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A Detail Review on Unmanned Aeronautical Ad-hoc Networks

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A B S T R A C T

One of the most significant design issues for multi-UAV (Unmanned Air Vehicle) systems is the communication which is necessary for collaboration and cooperation among the UAVs. If all Unmanned Air Vehicle systems are directly linked to an infrastructure, i.e. a satellite or a ground base, the communication among UAVs can be observed via the infrastructure. Since, this infrastructure depending communication architecture limits the abilities of the multi-UAV systems. Ad-hoc networking among UAVs can solve the problems creating from a fully infrastructure depending UAV networks. In this review paper, Flying Ad-Hoc Networks (FANETs) are reviewed which is an ad hoc network linking the UAVs. The differences between MANETs, FANETs and VANETs (Vehicle Ad-Hoc Networks) are explained first, and then the significant FANET design issues are proposed. Along with the available FANET protocols, open research issues are also talked about.

I. INTRODUCTION

As a result of the fast technological standards on sensor, electronic and communication techniques, it has been possible to build unmanned aerial vehicle (UAV) systems, which can fly independently or can be worked remotely without enforcing any human personnel. Due to their flexibility, versatility, relatively small operating expenses and easy installation, the utilization of UAVs predicts new ways for both civilian and military applications i.e. border surveillance[2], search and destroy operations [1], relay for ad hoc networks [4,5], managing wildfire [3], disaster monitoring [7], wind estimation [6], remote sensing [8] and traffic monitoring [9]. Though single-UAV systems have been in utilization for decades, rather than formulating and operating one broad UAV, utilizing a group of small UAVs has several benefits. Since, multi-UAV systems have also unique issues and one of the most high design challenges is communication. In this review paper, Flying Ad-Hoc Network (FANET), which is generally ad hoc network among UAVs, is reviewed as a novel network family. The differences between Vehicular Ad-hoc Network (VANET), Mobile Ad-hoc Network (MANET) and FANET are explained, and the most significant FANET design issues are proposed. In summation to the available solutions, the open research challenges are also talked about. With the development of the miniaturization capacity of micro electromechanical systems and embedded systems and, it has been possible to create mini or small UAVs at a less cost. Since, the ability of a single small UAV is restricted.

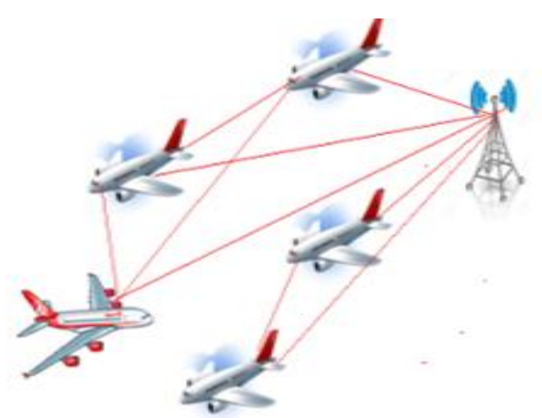

Figure 1: Flying Ad-hoc Network

Low number of UAVs in UAANET which have high mobility and subsequence perpetual changing topology network connectivity. That's why , to combat these topologies features, UAANETs have an effectual networking architecture not only that ,the various properties of UAANETs make it a challenge to use traditional routing protocols proposing a new routing protocol based on the available mechanism is the main focus of this thesis. The combination of a reactive routing protocol and greedy geographic forwarding is the aimed routing protocol, before the data dissemination, an on demand route discovery is executive on which

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reactive routing operates are based. owning to the route interruption the deed of network breaks. The route interruption may cause errors and data retransmission[1].

To partially full fill this problem mechanism like local repairing or backtracking have been represent in the literature [2]. The execution of graphic routing almost believe in up to date formation of location generally, providing authentic information of location in infrastructure less environment is difficult as the mobility increases, the source node need to have the information of location of the destination before the distribution of data[3]. By developing a separate location service module,it is almost assumed that the information of location approachable when there is not any location service , this presumptions is a challenge for an environment like UAANETs transformation of data or location spread can be a chicken/egg causality dilemma in these scenarios. UAVs require to spread information of location in order to communicate ,similarly , a communication structure is require to send location information using a flooding based location service for a source uses to obtain destination location by flooding the total network is a method of accessing the information of location.

