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Reactive Greedy Reactive Routing in Flying 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

Unmanned aerial vehicle (UAV) is a vehicle that does not need a human operator. In many applications UAVs must cooperate to increase reliability and decrease mission delay in very crucial operation. Owning to this cooperation UAVs share information which is established using wireless communication. These UAVs can construct as wireless communicating nodes that makes unmanned aeronautical 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(full fill) 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 paper. In this paper the combination of a reactive routing protocol and greedy geographic forwarding is the aimed routing protocol , before the data dissemination(broadcasting), an on demand route discovery is executive on which 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 likes local repairing or backtracking have been represent in the literature [2]. The execution of graphic routing almost 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. We are developing a novel protocol for Unmanned Aeronautical Ad-hoc Networks (UAANETs) [2] named as Reactive-Greedy-Reactive (RGR) [1]. Various Unmanned Aerial Vehicles (UAVs) keeps communicating with each other in UAANETs without having any fixed infrastructure To minimize the operation delay and to enhance the reliability in aerial missions , each UAV must communicate with rest of UAVs. [3]. Constant topological alterations can occur due to some unique features of UAANETs as high mobility and less number of UAVs in network . These changes occur due to a lot of link breaks in the network. Various proposed protocols for Mobile Ad-hoc Networks (MANETs) are not directly applicable to

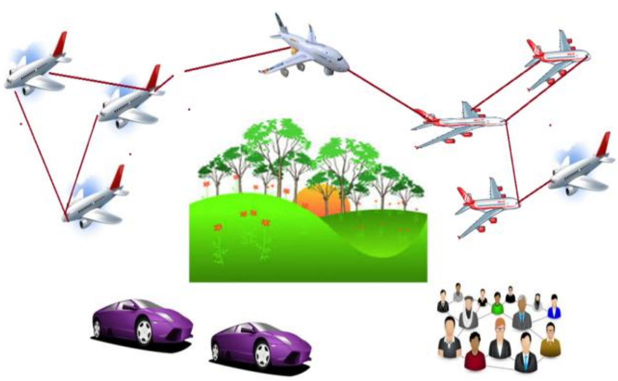

Figure 1: dimensional structure of UAANET

So, to overcome all these limitations, new routing protocols should be designed. A new protocol has been developed recently which is a combination of reactive routing and Greedy Geographic Forwarding (GGF) to address these shortcomings. In RGR , a reactive protocol (AODV in this case) is combined with greedy geographic forwarding (GGF) In RGR, If the proper route is not found for data packets , a route discovery procedure (as is the case in AODV) is started by source node to reach the destination node . These are called flooding Route Request data packets (RREQ). A reactive route is formed after receiving of the Route Response (RREP) packet from the destination node. After the establishment of this route, the data packets at source node can be propagated to the destination. .The novel thing about RGR is that as RREP packet get transmitted back to the source node, information about the location of destination node can be obtained from every intermediate node. . When in the route maintenance process, an intermediate node is unable to receive three successive HELLO messages , it is considered that the link is lost and there is break in reactive route. In such case, RGR negates the reactive route and get switched to the GGF mode. In GGF mode, data packets are sent to the nearest neighbor node of destination node. (in essence, salvaging it).

II. NETWORKING 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.

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.

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 requires to well arranged 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.

Medium Access Control Requirements: Although, the main goal of paper 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 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 describe 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 assigning 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

III. REACTIVE ROUTING:

After describing the architecture of the UAANET and UAANETs network requirements, now comes on ad-hoc routing protocols basic literature. ad-hoc routing protocols are used in this thesis as essential process of routing architecture of UAANETs. Routing protocols in MANETs can divide in three categories:

Reactive, proactive and geographic. Pro- active protocols maintain update routes to destinations. So, in highly dynamic networks they have been perform poorly[6]. In thesis we proposed RGR protocol that is the combination of the geographic forwarding and reactive protocol. In this section we discuss the reactive routing, .in reactive routing protocols by spreading the route request packet over the network the source node gets the route to destination. On the total performance of the network, route discovery set some latency for a reason that the process is on demand. network congestion and buffer overflow may caused by spreading of route request, examples of the reactive routings are: Ad-hoc on demand distance vector (AODV) and dynamic source routing (DSR).

