



Presenting a Method of Scheduling the Access to Data Relating to V-I in VANET

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Abstract

Today, vehicular Ad-hoc Network between automobiles has been accepted by the public, and many people are interested in exchanging information with other vehicles as well as with roadside equipment while driving. When a number of vehicles want to access to the data stored in RSU, the priority of servicing comes into face. In this case, some methods, such as D*S, D*S/N, have been presented so far. In this essay, in addition to investigating these methods, a new one has been suggested which, by using the information of the vehicle speed and GPS data, computes the time in which vehicle is under RSU coverage zone, and if only ($t1$) exceeds the time required for data transferring, the service will be requested. So, it ensures that the data transmission will be done before exiting the vehicle from the RSU coverage zone. We have used NS2 method to evaluate the efficiency of the suggested method. The results of the simulation show that the suggested method has enhanced the efficiency up to 25%.

Keywords: VANET, scheduling, roadside unit (RSU)

1. Introduction

Car accidents take the life of thousand people each year. This rate is much more than the casualties caused by diseases and natural disasters. Studies show that if the driver receives warning in less than half a second before the accident, approximately 60% of car accidents can be reduced [1]. Nowadays, modern vehicles are equipped with electronic equipment and estimate the distance from other vehicles by means of devices like radar. But this information is not enough to prevent car accident.

This will be achieved through exchanging information by means of radio equipment, so that the driver would be informed of the special condition quickly; therefore, he reacts reasonably, in appropriate time. A new generation of vehicular ad-hoc networks which has been added to vehicles is called VANET¹. It is used to connect vehicles to each other as well as to the roadside equipment [2-3][5-6].

In 1999, Federal Communication Committee allocated a frequency spectrum for wireless communication between two vehicles and between a vehicle and the roadside control center. Then, in 2003, this committee established rules for issuing permission as

1. Vehicular Ad-hoc Network

well as Short Range Communication Services (DSRC). DSRC is a communication service using 5.850-5.925 GHz band for private applications and public security purposes. This capability enables the vehicles and roadside equipment to establish vehicular Ad-hoc network, VANET. In this network, vehicles can communicate with each other wirelessly, without needing the central accessing point [1][12].

1.1 The Architecture of VANET

VANETs are based on no structure to communicate and propagate the information. They are performed in dynamic transportation environments. The architecture of VANETs is divided into three categories:

- Netwlan network: VANET can use fixed and accessible points of Netwlan in traffic intersections to connect to internet, and gather traffic information, or use them in order to find direction.
- Ad-hoc networks: all the vehicles and wireless roadside equipment are able to create a vehicular Ad-hoc network, in order to communicate between vehicles and achieve specific purposes, such as blocked path ways (a path way with no traffic lights).
- Mix: it is a combination of WLAN and Ad-hoc network.

1.2 Data transferring models in VANET

In VANETs, communication can be established not only between vehicles, which are within radio range district, but also between the vehicles and roadside unit (RSU). Totally, there are two models for data accessing :

PULL communication model: in this model, the user sends a request to a specific destination, and its receiver sends response including the requested information [11]. For example, the vehicle which needs a special data, such as traffic information, sends a request, and then, each automobile, which receives that request, processes it and sends the response separately [11].

PUSH communication model: in this method, when a node identifies an event in the network related to a specific user, it broadcasts the information within the network, without any request for receiving it. For example, as a vehicle identifies an unsuitable traffic situation, a data package is sent to all the vehicles within that district [11].

1.3 Communicative techniques in VANET

V-V: communication between two vehicles,

V-I: the relation and communication between the vehicle and roadside equipment,

I-V: the relation between roadside equipment and vehicle,

I-I: the communication between roadside equipment with each other.

In V-I communicative technique, by sending the requested package to the roadside equipment, the vehicle receives information. In this model, the communication can be one or two sided [6].

- One sided communication: in this model, the vehicle delivers information to RSU and does not wait for a response. For example, we can say that, a vehicle identifies an unsuitable road situation and sends this information to RSU in the form of a package, and RSU, also, sends this information to other vehicles.
- Two sided communication: in this model, the vehicle sends a request to RSU, and RSU responses it back [7].

1.4 Applied programs in mobile networks of vehicles

Traffic security application: (preventing car accidents, traffic warning, and traffic jam controlling) this application is associated with passenger and driver security [8].

Servicing application: (weather forecast, fuel price in path stations, automatic payment of road taxes, and so on) it is related to increasing the facility of drivers and passengers, and qualifying travels [9-10].

