Location and Signal Strength Based Predictive approach for Routing in FANET

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Abstract-The Unnamed Aerial Vehicles (UAVs) or nodes are communicated in high speed in Flying Ad hoc Network (FANET). The topology is highly dynamic and unreliable because of strong backbone like wireless network. The routing protocol are used for the establish the connection in between the sender and the receiver. The drones and flying jets are try to establish the connection for transferring information to each other. The efficient routing approach uses the concept of load balancing to reduce the packet loss in network. The UAVs having limited bandwidth and processing capability. The routing protocols are not able to handle the problem of load sharing. The location aware routing and UAVs selection for routing play an important role here. The higher value of Received Signal Strength (RSS) means strong connectivity between the UAVs.There are numbers of routes establish in network and some of the intermediate nodes are common in the route. The UAVs location-based approach helpful for reducing the overhead in routing and provides the better data receiving in network i.e., directly affected from heavy load in network. In the research, proposed a Predictive Approach in Location Aware routing in highly dynamic network. This paper effort is driven by the idea of taking into consideration a number of aspects in the routing design of FANET in a unified manner.PALR is a routing strategy that uses the light load reliable path for routing and balance the load by managing the packets incoming and outgoing on link and nodes. In this routing scheme strong link established for the sending the data packets in network. The link capacity based on the flow of packets in network. The performance of OLSR, AODV is compare with PALR The PALR strategy outperforms the competition in terms of performance over a shorter period of time. In the proposed technique performance matrices like PDR, Overhead and Delay are provided better results as compare to previous AODV and OLSR approach.

Index Terms- AODV, FANET, OLSR,PALR, RSS.

I. INTRODUCTION

The standard Ad-Hoc Network idea has been tweaked to create a new concept known as the Flying Ad-Hoc Network (FANET). FANETs are Unmanned Aerial Vehicles (UAVs) that are used to create networks in limited locations where terrestrial UAVs are impossible to access, especially after natural catastrophes. UAVs are in charge of monitoring a certain region by gathering photographs and sending them to a ground-based base station [1].

One of the most difficult aspects of FANETs is determining how to arrange the UAVs so that they can effectively monitor the area. The location of the UAVs is critical to the network's ability to create a link between them. Furthermore, because of their mobility (the capacity of a UAV to move in different directions and speeds), the devices may get closer or preserve a distance from one another, thus obstructing communication between the UAVs. The degree of movement is also crucial since the UAVs might fly too slowly or too fast, putting the link in jeopardy [2].

Another crucial element is the UAVs' flying autonomy, since most of them have a flight time of 30 minutes or less [3]-[4] Because a topology restructure is required, a UAV with poor flying autonomy will have to leave the network. This may impair the connection between UAVs. It is necessary to identify which devices have limited flight autonomy and to forecast network topology reorganisation in order to minimise the impact on the connection. Because a UAV monitors a specific region by recording photographs in real time, it's critical to analyse the image quality. It may be carried out with the use of Quality of Experience (QoE) measurements. The phrase Quality of Experience refers to the assessment of multimedia applications from the perspective of the user [5]. The word was coined to cover the "gaps" left by standard Quality of Service measures like flow, jitter, and latency, which demonstrate the impact of applications on the network. The Quality of Service (QoS) measurements do not represent the video's user experience and do not allow for the evaluation of the video's quality.

Mobility and flight autonomy, as previously indicated, are elements that necessitate network architecture adjustments. As a result, a routing protocol capable of coping with network changes is required. Traditional Ad-Hoc routing methods such as Ad-hoc On-Demand Distance Vector (AODV) and Optimized Link State Routing (OLSR) do not function well in FANET [6].

Paper is divided into multiple section, in section I describe about introduction, section II provide the literature survey, section III describe about our proposed work, section IV define the result discussion and section V describe about conclusion of proposed approach.

II. LITERATURE SURVEY

Oubbati et al. [7] established a taxonomy and categorization for position-based routing protocols, as well as a full explanation of the routing systems. They then recommended a comparative study for these methods, as well as some additional research tasks for the future.

Arafat & Moh [8] explores cluster-based routing protocols for UAV networks and, in contrast to evaluating location-based routing protocols, these in terms of notable features, properties, competitive advantages, and limitations. We compared the protocols qualitatively.

