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A Review of Data Aggregation Protocols in VANET and providing proposed protocol

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Abstract

Integration of network data is a promising mechanism to reduce the bandwidth required for an application in ad hoc networks. Data aggregation within the network reduces the required bandwidth and provides the possibility of compression in cars large networks. Aggregated data instead of sending a message all of which are separately sent can combine some similar messages in a aggregated message that has accumulated content. Data aggregation has some protocols that the aim of assessing data aggregation protocols is considering their problems and providing proposed protocol for solving their problems in reducing the bandwidth. In this article we try to explain data integration. Data aggregation protocol have a major role in solving network problems, which we have assessed the protocols and to address the problem of one of data integration protocols, we raised our proposed protocol that the proposed protocol helps to solve traffic problems and diminish bandwidth by indexing and providing appropriate clustering algorithm. Finally, we will compare and evaluate the proposed protocol and data aggregation protocol by simulation. The results show that the proposed protocol is effective to reduce the volume of messages sent and reduce bandwidth.

Keywords: VANET, data aggregation, protocol, indexing, clustering

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Introduction:

Car traffic on the roads today is raised as the crucial and important issue in large cities. Traffic congestion and traffic-related issues connected with car accident threats. VANET (Vehicular Ad hoc Network) is one of the areas of wireless communications. One of the big challenges of VANET is increasing bandwidth. Network data aggregation is a promising mechanism to reduce the bandwidth required for an application in ad hoc network (Parsaei and Salehi, 2015). Network Aggregation is a communication model that has the potential features to increase scalability of multiple communications, and by reducing the required bandwidth of applications, allows simultaneous activity of multiple applications on the network together. Instead, many nodes forward a single message, all of which have the same nature. The elements in the data can be combined to create an aggregated message with the content of a message in itself figure (1).

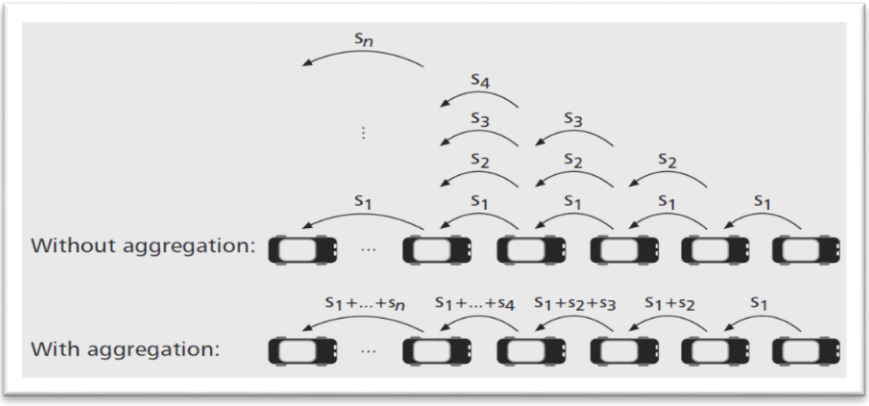

Figure 1: Schematic comparison of bandwidth between normal message release and aggregation

Data aggregation in VANET face challenges that include: 1. Large scale network, 2. Dynamic topology, 3. Frequent segmentation scale, which these challenges have been responsible for creating protocols that resolve the challenges of data aggregation with applied rules (Parsaei et al. 2016). Protocols in data aggregation are of great importance, because they deal with the aggregation efficiency improvement and resolving its challenges. Much research has been done in this area, resulting in the protocols that are shown in the table below and then we will present a brief explanation about each protocol.

Table 1: Comparison of data aggregation protocols features in VANET (zhijun Li, 2014)

Forward time	Routing structure	Communication model	Aggregation precision	Type of data	Protocol
No waiting	Ad hoc	V2V	Not to lose	Speed and position	sotis

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No waiting	Ad hoc	V2V	To lose	Speed	Traffic view
No waiting	Ad hoc	V2V & V2I	Not to lose	Parking information	Pro.Agg
Waiting	Ad hoc	V2V	To lose	Speed	Catch-up
No waiting	clustering	V2V	Not to lose	Speed	CASCADE

