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Multi-Vehicular Collaboration for Summary Harvesting based on Priority

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Abstract: There are some characteristics of Vehicular Ad Hoc Network (VANET) which resembles Mobile Ad Hoc Network (MANET) yet VANET's have distinctive attributes that frame it unique from MANET. A VANET network is self organized and used for V-2-V (Vehicle-to-Vehicle) communication and V-2-R (Vehicle-to-Roadside Wireless) communication. VANETs concept is elementary by integrating wireless communication and data distribution abilities, network can be build by the vehicles in a homogenous services that are used in home or organization networks. As of its self organized network it assures no breakages between the paths until the data transmission ends. During data dissemination some of the vehicles information may be missed at the base station and hence to recover the missed information Summary Harvesting technique is used. In this paper to reduce the overhead of the base station during Summary Harvesting multicasting of data between vehicles is done and the problem of redundancy of data is solved using the distance priority method.

Keywords: Vehicular Ad hoc Networks; Road Side Unit; Data Dissemination; Vehicular Density; Summary Harvesting; Multicasting.

I. INTRODUCTION

A VANET network is self organized with vehicles that achieve short scale data circulation. Vehicular communications are assigned with a set of standards by Intelligent Transportation Systems (ITS). Modern vehicles are generally depicted as local area networks (LANs), with the potential to connect several embedded computers which can communicate with other vehicles and also with themselves via numerous wireless connections. Thus the VANET is being used in several corporate applications like furnishing efficient routing information to the other vehicles, informing the drivers about the traffic constraints, accidents, and road shapes etc.

VANET architecture [1] is primarily an integration of an Application Units (AUs) and On Board Unit (OBU).Vehicles are provided with communication capabilities placed in a device that can be termed as OBU. An AU is simply a device which executes the applications by employing the communication capabilities of OBU.

The Ad hoc network incorporates vehicles provided with On Board Units (OBUs) and Stationary Units (SUs) placed along the road [2]. The primary role of VANET is to enhance vehicle to vehicle (V2V) communication in terms of road safety measures and traffic organization. The vehicular communication is of two types:-

1. Inter-vehicle communication

2. Intra-vehicle communication.

The intra-vehicle communications is used to describe communications within a vehicle, whereas the term inter-vehicle communications represents communications between vehicles or vehicles and sensors placed in or on various locations such as roadways, sign boards, parking areas, and even the home garage. Inter-vehicle communications can be considered to be more technically challenging because in this case the vehicle communications need to be supported both when vehicles are stationary and when they are moving.

VANET architecture permits communication among the neighboring vehicles and between roadside equipments [3]. There are three chances of communication:-

1. Vehicle-to-Vehicle ad hoc network (V2V): It provides Vehicle-to-Vehicle communication. It uses multi-hop multicast/broadcast to transmit traffic related information to a group of vehicles and is mainly employed for safety, security and data dissemination applications.

2. Vehicle-to-Infrastructure network (V2I): This configuration allows a vehicle to communicate with the roadside infrastructure mainly for information and data gathering applications and vehicular density to access road traffic conditions.

3. Hybrid architecture: It combines both Vehicle-to-Vehicle ad hoc network (V2V) and Vehicle-to-Infrastructure network (V2I).

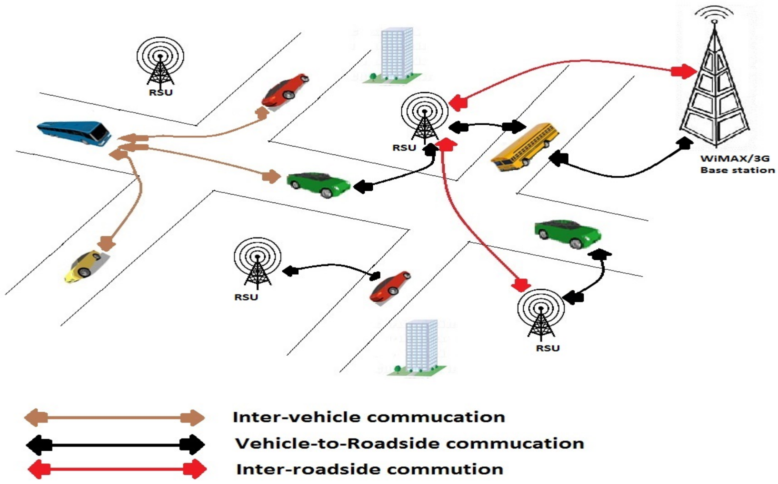

Fig. 1 Architecture of VANET

II. GENERALIZED METHOD FOR HARVESTING DATA

A. Data Dissemination

Data dissemination is superset of VANETs [4], in which data or information is spread over distributed wireless networks. Data aggregation is a technique which is used to reduce the number of data transmissions in a communication medium. Primarily it reduces the redundant data transmission.