Sharma et al. [9] addressed the issue of network partitioning between antennas and terrestrial ad hoc networks and presented a routing protocol for managing transmission in reciprocally coordinated systems. The link quality scheme, traffic load scheme, and physical distance scheme are all based on a hybrid of the three major schemes.

Puetal to avoid intentional glitches and disruptions, or isolated local failures that disrupt FANET's overall network performance. [10] presented a noise-resistant multipath routing protocol.

Gankyage Valley. [11] announced hybrid omnidirectional and directional transmission technology with dynamic angle adjustment. This allows the MANET routing protocol to be used with FANET. It is based on the frequency and time hopping technology to meet different data rate and timeliness requirements for different services of aeronautical network communications.

Fangetal. [12] proposed a hybrid media access control method based on pre-allocation of communication time slots and instant access. Guoetal. [13] presents a cross-layer, rate-efficient network utility maximization (RENUM) routing scheme that takes into account the lossy aspects of wireless networks, as well as multi-hop performance and average latency limits. did. For delay-aware applications, lost channel wireless sensor networks provide reliable and timely routing services. Use the residual energy of the network to increase the transmission capacity of most nodes.

Xuetal. [14] proposed a cross-layer optimized opportunistic routing strategy to improve the reliability of communication links and minimize latency.

Ploumi disetal. [15] studied the issue of multi-flow allocation on different paths of wireless random access using the multi-packet receive feature of wireless random access. To increase the average total flow throughput and reduce the packet delay, the problem is formulated as a non-convex optimization problem and a distributed flow allocation system is presented. Existing systems cannot manage QoS-enabled data delivery in next-generation wireless networks because the network needs to be reconfigured or replanned.

Sharma et al. [16] used UAVs to solve this problem and suggested a unique technique based on a set of neural network algorithms.

Hajies mailietal. [17] proposed a delay-aware dynamic network utility maximization algorithm for real-time streaming and video surveillance systems as a dual solution to the rate control problem. This technology aims to aggregate the maximum network gain that spreads over a defined period of time. There is a fundamental problem with real-time multimedia applications. How can I find an executable path that meets many constraints? Torkuzade Valley. [18] introduced a lightweight, multi-constrained QoS routing scheme based on an evolutionary approach to quickly identify effective solutions.

Yahiaoui et al. [19] introduced an on-demand routing system that provides QoS in terms of end-to-end delay and power consumption, based on delay and performance-sensitive routing protocols. These studies ignore changes in the network topology and the channel state that changes over time, so you can ignore FANET performance without optimization. On the other hand, these approaches offer the possibility to develop cross-layer optimizations using DelayConstrained FANET. Many approaches to solving cross-layer optimization problems have already been presented.

Tsiropoulou et al. [20,21] proposes a usage-based game theory framework for optimizing user uplink transmit power and rates in open access, two-tier, multi-service, simultaneous femme to cellular networks. The distributed algorithm is designed to match the corresponding arrival equilibrium point.

Kimetto et al. [22] studied the problem of maximizing the minimum rate in wireless communication networks with interfering channels to overcome strong imbalances. They also proposed Lagrange's dual approach and an algorithm based on the Perron-Frobenius theorem.

Energy harvesting cloud radio access network, Duan et al. [23] researched resource allocation systems for delay-sensitive applications and proposed efficient resource allocation algorithms to optimize user interests while ensuring delay margins. The above optimization techniques do not take into account network topology changes or delay-constrained transmissions and cannot be used to address delay-constrained FANET optimization problems.