SOTIS introduced SOTIS traffic system. The proposed protocol uses periodical monitoring techniques to exchange information. Received data about traffic care based on the segmentation of the road. For each section, the average speed is calculated and then sent to the front. Traffic view is a more advanced aggregation scheme used in the traffic system. This scheme, similar to SOTIS, releases information about the average speed of vehicles on the road. Unlike SOTIS, this method is the central node and not the central space. This means that reports of the nodes that are close to each other, by averaging their current speed and position on the road. However, to be able to authenticate nodes, the list of all the nodes involved in this scheme is stored as well. The aim of this method is to obtain estimates of vehicles. Lochert used a hierarchical method on the aggregation using map data of the roads. One of the great benefits of their system is the use of a plan adapted from Flajolet-Martin to achieve a possibility of free spaces set. Thus, aggregation can be combined and re-combined arbitrarily without counting multiple parking free spaces. Catch up , Van eenennaam provided a system that, instead of averaging the information about road sections, presented only the most relevant single information for specific plans of the roads for further vehicles. CASCADE , Ibrahim & weigle provided anaggregative scheme based on cluster that is suitable for the propagation of speed of the vehicles. Unlike provided schema previously, the CASCADE system uses syntactic compression without loss of data. In the local area in front of a vehicle, a published single report using broadcast is collected. Then the local perspective are clustered using the fixed landscape part sand the different encoding to compress vehicle information. Then the compressed information is released to the front. Among data aggregation protocol, we chose CASCADE protocol to review and improve. The aim of the choice of this protocol was closing to our proposal which will be explained later. One of the disadvantages of CASCADE protocol is the algorithm used in this protocol and the other is how to delete old messages, as described in the following explanation.

1. The algorithm used in CASCADE is not applied in heavy traffic, because in this algorithm the timer is used, that is any vehicle until it is in the limit of IVG (Inter-Vehicle Geocast)the messages will continue to be repeated. This messages repetition will be sent during different time intervals until the vehicle has come out coordinates of IVG algorithm. If the car in city traffic for a long time these messages will continue to be repeated. In fact, by sending a message to the vehicle, an answer is received and these messages will be continued until the car is in that traffic and to be out of that range and this issue increases the volume of messages in clusters and the bandwidth in the long term.

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2. Deleting old messages in CASCADE protocol is that vehicles that are physically pass by cars (from the local view) are deleted. If the cars are in a heavy urban traffic, several hours will be stable in a place. Messages will not be deleted and will continue to be repeated, because in this protocol, the vehicles send three frames of new reports per second. If a car is in traffic for half an hour and three frames are sent per second, 5400 frames or messages have been sent. This deletion method is used in very light traffic where vehicles are passing. In this article we will provide new protocol to improve CASCADE protocol and use a suitable clustering algorithm instead of IVG algorithm. To communicate optimally between vehicles of road surface, DSRC standard (Dedicated Short Range Communication) is used, so to split the cars in the various clusters is a good idea that provides an optimum and suitable relationship between cars in a cluster, through DSRC communications. In this article a protocol is proposed, the intended clustering and its algorithm raised and then solutions for leaving traffic are recommended. At last, our own protocol will be evaluated using simulation.

The overall structure of the proposed protocol:

We will provide a new protocol to solve problem of the said protocol in which we will take index from repeated messages that is from a message with more frequent repetition of which a sample is taken and the number of repetitions of the message is written. By this technique, we will provide with the vehicle the destination of traffic message in the form of a message with the number of repetitions which represents heavy traffic or style that it provides improved compression and helps to reduce bandwidth even further. This means that all vehicles that are faced on a street with traffic send separately a message to the server. The server must detect the mean of the traffic messages? For example, a traffic has been caused by car accident or a traffic caused by road repairs. To detect these messages we will categorize and we called them. For example, accident message: A, the traffic message: B, these messages are sent to the server. Then the messages will be clustered based on their names, that is traffic names are in a cluster. In fact, a cluster will be made with traffic messages. The clusters that their messages are highly repeated will be prioritized to take index and they will be wrote and sent compressed to cluster head and other cars with relevant name and number of repetitions. The prioritization is done based on number of messages repetition. Messages prioritization are obtained via server to 1. Message detection and 2. Separation It is done if the message are called on VANET devices inside the cars. The repeated messages will be deleted by indexing. The bandwidth of road will be highly reduced and it helps to separate messages quickly by calling messages and clustering cars in difference clusters. For example, if accident message is highly repeated, index will be sent to cluster head and other cars and at the same time, emergency centers and transportation department will be informed. By doing so, the messages will be sent in a high speed. The messages indexing can increase their sending speed. This technique reduce traffic volume. Reducing traffic volume is one of the advantages of our proposed protocol.

