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FANET Communication and Routing Protocol

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Abstract - In recent years the capability and role of Mobile Adhoc Networks has rapidly evolved. Their use in the situations of emergency, in the case of a natural disaster, military battle fields and UAVs is getting very popular as a result of cutting edge technologies in networking and communication. Taking the MANET technology as the base has helped in the evolvement of new technologies like FANET and VANET. FANET is a very new concept if compared to MANET with the abilities to tackle situations where traditional MANET cannot do so. And also we will discuss about the comparison and design consideration of FANET.

Keywords - *MANET*

1. Introduction

FANET is the short form of Flying adhoc network which can be thought of as a sub category of mobile adhoc network. FANET may consist of homogenous or heterogeneous flying agents that are able to communicate with each other in the vicinity, and also interacts with their surroundings to acquire some kind of valuable information. FANET technology does not use central controlled system [1]. Although mobile adhoc networks have versatile application but there is a need of a different technology which can overcome the drawbacks of MANET such as disaster situations like drowning or military combat field [2]. It is not desirable to install moving nodes (which move on surface) in such a communication area. FANET can provide solution to tackle such situations by using flying object called microair-vehicles (MAVs). The swarm of MAVs is used to converse in a large operational area. MAVs structure themselves to form wireless communication network. No GPS, radar or cameras are installed with them and they communicate in the neighborhood only [3, 4]. In FANET, the position of the MAVs changes frequently. Due to this there is a rapid change in topology. So it is a very challenging task to find a suitable routing techniquei.e FANET.

2. Overview of Routing Protocol

In this section, routing protocols AODV, DSDV and OLSR are described briefly and the performance parameters of these protocols are also discussed. This section also defines the basic difference of these routing protocols, that how these protocols define mechanism to their route strategy based classification like reactive or proactive.

2.1 Ad hoc on demand distance vector (AODV)

It is one of the routing protocols that is intended for mobile ad hoc networks. This protocol is adaptive to vigorous link conditions, low network utilization, slow processing, and memory overhead and for finding unicast paths to destinations nodes in the ad hoc network. This protocol is known to be an on demand protocol. This means that it forms route only for those nodes which are requested by source node according to its need. Nodes need to keep the route until required by source node. AODV creates a tree of group members and nodes needed by members. AODV use sequence numbers to recognize new route updates. The key properties of this protocol are that there is no looping, it is self-starting and used for large number of mobile nodes.

2.2 Destination Sequenced Distance Vector

Destination sequence distance vector routingis a routing algorithm designed for adhoc networks using the concept of Bellman-Ford algorithm. This routing algorithm was discovered by C. Perkins and P.Bhagwat in 1994. DSDV is modified version of Distance Vector Routing. Distance Vector Routing maintains hop count for each destination node. The routing table consists of destination, distance and next hop. Initially routing tables are empty [6]. Each node sends its routing table to the neighbor nodes

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periodically. Nodes re-compute there shortest distance and update their table. Main problems of Distance Vector Routing are count to infinity, slow convergence and looping. DSDV was designed to solve the problems of Distance Vector Routing. DSDV added two parameters < Sequence number, Damping >. Sequence number was added to avoid looping issues and damping was included to avoid unnecessary updates. DSDV routing updates are done in two forms.

- Periodic updates: Periodic updates are sent after every 15s. Entire routing table of each node is broadcasted.
- Trigger Updates: These are the updates that are sent in between periodic updates. These updates are sent when any update is received by any node.

2.3 Optimized Link State Routing (OLSR)

OLSR is proactive routing protocol for adhoc networks. The protocol inhibits the stability of link state algorithm. Because of the proactive nature of OLSR, it has a benefit of having routes available whenever required [7].In pure link state protocol, all the nodes declare and broadcast their neighbor links in the whole network. But in OLSR protocol we do optimization of pure link state for adhoc network. OLSR provides following features:

- By declaring a node as a multi-point-relay (MPR) selector for each of its neighbors, OLSR reduces the size of control Packet.
- MPRs nodes are only eligible for broadcasting data. By using these MPRs, OLSR reduces the scattering of its messages in the whole communication network.

3. FANET Communication Protocols

3.1 Adaptive MAC protocol

The link quality fluctuates in FANET because of high mobility of nodes and continuously changing the distance between nodes. MAC design for FANET faces new challenges because of such link quality fluctuations and failures. Latency can also be another challenge. A directional antenna can be helpful in scenarios to increase the range of communication, spatial reuse, enhancing security. In [3], an adaptive MAC protocol has beenproposed which uses an omnidirectional antenna for control packets transfer and directional antenna for data packets transfer. End to End Delay, Throughput and Bit Error Rate were improved with the use of this approach.

