Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN : 2581 - 611X)

Volume 5- Issue 1, Paper 40 January 2022

Systematic Investigation on Cloud Assisted IoT Devices, Challenges and Applications

Salil Bharany and Sandeep Sharma

CET Department, Guru Nanak Dev University,
Amritsar, India

Abstract— Over the past few years, technology has progressed and developed rapidly, where ad hoc networks have contributed a significant part to innovative development. There are four varieties of ad hoc networks such as mobile (MANET), vehicular (VANET), flying (FANET), and sea (SANET). Due to the variation of specifications, these four ad hoc networks have to turn into an alternative for providing connectivity in areas where infrastructure-based networks cannot be deployed. Therefore, this paper sets out a review of these four ad hoc networks, particularly focusing on the characteristics such as routing, density, and mobility. In addition, the variances between the four ad hoc networks are discussed with related works. This paper also outlines the challenges to be addressed in the deployments of these ad hoc networks.

Key words: WSN.IOT Cloud, FANETS, MANETS.

I. INTRODUCTION

The Internet of Things, or the 'Future Internet,' as it is sometimes referred to, is comprised of massive networked gadgets, also known as intelligent things,' that are connected to a global network and are accessible at any time and from any location. As described by the Internet of Things, the network of physical "things" that have embedded technology that allows devices to communicate and interact with one another and the external environment is a network of physical "objects." The Internet of Things (IoT) is essentially the integration of 'Things' such as RFID tags, actuators, sensors, and mobile phones that communicate utilizing the IPV6 addressing mechanism. The Internet of Things (IoT), which represents the third wave of the information technology revolution following mobile communication and the internet, has altered our lives in ways we have never experienced before. Although the phrase Internet of Things (IoT) was invented in 1999 by Kevin Ashton while working on a network of RFID items at Proctor & Gamble, the first publication to use the word IoT was in 2005, in an RFID magazine published by the International Telecommunication Union (ITU-T). The emergence of smartphones in 2005 aided the notion of the Internet of Things is gaining traction. However, in 2008, the number of devices connected by IoT surpassed the number of people, resulting in IoT being referred to as IoE (Internet of Everything) [4, an abbreviation for Internet of Everything]. With intelligent homes being the major contributors, the IoT industry is predicted to create a massive volume of profit that will surpass the total profit generated by the phone and PC markets. Smart homes are expected to make a net profit above $500 billion. The development of networking technology has enabled billions of devices worldwide to communicate with one another. In a 5G-enabled industrial automation setting, the Internet of Things (IoT) allows for high-speed device-to-device interactions and plug-in connections between machines, data, and humans, which would otherwise be impossible. According to Cisco's estimates, the number of IoT operational devices will reach around 24 billion by the end of this year and exceed 11 trillion devices every year by 2025 [6]. When it comes to data analysis platforms, the IoE (Internet of Everything), a superset comprising IoT and requiring coordination between three primary elements: people, process, and data, contains a variety of technologies and changeable platforms.

The items, also known as 'Things,' in the Internet of Things network are connected through RFID (Radio Frequency Identification) tags and other types of sensors to form a network. On the other hand,

the variability of items is a significant difficulty. For the Internet of Things to function correctly, numerous technologies such as sensor technology, nanotechnology, RFID technology, innovative technology, predictive analysis, artificial intelligence, and many more must be brought together. Even though the Internet of Things (IoT) has the potential to change people's lives, several critical challenges must be addressed before it can be fully utilised. These include interoperability across networked devices, increasing levels of intelligence and independence by devices, and preserving trust and security while protecting personal information (which will be explored later).

1.1. Motivation & Contribution

Because the Internet of Things (IoT) is a fantastic technology that significantly impacts every part of our lives, conducting a thorough survey was motivated by this realisation. We will only be able to reap the full benefits from this technology if we have a thorough understanding of the idea, its possible applications in other industries, its limitations, and if we make an effort to design a generic architecture. As a result, for the Internet of Things to diversify the course of technical breakthroughs, there is a great deal of need for concentration and attention in this area. The Internet of Things (IoT) is poised to transform the global economy in the coming years. It is predicted that around $6 trillion in money will be invested in this technology in the next several years. According to the report, according to a survey by the Cisco Internet Business Group, there will be more than 7 gadgets linked to the internet for every person in the next years. The Internet of Things (IoT) will make it feasible in the future to automate everything in our environment. In this way, the Internet of Things will significantly influence every industry, regardless of size.