Collaboration and coordination of several UAVs can build a system that is beyond the capacity of only one UAV. The benefits of the multi-UAV systems can be briefly explained as follows:

Cost: The maintenance and acquisition cost of small UAVs is much lesser as compared to a large UAV [10] cost.

Scalability: The use of large UAV enables only restricted amount of coverage region increases [11]. Since, multi- UAV systems can increase the operation scalability easily. Survivability: If the UAV fails in a mission which is ran by one UAV, the mission cannot success. Since, if a UAV goes off in a multi-UAV system, the operation can live with the other UAVs.

Speed-up: It is explained that the missions can be finished faster with a larger no. of UAVs [12]. Small radar cross-section: rather than one large radar cross-section, multi-UAV systems create very small radar cross-sections, which is essential for military applications [13]. The main purpose of this paper is to explain FANET as a separate ad hoc network family and to propose unique issues and design restraints. Though, there presents a few studies that address some particular challenges of networked UAVs [17, 18, 19].

II. FANET APPLICATION SCENARIOS

In this section, various FANET application scenarios are explained.

2.1. Extending the scalability of multi-UAV operations: If a multi-UAV communication network is demonstrated fully depending on an infrastructure, i.e. a ground base or a satellite, the operation area is restricted to the infrastructure communication coverage. If a UAV is not able to communicate with the infrastructure, it cannot work. On the other side, FANET depend on the UAV-to-UAV data connections rather than UAV-to-infrastructure data connections, and it can increase the operation coverage. Even if a FANET node cannot demonstrate a communication connection with the infrastructure, it can still work by communicating via the other UAVs. This scenario is shown in Fig. 2.

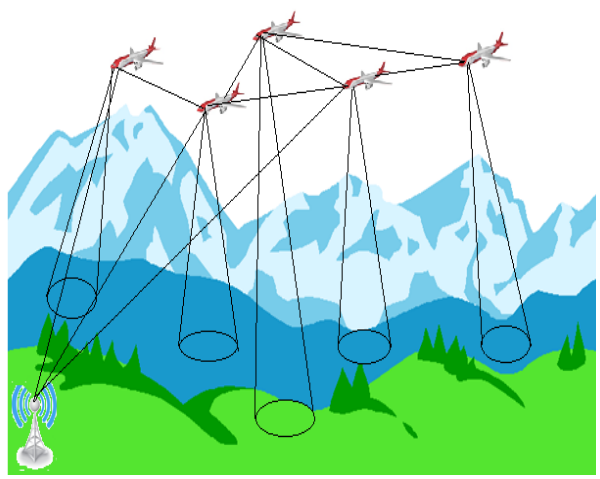

Figure 2: A FANET scenario to extend the scalability of multi-UAV systems

A. Reliable multi-UAV communication

In most cases, multi-UAV systems perform in a highly dynamic environment. The situations at the starting of a mission may vary during the operation. If there is no chance to demonstrate an ad hoc network, all UAVs must be linked to an infrastructure, as shown in Fig. 2a. Since, during the operation, due to the weather situation changes, many of the UAVs may be dispatched. If the multi-UAV system can provide support to FANET architecture, it can manage the links via the other UAVs, as it is illustrated in Fig. 2b. This connectivity characteristic increases the multi-UAV systems [16] reliability.