3.2 Token MAC

A Token based approach was proposed in [9] to update target information, to overcome the problem in traditional contention based protocols and link failures due to high mobility. Full Duplex Radios and Multi Packet Reception (MPR) were used to improve the MAC performance in a multi-UAV network environment. The delay is reduced with Full Duplex Systems as each node can transmit and receive at the same time and Multi-packet reception capabilities improve the throughput in multi-UAV systems.

3.3 Directional Optimized Link State Routing Protocol

In [8], a protocol is proposed which uses modified OLSR (Optimized Link State Routing Protocol) and uses directional antenna. In OLSR, the key step is selecting multi point relay (MPR). Reducing the number of MPR will result in reduced control packets transferred. In [8], as proposed by authors to transfer the packets, information about the destination is used and if the distance to the destination from source is less than half of maximum capacity of the directional antenna, then DOLSR is used otherwise, OLSR is used for routing. They have also proposed a new approach which reduces the number of MPR which results in reduced control overhead. The proposed approach reduces delay and enhances the overall throughput.

3.4 Time Slotted Ad-hoc on Demand Distance Vector routing

To reduce collisions, time slotted reservation scheme is used along with AODV. In [2] the authors proposed a hybrid approach to minimize the intermediate node communication. Time reservation mechanism used in this approach is similar to that of Slotted ALOHA. Each node is assigned a time slot to send data to a master node or cluster head and has communication privilege over other nodes in this particular time slot. The proposed approach reduces collisions and also improves packet delivery ratio.

3.5 Geographic Position Mobility Oriented Routing

In [12], a geographic-based routing protocol GPMOR is proposed which can find the best available next hop to effectively decrease the impact of intermittent connectivity caused by the highly dynamic mobility. Firstly, they used Gauss-Markov mobility model for predicting the node position to decrease routing failure. Secondly, they used the mobility relationship to select next-hop for routing more accurately [12]. The proposed approach improves the stability of cluster and cluster heads.

3.6 Mobility prediction clustering

In UAV networking, the existing clustering algorithms were not suitable because of high mobility and frequent cluster updates. To overcome such problems, in [10] a new mobility prediction which uses cluster weighted model is proposed which uses UAV attributes. It predicts the network topology using the Tree data structure dictionary prediction and link expiration time mobility model. It helps in constructing more stable cluster structure and improved network performance because of thereasonable cluster head electing algorithm and on-demand cluster maintenance mechanism.

4. FANET Design Considerations

The distinguishing features of FANET impose unique design considerations. In this subsection, the most prominent FANET design considerations; adaptability, scalability, latency, UAV platform constraints, and bandwidth requirement are discussed.

1. Adaptability:

There are several FANET parameters that can change during the operation of a multi-UAV system. FANET nodes are highly mobile and always change their location. Because of the operational requirements, the routes of the UAVs may be different, and the distance between UAVs cannot be constant. Another issue that must be considered is the UAV failures. Consequent to a technical problem or an attack against multi-UAV system, some of the UAVs may fail during the operation. While UAV failures decrease the number of UAVs, UAV injections may be required to maintain the multi-UAV system operation. UAV failures and UAV injections change the FANET parameters. Environmental conditions can also affect FANET. If the weather changes unexpectedly, FANET data links may not survive. FANET should be designed so that it should be able to continue to operate in a highly dynamic environment.

2. Scalability:

Collaborative work of UAVs can improve the performance of the system in comparison to a single-UAV system. In fact, this is the main motivation to use multi-UAV 498 based systems. In many applications, the performance enhancement is closely related with the number of UAVs. For example, the higher number of UAVs can complete a search and rescue operation faster [12]. FANET protocols and algorithms should be designed so that any number of UAVs can operate together with minimal performance degradation.

3. Latency:

It is one of the most important design issues for all types of networks and FANET is not an exception. FANET latency requirement is fully dependent on the application. Especially for real-time FANET applications, such as military monitoring, the data packets must be delivered within a certain delay bound. Another low latency requirement is valid for collision avoidance of multiple UAVs.

5. Conclusion

In this research, AODV, DSDV and OLSR routing protocols are analyzed under the different parameters i.e. End to End Delay, Average Throughput and Packet Delivery Ratio with respect to speed of mobile node. Through the simulation results it can be clearly seen that, OLSR routing protocol perform better than the other two routing protocol AODV and DSDV in terms of End to End Delay, Average Throughput and Packet Delivery Ratio. So the performance of FANET can be optimized by choosing OSLR routing protocol.

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