2. BACKGROUND

2.1 IoT assisted devices

i. Manets

MANET is a self-designing system of adaptable switches connected via distant connections that do not require the use of a tunnel to function. Each cell phone in a system can rule itself. [1] Cell phones are permitted to roam and sort themselves out objectively. The hubs share the distant medium in the MANET, and the system's topology changes rapidly and robustly. [2] Because hubs are free to travel wherever they choose in MANET, breaking interaction links often occurs. When it comes to the thickness of hubs and the number of hubs, it all depends on the applications we are using MANET. The advent of MANET has enabled the development of several applications such as tactical systems, wireless sensor systems, data networks, and device networks, among others. A few setup challenges and difficulties in surviving to persist despite a large number of apps available. [3] The primary goal of MANETS is to extend flexibility into the realm of self-sufficient, portable, and distant places, where a large number of hubs that can be consolidated switches and has - they form the system steering basis in an ad hoc design - are used. Many security vulnerabilities in a remote setting, such as a MANET, have been identified, and a large number of solutions have been offered in addition to these. Nonetheless, only a few provide a symmetrical guarantee to the basic security test. The essential vision of portable, exceptionally appointed systems administration is to support efficient and robust activity in flexible distant systems by fusing routing utility into portable hubs. A dynamic, occasionally rapidly growing, and arbitrary multi-hop topology is anticipated for such systems, which is likely to be composed of general data transfer capacity-constrained faraway links, as is the case in reality. MANET is less successful than a wired system due to flexible hubs, the hazards of trading off hubs

within the system, the lack of physical security, the use of dynamic topology, the lack of adaptability, and the absence of an integrated the board. MANET is becoming increasingly vulnerable to vengeful assaults in response to these weaknesses.

With the development of small devices and advancements in distant communication, ad hoc planning is becoming increasingly popular, as seen by the growing number of cross-industry applications in the commercial, military, and private sectors, among others. [7] Portable Ad-Hoc Networks (PAHNs) allow clients to connect to and exchange data regardless of their geographic location or proximity to the network's infrastructure. In contrast to the way foundations are organized, all hubs in MANETs are portable, and their relationships are dynamic, whereas foundations are not. MANETs, in contrast to other highly adaptable systems, do not operate within a rigid framework of rules. The system gains a valuable decentralized characteristic as a result of this. Due to the decentralization of power, the CONNECTION becomes more adaptive and vigorous over time. [8] A MANET is a specifically designated system that can shift locations and reorganize itself on the fly. Because MANETS are adaptable, they use distant associations to communicate with a variety of different systems. Depending on the situation, this can be a regular Wi-Fi association or another medium, such as a mobile phone or satellite transmission. Manets exhibit Autonomous Behavior in the same way that Each portable hub in a MANET serves as both a switch and a host simultaneously. Last but not least, portable hubs may perform the same functions as switches when it comes to sharing data. As a result, in MANET, terminals and switches are virtually indistinguishable.

1) **Dynamic topologies:** Because all of the hubs in the system are portable, they are free to move about at their own pace, resulting in a diverse system. The system's topology may alter at random over a certain period. All of the portable hubs connected to the network gradually begin to communicate, becoming their network infrastructure.

2**) Multi-jump directing**: When any hubs want to connect with various hubs out of range, the bundle is transferred through one or progressively middle-of-the-road hubs until it reaches its destination. There are several types of routing, such as single-hop and multi-hop. Single-hop is more essential than multi-jump regarding cost, structure, and execution. Because there is no context network for the primary control of the system activity, the system's control is communicated among the numerous hubs of the system. 3) Distributed activity:

4) **Lightweight terminal:** In the vast majority of situations, MANET is comprised of portable hubs with limited memory capacity, a low power repository, and limited CPU capability. Algorithms and procedures that execute processing and communication have been improved.