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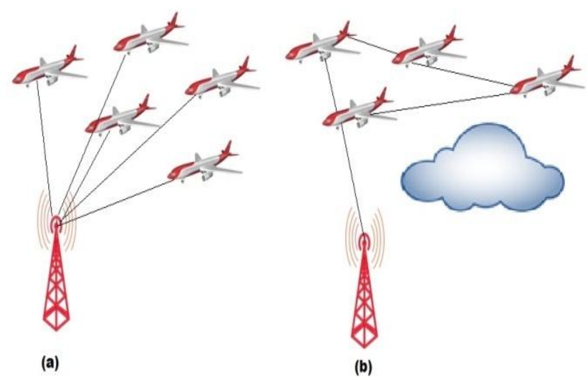

Figure 3: A FANET application scenario for reliable multi-UAV communication network

B. UAV SWARMS

Small UAVs have very less weight and have restricted payload capacity. Despite of their limited abilities, the swarm mature of various small UAVs can achieve complicated missions [21]. Swarm nature of UAVs needs coordinated functions, and UAVs must communicate with each other to obtain the coordination. Since, due to the restricted payloads of small UAVs, it may not be predictable to contain heavy UAV-to-infrastructure communication hardware. FANET, which requires relatively cheaper and lighter hardware, can be utilized to demonstrate a network between small UAVs. With the help of the FANET architectures, swarm UAVs can prevent themselves from collisions, and the coordination among UAVs can be used to finish the mission successfully.

III. CHARACTERISTICS OF UAANETS

Network characteristics of UAANETs are discussed in this section to have perception about the network requirements. Some UAANET are based on IEEE 802.11standard and MANET protocols but it is better to consider the unique characteristics of UAANETs. In the upcoming sections some of the important features of UAANET will be discussed. Before talking about the features of FANETs, we offer a formal definition of FANET and summarized view about the definition to explain FANET clearly. FANET can be explained as a new type of MANET in which nodes are UAVs. With respect to this definition, single- UAV systems cannot make a FANET, which is available only for multi-UAV systems. On the other side, not all multi- UAV systems make a FANET. The UAV communication must be understood with the help of an ad hoc network among UAVs. Hence, if the communication among UAVs fully depends on UAV-to-infrastructure connections, it cannot be categorized as a FANET.

1. Rapid Change in Topology

UAVs can attain the speed of hundreds of kilometers per hour unlike the MANET based mobile nodes but the limiting factor of UAANET is power which is not the case with satellites and AANETs. These networks also differ in the antenna technology which they can use. UAVs are smaller as compared to commercial aircrafts and satellites. The antennas which are used in the UAVs need to be cheap as well as easily transportable. Due to these reasons the range of transmission of UAVs are shorter compared to AANETs and satellite links. The velocity to radio link ratio of UAVs is thus not too low to keep them connected and prevent any change in the topology. Applications like searching increases the effect of high mobility of UAVs. –Fast changes in the topology make it difficult to establish stable end to end connections.

2. Application based mobility

Mobility models help in simulation of network and in the evaluation of performance of MANET protocols. The general mobility models for MANET evaluation are Brownian motion, random direction, random walk, random waypoint [38,39].Use of any mobility model like random walk is not consistent with intelligent UAVs but these models are well characterized. For example in random walk randomness can be adjusted by well defined parameters. The behaviors of UAVs are more random as compared to tracking. Random walk model parameters require welling arranging to support different randomness needs for modeling different UAVs. Thus, modification of the MANET mobility models original versions may be possible, so, MANET mobility model can make more congruous with environment of UAANETs. The feature of UAANETs is density variation effects on mobility and general network connectivity. Density will affected by numbers of UAVs which shaping the UAANET and also affected by different applications. Consider the UAANETs applications: tracking and searching. when an area is searched by UAVs ,area should be divided in field in a way that field can cover the entire area. If the area is large the UAVs distribution may track to a thin network. The same way when an object is tracked by UAVs the target is followed by much number of the UAVs. Therefore, they do not require disseminating and consequently UAVs remains in transmission range of each other.

