on Information and Digital Technologies (IDT)*. IEEE, pp. 106-112, 2017.
12. G. A. Q. Marrogy. Enhancing video streaming transmission in 5 GHz fanet drones parameters. *Telecommunications and Radio Engineering*, vol. 79, no. 11, pp. 997-1007, 2020.
13. R. Singh, N. Singh and A. G. Dinker. Performance analysis of TCP variants using AODV and DSDV routing protocols in MANETs. *Recent Advances in Computer Science and Communications*, vol. 14, no. 2, pp.448-455, 2021.
14. H. Ozkan, R. Temelli, O. Gurbuz, O. K. Koksal, A. K. Ipekoren, F. Canbal, B. D. Karahan and M. S. Kuran. Multimedia traffic classification with mixture of Markov components. *Ad Hoc Networks*, vol. 121, pp. 102608, 2021.