5) **The use of limited and constrained energy Bandwidth**: In today's modern age, every gadget relies entirely on batteries to function correctly. The system is being simplified to safeguard the vitality of mobile phone use. The remote arrangement has minimal data transfer capacity; therefore, the system must be simplified to achieve the highest level of efficiency possible within the limited data transmission timeframe.

ii. VANETS

Vehicular Ad-Hoc Network is the system in which communication has been done between RSUs to vehicles, vehicle to vehicle in a short scope of 100 to 300 m. In a VANET, vehicles will depend on the trustworthiness of got information for choosing when to display alarms to drivers. Further, this information might be utilized as the premise of control choices for self-governing vehicles later on. If this data is ruined, vehicles may introduce superfluous or wrong alerts to their drivers, and the consequences of control choices dependent on this data could be significantly progressively shocking. Data can be tainted by two different instruments: noxiousness and breakdown. Additionally, vehicles have two barrier components: an inside channel and outer information. Vehicular Ad-hoc Network (VANET) is not a new subject. It keeps on giving new investigate difficulties furthermore issues. The primary goal of VANET is to support a gathering of vehicles to set up and keep up a correspondence organized among them without utilizing any focal base station or, on the other hand, any controller. In the case of a VANET, no predetermined architecture or topology must be followed. A generic VANET, on the other hand, is made up of moving vehicles that communicate with one another and with certain nearby remote sensor units (RSU). A VANET differs from a MANET in that moving cars do not follow a random path, as hubs do in MANETs; instead, moving vehicles follow a few set paths, such as city streets and interstate highways. While it is straightforward to think about VANETs as a subset of MANETs, it is also necessary to consider them separately. [8] Onboard units (OBU) in vehicles are used in VANET engineering, and they are made up of a remote transmitter and a beneficiary. Three different communication scenarios might occur in a car. One possibility is that all cars interact with one another through a common RSU. This design is reminiscent of (WLAN). There is a second alternative. In this case cars interact with one another, and there is no requirement for an RSU. This is referred to as "ad hoc design." According to a third scenario, some of the cars can communicate with one another, while others may require the assistance of an RSU. alth-related crisis circumstances where there is no framework. At the same time, it is essential to pass on the data for sparing human lives. Be that as it may, alongside these beneficial uses of VANET, develop new difficulties and issues. The absence of a framework in VANET puts extra obligations on vehicles. Each vehicle turns out to be a piece of the system and oversees and controls the correspondence on this system alongside its correspondence prerequisites. Vehicular specially appointed systems are liable for the communication between moving vehicles in a specific condition. A vehicle can communicate with another vehicle straightforwardly which is called Vehicle to Vehicle (V2V) communication, or a vehicle can impart to a foundation, for example, a Road Side Unit (RSU), known as Vehicle-to-Infrastructure (V2I distributing this revocation information should distribute the info information securely, quickly, and broadly in order to limit the amount of damage illegitimate vehicles can do. First, we discuss the general architecture and security architecture of VANETs. Next, our paper addresses the analytical evaluation of different research papers in VANET. Then we compare different popular. Data obtained from defiled hubs ought to be dismissed or not trusted by genuine vehicles; generally, a noxious vehicle could, for instance, acquire a less blocked course for itself by exaggerating the number of vehicles on its ideal roadway. As a Second model, an undermined hub could trigger a mistaken driver to be shown in different vehicles by distorting its position data. IEEE 1609.2, the preliminary utilize standard concerning security administrations for vehicular situations, stipulates that vehicle will be verified utilizing

testaments given by a Certificate Authority (CA) in an Open Key Infrastructure (PKI) arrangement. Vehicles ought to have these authentications renounced and ought to be distributed and dispersed to authentic vehicles. Whatever component is utilized for dispersing this repudiation data ought to disperse the data safely, rapidly, and extensively to confine the measure of harm vehicles can do. First, we examine the general design and security engineering of vanet. Then the paper addresses the assessment of various researches in VANET.