3. Medium Access Control Requirements:

Although, the main goal of thesis is not MAC, yet we introduce some as aspects of UAV MAC. The important task of MAC layer is to gratify the latency requirements of data bouts that contain different

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priorities In UAANETs entry control and different services are requires at MAC layer to packet scheduling. Traditional wireless MAC protocols like IEEE 802.11are used in many UAANETs prototypes [31-33, 40]. Different classes of quality of services, different applications require to be describing to be able to support priorities. Also, for nodes to manage sleep mode MAC protocols address provide power shaving technique and assign power levels of transmission. To manage power ingestion power assignments and range of dynamic transmission can be used[41]. The thought of dynamic transmission range stems from the act that in space and time the density of UAVs is changed So we can use different transmission range every time and ever where. If different acts with different priorities and disseminating needs are assign to different parts of UAANETs then power assignment is useful and also advantageous. Less transmission powers are assigned to the UAVs that have less duties, and to UAVs that have more responsibilities are assigned higher transmission powers

IV. DIFFERENCES BETWEEN FANET ,MANET AND VANET

Wireless ad hoc networks are categorized with respect to their usage, communication, deployment and mission aims. By definition, FANET is a kind of MANET, and there are several common design considerations for FANET and MANET. In summation to this, FANET can also be categorized as a subset of VANET, which is also a subset of MANET. This relationship is shown in Fig. 3. As a developing research area, FANET shares common features with these networks, and it also has various unique design issues. In this section, the differences between FANET and the available wireless ad hoc networks are described in a detailed way.

Node mobility: Node mobility related challenges are the most famous difference between FANET and the other ad hoc networks. the node movement of MANET is comparatively slow in comparison of VANET. In FANET, the degree of node's mobility is much higher in comparison of MANET and VANET. With respect to [16], a UAV has a speed of 30–460 km/h, and this condition results in various challenging communication design issues [33].

Mobility model: While MANET nodes travel on a particular terrain, VANET nodes travel on the highways, and FANET nodes fly in the sky. MANETs normally carry out the random waypoint mobility model [34], in which the speed and direction of the nodes are selected in a random manner. VANET nodes are limited to travel on roads or highways. Hence, VANET mobility models are highly certain.

Node density: Node density can be explained as the average no. of nodes in a unit area. FANET nodes are normally distributed in the sky, and the distance between UAVs can be many kilometers even for small multi-UAV systems [37]. The result of this, the node density of FANET is much lesser as compared to the VANET and MANET.

Topology change: Based on the higher degree of mobility, FANET configuration also changes more rapidly as compared to VANET and MANET configuration. In summation to FANET nodes mobility, UAV platform failures also affect the network configuration. When a UAV fails, the connections that the UAV has been included in also fail, and it results in a configuration update. As in the UAV failures, UAV injections also conclude a configuration update. Another element that affects the FANET configuration is the connection outages. Due to the UAV variations and movements of FANET node distances, connection quality changes very quickly, and it also leads connection outages and configuration changes [38].

V. REACTIVE-GREEDY-REACTIVE *(RGR)*PROTOCOL

Reactive-Greedy-Reactive (RGR) [1] is a novel routing protocol for Unmanned Aeronautical Ad-hoc Networks (UAANETs) [2] that we are formulating. UAANETs contain many Unmanned Aerial Vehicles (UAVs) that interact with each other without static infrastructure. Each UAV must interact with others for reducing mission delay and enhance reliability in serious aerial operations [3]. UAANETs have unique features i.e. high mobility and comparatively less no. of network UAVs. These features can cause constant configuration changes because of multiple connection breaks in the network. Some protocols which have been introduced for Mobile Ad-hoc Networks (MANETs) [4, 5, 6] cannot directly be used to UAANETs because of their unique characteristics. Thus, it is essential to design new effective routing protocols that properly address these restricting topological characteristics. Currently, a novel protocol, known as RGR, which integrates Greedy Geographic Forwarding (GGF) and reactive routing [7] has been formulated for these high mobility scenarios.