III. PROPOSED APPROACH

Flying ad hoc network is a collection of unmanned aerial vehicles (UAVs) devices and Base station's (BSs) to form a temporary network. FANET is semi-infrastructure based network because in the network some devices such as UAVs are movable and only Base station is static. In the flying ad hoc network communication take place between UAVs to UAVs or (BS) with direct or indirect path where base station and UAVs provide the radio zone to source or receiver devices. In the dynamic network, routing decision and their maintenance is a crucial task because uncertain changes the network topology due to high speed devices movement. To overcome the problem of routing decision we proposed predictive approach location based routing (PALR) which is predictive approach based on node current location and respective signal strength for identify high reliable path between source to intended receiver. In the proposed predictive routing approach, any UAV want to established communication from Base station or any other UAV. UAV generates the route message and broadcast it into the network to search the route, while the route discovery message came into the any UAV (treated as intermediate device) it get the information about location and signal strength with references to their predecessor node which is useful for the estimation of the route stability time (which is forecast based on current or previous location and signal strength of UAVs) of UAVs in path. The same procedure follows by all the nodes in network those are participated in network, at the end while route discovery packet comes into the receiver (base station or UAVs) node it select the path which provide maximum stability time and signal strength. The proposed approach provide reliable and stable route for data delivery to destination device. The Proposed PALR protocols also monitor the each UAVs energy information for the optimization of path reliability in network. After completing the route establishment process, source node generate the data packet and sent to intended receiver using (PALR) routing approach. At the time of data delivery each node in route consume the energy for every transmission, PALR monitor each node, how much energy consume, what is expected energy require for future transmission and take necessary steps for further communication, while energy of any intermediate node is less than of required energy for communication, than PALR execute local route repair for the forming of new route without the communication breakdown. Flying ad hoc network is also delay constraint network which means we cannot tolerate the delay factor for data transmission, the proposed PALR helps to provide data in timely manner without disruption of network because its emphasize based on node stability with higher signal strength which minimize the frequently route disruption that associated with delay parameter. The PALR routing approach is best suitable for the FANET which enhance the routing capability of flying ad hoc network.

A. Proposed Algorithm

In this section describe how the PALR implemented, predictive routing approach basically depends the UAV location and signal strength based on current as well as historic behavior of UAV select in path for communication. In the proposed algorithm step by step procedure define which implemented for optimize the routing strategy of FANET.

Algorithm: Location and Signal Strength Based Predictive approach for Routing in FANET (PALR)

Input:

FANET: flying ad hoc network
BS_i: Base station
UAV_s: unmanned aerial vehicles
PALR: routing protocol
S_t: Signal strength
L_t: Location information
Th_s: signal strength threshold 10%
ack: acknowledgement packet
$S_d(x)$: node speed per second
e_i: initial energy in joule
e_t: transmission energy
e_d: discharge energy
e_{th}: energy threshold 10 joule
Ψ: radio range ($550m^2$)

Output: Packet delivery ratio, throughput, packet drop, normal routing load, data receives, delay

Procedure:

Step1: UAV initiate route & call (PALR)
Step2: Generate Route_Pkt (UAV, BS, PALR)
Step3: **If** UAV_s in Ψ & S_t of $UAV_s > Th_s$ **than**
get (S_t,L_t,$S_d(x)$)
Forward route_pkt to next UAV_s till BS_i reach
Call energy module & calculate e_i, e_t, e_d of UAV_s
Step4: **If** BS_i get route_pkt > 1 **than**

Compute min(S_t), max($S_d(x)$, e_d) of each route
Select max(min(S_t)), min(max($S_d(x)$, e_d))
Send ack to source UAV by selected path
Source UAV get ack and use the selected path
Call Data(UAV, BS, tcp/udp)
Else
Send ack to source UAV
Source UAV call data(UAV,BS, tcp/udp)
Else
UAV_s not found || Signal Strength lower than Th_s

End if
Step5: Data(UAV, BS, tcp/udp)
UAV send data to BS with selected path
Compute e_i, e_t, e_d of each path
Step6: **If** $e_d < e_{th}$ & $S_d(x)$ is less avg($S_d(N)$) **than**
Intermediate UAV_s is active to send data to BS
Else
Local route repair execute by PALR
Goto **Step3**
End if

B. Proposed Architecture

This section describes the behavioral architecture proposed by PALR shown in Figure 1, in the architecture source UAV initially call the routing module of PALR, which provide the location and signal strength information to call UAV and forward routing packet to next node till receiver Base station.