In DSR, the source node disseminate a path discovery packet. Before forwarding the discovery packet intermediate node observe their cache . if no route is available in the cache the node set in its the IP address in the data packet and forward it to their neighbors . when any intermediate node or destination node sends reply back to the source, nodes on specify route cache. Local interference may comes when the many replies comes from the neighbors nodes, to prevent this ,according to the distance of nodes to source node each nodes delays their replies. In AODV, a route request is disseminated by the source node to its neighbor, which forwards it to its neighbor ,until the route request reach to the destination. The neighbor node have records From where they get root request .the destination node chose the route, which have minimum link cost, and through this chosen path destination send reply back. the nodes records the forwarding path to its routing table. Route request may use multiple path achieve at destination , but , the optimal path is chosen by the destination. When the intermediate move apart, link failure is detected by its neighbors and failure notification is sent to the upstream notification which in turn forward the information up to the source..

IV. REACTIVE-GREEDY-REACTIVE (RGR)

A new protocol has been developed recently which is a combination of reactive routing and Greedy Geographic Forwarding (GGF) to address these shortcomings. In RGR , a reactive protocol (AODV in this case) is combined with greedy geographic forwarding (GGF) In RGR, If the proper route is not found for data packets , a route discovery procedure (as is the case in AODV) is started by source node to reach the destination node . These are called flooding Route Request data packets (RREQ). A reactive route is formed after receiving of the Route Response (RREP) packet from the destination node. After the establishment of this route, the data packets at source node can be propagated to the destination. .

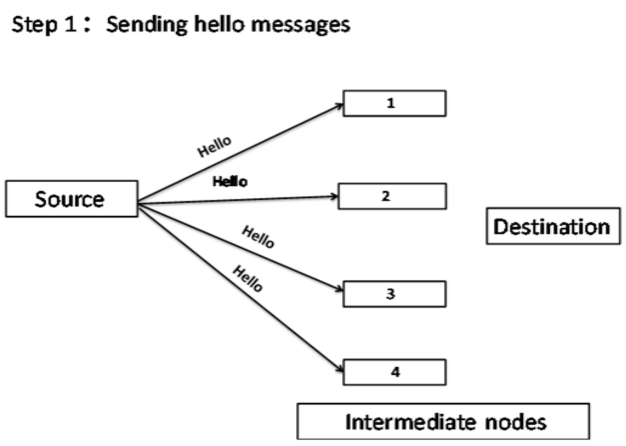

Figure 2: sending hello message

The novel thing about RGR is that as RREP packet get transmitted back to the source node, information about the location of destination node can be obtained from every intermediate node. . When in the route maintenance process, an intermediate node is unable to receive three successive HELLO messages, it is considered that the link is lost and there is break in reactive route. In such case, RGR negates the reactive route and get switched to the GGF mode. In GGF mode, data packets are sent to the nearest neighbor node of destination node. (in essence, salvaging it). At the same 0 time.