iii. FANETS

A mobile ad-hoc network (MANET) is a portable system of independent wireless gadgets that do not have a central hub or framework but can self-design its configuration. MANETs have a wide range of uses, including disaster relief, military communication, press conferences, etc. The fundamental advantage of MANETs is their portability or adaptability to various situations. The widespread use of MANETs has facilitated the development of subclasses of ad-hoc networking, such as vehicular ad-hoc networks (VANETs) and flying ad-hoc networks (FANETs) (FANETs). A typical characteristic of these systems is their great adaptability, which allows for rapid topology modifications compared to operating MANETs in tandem with both VANETs and FANETs, where the vast majority of the hubs are automobiles and UAVs (Unmanned Ariel Vehicles), respectively. VANETs enable communication between vehicles (V2V) and between vehicles and infrastructure (V2I). The primary aims of VANETs are to increase traffic productivity and congestion, access to data and news to keep a safe distance from accidents and stimulate rational thought while driving, among other things. The Flying Ad-hoc Network (FANET) is a unique type of MANET distinguished by its extreme mobility. In FANETs, the hubs are often Unmanned Aerial Vehicles (UAVs) operating in the Unmanned Aerial Systems (UASs) mode instead of conventional UAVs. This technology is intended to be used to construct self-sorting out systems using flying aero planes in the sky. UAVs are being used for various applications, both military and civilian. Examples of UAV applications include rural aeronautics administration, reconnaissance, watching the outskirt zone, traffic management, pipeline inspection, seismic events, spring of flowing lava observation, environmental monitoring, etc. Single uncrewed aerial vehicles (UAVs) have been in operation for a substantial time. [7] Even though single UAV frameworks are constantly in use, including multiple UAVs is a very productive idea due to its advantages over a single UAV framework. As a result, these types of frameworks are called multi-UAV frameworks. In single-UAV arrangements, the UAVs are connected to either a ground-based base station or a satellite station for correspondence with star topology behaviors, depending on the configuration. Multi-UAV frameworks, as opposed to single-UAV frameworks, have more than one UAV; as a result, multi-UAV frameworks may operate in multi-bounce situations, and there is no requirement for all UAVs to be lawfully associated with the ground station or satellite station. Aside from that, there are several particular points of interest and issues associated with Multi-UAV frameworks. A number of the advantages of using a single UAV framework are as follows:
Several advantages of using a single UAV framework are discussed below.

1. Efficient: Large unmanned aerial vehicles' upkeep and setup costs (UAVs) are significantly greater than those of small unmanned aerial vehicles (utilized in a single UAV framework). Because the inclusion zone of single UAV frameworks is smaller than multi-UAV frameworks, the inclusion rate is lower; nevertheless, multi-UAV frameworks can adapt to various situations more effectively than single UAV frameworks.

2. Soundness: One of the significant drawbacks of a single UAV framework is the single point of failure. For example, if a UAV fails to complete its mission, the assignment will not be completed until another UAV is dispatched to complete it. When using multi-UAVs, if one UAV fails to complete the mission, the mission should be able to be completed by different UAVs by multiple courses.

3. Time-efficient: It is undeniable that, as compared to a single UAV, several UAVs operate more quickly to complete a task. Multi-UAV frameworks are more manageable than single-UAV frameworks in cost and complexity.

4. The cost of the equipment: The equipment required for communication with either the ground station or the satellite station is quite expensive, and it must be purchased separately. Because of their excellent mobility, the reliability of the communication is a crucial source of concern in multi-UAV systems, which require consistent quality. Because of the excellent mobility of the multi-UAV framework, the correspondence connections are made and broken very fast. As a result, it will impact the trustworthiness of the information.

5. Inclusion Area: The transmission range of a UAV (in meter unit) within which it can maintain a connection with the ground station is the coverage zone. The provision of an exceptionally designed system is the replacement arrangement for every one of these challenges.