2. Related works

Considering the variety of applied programs and numerous applications, as well as limitation of the bandwidth, dealing with all requests is not possible. So, the scheduling of services is necessary. Series of algorithms have been presented for scheduling, among which the followings can be mentioned [3][13-15]:

FCFS (First Come First Serve): the application, which has been distributed earlier, has priority for servicing.

FDF (First Deadline First): The request which has a shorter deadline is serviced first.

SDF (Smallest Data Size First): the application which requests smaller data should be serviced first.

These algorithms simulation results show that in low load, FDF is the most efficient of all, because, in low load, the deadline has the most importance. In high loads, SDF works better, and in all conditions, FCFS is the worst. In the source[4] a method has been presented which uses the caching technology to decrease the response time and improve the efficiency of network.

D*S algorithm is a new scheduling method which considers the parameters of package size and deadlines. This algorithm is based on the followings [3]:

1-Among requests which have the same deadline, the request should be serviced that is related to the smaller packages.

2-Among applications with the same size, the nearer deadline application should be serviced earlier. According to this point of view, each request, according to its deadline and its related package size, receives a service value which is called D*S-value:

$$DS_Value = (Deadline - Current\ Clock) * Data\ Size$$

D*S-value: according to this algorithm, always, the algorithm which has a smaller D*S-value is serviced.

D*S/N algorithm: The idea of the D*S/N algorithm, which is the enhanced version of D*S is: if a package receives multitude applications, the number of applications of that package is influential in selecting that application for servicing. In that case, by sending the package to its applicants, the algorithm tries to service manifold of applications simultaneously:

$$DSN-Value = (Deadline - Current\ Clock) * Data\ Size / Number$$

Another improvement has been applied in this algorithm. In this enhancement, download and upload applications are serviced in two separate lines. Because automobiles are able to communicate data with roadside equipment, just when they are located in radio coverage district, hence, it is likely that an application, which belongs to the first vehicle, priority receives the servicing. But, since it is just t units of time in the radio coverage district, RSU, and t is less than the required time for communicating the

data, so, the data transferring process faces with problem. Therefore, application fails, and this causes the reduction of the rate of servicing. It seems that the sole applying of the size parameter of the data, or prioritization based on entrance priority and etc, cannot be profitable. So, in offered method, in order to apply the priority of servicing, a combination of previous works and another parameter, called “allowable servicing time”, have been used. Based on this, an application is priority serviced which is in the radio coverage district of RSU.

2.1 The suggested method

As it was mentioned, one of the communication models is V-I. In this model, the vehicle exchanges information with roadside equipment. Different and various requests are sent to the RSU and, surely, because of the high speed of vehicles, it is impossible to answer and service to all of them. Since vehicles exit from radio range district of RSU, the necessity of scheduling services is felt. We are going to present a method by which more requests would be serviced.

As it was clarified, one of the characteristics of vehicular ad-hoc networks is the high speed of nodes. On the other hand, the nodes have communication with each other only when they are in a same radio range district. Therefore, a parameter, as the priority criterion to use the features of VANET, has been determined. Hence, we use a criterion to apply the prioritization called “reasonable time for servicing”.

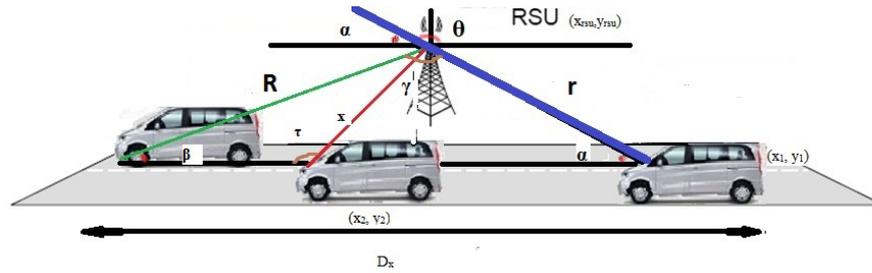


Figure 1. The System Model Architecture

To calculate this criterion, the period when the vehicle is in the radio range district of RSU, should be computed. According to the above picture, it could be said that: for calculating the period of which the vehicle is in the radio range district (t_1), first, the distance, in which the vehicle exist in this district, should be computed. In this way, one can compute (D_x) using following formulas:

$$\frac{r}{\sin \beta} = \frac{R}{\sin \alpha} = \frac{D_x}{\sin \gamma} \quad (1)$$

