Inquiry algorithm and Message transmission algorithm in VANET

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Abstract – **Wireless communications is developing very fast in the last few years. Vehicular Ad-Hoc Networks (VANET) is also wireless network to exchange information among cars, buses and trucks. VANET uses moving cars as nodes in a network to create a mobile network. VANET turns every participating car into a wireless router, allowing cars of each other to connect and create a network with a wide range. It can provide wide variety of services such as Intelligent Transportation System (ITS) e.g. safety applications.**

The research algorithms and protocols in VANET are important and necessary for ITS. This paper describes Inquiry algorithm and Message transmission algorithm. The main idea is to propose algorithm which spread information about congestions, accidents, bad roads, dangerous weather and so on. All of this will make our life safer and easier.

Keywords – **VANET, Inquiry algorithm, Message transmission algorithm**

I. Introduction

The problem with road traffic has existed for a long time. There are many incidents with vehicle in all over the world. Every year numbers of dead cases increase resulting in 1.3 million people died. By developing the Intelligent Transport System (ITS) this number can decrease. VANET is a future network which promises to decide this problem. Providing the necessary connectivity and access to network services in this case requires the construction of a mobile ad-hoc network. Mobile ad-hoc network VANET consists of devices, which are in condition to self-configuration. Mobile stations can move randomly. They have dynamic topology. This network can be independent or connected to others networks like Internet.

One of the purposes of VANET is transferring data with high speed and minimizing the delay in a communication range. In a VANET, communication occurs from vehicle to vehicle (V2V), vehicle to infrastructure (V2I) and vehicle to broadband (V2B). When nodes are moving and if we have information for them, we can predict the future position on the road. This information could enable us to compute the traffic and in this way to decrease congestions, accidents and harmful air emissions.

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Given the distinct features of VANET, different problems are tackled by the researchers. The main part of research works has focused on algorithms.

Additionally, characteristics like the lack of fixed infrastructure and the fact that the mobile stations are not only routers, but are also routing packets to other stations on their way to the final recipient (the so-called multihop routing), are unique to this type of network and they hide new research topics such as network configuration, neighbor's detection, topology support, addressing and routing [1].

The paper aim is to present algorithm for message transmission. This is a very important topic for the future network – VANET.

II. VANET Architecture

This part describes the system architecture of vehicular ad hoc networks. The architecture integrates features of traditional ad hoc networking technologies and VANET technologies.

As shown in Figure 1, the in-vehicle domain is composed of an on-board unit (OBU) and one or multiple application units (AUs). The connections between them are usually wired and wireless. However, the ad hoc domain is composed of vehicles equipped with OBUs and roadside units (RSUs). An OBU can be seen as a mobile node of an ad hoc network and RSU is a static node likewise. An RSU can be connected to the Internet via the gateway; RSUs can communicate with each other directly or via multihop as well. There are two types of infrastructure domain access, RSUs and hot spots (HSs). OBUs may communicate with Internet via RSUs or HSs. In the absence of RSUs and HSs, OBUs can also communicate with each other by using cellular radio networks (GSM, GPRS, UMTS, WiMAX, and 4G) [2], [3], [4].