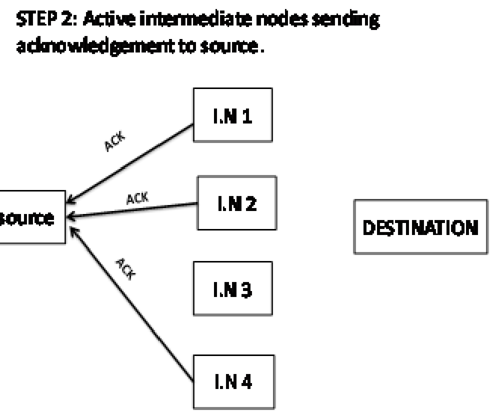

Figure 3: Sending ACK. Message

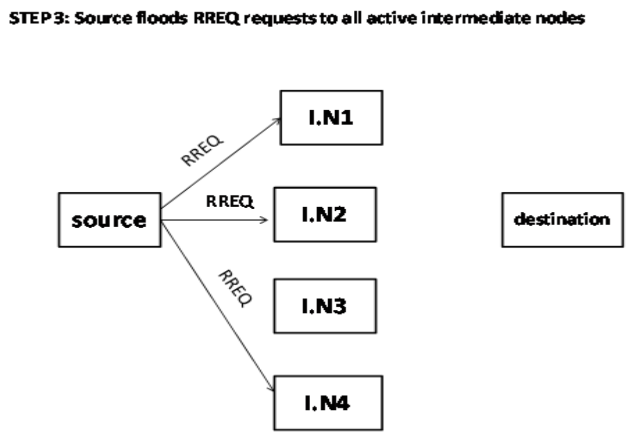

Figure 4: Source Floods RREQ

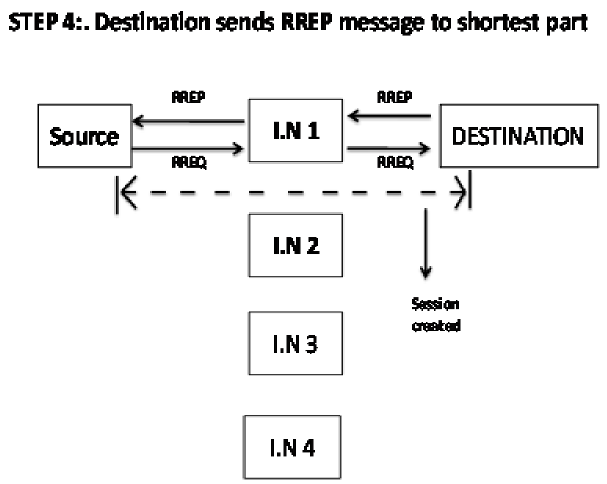

Figure 5: Destination sends RREP

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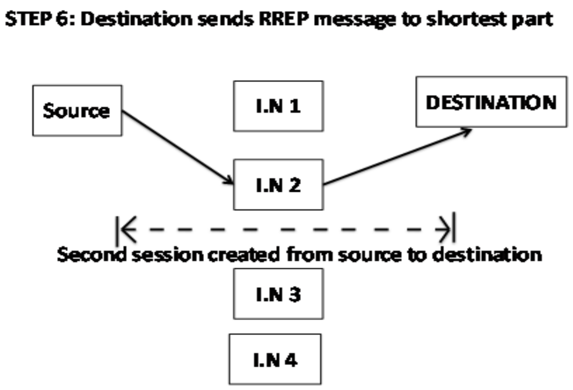

Figure 6: Destination sends RREP message

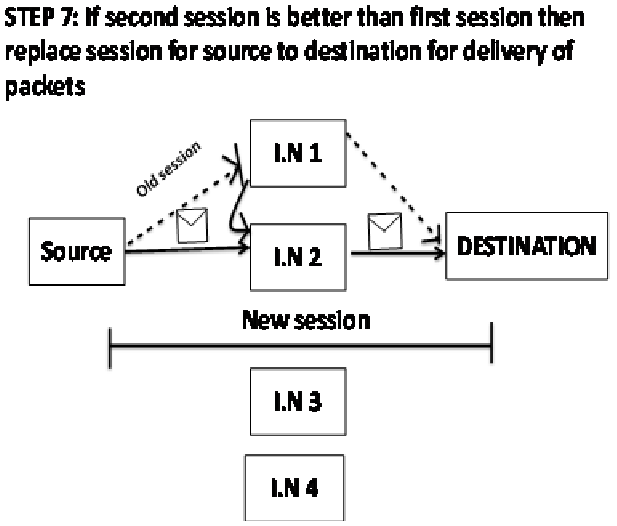

Figure 7: Replacement of sessions

RGR Functionality

In this section, High level overview of functionality of RGR is provides appropriate to presented OPNET implementation. The main focus of this part, a part added to AODV to convert AODV to RGR. So the reactive routing communications are discussed. Also explained the process which takes place after switching to GGF (greedy geography forwarding) .

Elements of RGR Mechanism

Here we introduce RGR main elements. then discussed the mechanism of RGR in detail. In this figure source (S)nodes wants to share the information with destination node(D).

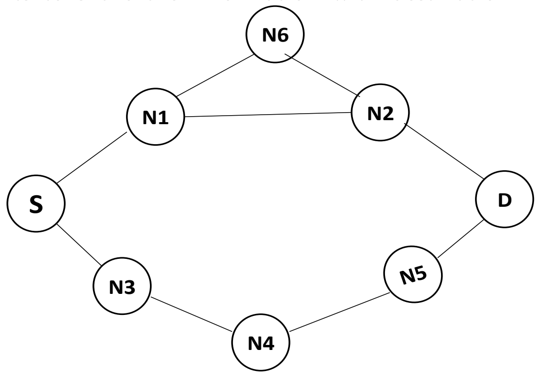

Figure 8: The scenario to establish a reactive route from S to D

In this scenario 6 other nodes are also included ,which are used to provide route from source to destination. In reactive session, source check routing table, there is any route available in the table. If there is any route available in the routing table, then information is sent over the path. If no route is available then RREQ/RREP mechanism is applied. The output of RREQ/RREP exchange, information of location is arrived back to the source. Then source node forward the data to destination like AODV process .intermediate nodes receive the data packet and sent it to destination. In second scenario, suppose that intermediate node N1 receive the data packet, then firstly node check there is any reactive route available to destination. If there is no reactive route is exist(due to neighboring nodes mobility),then data packet is sent geographically. The coming algorithm represent the greedy geographical forwarding used in nodes

Check table of node and calculate Distneighi = Dist(neighi ; Dest) for i =1; 2; :::;N.