The basic concept behind RGR, which has been introduced in [1], is to integrate a reactive protocol i.e. AODV) with greedy geographic forwarding (GGF). In RGR, if there is no legal route for data packets to be transferred, the source node of the data packets initiates a route discovery mechanism (as in

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AODV) for finding a legal route entry to arrive the destination node, flooding Route Request (RREQ) packets into the network. In fact, a reactive route is demonstrated when the source node obtains the Route Response (RREP) packet from the destination node. Once the route is demonstrated, data packets stored at the source node can be transmitted to the destination node. The newness in RGR is that the position information of the destination is achieved by each intermediary node as the RREP packet returns back to the source node. In the route maintenance mechanism, if an intermediary node cannot obtain 3 successive HELLO messages, the connection is assumed lost and the reactive route bursts. RGR avoids the reactive route and uses the GGF mode. In this mode, the protocol forwards the data packets to the neighboring node which is nearest to the destination node (in essence) simultaneously.

The first process is as follows. When a route discovery mechanism is started for the first time, the source node broadcasts the RREQ packets into the entire network and waits for the RREPs message from the destination. When the RREP packets reach at the source node, a legal reactive route will be established and, meanwhile, the position information of the destination will be known by the source node. After a short interval of time, a new route discovery mechanism may require to be performed for the same destination node because of a route break due to the highly dynamic configuration of our UAANET scenarios. In this situation, utilizing the destination location known previously, the source node computes the distance to arrive the destination node and involves this result in the RREQ packet (as well as its information of the destination's position). This new request packet is flooded to all neighbor nodes. Upon obtaining the RREQ packet, a neighboring node removes the value of distance from the RREQ packet and re-computes its own distance to arrive the destination node. If this computed distance is lower than the distance from the RREQ packet, the neighboring node should substitute the old value with the new value in the RREQ packet and re-flood the packet to its neighboring nodes. Else, this RREQ packet will be dropped. This mechanism continues until the RREQ packet arrives to the destination node, which then responses through a RREP, managing its position information in the mechanism. The source node will wait to obtain a route response to the evaluated RREQ.

VI. FANET DESIGN CONSIDERATIONS

The different characteristics of FANET impose unique design conditions. In this section, the most famous FANET design considerations; adaptability, scalability, latency are explained.

Adaptability: There are various FANET factors that can change during the multi-UAV system operation. FANET nodes always change their location and are highly mobile. Due to the operational needs, the UAVs routes may be different, and the distance among UAVs cannot be constant.

Another challenge that must be taken is the UAV failures. Following to a technical problem, some UAVs may fail at the time of operation. While UAV failures reduce the no. of UAVs, UAV injections may be needed to manage the multi-UAV system operation. UAV injections and UAV failures change the FANET factors.

Scalability: Coordinated work of UAVs can enhance system performance as comparison to a single-UAV system. In fact, this is the primary purpose to utilize multi-UAV based systems. In some applications, the performance improvement is closely related with the no. of UAVs. For instance, the higher no. of UAVs can finish a search and rescue operation quicker [12]. FANET algorithms and protocols should be designed so that any no. of UAVs can work together with minimal performance reduction.

Latency: Latency is one of the most significant design factor for all kinds of networks, and FANET is not an exception. FANET latency need is fully based on the application. Particularly for real-time FANET applications, i.e. military monitoring, the data packets must be reached within a specific delay bound. Another low latency need is applicable for collision avoidance of several UAVs [14, 46].

VII. COMMUNICATION PROTOCOLS FOR FANETS

In this section, the FANET communication protocols and the open research issues are explained. We review the available FANET protocols introduced for the physical layer, medium access control (MAC) layer, network layer, transport layer, and their cross-layer interactions.

A. *Physical layer:* The physical layer covers the basic signal transmission techniques, i.e. signal or modulation coding. Several data bit sequences can be shown with different waveforms by changing the amplitude, frequency and phase of a signal. Totally, in the physical layer, the data bits are regulated to sinusoidal waveforms and transmitted into the air by using an antenna. The performance of MANET system is highly based on its physical layer, and the very high mobility puts additional problems on FANET. For developing sustainable and robust data communication architectures for FANET, the physical layer situations have to be well-defined and

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well-understood. Recently, UAV-to- ground communication and UAV-to-UAV scenarios have been widely studied in both real-time and simulation environments. Antenna structures and Radio propagation models are enquired as the key factors that affect FANET physical layer design.