$$\alpha = 180 - \theta \quad (2)$$

$$\theta = \tan^{-1} m \quad (3)$$

$$\tan \theta = m \quad (4)$$

$$m = \frac{y_{rsu} - y_1}{x_{rsu} - x_1} \quad (5)$$

$$\sin \beta = \frac{x}{R} \Rightarrow \beta = \sin^{-1} \frac{x}{R} \quad (6)$$

$$\sin \alpha = \frac{x}{r} \Rightarrow x = r \sin \alpha \quad (7)$$

$$\gamma = 180 - (\alpha + \beta) \quad (8)$$

$$r = \sqrt{(X_{rsu} - X_1)^2 + (Y_{rsu} - Y_1)^2} \quad (9)$$

In the above formula, (x_1, y_1) is the position of vehicle, and (x_{RSU}, y_{RSU}) is the position of RSU. According to (1), in order to compute D_x , having 2 angles of 3 angles α , β and γ , is necessary. Hence, using equation 2 to 5, one can calculate α , and by using equation 6, β can be calculated. Using 8, one can calculate γ . Equations 9 and 7 are used to compute x . Now, by using following equation, T can easily be calculated:

$$T = \frac{D_x}{V}$$

In the above equation, V is vehicle's velocity. Now, in the next stage, the time for transferring data (TTD) should be computed. For calculating TTD, following formula can be used:

$$TTD = \frac{\text{size of data}}{\text{bandwidth}}$$

2.2 The algorithm of suggested method

1. Every vehicle sends its data size position, deadline time opportunity, and its velocity within its requested package. Position in equation 9 and the velocity are used in equation 10.
2. RSU receives the package and, according to its deadline, puts it in its appropriate position. FDF algorithm orders the packages, so that the package, which has less time, is prior in the queue.
3. during servicing the requests, by using information existed in the package, TTD calculates the T , and the package is serviced only if $TTD < T$. Otherwise, no request is serviced.

As it was mentioned, at the moment of request, the vehicle enters its positional information in the package, and the package goes to the waiting queue. When, in the third stage of algorithm, RSU wants to compute T , real position of vehicle is definitely different from the positional information included in the package; because, during the waiting time, the vehicle has continued its motion. In order to compute D_x exactly, it is necessary to have the information of vehicle's new position which is obtained by using the following equations:

$$Y_2 = Y_1 + tV \sin \tau$$

$$X_2 = X_1 + tV \cos \tau$$

(X_1, Y_1) is vehicle position at the time of sending the request.

3. Simulation results

Evaluating the suggested method in real condition entails great time and expense. In order to evaluate the efficiency of the suggested method, NS simulation is used. The experimental scenario is based on a square street (300*300), including a junction with horizontal and vertical roads and RSU in the center. All the vehicles, following traffic

current in crossroads, go to the end of each road, consecutively. In this scenario, 211 vehicles are considered which are running at a speed of 0 to 60 m/s. Simulation parameters are mentioned in table1.

Table 1. Simulation Parameters

Parameter	Value
Simulation time	90s
Transmission rate	64kb/s
Vehicle velocity	0-60m/s
Wireless coverage	100m
Packet size	1000byte
Data item size	Various500,1000,2000KB
Routing protocol	AODV
Ratio propagation model	Two ray ground
Antenna model	Omni antenna
Mac type	IEEE 802.11
Traffic type	UDP
Network size	300m*300m

In this study, efficiency parameter is considered as the most important parameter, and the main goal of the study is increasing the number of servicing.

Efficiency: it is the number of bits in a unit of time which is transferred in the network successfully.

The results of the simulation are examined according to these parameters:

1. The results which show evaluating criteria, according to the time, Figure2.
2. The results which show evaluating criteria, according to the various efficient loads, Figure 3.