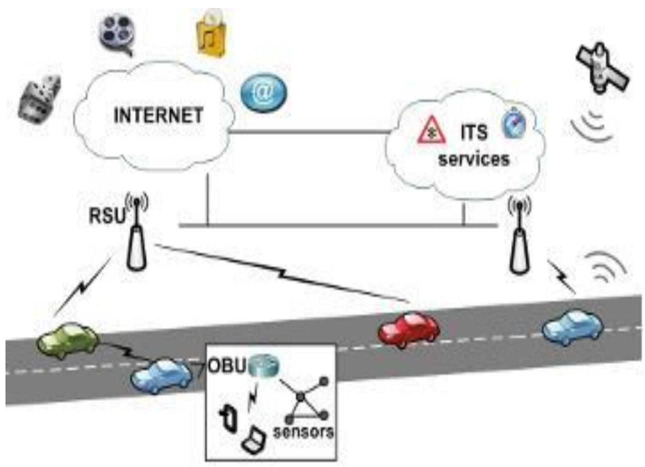


Figure 1. Network Architecture and communication types in VANET

Communication types in VANETs can be categorized into four types. The category is closely related to VANETs components as described above. Figure 1 describes the key functions of each communication type [5]. In-vehicle communication, which is more and more necessary and important in VANETs research, refers to the in vehicle domain. In-vehicle communication system can detect a vehicle's performance and especially driver's fatigue and drowsiness, which is critical for driver and public safety. Vehicle-to-vehicle (V2V) communication can provide a data exchange platform for the drivers to share information and warning messages, so as to expand driver assistance. Vehicle-to-road infrastructure (V2I) communication is another useful research field in VANETs. V2I communication enables real-time traffic/weather updates for drivers and provides environmental sensing and monitoring. Vehicle-to-broadband cloud (V2B) communication means that vehicles may communicate via wireless broadband mechanisms such as 3G/4G. The broadband cloud may include more traffic information and monitoring data as well as infotainment, this type of communication will be useful for active driver assistance and vehicle tracking [6].

III. Algorithms Design

It is assumed that the congestion has occurred and the cars that have come into it are aware of its presence. In the figure 2 those are the dark-moving automobiles moving to the left. The cars on the opposite side of the road are moving and one of them, whose turn has arrived, sends a request message. In the message it includes its location and moving direction. The message is received by all other vehicles in its transmission range. Vehicles that are moving in the same direction as the requesting vehicle will not transmit request packages for a certain period. Vehicles from the opposite lane that have registered events begin to respond one at a time. In the case in question, the vehicles are stuck in traffic and therefore the incoming car will receive traffic jams messages. Then it will make a decision about the authenticity of the registered event based on the number of responses received and the number of lanes in the opposite direction of the road. Depending on that, it does or does not generate a message indicating that there is a traffic jam. Inaccurate information that could be generated by the not completely precise method used by the vehicles is filtered at this step of process.

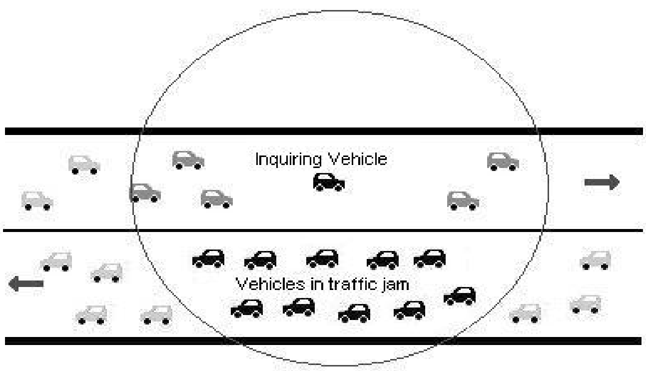


Figure 2. Process of inquiry

In case that the congestion is confirmed a message with the following structure is generated:

- Current location of the vehicle transmitting the message
- Time that the event was registered
- Location of the traffic jam (road lane)
- Direction of the event
- Status field (Active, Passive)
- Event code
- Time To Live (TTL)
- Other data

Most of the field names are self-explanatory. Current location is used by other vehicles to determine whether they are before the vehicle that has transmitted the message and therefore start transmitting the message as well. The next three fields contain data about the event that can be used to update old event data the other vehicles have. Status and TTL fields will be discussed in more details later on. The Event code field is used to differentiate traffic jam from other possible events. Since only the case of congestion has been addressed, to allow for future changes there is an option to add more fields.

There are two methods for exchanges of messages. They are directly dependent on the type of message. In the first (Figure 3 (a)) the station that wants to transmit, first advertises the data by sending only part of the message. If the station receives a request, then sends the entire message. The first approach is more appropriate if we have large messages with relatively small meta data. Since this is not the case in the present case, the second approach is chosen.

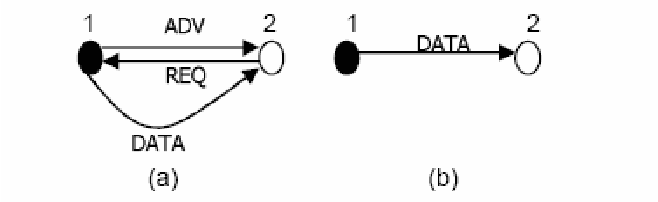


Figure 3. Methods of exchanging messages

For the case it is assumed that the congestion has been registered. The interrogating car generates a congestion message, which among other fields, marks itself as active in the status field. The generated message is then sent to other nearby vehicles that stop the queries and copy the message. These cars mark themselves as passive to this message and continue the normal process of asking the other cars.