B. 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 [49]. FANET environment has many unique issues in terms of radio propagation as compared to the other kinds of wireless networks.

C. MAC layer: Though VANET, MANET and FANET have various issues and features, they have also many common design considerations. Generally, FANET is a particular subpart of VANET and MANET. In this way, the first FANET examples utilize IEEE 802.11 with omni-directional antennas [34,32], which is one of the most generally utilized MAC layers for MANETs. With the help of the clear-to-send (CTS) and request-to-send (RTS) signal exchange scheme, IEEE 802.11 can cover the conceal node problem [63].

D. Network layer: The starting FANET experiments and studies are designed with the available MANET routing protocols. One of the first fly experiments with FANET architecture is dine in SRI International [68]. In this research, Topology Broadcast based on Reverse-Path Forwarding (TBRPF) [69], which is generally a proactive protocol, is employed as the network layer to reduce the overhead. In [70], Brown et al. formulated another FANET test bed with Dynamic Source Routing (DSR) [71] protocol. The primary purpose to select DSR is its reactive structure.

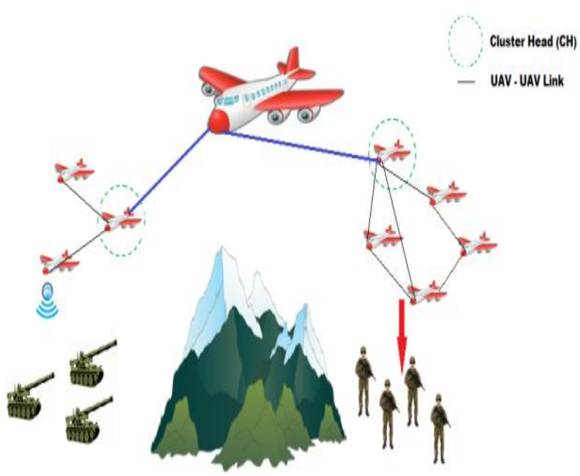

Fig. 4. Hierarchical routing in FANET

The source attempts to discover a route to a destination, only if it has data to forward. There are also many other FANET studies that utilize DSR. Khare et al. began that DSR is more suitable as compared to proactive mechanisms for FANETs, where the nodes are highly mobile, and the configuration is unstable [72].

E. Transport layer: The FANET designs success is closely related to the communication architecture reliability, and establishing a reliable transport method is necessary, particularly in a highly dynamic environment. The important responsibilities of a FANET transport protocol are:

Reliability: Reliability has always been the main responsibility of transport protocols in communication networks. Messages should be reliably forwarded to the destination node to confirm suitable functionalities. Data may be simple text/binary in which 100% reliability is needed, or it may be multimedia streams in which low reliability is sufficient. FANET transport protocol should provide support to various reliability levels for many FANET applications.

Congestion control: The typical results of a congested network are the reduction in packet delivery ratio and the increment in latency. If a FANET is congested, collision and collaboration avoidance between UAVs cannot be done properly. A congestion control scheme is essential to obtain a reliable and efficient FANET design.

Flow control: due to a fast sender or many senders, the recipient may be overloaded. Flow control can be a critical problem particularly for heterogeneous multi- UAV systems.

VIII. RELATED WORK

Nanxiang Shi et. al.[1] In this paper authors analyzed the performance 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 forms stable cluster architecture of UAV fleet as the basis and then performs route discovery and route maintenance by using the geographic location of UAVs. In their work they evaluated and compared performance of the proposed CBLADSR with DSR and GRP on OPNET Modeler.

R.Suganthi et. al.[2] This paper analyzed the performance of DOFP protocol for UAANET. In their work they reduce the routing overhead and the possibility of data loss. In their results they compared DOFP algorithm with RGR and AODV. For the simulation purpose they had taken Network Simulator 2 (NS2) simulator.