FANET is the name given to this specially designated system. FANET has the capability of dealing with the issue of correspondence amongst unmanned aerial vehicles. When connecting to the base station, multi-UAV systems may use star topology to establish a connection. A section of the hubs (UAVs) communicates with a base station located somewhere on the ground, and various hubs can communicate with a space station, which might be a satellite, among other things. The architecture for UAV-to-UAV communication has several acquired plan issues that need to be addressed. In order to connect with ground and satellite stations, unmanned aerial vehicles (UAVs) are required. The study describes the FANET routing protocol in detail and emphasizes the need for additional research. FANETs have many features to MANETs, such as the lack of a central point of control, many hops, self-organization, and self-healing. However, they also have their own design goals and network properties. Because of the high level of conflict and the rapid speed with which the aircraft nodes navigate, their characteristics are quick, maneuverable, and complicated in the flight environment and in itself. It will result in a reduction in the available bandwidth of the communication transmission connection, frequent switching changes, and a high error rate.

3. CHALLENGES

3.1 MANETs

A. Self-sufficient - *There is no concentrated organization material available to cope with the activities of the several mobile hubs; therefore, the system is self-sufficient.*

B. Dynamic topology is characterized by the fact that nodes are portable and may be forcefully connected self-assertively. The system's connections move when it is convenient and are dependent on the proximity of one hub to another hub.

C. Disclosure of gadgets Identifying major freshly relocated hubs and informing the public about their presence requires dynamic updating to support programmed optimal course determination. Enhancing the transfer speed is step

D. Wireless connections have a significantly lower restriction compared to conventional connections. Using distant conventions to direct conventions consistently utilizes data transfer in the most efficient manner possible by keeping the overhead as low as is reasonably possible under the circumstances. The confined transmission run imposes a demand for steering conventions to maintain the topological data. Maintaining topological data is difficult in MANETS because of the constant changes in network topology. Hubs incur additional control costs, which results in increased data transmission waste.

E. Assets with limited availability: Mobile hubs rely on battery control, a scarce resource. Too much capacity is being used, and electricity is being severely restricted.

F. Versatility: A system's capacity to scale is primarily defined by its ability to maintain a sufficient administration level even when many hubs are near one another.

G. Physical security that is constrained-Mobility implies increased security risks, such as dispersed organization design or a mutual distant media accessible to both actual system clients and malicious assailants. Attacks against the government that include listening in, ridiculing, and disavowal of authority should be considered.

H. A foundation-less and self-worked approach: Requests for self-recovering highlight requests MANET should realign itself to cover any hub that moves out of its coverage area. One of the most common problems with distant communication is poor transmission quality, which is produced by a few erroneous sources that result in contamination of the received signal. Ad hoc issues arise on an as-needed basis and are not part of a regular plan that is being put into effect. In addition, the whole MANET foundation is dynamic, which serves as the basis for both the emotional attachment and disengagement of the variable connections.

L. Maintenance of the topology: MANETs undergo a critical test in which the data of dynamic connections between hubs must be updated.

3.2 VANETs

(a). Quality of Service (quality of service): Ensuring that specific quality administration levels are available in VANET is a time-consuming undertaking. A system with the least amount of delay for information delivery, the least number of retransmissions, and, more importantly, a high availability time can provide a specific level of Quality of Service (quality of service) to the clients. Providing high-quality service to a broad set of client applications in a dynamically changing environment is an exciting and challenging job in VANET design.

(b). Design of Efficient Routing Algorithms: To transport information bundles from one hub to another hub conveniently and suitably, it is necessary to design efficient routing algorithms that are both efficient and appropriate. [13] Practical directing calculation in a VANET refers to a routing technique that minimizes deferral while maximizing system functioning and requiring the most minor complexity.

c). Scalability and robustness: The design of an adaptive and robust connection is an open research area in VANET that has not been fully explored. It is necessary to have a VANET system that is adaptable to various networks while also being strong enough to handle topological changes. A growing field of research for the VANET environment is in this area.

