Analysis of Rapid Routing in FANET

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Abstract—MANETs is a collection of wireless moving nodes which communicate with each other and exchange data without any fixed base station or without the need of any kind of wired backbone network. These design characteristics make routing in wireless network a critical issue as routing protocols adopted in wireless network is completely different from wired network in which a backbone router determines the routing path. In this paper we discussed a OLSR routing protocol for routing path and discuss the problems of OLSR routing protocol due to mobility of nodes. We integrate our solution to OLSR protocol called as P-OLSR. P-OLSR is an extension that we designed for FANETs; it takes advantage of the GPS information available on board. Performance evaluation of OLSR and P-OLSR is done through NS simulation. Simulation results show that P-OLSR outperforms OLSR with respect to overheads. Our experiments evaluate the link performance and the communication range, as well as the routing performance.

Keywords—FANET; OLSR Algorithm; P-OLSR Algorithm; Unmanned Aerial Vehicle (UAV).

Abbreviations—Flying Ad-hoc Network (FANET); Optimized Link State Routing (OLSR) Algorithm; Predictive-Optimized Link State Routing (P-OLSR) Algorithm; Unmanned Aerial Vehicle (UAV).

I. INTRODUCTION

Flying Ad hoc Networks (FANETs) composed of small unmanned aerial vehicles (UAVs) are flexible, inexpensive and fast to deploy. This makes them a very attractive technology for many civilian and military applications. Due to the high mobility of the nodes, maintaining a communication link between the UAV’s is a challenging task.

An Unmanned Aerial Vehicle (UAV), commonly known as a drone, Unmanned Aircraft System (UAS), or by several other names, is an aircraft without a human pilot aboard. The flight of UAVs may operate with various degrees of autonomy: either under remote control by a human operator, or fully or intermittently autonomously, by onboard computers [Stefano Rosati et al., 1].

Compared to manned aircraft, UAVs are often preferred for missions that are too "dull, dirty or dangerous" for humans. They originated mostly in military applications, although their use is expanding in commercial, scientific, recreational, agricultural, and other applications, such as policing and surveillance, product deliveries, aerial photography, agriculture and drone racing [Guo et al., 2].

1.1. Classification of Routing Protocol in MANET Network

In network infrastructure, the network layer also known as IP layer is playing the biggest roles, thereby also called backbone of the communication network. In case of wired network, the network nodes are communicating with each other through the dedicated wired link whereas in case of MANET moving node is to successfully transmit data packets from the source to the destination without any kind of fixed or dedicated links between them. Therefore, efficient routing of packets is a primary MANET challenge. On the basis of routing information update mechanism routing protocol for ad-hoc wireless network can be classified into three categories [Jiang & Swindlehurst, 3]. Figure 1 shows basic classification of routing protocol:

1.1.1. The Routing Protocol for Ad-hoc is Classified as:

- Table driven (pro active ) routing protocol
- On-demand (reactive) routing protocol
- Hybrid routing protocol
A. Table Driven Routing Protocol

The table driven approach is very similar to the connectionless approach where there is no dedicated mechanism when and how frequently the packets should be forwarded and when that route is desired for sending of packets. It completely relies on the underlying protocol in communication. Here, a route to every other node in ad hoc network is always available, regardless of whether or not it is needed [Bekmezci et al., 4].

B. On-demand Driven Routing Protocols

These protocols try to eliminate the conventional routing tables and consequently reduce the need for updating these tables to track changes in the network topology. In the On-Demand approach, when a node desires a route to a new destination, it will have to wait until such a route can be discovered i.e. routes are discovered whenever a source node have packets to send and maintain it until either the route is no longer desired or it becomes inaccessible, and finally remove it by route deletion procedure [Sahingoz, 5].

C. Hybrid Routing Protocol

Both of the routing protocols known as proactive and reactive protocol are working best in different scenarios, hybrid method uses both. These protocols combine the best good features of reactive and proactive protocol. It is used to find a balance between both protocols. Proactive operations are restricted to small domain, whereas, reactive protocols are used for locating nodes outside those domains. Examples of hybrid protocols are:
- Zone Routing Protocol, (ZRP)
- Wireless adhoc routing protocol

II. Description of OLSR Protocol

The Optimized Link State routing protocol (OLSR) is an optimization of the pure link state algorithm. The key concept specific for this protocol is to use the Multi Point Relays (MPRs). The MPR is a node which is selected such that it covers all nodes that are two hops away. The node N, which is selected by its neighbors, periodically announces the information about who has selected it as an MPR. Such a message is received and processed by all the neighbors of node N, but only the neighbor who are in N’s MPR set retransmit it. This is the concept of optimization of flooding [Zhang et al., 6].
III.  TOOLS AND TECHNIQUES USED

3.1.  NS-2 Simulator

NS (version 2) is an object-oriented, discrete event driven network simulator developed at UC Berkley written in C++ and OTCL (TCL script language with Object-oriented extensions). It implements network protocols such as TCP and UPD, traffic source behavior such as FTP, Telnet, Web, CBR and VBR, router queue management mechanism such as Drop Tail, RED and CBQ, routing algorithms such as Dijkstra and more. NS also implements multicasting and some of the MAC layer protocols for LAN simulations [Clausen & Jacquet, 8].