Ilker Bekmezci et. al.[3] In this paper authors analyzed the performance of Flying Ad-hoc Network

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(FANET) with various applications. In their work they present several FANET application scenarios. They also discuss the various differences 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 had taken Test bed for Micro-Aerial Vehicle Swarm Experiment.

Jean-Daniel Medjo Me Biomo et. al.[4] In this paper authors investigate various mobility models that affect the performance of UAANET in simulations in order to come up with results that provide a benchmark for future UAANET simulations. In their work they used OPNET Modeler 16.0 for the simulation of the routing protocols

IX. FANET TEST BEDS AND SIMULATORS

In this section, the available FANET test beds and simulators are enquired to offer a fast guideline for novel FANET researchers.

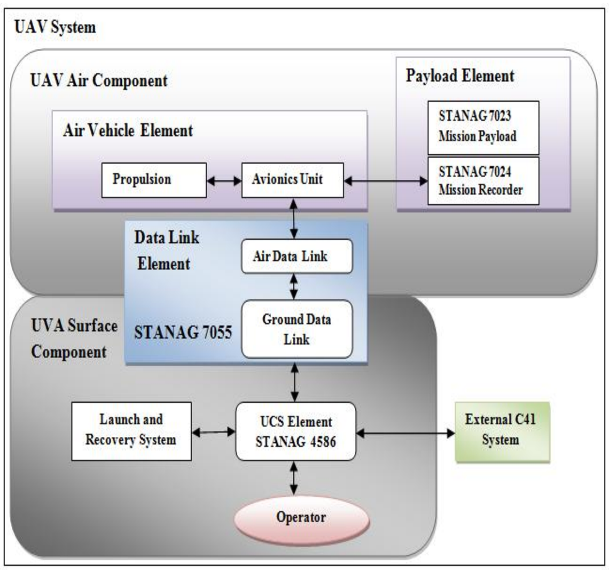

Fig. 5. UAV system interoperability architecture

First FANET test beds were carried out in University of Colorado [32]. It was formulated and recognized with IEEE 802.11b radio equipment fitted on small UAVs with Fidelity-Comtech bidirectional amplifier up to 1W output and a GPS. Dynamic Source Routing (DSR) was selected as the network protocol, and a monitoring system was fitted into the radios for detailed performance analysis and characterization.

OPNET:- OPNET's is normally specialized for network development and research. It is reliably utilized for communication networks study, about protocols, devices and the applications. As this is commercial service supplier it has a good graphical interface for subscriber and the graphical interface is utilized to make the network topology application and entities from the system application layer to the physical layer. Here, the object oriented programming language is utilized to generate a mapping from the graphical interface for the real implementation. The diagram below represents the graphical representation of every network nodes and the graphical output. As it has a graphical aspect, the parameter can be varied and seen the result repeatedly very easily without much hard work. This modeller is famous for network research and industry for the development. The provided programming tools and GUI interface are very useful to make the system according to subscriber need and to model the system.

OPNET has three important services as modelling, simulation and analysis. For modelling it offers good graphical interface to describe and generate all types of model protocol. For simulation it utilized different kind of advanced simulation technique to deal and address broad range of study aim. For analysis, the simulation results and data can be showed graphically in user friendly forms of graphs, charts and in statistics form for subscriber comfort.

Network Simulator 2 (NS2):- NS2 is the most famous network simulators. This is a discrete event modeller mainly designed for the network researchers. NS2 is the second version of NS (Network Simulator) and NS was formulated in 1989. The latest version of NS2 is broadly utilized for academic research. After that lots of packages are contributed by some non-profit groups to enhance and build it much better. Network Simulator or in short NS2 is an object oriented discrete event driven network modeller. It was first formulated at the California-Berkely university. The programming language utilized is Tcl script and C++ language with object-oriented extension (OTcl). There is cause utilizing these two languages. C++ is very effective to design but complicated for visual and graphical implementation. OTcl is employed to fill the lap that the C++ lacks. So the integration of these two languages appears to be very efficient. Normally the C++ is employed to implement the detail simulation protocol and OTcl is employed for the subscriber to control the simulation and organize the events. The OTcl script is utilized to start the event scheduler, to establish the network configuration and to tell traffic source whether to forward or stop forwarding the packet from event scheduler. The view can easily change by the OTcl script. There is reliability that when a subscriber wish a new network object they can simply write the code utilizing

