Neighbor Trigger for Hovering Information

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Abstract. Hovering information is generated by specific area in a mobile ad hoc network (MANET) to be attached to the anchor area for some time. MANET is a self-organizing and dynamic topology network without infrastructure. Some nodes maybe not receive the hovering information due to possible partitioning of the network in some areas with sparse nodes, on the other hand broadcast packets lead to broadcast storm problem and high latency in high traffic density network. To improve the reachability and deduce the number of broadcast of hovering information, the adaptive probabilistic flooding scheme is proposed by Andreas Xeros. But the calculation of probability $p$ is too complex. So, this paper proposes a new adaptive probability flooding scheme based on random graph and neighbour trigger (algorithm of neighbour trigger, ANT) for floating the information in the hovering area. When a new node enters the range of hovered node and become a neighbour of the node that has received the hovering information, the informed node checks its neighbour list to decide whether to trigger the broadcast program with probability $p$. I analyse the performance of the proposed algorithm. The results show that the ANT outperforms other candidate hovering information algorithms in terms of the number of broadcast messages.

1. Introduction
Messages such as emergency messages, commercial advertisements must continue to be attached to the anchor area for some time to transmit the messages to new network nodes that enter the area. To float message within the anchor area, hovering information is proposed.

1.1 Mobile ad hoc
MANET [1] is a temporary dynamic network include many wireless mobile nodes, and it does not use any fixed network infrastructure. Node is free to move randomly and can exchange message directly with another mobile node within the range of radio transmission. When a destination that is located outside source node's radio radius, packets are stored and forwarded through a sequence of intermediate nodes. The all nodes in a MANET are required to participate in the relay of packets on behalf of other nodes.

VANET is vehicular MANET that has appeared over the past few years. VANET can provide safety and convenient services through wireless communications between vehicles that brings people with new functions and applications such as emergency services. However, VANET is confronted with many great challenges due to fast changing network topology. It is an important problem to study an efficient and reliable solution for packets dissemination in a VANET [2].

1.2 Hovering information
Hovering information is an information dissemination scheme in MANET. It was first proposed by A. Villalba and D. Konstantas [3], and a more elaborate and definition are provided by [4]. Alfredo A. Villalba Castro defined formally hovering information later in [5].

Some application, such as emergency messages in a MANET, as well as traffic accident and traffic congestion in the VANET, can generate a piece of floating information. The area around the source node is called hovering area. It is very important for each node residing in the hovering to be informed of the emergency to take effective and valid ways. Every node in hovering area stores and rebroadcasts the hovering information to suspend the information in the special zone. Hovering information transmits from one mobile node to another through ad hoc connectivity. The information which is floating on the anchor area is available to nodes that are entering the area. The hovering information is applicable to MANET, especially to VANETs.

2. Related works
A few researches have been done on disseminating information in MANET. This section reviews the epidemic routing and adaptive probability flooding protocol of hovering information in MANET (VANET).

2.1 Epidemic routing
In a MANET or VANET, due to a source and a destination are not always direct connect there must be a routing (such as DSR and DSDV, et al.) to deliver this messages through intermediate nodes. But these routings are limited to fully connected networks. In fact, there are disconnected portions of MANET (VANET) due to the mobility of the nodes and limitations in radio range. The presence of such scenarios where the connection path from the source to the destination is not always available.

According to these requirements and limitation, epidemic routing based on epidemic algorithm [6] was proposed by Vahdat and Becker [7] to solve the problems caused by such scenarios. The goals are to 1) provide message delivery with high probability, 2) minimize message latency, 3) minimize the total resource consumption. Epidemic routing relies on nodes called carriers which receive the message then store it in their buffers. When carrier comes into the range of another node through node mobility, two nodes exchange message. The message spread into additional island of nodes, so achieve high delivery ratios. Epidemic routing (host S sends a message to host D) is shown in figure 1.

\[
p = e^{-\frac{d^2}{2\sigma^2}}
\]

(1)

2.2 Adaptive probability flooding (APF)
Andreas Xeros [8] proposed an algorithm using adaptive probabilistic flooding to float information in VANET. APF used epidemic route inside the anchor area and probabilistic flooding outside the anchor area. Vehicles outside the anchor area received the hovering information then rebroadcast the packet with probability p. The p is given by equation (1).
The $\sigma$ is a design parameter representing the standard deviation, $d$ represents the distance from vehicles to the hovering area. The $\sigma$ must be updated in time based on the connectivity of the network in the hovering area.

