Routing Strategies in Flying Ad-Hoc Networks

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Abstract –FANET is a popular technology in networking and communication. It works in those areas where MANET cannot do. It is difficult to implement routing in FANETs because of the fast change in topology and high mobility.For an effective communication, routing protocols plays a great role.The nodes transfer data on the basis of a particular routing protocol. As the location of the nodes changes frequently, we need an efficient routing protocol. In this paper, we study different routing protocols like LCDR, DCR, DSDV,OLSR etc. for FANET and their routing strategies.

Index Terms – FANET, Routing protocols, UAVs , Sensor nodes, MANET,VANET.

1. INTRODUCTION

Flying Ad Hoc Networks (FANETs) are the most recent technologies for both military civilian and military near space wireless networks. FANET is basically a special form of MANET/VANET. There are also many differences between FANET and other ad-hoc networks like MANET/VANET. The mobility degree of FANET nodes is much higher than MANET or VANET nodes. The VANET and MANET nodes are the vehicles or walking human beings respectively but the FANET nodes are fly in the sky. As the mobility of FANET nodes is high, so the topology changes more frequently than the network topologies of MANET or VANET. FANET is allow to send information quickly and accurately in a situation, where other adhoc networks are not suitable to do so. FANET can perform better than other form of mobile adhoc networks at the time of natural disaster like flooding, earthquakes and in military battlefield . .So it is a challenging task to find appropriate route due to rapid change in topology.

Unmanned aerial vehicle (UAV) can move independently and operated distantly .The use of UAVs increases day by day in various areas like military and civilian applications. There are various issues in communication among UAVs. It is advantageous to use a group of small UAVs. So, multi UAV systems are necessary to create an network between the UAVs which is known as FANET.

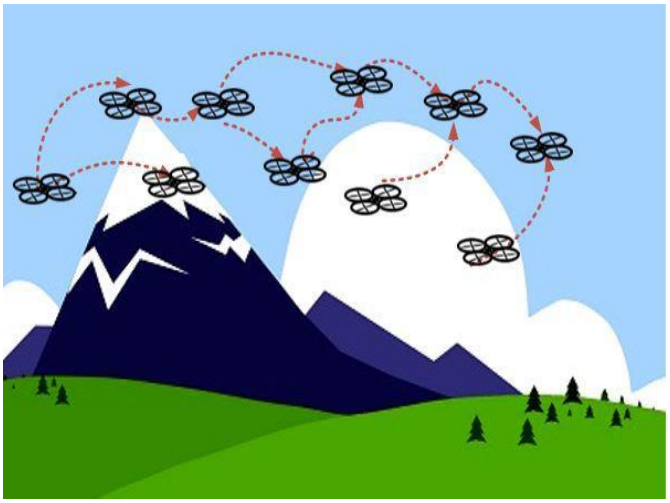

Fig. 1- Flying Ad Hoc Network

2. FANET NETWORKING PROTOCOLS

The main purpose of routing protocols is to find appropriate path for data transmission. There exists many routing protocols for wireless networks like pre-computed routing, dynamic source routing, on demand routing, flooding, cluster based routing etc. FANET is a sub-class of VANET and MANET networks. Therefore, MANET routing protocols are initially chosen and tested for FANET.

The protocols for MANET are divided into following categories:-

- **Static protocols**, which have fixed routing table as there is no need to refresh these tables.
- **Proactive protocols**, have routing tables that are periodically refreshed.
- **Reactive protocols** (also called on-demand protocols) must discover paths for messages on demand.
- **Hybrid protocols** uses both proactive and reactive protocols.

FANET can discover new paths for the communicating nodes with the help of these routing protocols.

A. **Static Routing Protocols**

In static routing protocol, a routing table must be computed and loaded for UAV nodes before a operation that cannot be updated during that operation. So, it is known as static. Here UAVs have a particular fixed topology that cannot be changed until the operation ends. Each node must communicate with some UAVs or ground stations, and stores only their information. In a failure for updation of the tables, it is necessary to wait for the end of the mission. Therefore, these protocols are not fault tolerant.

Load Carry and Delivery Routing (LCDR)

It is the first routing models in FANET. Here a UAV loads its data from a ground node which can be video image of its path and after this UAV carries this valuable data to the destination node by flying; and then it delivers the data to a destination ground node which can be a military team or ground control station.

Data Centric Routing(DCR)

Data-centric routing is a routing mechanism for FANET. In this model, the consumer node that can be a ground node or UAV disseminates queries as subscription message in order to collect specific data from a specific area. The producer node decides which information has to be publish and starts the data dissemination. When published data reach a UAV (as a relay node), it checks accordingly subscription messages on it and forwards this data . Routing is done with respect to the content of data; and if needed, data aggregation algorithms can be used for energy-efficient data dissemination**.**

This routing executes three scopes of decoupling:

• Space decoupling: In which the communicating parties can be anywhere.

• Time decoupling: Here the data can be transmitted to the subscribers later or instantly.

• Flow decoupling: In this the delivery can be accomplished constantly.

Fig 2-Data centric routing in FANET

B. Proactive Routing Protocols

Proactive routing protocols (PRP) maintains tables to store all the routing information regarding nodes of a particular region in the network and each other's node.There are various table-driven protocols that can be used in FANET, and they are different from each other in the way of updating mechanism of the routing tables according to the topology change in topology.

The main advantage of this routing is that it just contains the latest information of the routing nodes .So, there is no need to wait and easy to select a routing path from sender to receiver.

There are some explicit disadvantages.-

- As there is a need of lot of message exchanges between nodes. Due to this bandwidth cannot be used efficiently used. So, this is not suitable for larger communications.
- When topology changed or failure occurs then these protocols shows the slow reaction.