There are different types of data dissemination models:-

1. Push-based: data delivery from source to many vehicles

2. Pull-based: data query from one vehicle to specific targets

3. One-hop Scheduling: Upload/Download

B. Summary Harvesting

Besides data dissemination, Uichin Lee et al [5] conferred the procedure of “Summary Harvesting” for discovering the missing information as below:

The RSU publishes a harvest request message to all vehicles in its neighborhood. Each vehicle in the network constructs a list of missing packets and sends the information to RSU. The RSU reverts with an acknowledgement to all the vehicles, and the neighboring vehicles to modify their list of missing packets. Figure 2 depicts the way of Summary Harvesting

The base station prepares a list of packets and broadcasts it to all its neighboring vehicles within the network. The vehicles revert with the missing packets and any one of the vehicle in the network responds to the base station with those missing packets [6]. The base station acknowledges all vehicles and the vehicles modify their catalogue of packets by picking out the missing packets. Therefore, both Summary Harvesting and Data dissemination involves broadcasting data to all the vehicles present in the network. This method is used for monitoring and controlling complex traffic conditions and also police surveillance. The traffic monitoring is taken here and analyzed with detailed graphs. This communication is done via sensors in the transport. There would be a facility of Base station in which it will have a range for sending and receiving of data [7]. All the cars are connected to either the base station or the Remote Subscribing units (RSU). The data will be streamed frequently and live traffic will be synchronized.

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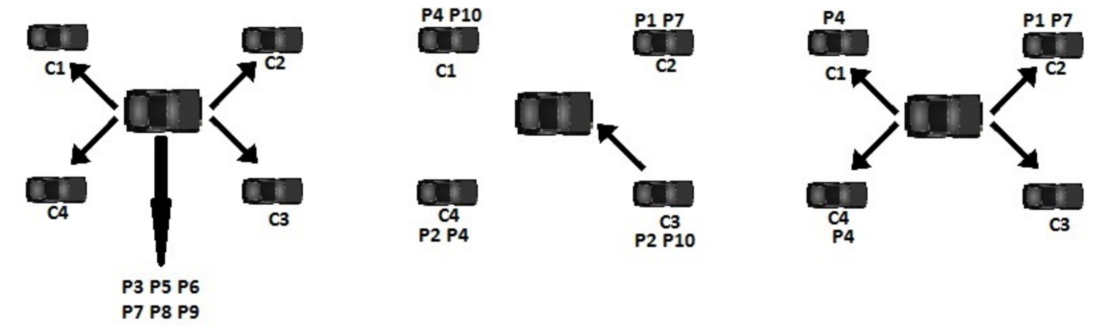

(a) Broadcast a harvest message (b) C3 first returns missing packets (c) Broadcast acknowledgement

Fig.2 Summary Harvesting

The analysis is done using 4 cars as parameters and a single base station in which the 4 cars are in contact with the base station. The base station has data packets P3, P5, P6, P7, P8 and P9. The cars C1, C2, C3 and C4 are having connection with the base station and the remaining data packets P1, P2, P4 and P10 are missing in the base station. The car C1 is having the data P4 and P10; the car C2 is having the data P1 and P7; the car C3 is having the data P2 and P10; the car C4 is having the data P2 and P4. First, the base station broadcasts request for all the connected cars, now if C3 has sent its packet data P2 and P10 to the base station, then the acknowledgement message is sent to all the neighboring vehicles for to stop sending if it has acquired the required data of a particular missing packet. In this case the base station will send the acknowledgement as P4 and P10 to all the neighboring vehicles. But the data P2 and P10 is already present in the vehicles C1 and C4 that is P10 in the C1 and P4 in the vehicle C4. So the redundant data is deleted from the C1 and C4. The remaining data will be present in the vehicle’s system, that is, after acquiring the acknowledgement signal from the base station, the vehicle C1 which is already having the data P4 and P10, the data P10 will be removed from the system and the data P4 will be stored, similarly, the C4 already having the data P2 and P4, after receiving the acknowledgement, will delete the data P2 from C4 and the data P4 will be remained in C4. So in this way the whole information of the neighboring vehicles are processed and updated frequently. There is a overhead on the base station as it needs to continuously monitor the incoming and outgoing information. Also the above method doesn't prevail if there would be two vehicles sending data at the same time to the base station. Consider the case if vehicles C1 and C3 are sending the data at the same time, the vehicle C1 is having the data P4 and P10, the C3 is having the data P2 and P10. Here the data P10 is common between the two vehicles. So there lies a redundancy at the base station of which one to choose from the available data from the two vehicles.