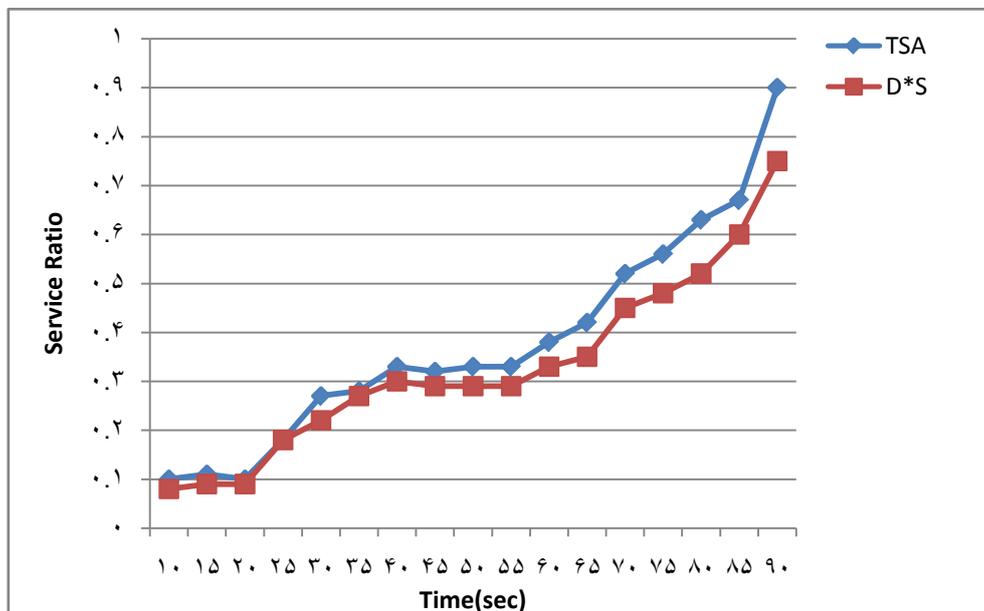


Figure 2. the rate of servicing in a unit of time

As it is showed in figure2, at the beginning, because of the few number of requests and light traffic, the suggested and D*S methods are the same, comparatively. By passing the time and increasing the number of requests, the suggested method has better

function. It is because of using time factor in the covered district of RSU in the process of applying the prioritization of servicing.

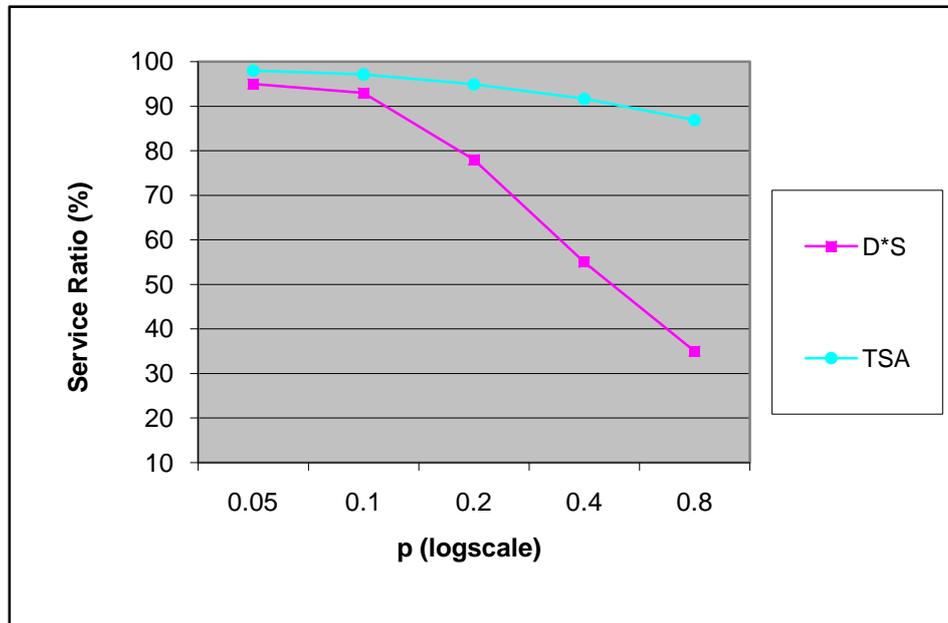


Figure 3. the rate of servicing in different efficient loads

Figure 3 shows the function of suggested method in various efficient loads. Here, ρ is the probability of requesting services for each vehicle according to the Poisson distribution and the interval between the requests, based on the exponential function. Its extent is $0 < \rho < 1$. By increasing ρ , efficient load becomes heavier and, as it is in the figure, in light efficient load, both algorithms act alike, and in heavy efficient load, the algorithm of suggested method acts more efficiently.

4. Conclusion

In this section, the result of using the suggested method was examined. Briefly, it can be said that the suggested method can improve the number of servicing by using time factor for presence of vehicle in covered district of RSU. Keeping it in mind, a request has priority that can be serviced when it is in the radio range district of RSU.

In a VANET, because of the number of applied programs and requests and the limitation of the extent of band, it is impossible to service all of the requests. So, the question is that: which one should be replied first? To schedule the services, different methods are presented. Each of these methods proceeds to schedule from its point of view. In most methods, it seems inefficient just to use size parameter or priority, according to the entrance arrangement and so on.

Because of the high speed of vehicles and the number and variety of received requests to RSU, surely, answering and servicing to all of these requests are not possible. Since the vehicles exit from the radio range district of RSU, and due to the high speed of the nodes as a feature of VANET, nodes can only connect to each other when they are in a same radio district.

While following other methods, we present a method which can service more requests, as much as possible. So, another parameter can be used which is called “reasonable time for servicing”. Therefore, the request has priority to be answered that can be serviced in a duration that the vehicle is in the radio range district of RSU.

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