2. Find Distmin = minfDistneighi g for i = 1; 2; :::;N.

3. If there exists a geographically closer neighbour (Distmin < Dist(node;Dest)),forward the packet to neighbor j, Arg{Distain}.

4. Else, packet is dropped.

5. End

In algorithm here explained, N is the number of neighbours.

Dist (node;Dest) = current node distance to destination.

Dist (neighi, Dest)= ith neighbour distance to destination.

Arg{Distmin}= arguments, their distance is minimum to the destination.

In following flow chart the data arrival function in RGR is shown

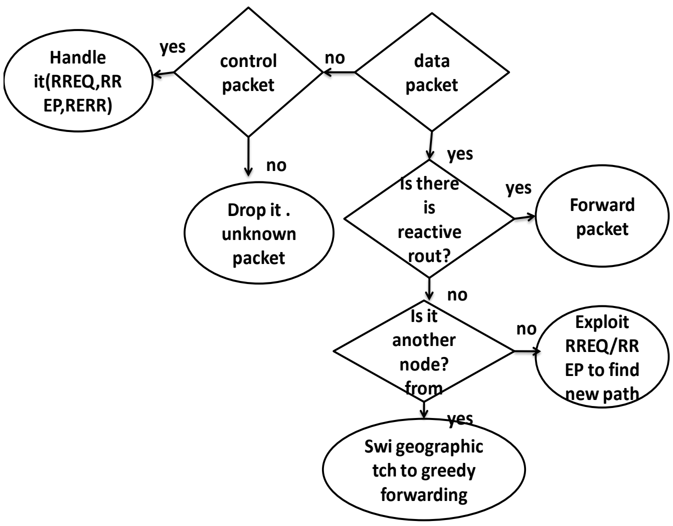

Figure 9: Handling a packet arrival in RGR

Node tables

Here, we describe the two types of routing tables in RGR architecture .that are based on the AODV routing table, routing table of AODV is indexes by IP address of destination. And holds the information about destination. Keep a neighbor table, number of neighbors present. There are two tables discussed.1.neighboue table 2. Route table.

Packet Forwarding in an Intermediate Node

When data packet reached in intermediate node, it check routing table weather there is reactive path is available towards destination. In routing table route that are going towards destination is broken, then greedy geography function is occur . the process in which the reactive is switched to greedy geographic is evaluate as sub function in OPNET. in greedy geographic, information of location of destination is achieve from routing table. also information of neighbours are distributed by hello message and manage by neighbour table.

Route errors

Source get a route error when AODV route break down.route errors are sent in AODV when one of the following event is happened.

1. When AodvC Link Break Detect in OPNET.
2. When in OPNET AodvC Data Packet No Route type.
3. When in OPNET AodvC Rerr Received type.

Destination operations

Destination can get a packet either via greedy geographic forwarding or via reactive route, packet is coming from neighbor. Reactive route receive a data packet cab be receive from source, in this case source knows the destination or from source, which have no knowledge of destination. In any of both cases, node deliver data packet to application, when node recognize itself as destination. if a response is required , to find a fresh route , checked the routing table, if yes, then the response data packets are send back via the route like AODV.

V. LITERATURE REVIEW

In this paper, author did survey on the flying ad-hoc network (FANET) , FANET is an ad hoc network ,which is used to connect the UAVs. firstly author clarified difference between MANETs, FANETs and VANETs, after this author introduce the challenges of main FANET design. Existing FANET protocol as well as issues of open research issues is also considered. In this paper, author surveyed ad hoc network between UAVs as flying ad hoc network (FNET),author also discuss the variations between flying ad hoc network and other types of ad hoc networks, in terms of localization, computational power, power consumption, radio propagation, topology change, node density and mobility. Author offer along with a wide review of FANETs literature, also layered approach issues. Author also discusses issues of open research for FANET, as well as cross layer designs.

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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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