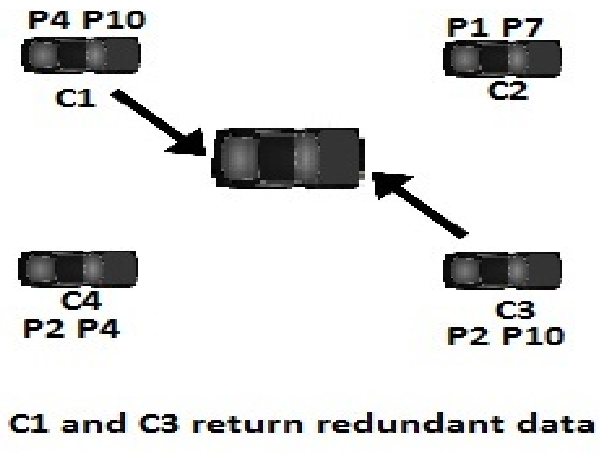

Fig.3 Redundant data accumulation

III. Multi-Vehicular Collaboration for Summary Harvesting Based on Priority (MVCSH)

In the proposed *Multi-Vehicular Collaboration for Summary Harvesting based on Priority,* to reduce the overhead on the base station during data dissemination multicasting of data between vehicles is done. To identify the missed information in the network, the Base station broadcasts a message to all vehicles in the network enquiring missed information. The vehicles after receiving the message identify the missed packets information i.e. performs set difference between the list of packets sent by the base station and its own packets. One of the vehicles responds to the base station with the missed information and at the same time multicasts an acknowledgement message to all other vehicles connected to the base station intimating them about it. The vehicles after receiving the corresponding acknowledgement message update their list of information. Also when two vehicles having the same missed information responds to the base station at the same time then redundancy occurs. Hence to overcome redundancy of data in the base station the distance is taken as a priority between the two vehicles from the base station. So the vehicle which has the least distance from the base station is taken as the first priority to disseminate data and hence eliminates data redundancy.

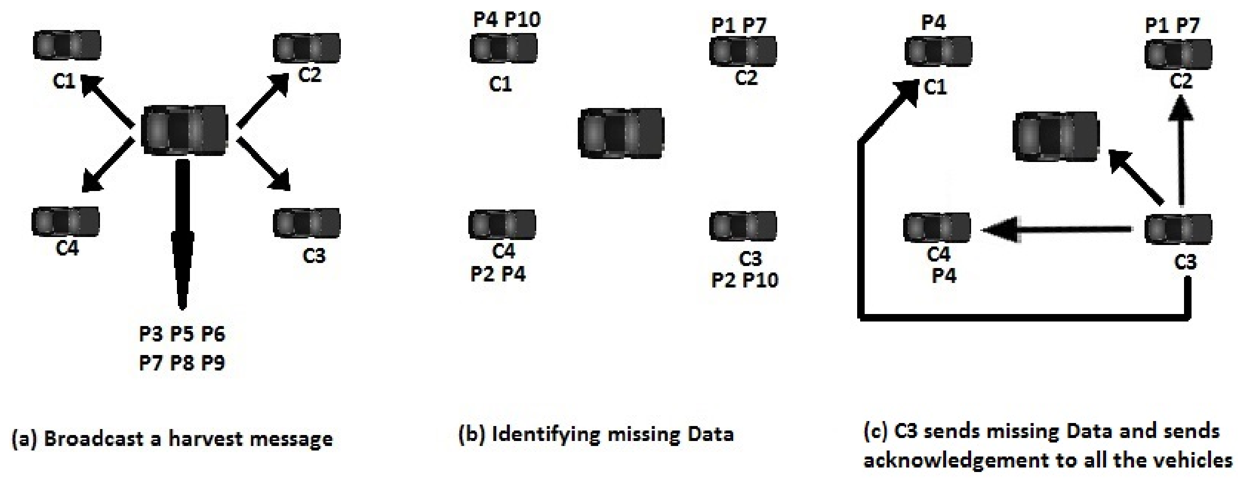

Fig.4 Multi-Vehicular Collaboration for Summary Harvesting based on Priority

Initially the base station sends a harvest message to all the vehicles. After receiving the harvest request message the vehicles generate the missed information available with them. From figure 4, the missing data packet P10 is available with C3, so now it sends the missing data to the base station, and also C3 sends acknowledgement to all the remaining vehicles to stop sending the data and remove the data from their registers, and hence C1 which has also the missing packet data P10 will remove the data from its registry.