The time each vehicle makes a query is set to s2 and is a system parameter. Determining an appropriate value for s2 is a compromise between frequent bandwidth and early detection of congestion. The distribution process is carried out by periodically broadcasting the message using a broadcast address.

Once a new message is generated and active and passive vehicles are determinate, it remains to be seen how the transmitted and received of the message to other cars will be. The status field, as already mentioned above, shows the status of the vehicle for the specific message. A certain vehicle may be active for one message and passive for another. The message is distributed only by active cars. The distribution period is s3, where s3 is a system parameter and its choice is a compromise between this message being received more than once by some cars (with less s3) and there are cars that do not receive it at all (with a larger s3).

The reason for having passive cars is to increase the reliable transmission of the message in the event of a drop in the active station and to extend the area of the vehicles receiving the message. However, since passive cars do not distribute the message, we have fewer exchanged messages. The following rows look at when a car is marked as active when it passes into a passive state and when it erases the message.

The options for a car to go into active status for a message are three. The first one was already mentioned, the car that generates the message marks itself as active. The second is when a vehicle that has previously been in a passive state stops "hearing" the message from the active for a period longer than the distribution period s3. Then it is supposed to be dropped and then the station changes the value of the status field to active and begins to spread the message. Thus, after intersection a part of the vehicles start to go on different roads, they will expand the area of distribution of the message. The third possible scenario for a vehicle to become active for a given message is when it receives a message from a vehicle that is further behind in the direction of travel. Then it copied the message and marked itself as active with respect to it.

The possibilities for a car to be marked as passive for a message are two. The first is because the vehicle was within the reach of the interrogator, copied the generated message and marked as passive. The second case is when an active car receives the same message from a car ahead of it in the direction of travel. In this case, it passes into a passive state by previously notifying other passive vehicles that delete the message. Here, however, an unstable situation can occur, leading to a frequent change in the status of the second car, therefore a possible optimization would be the second car to remain active while the distance to the previous one is not less than 70% of the maximum range.

Finally, it is considered when the messages are deleted. A message is destroyed first when its TTL field becomes zero. This controls the distribution area of the message. The second reason to delete a message is when a passive station receives an order for it from the active one. The third reason is when a message with more up-to-date information is received. In this case, it is superfluous to continue to distribute the old message [7], [8], [9].

IV. PSEUDO-CODES AND BLOCK DIAGRAMS OF THE ALGORITHMS

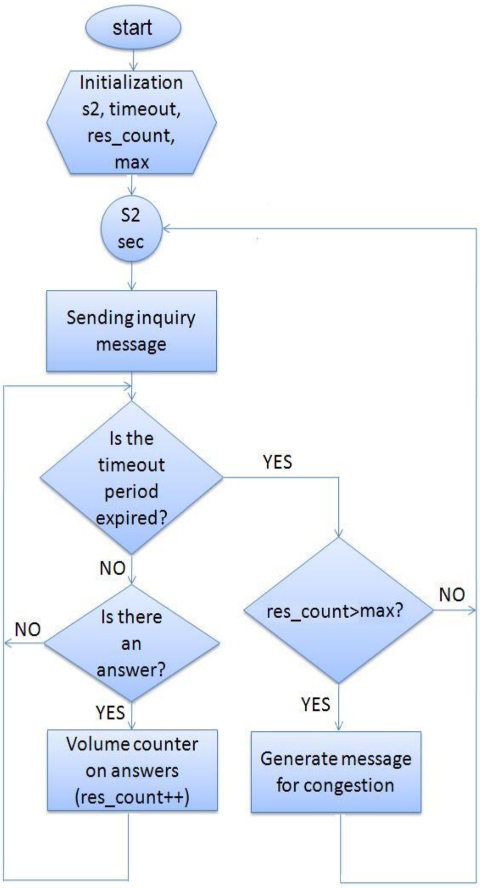
This part presents pseudo-codes and blog diagrams of Inquiry algorithm and Message transmission algorithm (MTA). Thise algorithms can work together with other algorithms. The main idea is to transmission information about congestions, accidents, emergency cases, bad weather, road conditions and more.