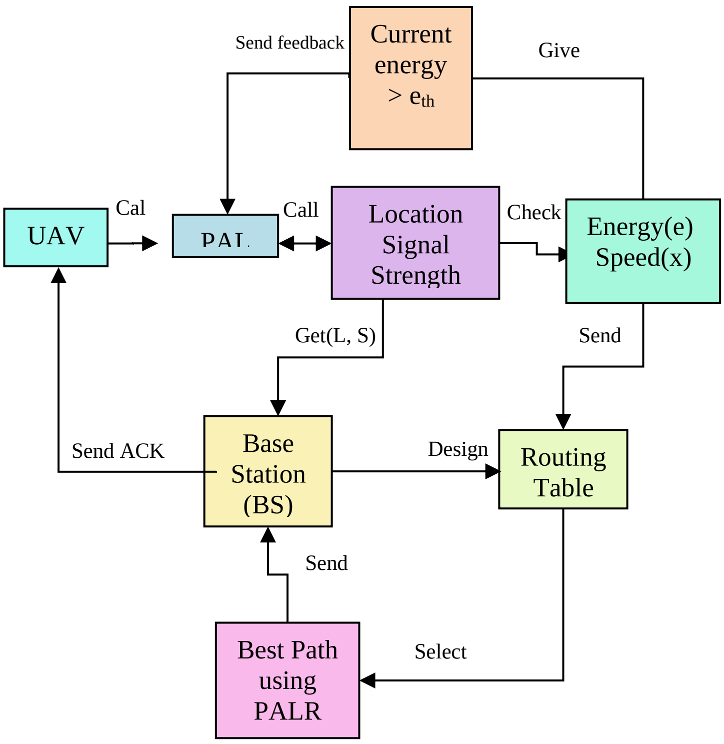

Fig.1. PALR proposed working architecture

While base station get the routing packet it select the best path based on signal and location base approach which energy utilization is also lower. After selection the route, base station send the acknowledgement to source node for further communication.

IV. RESULT DESCRIPTION

Simulation Parameters

In this section describe about simulation parameter of flying ad hoc network, which is define by the given table 1. where we take antenna type Omni-direction, propagation is two ray ground, number of UAVs is 50 and energy parameter such as (initial, transmission, receiving, idle and sensing power). Those parameters taken as input for developing the network architecture and get the output behavior of flying ad hoc network.

Table 1: FANET Simulation Parameters

Simulation Parameter	
Network	Flying Ad Hoc Networks
Antenna Type	Omni-Direction,
Propagation Type	Two Way Ground
No. of Flying User	Fifty
Energy Model	Initial 100 Joule Transmission power 0.1 Receiving Power .1 Idle Power 0.05 Sensing Power 0.08
Network Protocol	OLSR, AODV, PALR
Transport Layer	TCP, UDP
Application Data	CBR
Message length	Random
Mobility	Random
Simulation Time	250 Seconds

A. Successful Data Delivery Ratio %

The Packet Delivery Ratio (PDR) is defined as the ratio of the number of packets received to the number of packets sent in a certain time period in a network. The performance of the proposed PALR routing protocol is shown to be superior to that of the previous OLSR and AODV routing protocol in this graph. The RSS maintain the strong connectivity between the adjacent nodes and reduce energy consumption. Here, the packet delivery ratioof AODV is 85% and OLSR is 80%up to the end of simulation time 250 seconds butPDR of PALRapproach showing the improvement in performance and gives 95% up to the end of simulation time. The packet transmission differences between the previous and proposed schemes are nearly identical, but the receiving differences between the previous and proposed schemes are greater due to the fact that the PDR arises and showing better performance.

Fig.2. Percentage of Data Receives

B. Data Receives Analysis

The packets received analysis based on the number of packets received after the successful sending in the network. If the network is reliable, it indicates that data delivery is efficient in the network. This graph depicts the number of packets received in the network in the case of the proposed PALR and the previous AODV and OLSR routing. The location aware routing is efficient, if the UAVs in the network are capable of maintain the location information. This means that fewer packets are dropped in the network, which results in a greater number of packets being received in the network. In this graph, maximum 2300 packet received in AODV, 2900 in OLSR and 4700 in PALA count in the network. This means that a higher number of packets are received in network and secured more energy efficiently in the network.