3.2.  Trace Graph

Trace graph is third party software helps in plotting the graphs for NS2 and other networking simulation software. Trace graph when opened, it opens 3 windows one window to select the trace file (.tr) that was created by NS2.

IV.  PROPOSED METHOD

4.1.  P-OLSR Methodology

This section describes neighbor prediction scheme, and POLSR algorithmic approach.

4.1.1.  Neighbour Prediction Scheme

Say position of node i at time t0 is (XA, YA, ZA) (point A) and we want to calculate position of node at time t1, where (t1 > t0) (point B). Now if difference of t1 and t0 is not much then it can be assumed that node i moves with same speed (speedi) and direction ratio (point A). Equation of line AB can be given by Eq. 1.

\[
\frac{x - X_A}{d_x} = \frac{y - Y_A}{d_y} = \frac{z - Z_A}{d_z} = k
\]  

Distance between point A and B is calculated by Eq. 2.

\[
AB = \sqrt{(X_B - X_A)^2 + (Y_B - Y_A)^2 + (Z_B - Z_A)^2}
\]  

As point B lies on line AB, it satisfies Eq. 1. Thus now putting the value ofXB, YB and ZB obtained by replacing x, y, z of Eq. 1 with these values in Eq. 2.

\[
AB = k \times \sqrt{d_x^2 + d_y^2 + d_z^2}
\]  

As node i moves with same speed till t1, distance between A and B can be calculated as follows

\[
AB = \text{speedi} \times (t_1 - t_0)
\]  

Thus value of k obtained from Eq. 3 and Eq. 4 is given as:

\[
k = \frac{\text{speedi} \times (t_1 - t_0)}{\sqrt{d_x^2 + d_y^2 + d_z^2}}
\]  

Value of XA, YA, ZA can be obtained from eq. 1 by putting the value of k. Thus value of XB is equal to:

\[
X_B = X_A + \frac{\text{speedi} \times d_x}{\sqrt{d_x^2 + d_y^2 + d_z^2}} \times (t_1 - t_0)
\]  

Now velocity components in x, y, z direction can be taken

\[
v_x = \frac{\text{speedi}}{\sqrt{d_x^2 + d_y^2 + d_z^2}}
\]  

Thus value of (XA, YA, ZA) at time t1 can be calculated as

\[
X_B = X_A + (t_1 - t_0) \times vx
\]

\[
Y_B = Y_A + (t_1 - t_0) \times vy
\]

\[
Z_B = Z_A + (t_1 - t_0) \times vz
\]

Now the question arises that how position, speed and direction ratio can be known in wireless ad hoc networks. Position of the nodes can be inferred from positioning techniques like Global Positioning System (GPS). Similarly speed (speed) and direction ratio \((d_x, d_y, d_z)\) can be inferred either from GPS or nodes own instruments and sensors e.g. campus, odometer, speed sensors etc. Instead, P-OLSR also uses radio range of node in its algorithmic approach. This radio range can be determined from transmission power and radio propagation properties.

4.1.2.  P-OLSR Algorithmic Approach

As position of neighbor can be predicted at any time, each node can find that its neighbor is in radio range or not. So in MPRs calculation, nodes in P-OLSR consider only those neighbors which are in radio range at that time. Furthermore, for the solution of second problem, nodes consider the shortest path in routing table construction, whose next hop node is in radio range according to current position of that node. For third problem, if the entry from routing table is selected whose next hop node is in out of range, node recomputes its routing table and then forwards the packet according to entry, defined in table. But if newly recomputed table does not contain any entry for that destination, nodes in P-OLSR simply drop the packet.

Now to lessen the problem that MPR can also move out of range in its MPR period, P-OLSR recompute MPRs at following situation. If the next hop node from routing table is in out of range, first node forwards the packet to the next hop according to the solution for third problem described above, then it re computes the MPR list if out of range next hop node is a MPR for that node [Dearlove et al., 9; Frew & Brown, 10].

4.1.3.  P-OLSR Advantage

- P-OLSR can predict the change in topology and react before the previous link breaks.
- Predict the quality of wireless link between the nodes
- It exploits the information from the GPS
- Robust against the isolated attacks and node failures
- P-OLSR increases the average goodput compared to OLSR
P-OLSR gives more packet delivery because probability of electing MPRs which are out of radio range is less for P-OLSR. Moreover, P-OLSR also takes precautions if MPR moves out of radio range in its MPR period. For the routing of data packet, P-OLSR follows strict rule that next hop node should be in radio range. It might forward the packet to the node or elect the MPR node which is out of range, only when neighbor position prediction scheme gives wrong position due to change in speed and/or direction. As P-OLSR packet delivery results do not show much variation with increase in maximum speed of node, chances of wrong prediction of position is less for P-OLSR. In other words, the impact of faster node movement has greatly reduced after applying P-OLSR solutions. To summarize, in comparison with OLSR, P-OLSR delivers more bytes of data with less delay and less normalized routing overheads. Its routing overheads are more but normalized routing overheads are still better than OLSR protocol.

**REFERENCES**