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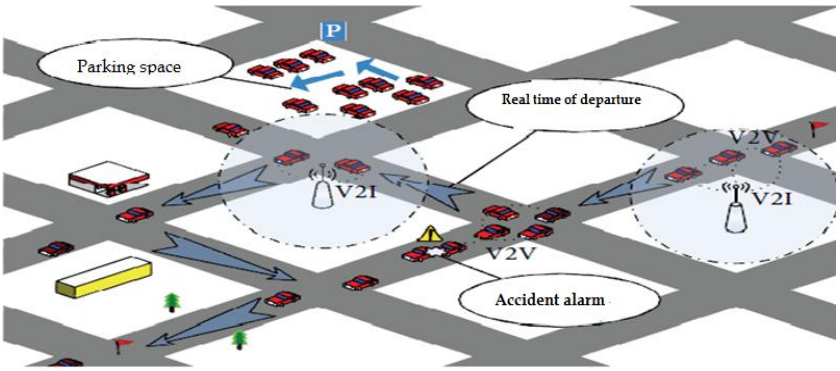

Figure 1: General view of the proposed protocols

To present our proposed protocol, we need a clustering. In such a clustering, we will cluster cars by receiving the cars speed and their sent messages to be able to take index by clustering messages and send to cluster head.

Vehicular Clustering:

In our proposed clustering method, the clusters can be large, because we will do clustering in the intended plan based on the received messages, that is the cars with traffic message in a cluster and the cars with an accident message in other cluster. To specify type of messages, we will call them. The large clusters will send many messages and it may make traffic in cluster head and lead to communication overhead. We will take index from messages using the plan, that is, we will compress the received message in traffic cluster and send to cluster head under a message with repetitions. By doing so, the cluster head will send quickly the message to RUS and other cars out of the cluster (Figure 2). By such a clustering, bandwidth will be highly reduced and the speed to receive and send messages will be increased. We will not use small cluster in this plan, because it may reduce the stability of the network (because rejoining to the network increases).

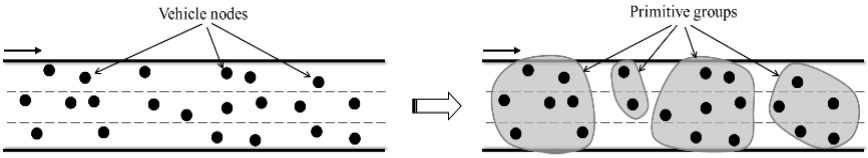

Figure 2: The Grouping made by vehicles

Clustering Processes

Clustering is done based on the sent messages. We recommend to choose speed and number of cars in communication range and cars direction and indexing in the clustering method. The difference of relative

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speed among adjacent cars is the first parameter to determine the members of cluster. To choose the members of cluster, we will discuss the cars speed. In fact, the cars speed shows us that there are many adjacent cars with the same speed which are put in the same cluster. The cars in their communication range distribute their speed "R" for other cars. The cars in the limit of "R" with the minimum speed threshold ($\pm\Delta v$) are classified in a cluster. If their speed difference is less than $\pm\Delta v_{th}$, it is considered as the least speed in traffic cluster. To cluster dynamically, the cars with the same track are put in one line and the current cars in the opposite direction are eliminated. According to (Kakkasageri,2012), speed can be identified with normal distribution and μ average and $^2\sigma$ variance and its normal distribution function is obtained as follows:

$$e^{\frac{-(v-\mu)^2}{2\sigma^2}} = \frac{1}{\sigma\sqrt{2\pi}}(v)\rho_v(1)$$

The speed difference (Δv) between a car and its adjacent car follows normal distribution with the following possible intensity function:

$$e^{\frac{-(\Delta v-\mu_{\Delta v})^2}{2\sigma_{\Delta v}^2}} = \frac{1}{\sigma_{\Delta v}\sqrt{2\pi}}(\Delta v)\rho_{\Delta v}(2)$$

Where $\Delta v = v_1 - v_2$, $\mu_{\Delta v} = \mu_1 - \mu_2$ and $\sigma_{\Delta v}^2 = \sigma_1^2 + \sigma_2^2$.