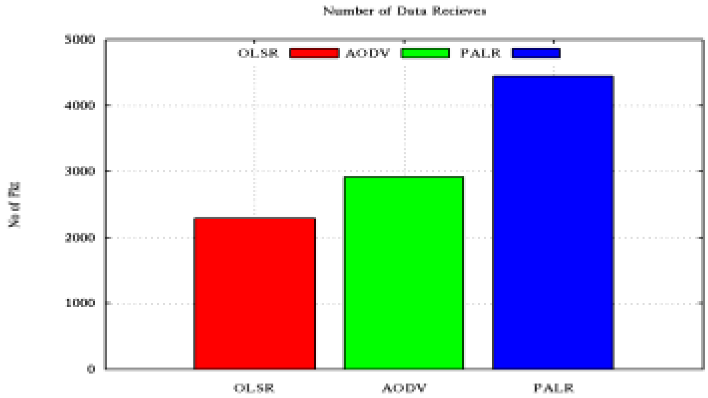

Fig.3. Analysis of Data Receives

C. Network Throughput Analysis

The number of packets transmitted and received in a unit of time is represented by the term throughput. In this graph, the throughput of AODV and OLSRis less than the throughput of the proposed PALR protocol. The PALR technique utilizes the UAVs buffer capacity and improves link quality for balance the load in network. The location based high receiving signal strength approach improved the performance of the routing protocol. The throughput of the AODV and OLSR routing protocol is showing the degradation in all the scenarios but the throughput of the proposed PALR routing protocol is showing enhancement until the end of the simulation. The previous routing methods gives an alternative path, but the load distribution does not occur, resulting in a reduction in the efficiency of routing. On the other hand, proposed method ensures that the load distribution properly and result in an increase in the efficiency of routing in FANET.

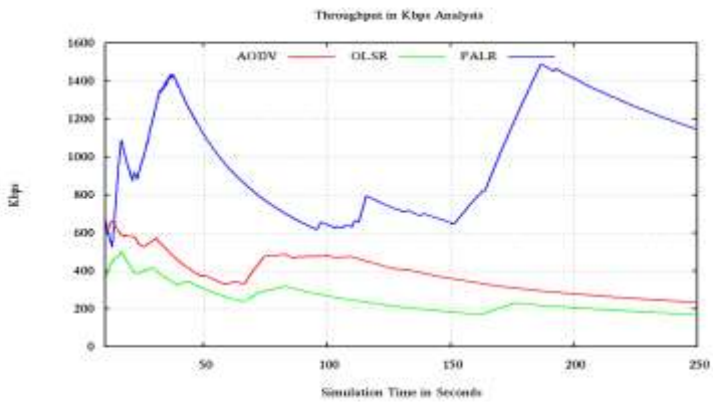

Fig.4. Comparative Analysis of Throughput

D. Packet Dropped Analysis

The packets dropping based on the packet's loss or loss of data in network. If the network is reliable, it indicates that data delivery is efficient in the network. This graph depicts the number of packets that were loss in the network in the case of the proposed PALR and the previous AODV and OLSR routing. The location aware routing is efficient, if the UAVs in the network are capable of maintain the location information. This means that fewer packets are dropped in the network, which results in a greater number of packets being received in the network. In this graph, maximum 570 packet loss in AODV, 430 in AODV and 270 in PALA measured in the network. This means that a lower number of packets are dropped in network and secured more energy efficiently in the network.

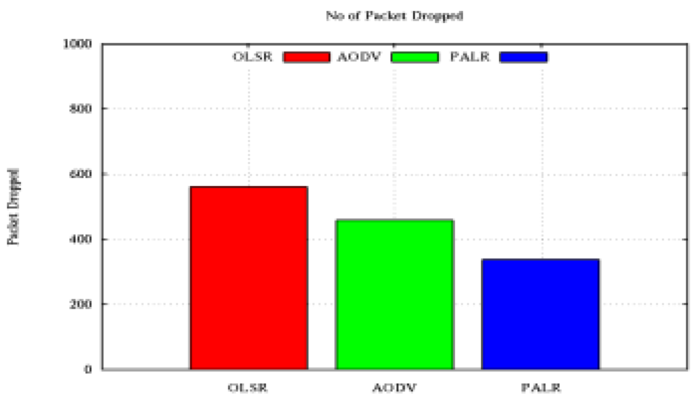

Fig.5. Number of Packet Dropped Analysis

E. Analysis of Normal Routing Load

Hello packets or routing packets are often referred to as routing packets or overhead packets. In this graph, the routing load in the case of the proposed PALA scheme is lower than the routing load in the case of the prior AODV and OLSR routing. The lower value of the routing load improves the performance of the network. Specifically, in this scenario, the proposed approach about 1.8 routing overhead to the network, whereas the previous AODV overhead is 2.6 and OLSR is 6.7 in network. The RSS play an important role for establishes the strong connection between sender and receiver. The increased routing load reflects wasteful flooding in the network as well as energy waste; nevertheless, the energy component has been considered in the proposed work and also improves the routing performance of the PALR protocol.