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the available object library and also plumb the data path from object. The significant plumbing builds NS2 very powerful. Another significant characteristic is that, the event scheduler which keeps tracks of time of simulation. It participates in releasing the event in the event queue invoking a suitable network component.

OMNeT++:- OMNeT++ is a public source, a discrete event modeller with GUI support of component based network modeller. The primary application field of this simulator is the communication networks along with its reliable architecture it has other areas i.e. hardware architecture, IT systems, queuing network and also in business mechanism. Here the components are known as modules and programmed in C++ language. Its operating principal is same as that of Python in NS3 and OTcl in NS2. The smaller components are integrated into larger components and models utilizing high level language. The OMNeT++ is intended particularly for the complex based architecture. Basically the reusable components are aggregated to build OMNeT++ module. The major characteristics of OMNeT++ are the modules are reusable and the modules are integrated in several ways. The key characteristic is the simulation kernel C++ class library which contains utility class and simulation kernel essential for simulation components. It has runtime subscriber environments and interface for simulation. OMNeT++ support multiple platform like it can operate on Unux, other Linux-like systems and on Windows systems.

Open Cirrus :-Open Cirrus is an open cloud computing testbed sponsored by Inter, Hewlett-Packard (HP)and Yahoo! in cooperation with some other organizations. In accordance of [6] the Open Cirrus aspires to obtain the below objectives: 1. Foster systems-level research in cloud computing. 2. Promote new cloud computing applications and applications-level research. 3. Provide a set of experimental datasets. 4. Formulate APIs and open-source stacks for the cloud. Open Cirrus offers a cloud stack consisting of virtual and physical machines, and global facilities i.e. monitoring, sign-on, job submission and storage.

CDOSim :-CDOSim is a cloud deployment option (CDO) Simulator which can model the SLA violations, response times and costs of a CDO. A CDO is a decisions relating simulator which takes decision about the choice of a specific runtime adaptation strategies, cloud provider, components deployment of virtual machine and its instances configuration. Component deployment to virtual machine instances involves the probability of making new components of already available components. Virtual machine instances configuration, relate to the instance type of virtual machine instances. CDOSim can model cloud deployments of software systems that were reverse engineered to KDM models. CDOSim has capability to represent the subscribers instead o the suppliers point of view. CDOSim is a simulator that permits the combination of fine grained models. CDOSim is best instance for runtime reconfiguration plans comparison or for finding the tradeoff between performance and costs [13].

CDOSim is intended to address the major drawbacks of other available cloud simulators i.e. 1. Accordingly oriented towards the cloud user point of view rather than exposing fine-grained internals of a cloud platform. 2. Mitigates the cloud subscribers lack of knowledge and control relating to a cloud platform structure 3. Simulation is not dependent of concrete programming languages in the case suitable KDM extractors available for a specific language. 4. Workload profiles from production monitoring data can be utilized to replay actual subscriber behavior for simulating CDOs.

CONCLUSION

Communication is one of the most important design issues for multi-UAV systems. In this review paper, ad hoc networks among UAVs are reviewed as a separate network family i.e. Flying Ad-hoc Network (FANET). We define FANET and explain various FANET application scenarios. We also talk about the differences between FANET and other ad hoc network kinds in terms of node density, mobility, configuration change. FANET design conditions are also enquired as scalability, adaptability and latency. We offer a comprehensive survey of the recent literature on FANETs and related challenges in a layered mechanism. Moreover, we also talk about open research issues for FANETs, with the cross-layer designs. The available FANET test beds and simulators are also explained.

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