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Review Article

# A Review Paper of Data Aggregation in VANET Architecture

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***Abstract***

*Vehicular ad hoc networks (VANETs) enable vehicles to communicate with each other on the road. Many applications have been proposed for this kind of mobile ad hoc communication. Some of the examples of its applications that enhance road safety and efficiency along with supporting drivers, and provide infotainment services are intersection collision warning, lane merge assistance and smart traffic management. The main purpose of this paper is to study the components of the VANET architecture along with its data aggregation flow process and discuss two of the main aggregation techniques.*

***Keywords:*** *Vehicular ad hoc network (VANET), infotainment, aggregation techniques, dissemination, fusion.*

## 1. Introduction

Nowadays eight out of ten people own car. People hardly travel without it. Unfortunately, using car has many issues regarding safety and pollution. Around 1.3 million people die in road crashes every year, on average 3,287 deaths a day. In spite noteworthy efforts are being made to reduce the accidents on road, this number doesn't seem to be decreasing. It is mainly attributed to human factors such as poor roadway construction, reckless driving and more. Our work focuses on management of data in inter -vehicular ad hoc networks. These wireless ad hoc networks use IEEE 802.11 or Ultra Wide Band (UWB) standards for vehicles to communicate for providing bandwidth in the range of Mbps. With the help of such communication networks, a car driver can receive information from their neighbors. Numerous pieces of information may be exchanged in the context of inter-vehicle communications, for example to warn drivers when a potentially dangerous event arises (emergency braking, accident, obstacle on the road, etc.) or to try to help them for finding available parking spaces, escaping traffic congestions, being alert of real-time traffic situation, etc. In the previous years, research works have investigated on data sharing and data relevance evaluation in inter-vehicle networks. This paper presents our approach that considers both fresh data for warning drivers but that also maintains and aggregates data histories for disseminating knowledge among vehicles. Indeed, once data is considered no relevant or obsolete, for example because it has been already used to warn the driver, we propose to aggregate it to produce additional knowledge to be used later on. This approach enables for example the real-time detection of potentially dangerous areas on the roads due to bad weather conditions; or the identification of those places where there is a high probability to find parking with available places. Such knowledge can be determined using previously received warnings even if no new event has arrived during a period of time

## 2. The Architectural Model of VANET

The entire modeling approach is mainly divided into two main parts or components namely architectural model and aggregation flow process. All the functional components of an aggregation scheme are described by the architectural model. The entire process of data aggregation and processing of information is described in aggregation flow process. Finally the data processed and forwarded is described in the dissemination process. Data aggregation can contribute in providing scalability for multi hop communication and enable the co-existence of multiple different applications by reducing per-application bandwidth requirements. Instead of a number of vehicles sending single messages, which are all forwarded individually, multiple similar messages can be combined into one aggregated message that represents the accumulated content.

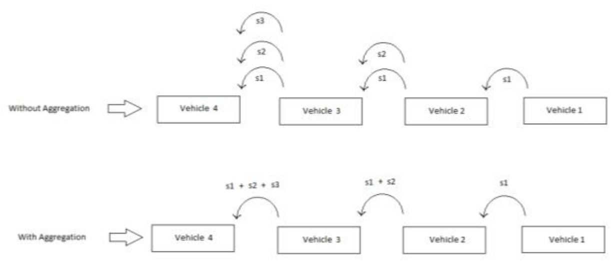


**Fig.1** Comparative diagram of data sent with aggregation and without aggregation.

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*2.1 Functional Components of the Architecture*

The communication between various vehicles or between a RSU and a vehicle is achieved through a wireless medium called WAVE. A wide range of information is provided to drivers and travellers by this method of communication. It also enables safety applications to enhance road safety and provide a comfortable driving. The major system components are the application unit (AU), OBU and RSU. The working is done in the following manner. Basically the RSU hosts an application that provides services and the OBU is a peer device that uses the services provided by the RSU and local sensors. The hosted application may reside in the RSU or in the OBU. The device that hosts the application is called the provider and the device using the application is described as the user. Thus the provider and the user could be either a RSU or OBU. Just like the client server architecture in which the client requests for information to the server. Then in response to this request the server provides the information to the client. In order to receive the information and to forward it to the other devices the vehicle needs sensors. Thus each vehicle is equipped with an OBU and a set of sensors to collect and process the information. Once the information is collected and processed it needs to be sent to the neighboring devices thus this processed information is then sent on as a message to other vehicles or RSUs through the wireless medium which is called wave.