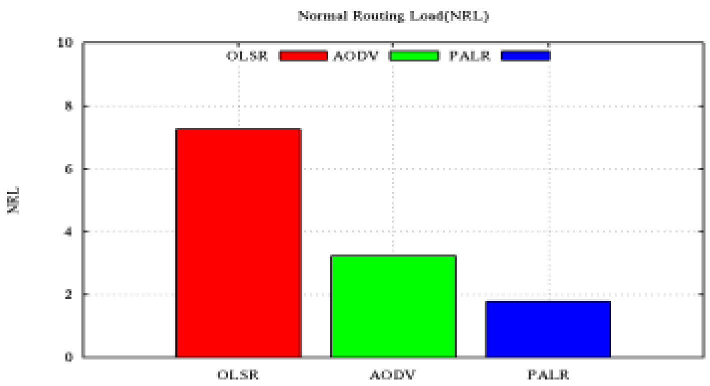

Fig.6. Network Routing Load Analysis

F. Network Delay Analysis

The more delay in the network shows degradation in performance of protocols. The delay is measured in milli seconds (ms). It is the extra time required for received the data successfully at destination. In this graph the delay performance of previous AODV, OLSR and PALR measured in different node time scenarios. In the proposed PALR protocol, the load and RSS determined in order to evaluate its performance. Although in the previous scheme, the RSS not evaluate and location information not maintained. In this case, less packets are received as comparison to the previous scheme and showing higher delay in network. However, the proposed PALR scheme balances load with proper distribution.

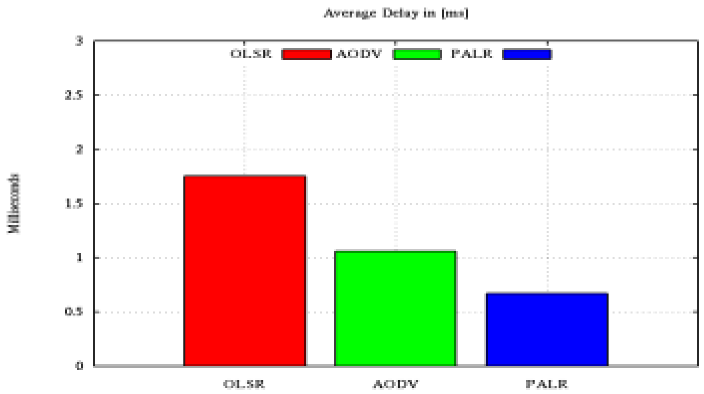

Fig.7. Average Network Delay [ms]

V. CONCLUSION

The FANET is a group of mobile hosts that are outfitted with wireless communication devices to communicate with one another. The primary characteristic of FANET is that it operates without the assistance of a central coordinator. Rapidly deployable, self-configuring, and extensible multi-hop radio communication, frequent connection breaking owing to mobile UAVs, resource constraints (bandwidth, processing power, battery lifetime, etc.), and the fact that all UAVs are movable means that the topology might be extremely volatile. There are numbers of routes establish in network and some of the intermediate UAVs are common in the route. In this work, proposed the Enhanced dynamic source routing based on link capacity and queue optimization (PALR) in FANET for balance the load and control the congestion. The UAVs buffer capacity and link capacity directly affected from heavy load in network. So that the routing protocol in FANET can achieve the primary challenges of being fully distributed, adaptable to frequent topology changes, and scalable among other things for achieving better performance. Simple computation and maintenance, an optimal and loop-free route, the most efficient use of available resources like bandwidth and UAVs processing capability. The performance of previous AODV, OLSR showing better results but utilization of resources is poor. The proposed PALR showing the improvement in performance and utilizes the resources efficiently for better performance. The PDR showing the improvement of 5% and in throughput showing the improvement of 600kps (maximum). The delay and overhead performance showing the better results in PALR protocol. The performance of PALR is better as compare to AODV and OLSR in all performance metrics. Congestion problem is crucial in wireless network because the enhancement in bandwidth is not possible. There are many factors that affected the performance of network; the low data rate is one of the constraints in network. In the future, link prediction methods for building strong links in FANET have been proposed.

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