(d). Cooperative Interaction: One of the most challenging aspects of VANET is establishing communication amongst the numerous hubs. It is possible that different concepts of cooperative communication from a remote system will not apply to VANET. For example, this cooperative

communication, the extent to which hubs should share data among themselves, is one of the critical study areas identified in the VANET strategy as necessary.

(e). Network Security: Because the hubs in the VANET state are continually attempting to exchange data, ensuring that specific fundamental protection data remains within the concerned hub is a critical structure consideration from a technical standpoint. Developing a suitable verification method and a trust-based security convention is an exciting and unexplored research area in the VANET community.

3.3 FANETS

Considering some of the standard features between FANET, MANET and VANET, FANET acquires a portion of the issues and difficulties from MANET and VANET. Be that as it may, because of extra attributes, for example, the rapid of UAVs in FANET, the routing protocols require significant survey and examination. Thus, the information directed between UAVs experiences a real test. The directing interchanges convention must have the option to refresh the steering table or store powerfully as indicated by a change in the topology. The previous protocol does not give reliable communication. Along these lines, there is a need for new communication algorithm to give an adaptable and dependable communication. Likewise, there are different issues identified with transmissions like security overheads, loss of information parcels, and vitality utilization. To a few degrees, a FANET is not exactly equivalent to standard MANETs and VANETs; however, the principal thought is the equivalent: having dynamic hubs in a specially appointed way. Thus, in a FANET, a couple of troubles are generous as in a VANET while standing up to with additional troubles. Numerous requests have been performed to manufacture the efficiency of the framework with flying hubs. Various unsolved issues should be researched.

A. Routing-In a FANET, directing of information between UAVs is a genuine test, which isn't the same as the MANETs with low versatility portability conditions. As shown by topology changes, steering tables must be refreshed progressively. A large portion of previous routing algorithm metric computations are not included in FANET to give reliable communication between UAVs.[12] Dependability of courses is the main issue because of the high portability in FANET. An extremely stable routing protocol is suggested. This way, a new research course needs to compute directing measurements and create practical steering calculations and system models to build a versatile and responsive specially appointed model.

B. Way Planning: In an enormous scale of strategic and multi-UAV activities, interest and coordination between UAVs are one of the most significant variables to build the effectiveness of a FANET. In such cases, each UAV needs to change its pathway, and new ones should be re- processed dynamically. Appropriately, new techniques/calculations are required to mastermind the FANET hubs for sorting out the groups of UAVs.

C. Quality of Service (quality of service): A FANET can be used to ship different kinds of products to the client's homes, such as the conveyance rambles from Amazon. They fuse GPS maps, spilling video/voice, pictures, plain texts, etc. The arrangement of specific characteristics to support parameters, such as deferral, transmission capacity, and bundle misfortune, is fundamental for FANET applications. Describing a comprehensive framework for QoS-engaged middleware is a genuine test that should be defeated because of the exceedingly portable and dynamic structure of FANET. Mischievous activities of hubs in FANET could likewise influence the quality of administrations in their tasks. Coordination among UAVs and keeping an eye on flying machines: It is an unpreventable certainty that later on, with the expanded number of UAVs, the flights of UAVs must be facilitated with the kept an eye on flying machine. Correspondingly, from a military viewpoint, the decimation of

adversary flying machines may be accomplished by using a FANET or these UAVs can be used as electronic jammers. Moreover, these UAVs can be utilized for observation in a few areas.

4. CONCLUSION

The swarm of unmanned aerial vehicles Right now, there are a variety of uses for unmanned aerial vehicles (UAVs), such as emergency response and search-and-rescue missions and medical surveillance and research. They are also used in a variety of media outlets, including news organizations, photographers, filmmakers, athletes, the entertainment industry in general, and the military and intelligence community. An efficient control system, safe activities, and speedier communication from UAV-to-UAV and UAV-to-GCS are only a few requirements for using unmanned aerial vehicles (UAVs) in communications. Swarm-based applications rely on efficient and reliable communication. Delivery services are the most common use for UAV swarms. Amazon and the United States Postal Service have expressed interest in deploying unmanned aerial vehicles (UAVs) for package delivery.