*2.1.1 Road Side Unit (RSU)*

The RSU is a wave device which acts as an information source. As the name suggests, the RSUs are usually fixed along the road side or in dedicated locations such as at junctions or near parking spaces. The RSU can connect to the Internet or to another server. This function of RSU allows AU's from multiple vehicles to connect to the Internet in order to exchange the information. This connection with the internet forms a fixed rigid infrastructure that provides the capability of communication with each other as well as with roaming vehicles. Various cooperative and distributed applications are supported by RSUs in which the RSUs and the vehicles work together to coordinate actions and to share the processed information. Till date the RSUs have been used for various roles such as traffic directories, location servers, data disseminators, security managers, and service proxies. Thus RSUs re-distribute the information to the OBUs thereby extending the communication range of the ad hoc network.

*2.1.2 On Board Unit (OBU)*

The main communication link to the AU is provided by the OBU in order to execute one or more of a set of applications provided by the application provider using the communication capabilities of the OBU. As the name suggests OBU is available in each vehicle along with AU. It receives information from other neighboring vehicles or RSUs. Thus to store this information in order to process it, it consists of (RCP) resource command processor. It includes read/write memory to store information while receiving and retrieve it later when it needs to forward it to other vehicles or RSUs. In order to communicate with the network devices for short range wireless communication it also has user interface. Besides providing communication services to the AU, OBU also transmits data on behalf of other OBUs by aggregating the information received in the aggregation flow stage of architecture. All the connections made by OBU are wireless connections based on IEEE802.11p radio technology. Some of the other functions of OBUs are network congestion control along with reliable message transfer.

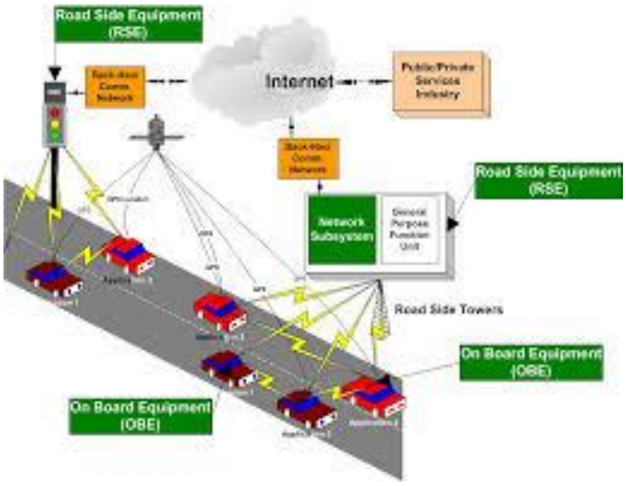


**Fig.2** Communication between the components of VANET

*2.1.3 Application Unit (AU)*

Application unit exists in each vehicle along with OBU. It uses the application provided by the provider. As it resides in the in-vehicle communication domain, it is either connected to OBU by a wired connection or wireless connection. If not connected via wire it can also be mounted along with OBU as a single physical unit.

*2.2 Aggregation flow process of VANET architecture*

A vehicle receives information from remote vehicles or local sensor observations. The data received in form of information is then processed inside the vehicle and then periodically disseminated to direct neighbor vehicles. Neighboring vehicles apply the same scheme, thereby achieving an implicit multihop dissemination.

Inside a vehicle, an aggregation scheme can be sufficiently described by four tasks and respective components.

1- Decision: in this task a decision is made whether the data items can be aggregated.
2- Fusion: In this task several data items are fused together.
3- World Model: This is the stage where the world model is maintained that is composed of received information as well as the self-obtained information.
4- Dissemination: in this stage the world models are disseminated to the other vehicles

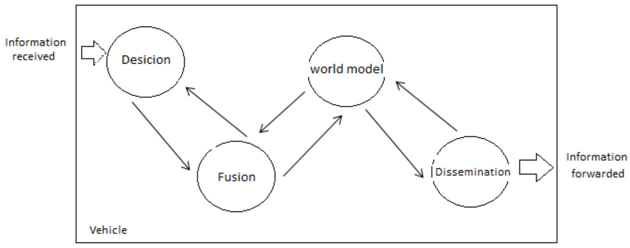


**Fig.3** Data aggregation flow process diagram

*2.2.1 Decision component*

Whenever the vehicle receives information from the other vehicles it has to decide whether the given information can be aggregated. The decision component has to check for the data granularity. To what level the data can be aggregated and then sent to the other vehicles as the distance increases. The decision about the aggregation of the data is done with the help of presented items as well as with all the information in the world model. Flexibility is the most important requirement for the decision component.

*2.2.2 Fusion*

A data fusion node collects the results from multiple vehicles. It combines the results with its own based on a decision criterion and then sends the fused data to another vehicle. Fusion is a process in which unnecessary information is discarded. When the large-area data dissemination is to be done, bandwidth reduction is required. Data Fusion is not sufficient enough to achieve this required bandwidth reduction. To build a good lossy aggregation scheme, application domain knowledge is a must. Such knowledge helps to decide which data items are important for application decisions, and which data items can be removed in the aggregation process without losing too much required information. Some of the Advantages of Data Fusion are that it reduces the traffic load and conserves energy of the sensors. To build a good lossy aggregation scheme, application domain knowledge is a must. Such knowledge helps to decide which data items are important for application decisions, and which data items can be removed in the aggregation process without losing too much required information.