A. Pseudo-code and bloc diagrams of Inquiry algorithm

Pseudo-code diagrams of Inquiry algorithm:

1. **start**
2. **initialization:** s2 ,timeout, res_count, max
3. send (enquiry message) to all neighbors;
4. **while** receiving responses **do**
5. responses_count++;
6. **If** responses_count > (max * Number of lanes) **then**
7. generate_message (jam);
8. Sleep (s_2 seconds);

where:
s2 - the time each vehicle makes a query
timeout – this is the period
res_count – this is the response counter
max – parameter



Picture 4. Block diagram of Inquiry algorithm

B. Pseudo-code and block diagram of Message transmission algorithm

Pseudo-code of message transmission algorithm:

1. **start**
2. **initialization:** time to live, s3, offset
3. **If** status of message m is Active **then**

4. **If** new message m1 is received and m1 is new version of m **then**
5. Erase (m);
6. m.status = passive;
7. **Else**
8. send (m) to all neighbors;
9. Sleep (s3 seconds);
10. **Else if** new message m2 is received and m2.status = active **then**
11. Sleep (s3 + random offset);
12. **Else**
13. m.status = active ;
14. Sleep (s3 seconds);
15. **End if**

where:
Time to live (TTL) – message lifetime
s3 - the distribution period

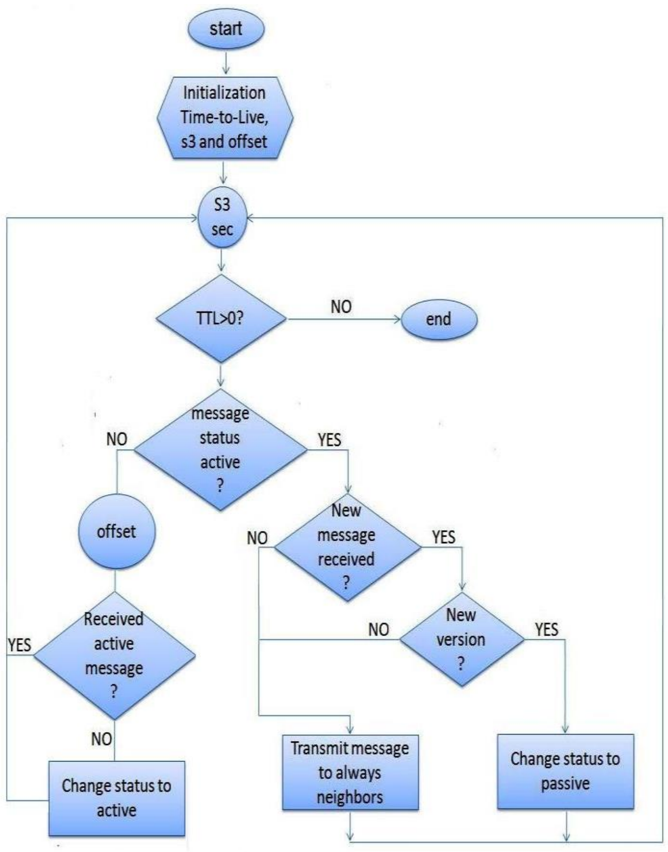


Figure 5. Block diagram of Message transmission algorithm

The developed algorithms take into account the latest developments in the area of ad-hoc networks. They are reliable and flexible.

V. Conclusion

One of the most important areas of investigation nowadays are Intelligent Transport Systems – ITS. Ad-hoc network VANET is a new and perspective class, which is gaining popularity and promises to decide traffic problems. In conclusion, there are not most optimal and design works on new algorithms have to continue.

The paper presents VANET network and algorithms. We have proposed Inquiry algorithm and Message transmission algorithm. Part three describe algorithms design. Inquiry process and methods of exchanging messages have been considered. Part four contains pseudo codes and block diagrams of algorithms. Message transmission algorithm in VANET is a novel traffic broadcasting algorithm designed for improving communication performance of a particular VANET. In MTA, the approaches of the message delivery very relying on the features of nodes, including the type, position direction of each communication vehicle at the moment. The collision in this algorithm is low and reliability is moderate. As a result – it improves road safety like the vehicles transmit and receive messages for congestions, accidents, bad weather, poor road condition and more.

Future work should concentrate on working the algorithm in real urban environments and doing researchs and simulations.

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