REFERENCES

1. Bharany, S., Sharma, S., Badotra, S., Khalaf, O. I., Alotaibi, Y., Alghamdi, S., & Alassery, F. (2021). Energy-Efficient Clustering Scheme for Flying Ad-Hoc Networks Using an Optimized LEACH Protocol. In Energies (Vol. 14, Issue 19, p. 6016). MDPI AG. https://doi.org/10.3390/en14196016
2. Talwar, B., Arora, A., & Bharany, S. (2021). An Energy Efficient Agent Aware Proactive Fault Tolerance for Preventing Deterioration of Virtual Machines Within Cloud Environment. In 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO).IEEE. https://doi.org/10.1109/icrito51393.2021.9596453.
3. Zhang, C.; Zhang, W.; Wang, W.; Yang, L.; Zhang, W. Research challenges and opportunities of UAV millimeter-wave communications. IEEE Wirel. Commun. **2019**, 26, 58–62.
4. Bürkle, A.; Segor, F.; Kollmann, M. Towards autonomous micro UAV swarms. J. Intell. Robot. Syst. **2011**, 61, 339–353.
5. Ben-Asher, Y.; Feldman, S.; Gurfil, P.; Feldman, M. Distributed decision and control for cooperative UAVs using ad hoc communication. IEEE Trans. Control Syst. Technol. **2008**, 16, 511–516.
6. Song, Q.; Jin, S.; Zheng, F.-C. Completion time and energy consumption minimization for UAV-enabled multicasting. IEEE Wirel. Commun. Lett. **2019**, 8, 821–824.
7. M. Thammawichai, S. P. Baliyarasimhuni, E. C. Kerrigan, and J. B. Sousa, ``Optimizing communication and computation for multi-UAV information gathering applications," *IEEE Trans. Aerosp. Electron. Syst.*, vol. 54, no. 2, pp. 601_615, Apr. 2018.
8. A. Trotta, M. Di Felice, F. Montori, K. R. Chowdhury, and L. Bononi, ``Joint coverage, connectivity, and charging strategies for distributedUAV networks," *IEEE Trans. Robot.*, vol. 34, no. 4, pp. 883_900, Aug. 2018.
9. Y. Wang, T. Sun, G. Rao, and D. Li, ``Formation tracking in sparse airborne networks," *IEEE J. Sel. Areas Commun.*, vol. 36, no. 9, pp. 2000_2014, Sep. 2018.
10. Z. Zheng, A. K. Sangaiah, and T. Wang, ``Adaptive communication protocols in _ying ad hoc network," *IEEE Commun. Mag.*, vol. 56, no. 1, pp. 136_142, Jan. 2018.
11. A. Bujari, C. E. Palazzi, and D. Ronzani, ``A comparison of stateless position-based packet routing algorithms for FANETs," *IEEE Trans. Mobile Comput.*, vol. 17, no. 1, pp. 2468_2482, Nov. 2018.
12. W. Shi, H. Zhou, J. Li, W. Xu, N. Zhang, and X. Shen, ``Drone assisted vehicular networks: Architecture, challenges and opportunities," *IEEE Netw.*, vol. 32, no. 3, pp. 130_137, May/Jun. 2018.
13. D. Korneev, A. Leonov, and G. Litvinov, ``Estimation of mini-UAVs network parameters for search and rescue operation scenario with Gauss-Markov mobility model," in *Proc. Syst. Signal Synchronization, Gener. Process. Telecommun. (SYNCHROINFO)*, Jul. 2018, pp. 1_7.
14. H. Wang, G. Ding, F. Gao, J. Chen, J. Wang, and L. Wang, ``Power control in UAV-supported ultra dense networks: Communications, caching, and energy transfer," *IEEE Commun. Mag.*, vol. 56, no. 6, pp. 28_34, Jun. 2018.
15. P. Cumino,W. L. Junior, T. Tavares, H. Santos, D. Rosário, E. Cerqueira, L. A. Villas, and M. Gerla, ``Cooperative UAV scheme for enhancing video transmission and global network energy efciency," *Sensors*, vol. 18, no. 12, p. 4155, 2018.
16. M. H. Tareque, M. S. Hossain, and M. Atiquzzaman, ``On the routing in flying ad hoc networks," in *Proc. Federated Conf. Comput. Sci. Inf. Syst. (FedCSIS)*, 2015, pp. 1_9.
17. M. Y. Arafat and S. Moh, ``A survey on cluster-based routing protocols for unmanned aerial vehicle networks," *IEEE Access*, vol. 7, pp. 498_516, 2018.