*2.2.3 World Model*

A vehicle's *world model* collects all information available to that vehicle received by the other vehicles or RSUs. It is time dependent which means that it changes from time to time. This change is due to the reception of formerly unknown Information from other vehicles. The main requirement for the world model is to support efficient range queries for subsets of the contained data.

*2.2.4 Dissemination*

Data dissemination can be described as broadcasting information about itself and the other vehicles it knows about. After data aggregation is completed, the *dissemination component*'s job is to transmit information to neighboring vehicles. Whenever a vehicle receives information broadcasted by another vehicle, it updates its stored information accordingly, and submits forwarding the information to the next broadcast period, and at same time it broadcasts its updated information. However, it is not necessary to flood new information directly. A vehicle can periodically broadcast a subset of its world model to neighboring vehicles, which in turn will continue to disseminate the information to vehicles further away. The dissemination system should be scalable, since the number of broadcast messages is restricted, and they do not flood the network. VANET characteristics like frequent topology change, high-speed node movement, and short connection lifetime especially with multi-hop paths needs some typical data dissemination models for VANETs. In VANET data can be shared using two approaches namely data push and data pull mechanism. In push mechanism, the data can be efficiently delivered from the moving vehicles or fixed base station (RSU) to another vehicle, it is mostly used in the traffic conditions, e-advertisement. Whereas in pull mechanism, any vehicle is enabled to query information about specific location or target it is form of request and respond type model. It is mainly used in enquiry about the parking lot, nearby coffee shop basically non popular data which user specific.

## 3. Data Aggregation and its Techniques

Data aggregation is any process in which information is gathered and expressed in the form of summary, for purposes such as statistical analysis. To provide information to non-neighboring vehicles, the messages must be forwarded to vehicles outside the original sender's broadcast range. The more vehicles participating in the VANET, the larger the number of messages sent, and the higher the probability of wireless collisions. In order to reduce the number of messages that need to be sent, several data aggregation techniques have been proposed so far. Unfortunately, with these techniques, some accuracy of the data is lost upon aggregation, and data aggregated by one vehicle cannot be combined with data aggregated by another. Aggregation techniques mainly refer to the way by which or the method by which data is aggregated. In this paper we mainly categorize different aggregation techniques into two main techniques namely syntactic aggregation and semantic aggregation.

*3.1 Syntactic Aggregation*

Syntactical aggregation is pretty straightforward. It concatenates the data and sends it as one package. Syntactic aggregation uses a technique to compress or encode the data from multiple vehicles in order to fit the data into a single frame. This results in lower overhead than sending each message individually. In this paper, we present CASCADE (Cluster-based Accurate Syntactic Compression of Aggregated Data in VANETs), a new method for accurate aggregation of traffic information in VANETs, featuring cluster-based compression. In aggregated frames, we represent each vehicle's location based on its difference from the location of the center of the cluster and its speed based on its difference from the median speed of all vehicles in the cluster.

*3.2 Semantic Aggregation*

In semantic aggregation, in contrast to syntactic aggregation the data obtained from individual vehicles is summarized. For example, instead of reporting about the exact position of three vehicles, only the fact that these three vehicles exist is reported. Thus even when the entire accurate information is not provided to the driver, the short summary of the information which is sufficient enough for the driver to know is been presented to him. The goal of Traffic View is to assist the driver of the vehicle by providing information about traffic and road conditions. In semantics aggregation the exchange of information takes place by flooding and dissemination.

Thus after going through the two techniques we conclude that the solutions that are able to support semantic aggregation can be considered more scalable than solutions that only support syntactic aggregation. This is because when semantic aggregation is used in contrast to the syntactic aggregation the size of an aggregated packet might not be entirely dependent on the amount of individual data that needs to be aggregated.

## Conclusions

Thus in this paper we have primarily analysed various components of the VANET architecture such as Road Side Unit (RSU), On Board Unit (OBU) and Application Unit (AU). This paper also reviews the data aggregation flow process which describes the various phases or stages by which the information, received by the vehicles, goes through. The paper also enables the researches to focus on the issues such as what components of VANET architecture to focus on. Which components are responsible for the communication of the vehicles in a particular ad hoc network? After reviewing the architecture, this paper also reviews the two main data aggregation techniques namely semantic aggregation and syntactic aggregation technique. Various applications regarding the safety of people, traffic management can be developed using this architecture in future.

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