Calling the messages helps to choose them in suitable cluster, that is, before sending a message, the messages are called in VANET device installed on the car. It will help to cluster correctly, safely and quickly, because by calling them, for example, message A = traffic, the cars will be put in their suitable cluster by sending A. After the clustering is determined, the messages are sent by cars. To avoid high volume of messages, compression is used in which single messages are collected. The collected messages are indexed; in fact, the messages are prepared in the form of a message with number of repetitions to be sent to cluster head. In this stage, after indexing, we will wait the message to be received in cluster head. If it is received in cluster head in a specified time, the compressed messages are deleted, otherwise, the message will be sent again. If the message is received by cluster head, the cluster head will sent ACK message to the cars of cluster and it prevents to re-send messages by cars.

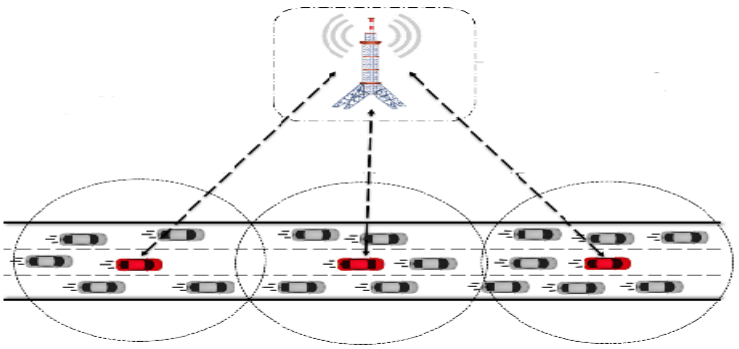

Figure 3: Clustering based on the proposed plan

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Clustering Algorithm

To write the clustering algorithm, we assume that the message have been previously called, for example m_j traffic message and m_j accident message. The members of CM (Cluster Member) cluster, ST indexing and cars speed are shown by V_s. The cars send the messages after clustering. The indexing is done with high volume of messages and then the messages index is sent to Cluster Head (CH).

Algorithm (1): The proposed clustering algorithm
Before clustering vehicles for each sending message, one messageID consider.
If V_s >100km then
Traffic not = received not message
Remove from known message list
end if
else if V_s < 50 km then vehicles are in traffic
m_j = vehicles
m_j = CM ,$m_j \epsilon$ cluster.
if CM> 100 vehicles then used of ST
ST= m_j - (m_j - 1) , ST sending m_j CH
ST (T_{wait} = 2s)
If received message of CH then
ST= CH
end else if
end if
end if

The separated and indexed messages are indexed using the clustering algorithm and a sample is received and sent from each cluster. This proposed protocol and its clustering algorithm lead to the fast received message, reduced messages volume and highly reduced bandwidth. Communication overheadis also avoided.

The Approaches to exit urban traffic:

After clustering, the speed of messages sent are increased by which the vehicles not to entered to traffic will be informed early and so they will choose other road. The cars involved in the traffic can exit and release urban traffic using the followings:

1. Identifying the nearest public parking space and free spaces to park based on the track of vehicle
2. Identifying the nearest public transport to get the driver to destination

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3. Timing for traffic track, that is, the driver is informed that it is the ahead routes to go out of traffic, how to get to the intended destination. The driver selects the best path to get out of traffic.

Evaluation of the proposed protocol:

In this section, the results of the evaluations conducted on the proposed protocol will be analyzed and presented using simulation. We used a SUMO simulation field . We will consider different traffic features in the simulation which include the space and distance between cars, cars density and MAC layer delay (Media Access Control). The space between two cars is the distance between cars. The density is total cars in an area shown usually by car/km. The cars density has been considered in the simulation scenario of the specified part of expressway in three types of low, average and density and Poison distribution is considered to calculate it which is 53, 66 and 90 car/km for low, average and high density, respectively. It should be noted that we will use CASCADE protocol cars density to have a better comparison with the propose protocol. Density is collected from traffic speed and volume. In order to study the effect of the use of compression and indexing, MAC layer delay was used for each frame. This delay indicates the time between received frames in MAC layer to be transferred and presented to physical layer. In a specified time, if the wireless network is very busy, MAC delay will be increased, because the sender will not be able to detect the channel. But by indexing, there is very low delay, because the volume of messages will be low by indexing and network will not be busy. Other parameters are required to run simulation process which are based on the expressway scenario as shown in table 2.