18. P. Kumar and S. Verma, ``Research challenges in airborne ad-hoc networks (AANETs)," in *Proc. 2nd Int. Conf. Commun., Comput. Netw.* Singapore: Springer, 2019, pp. 261_270.
19. K. Namuduri, Y. Wan, and M. Gomathisankaran, ``Mobile ad hoc networks in the sky: State of the art, opportunities, and challenges," in *Proc. 2nd ACM MobiHoc Workshop Airborne Netw. Commun.*, 2013, pp. 25_28.
20. O. K. Sahingoz, ``Mobile networking with UAVs: Opportunities and challenges," in *Proc. Int. Conf. Unmanned Aircr. Syst. (ICUAS)*, 2013, pp. 933_941.
21. K. Kanistras, G. Martins, M. J. Rutherford, and K. P.Valavanis, ``Asurvey of unmanned aerial vehicles (UAVs) for traf_c monitoring," in *Proc. Int. Conf. Unmanned Aircr. Syst. (ICUAS)*, May 2013, pp. 221_234.
22. M. Alzenad, M. Z. Shakir, H. Yanikomeroglu, and M.-S. Alouini `FSO-based vertical backhaul/fronthaul framework for 5GC wireless networks," *IEEE Commun. Mag.*, vol. 56, no. 1, pp. 218_224, Jan. 2018.
23. Q. Wu, Y. Zeng, and R. Zhang, ``Joint trajectory and communication design for multi-UAV enabled wireless networks," *IEEE Trans. Wireless Commun.*, vol. 17, no. 3, pp. 2109_2121, Mar. 2018.
24. N. Cheng, W. Xu, W. Shi, Y. Zhou, N. Lu, H. Zhou, and X. Shen `Air-ground integrated mobile edge networks: Architecture, challenges, and opportunities," *IEEE Commun. Mag.*, vol. 56, no. 8, pp. 26_32Aug. 2018.
25. B. Talwar, A. Arora and S. Bharany, "An Energy Efficient Agent Aware Proactive Fault Tolerance for Preventing Deterioration of Virtual Machines Within Cloud Environment," *2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)*, 2021, pp. 1-7, doi: 10.1109/ICRITO51393.2021.959645
26. A. Arora, B. Talwar and S. Bharany, "Reliability Aware Mechanism to ensure increased Fault Tolerance using Throttle Load Balancer," *2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)*, 2021, pp. 1-5, doi: 10.1109/ICRITO51393.2021.9

SALIL BHARANY is a research scholar pursuing a PhD at the Department of Computer Engineering and Technology, Guru Nanak Dev University, Amritsar. He gained his B.Tech(CSE) from Punjab technical university and M.Tech(CSE) from Guru Nanak Dev. His main areas of interest are Green Cloud Computing, Internet of things, and Wireless Sensor Networks.

SANDEEP SHARMA graduated with a BE (Computer) degree from the University of Pune, received a ME (Computer) from Thapar University Patiala and received his PhD degree from Guru Nanak Dev University, Amritsar. He is a Senior Professor and Head of the Department in Computer Engineering and Technology at Guru Nanak Dev University. He is a chief security information officer as well as the Nodal Officer of Digital India Week. He is also the network and mail administrator of Guru Nanak Dev University. He has had many research papers published in the areas of parallel processing, wireless sensor networks and cloud computing.