Because of possible partitioning of the network in some areas with sparse nodes, some nodes maybe not receive the hovering information. The epidemic routing approach can alleviate the problem. Those informed vehicles can store and forward the message serving as information bridges. With the mobility of informed vehicles, the hovering information may be relayed to the partitioned uninformed areas. The scheme increases the achieved reachability. However, epidemic routing within the anchor area will generate a lot of broadcast packets leading to broadcast storm problem and high latency in high traffic density network. In high traffic density network, the VANET is almost fully connected. So, no each vehicle floods the received critical messages are required inside the hovering area and no each vehicle replicates the message are required outside. Probabilistic flooding within the hovering area is applied in paper [9].

Adaptive probability flooding protocol reduces large number of redundant messages of hovering information based on epidemic routing. Redundant broadcasts increase the communication channel burden and contention and lead to large delay of packet delivery.

3. Algorithm of neighbor trigger (ANT) for hovering information

Adaptive probability flooding protocol reduces large number of redundant messages of hovering information based on epidemic routing and increases the achieved reachability of message. However, the probability $p$ in the protocol is related to $\sigma$. The parameter $\sigma$ is computed online and complexly. In order to reduce the complexity of $p$ in APF, I propose a new adaptive probability flooding based on random graph and neighbor trigger. The probability $p$ is defined by equation (2).

$$p = \frac{1}{n}$$ (2)

The $n$ is the number of nodes that received the hovering information in a connected portion. Random geometric graph (RGG) is a stochastic graph with metric. RGG has been used in model of large networks, such as MANET. Each node randomly and independently placed in RGG and can be connect with each other only within the distance $r$ (radio radius) [10]. The threshold for connectivity is $p = \log n/n$ and the threshold for a giant component is $p = 1/n$ in the ER random graph $G(n, p)$ [11].

3.1 Algorithm of neighbor trigger

Each node has a neighbor list to store its current neighbors. The nodes in the communication range can exchange neighbor information with each other through the neighbor discovery procedure. The algorithm is given as follow.

Procedure Discover neighbor
  Send hello message to find neighbor;
  Exchange $(id, flag)$; /*if received the hovering information then $flag=1$ else $flag=0$*/
  Update owe neighbor node list;
  If has a new neighbor
    Then
      Return $newneighbor=1$;
    Else
      Return $newneighbor=0$;
  Endif
Endprocedure

When a new node enters the range of hovering node, the node checks its list to decide whether to trigger the broadcast program. The process is shown in figure 2.
The procedure ANT is shown as follow.

Procedure ANT

Discover neighbor ();

Compute (p); /* compute probability p */

If newneighbor then

Replication (p); /* relay the received hovering information with p */

Endif

If received a replication then

Rebroadcast (p); /* relay the received hovering information with p */

Endif

Endprocedure

Hovering node traverses own neighbor list to count the number of informed node to compute the probability p. The procedure is shown as follow.

Procedure Compute(p)
n=1;
While (neighbor list is not null)
    If flag then
        n=n+1;
    Endif
Endwhile
p=1/n;
Endprocedure

3.2 Performance analysis
I analysis the number of message of the ANT in the scenario descripted in paper [8]. The radium of hovering area is 500m, the radio radius of node is set to 150m-180m. I vary the number of nodes \( N = \{5, 10, 15, 20\} \). Comparison of the ANT with APF in terms of the number of message is shown in figure 3.

![Figure 3. Comparison of the number of message.](image)

Figure 3 shows the number of message broadcast by ANT is less than that of APF.

4. Summary
In this paper, I proposed a scheme for hovering information in an anchor area. The proposed scheme is based on epidemic routing and RGG. When an uninformed node enters the range of hovering node, the replication procedure is triggered with probability \( p \). Any node will rebroadcast the hovering information with probability \( p \) when it receives replication. The result of analysis shows the ANT outperforms APF in terms of the number of message.

In the future, we will use more realistic simulations of scenario and network. Use RGG to establish more accurate model for analysis and optimization.

Acknowledgement
This research was supported by the Taizhou University Foundation for the Talents (QD2016035(702065)).

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