Table 2: Simulation parameters

Values	Parameters
360s	**Simulation duration**
100km	**Expressway length**
30-120km	**Cars speed**
300byte	**Message volume**

In the simulation sets table, we showed summarily that all cars in a road to a four-line expressway are divided 100 kilometers in length. The speed of cars uses normal distribution with μ average and σ standard deviation. The messages are sent every 2 seconds. The size of messages is 300 bytes. In the results obtained from simulation, we will discuss MAC layer delay and cars density on CASCADE protocol and our proposed plan and compare their differences using compared diagram.

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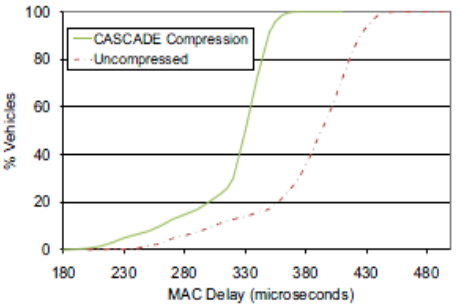

Diagram (1)

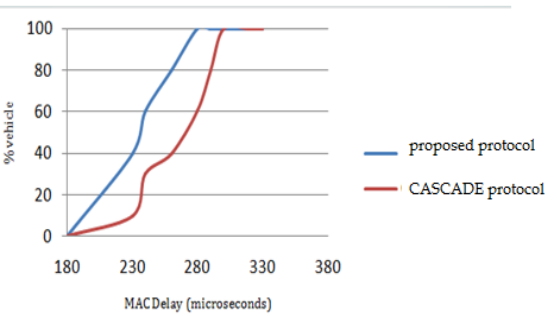

Diagram (2)

Diagram 1: MAC delay in compression with vehicle average density shown in CASCADE protocol
Diagram 2: The comparison of MAC delay in the proposed protocol with CASCADE compression

In case of the use of compression, information volume will be decreased and their transfer will be done in less time. In CASCADE protocol, MAC delay is still small in high density. The value of MAC delay will be highly reduced using our proposed plan which is done using indexing and delay will be minimum in cars density. As you can see, MAC layer delay has been reduced using indexing. Given that if there are many cars in MAC layer, MAC delay will be increased, but we showed that the messages volume will be decreased by indexing, even if there are many cars. In diagram (3), we compared the speed of received messages in the proposed clustering algorithm and IVG algorithm with high density of cars using the indexing technique.

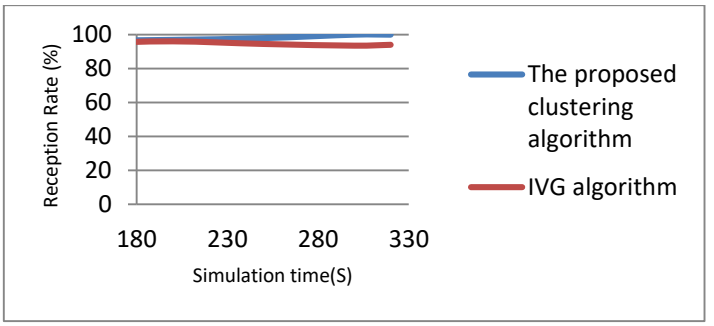

Diagram (3): Speed of receiving messages

As you can see, the speed of received messages in out proposed algorithm using indexing is high and this leads to receive messages quickly in cluster head, server and other cars and emergency and transportation departments. The traffic volume will be reduced and finally the proposed indexing in the proposed protocol lead to improve bandwidth and reduce traffic in roads.

Conclusion:

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Data aggregation helps to message compression in VANET system. In this articlewe raised our proposed protocol to reduce bandwidth in data aggregation. In the proposed protocol, we provided clustering algorithm and indexing. Indexing aims to transfer messages in a low volume and high speed to cluster head and it helps to decrease bandwidth. In our protocol, we presented an algorithm for dynamic clustering to cluster them according to speed and position of cars. Finally, we compared scientifically our protocol and CASCADE protocol and algorithm of the two protocols using simulation.

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