Two main protocols are widely used - Destination-Sequenced Distance Vector (DSDV) protocol and Optimized Link State Routing (OLSR).

Destination- Sequenced Distance Vector (DSDV)

It is a table-driven proactive routing protocol in which each node acts as a router. Here each node maintains a routing table which contains sequence number for all other nodes, not only for the neighbor nodes. When the network topology changes the these changes are disseminated by update mechanism of the protocol. Here, sequence number is associated with each route.

This protocol is not suitable for dynamic networks where topology changes rapidly and does not support for multipath routing. It also requires large updation of routing tables.

Optimized Link State Routing Protocol (OLSR)

It is a link-state proactive routing protocol that uses two types of messages (hello and topology control messages) in order to discover neighbors. Hello messages basically used for detecting the neighbor nodes in between the direct communication range. Generally, this message contains the known neighbors list, and it is periodically broadcast to one-hop neighbors. The topology control messages are used to maintain the topological information of the system. These messages are used for periodically refresh the topology information. So, each node can re-calculate the routes to all nodes in the system. Therefore, this periodic flooding nature of protocol results in a large amount of overhead. In order to reduce this overhead Multi Point Relay (MPR) mechanism must be used.

C. Reactive Routing Protocols

Reactive Routing Protocol (RRP) also referred as on demand routing protocol. If there is no connection between two nodes, there is no need to calculate a route between them. The concept RRP overcomes the overhead problem of PRP.

There are two types of messages in this protocol:-

Route Request messages and Route Reply messages. Route Request messages are generally created and transmitted by the source node in order to send messages, and Route Reply message used by the destination in order to node responses to this message.

The main advantage of RRP is its bandwidth efficiency as there is no periodic messaging. The main protocols in this are Dynamic Source Routing (DSR) and Ad-hoc On demand Distance Vector (AODV).

Dynamic Source Routing(DSR)

Dynamic Source Routing (DSR) is a reactive protocol designed for wireless mesh networks. Here, route is determined by the sender from source to destination. In DSR ,the source node generally sends a route request message to the neighbor nodes. There can be many route request messages in the entire communication route So. in order to avoid mixing the source node must adds a unique request id. Here, all the nodes must be associated with route caches in which all the routes are present. So, the main problem in this is the maintaining and updating the route caches.

Ad-hoc On-demand Distance Vector(AODV)

Ad-hoc On demand Distance Vector (AODV) has similar features with DSR as it is a combination of DSR and DSDV. The only difference maintenance of routing table .In DSR each node stores multiple entries in the routing table for every destination while in AODV; there is only a single record for every destination. Another difference is this that in DSR , all the data packets must transfer the complete route between source and destination nodes. But in AODV, the source node stores only the next-hop information which is consistent to each data communication. AODV routing protocol generally consists of three phases: discovery of route, packet transmission and route maintaining and three message types like route request, route replies and route errors.

D. Hybrid Routing Protocols

Hybrid routing protocol (HRP) is basically a combination of previous protocols, and used to overcome the previous protocols limitations. It generally needs extra time in order to discover routes and overhead of control messages. HRP is suitable for large networks. A network must be divided into a number of zones and intrazone routing uses the proactive method while inner-zone routing generally uses reactive method.

. **Zone Routing Protocol (ZRP)**

Zone Routing Protocol depends on the idea of zones . In this convention, each hub has an alternate zone. The zone is characterized as the arrangement of hubs whose base separation is predefined range R. Along these lines, the zones of neighboring hubs meet. The directing inside the zone is called as intra-zone directing, and it utilizes proactive strategy. On the off chance that the source and destination hubs are in the same zone, the source hub can begin information correspondence right away. At the point when the information bundles need to send outside the zone the interzone routing is utilized and reactive technique is also used.

Temporarily Ordered Routing Algorithm(TORA)

Temporarily Ordered Routing Algorithm(TORA) is basically a hybrid distributed routing protocol for multi-hop systems, in which routers just keep up data about contiguous routers .Its point is to restrict the proliferation of control message in the very rapid versatile registering environment, by minimizing the responses to topological changes. In spite of the fact that, it essentially utilizes a reactive routing protocols, it is additionally upgraded with some proactive methodologies. It constructs and keeps up a Directed Acyclic Graph (DAG) from the source hub to the destination. There are various routes between these hubs in DAG. It is favored for rapidly finding new routes in the event of broken connections and for expanding flexibility. TORA does not utilize a most limited way arrangement, and more courses are regularly utilized to diminish network overhead.

3. RESEARCH PROBLEMS

A) In a FANET, due to the quick movement of UAVs, the network topology can change rapidly .So, the data routing between UAVs undergoes a serious challenge or issue. The routing protocols must be able to update routing tables or caches dynamically according to change in topology changes. Previous protocols donot provide a reliable communication .So, there is a need of new protocols to provide a flexible or reliable communication.

B) There are also various issues during transmission like security overheads, dropping of data packets, utilization of energy.

4. CONCLUSION

Unmanned Aerial Vehicles have promising role in a large operation zone with complicated missions. For the region that are reasonably isolated from the ground and to accomplish complex tasks, UAVs require cooperation with one another and need a quick and easy deploying network system. Multi UAV system reduces the operation accomplishment time and increases reliability of the system for airborne operations when compared to a single-UAV system. To apply

networking in non-LOS, urban, aggressive, and noisy environment, multi-UAV system is very effective and accurate. Communication is one of the most challenging issues for multi-UAV systems. In this paper, ad hoc networks among the UAVs, i.e, FANETs are surveyed along with its key challenges compared to traditional ad hoc networks. The existing routing protocols for FANETs are classified into six major categories which are then critically analyzed and compared based on various performance criteria. Finally, we list several open research issues related to FANET routing protocols to inspire researchers work on these open problems.

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