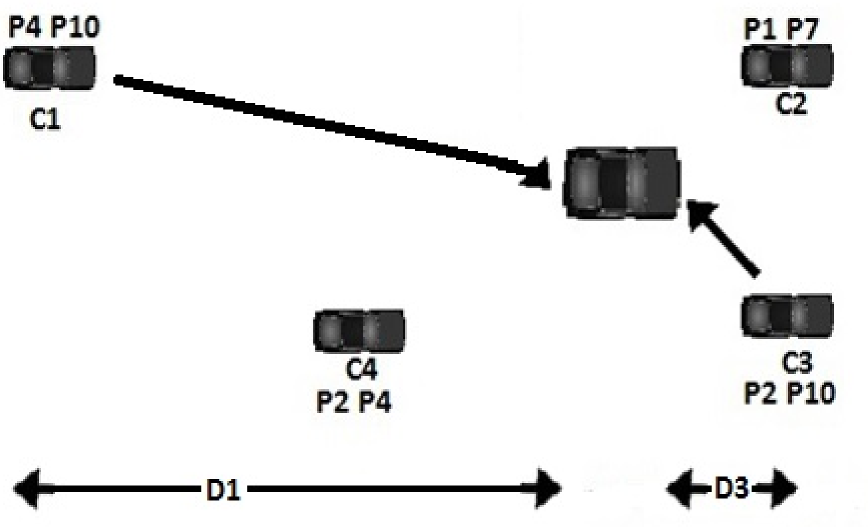

Fig.5 Actual Distance to base station taken as priority

To avoid redundancy of data distance of the vehicles from the base station is taken as priority. For example in figure 5, D3 is the distance of base station to C3, the vehicle C3 is nearer to base station and C1 has a distance greater than C3 from the base station. As discussed by taking the distance as priority in this case, the data from C3 is taken first and as usual, the acknowledgement is sent to all the vehicles.

IV. Results and Discussions

The below Table I give the analysis of different techniques used to identify the missed information:

Table I: Comparison between different harvesting techniques

Harvesting Technique	**Performance**	**Congestion**	**Collision**	**Contention**
Summary Harvesting	Moderate	Moderate	Moderate	High
MVCSH	High	Controlled	Moderate	Low

The proposed architecture *Multi-Vehicular Collaboration for Summary Harvesting based on Priority* features the Distance based Priority; it efficiently reduces redundancy and also reduces the overhead on the base station. In addition, it makes controlled congestion and contention very low. The architecture has very high performance as it improves message reliability. Performance comparison of the mechanisms Summary Harvesting and *Multi-Vehicular Collaboration for Summary Harvesting based on Priority (MVCSH)* is analyzed using R console in terms of Packet Delivery Ratio and Total Delay.

A. Packet Delivery Ratio

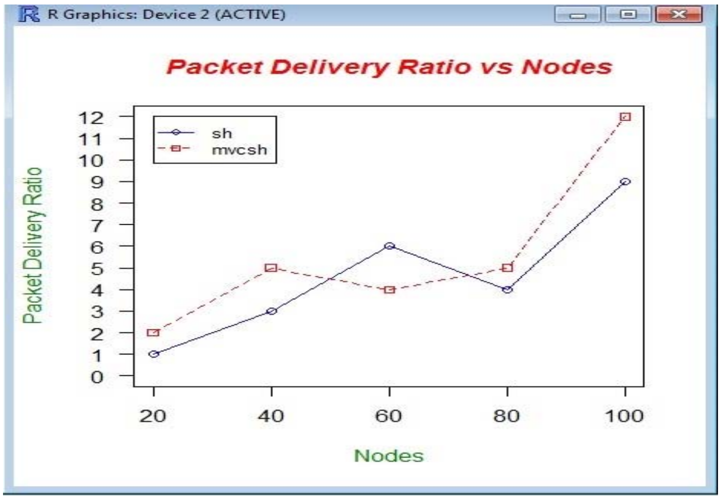

Fig. 6 R-graph for Packet Delivery Ratio versus Nodes

Figure 6 shows the graph between the mechanisms Summary Harvesting and MVCSH. In this graph the X-axis represents number of nodes and Y-axis represents Packet Delivery Ratio. Red line is for MVCSH and Blue line is for Summary Harvesting. From the graph, it is analyzed that both the mechanisms perform same till 80 nodes. Beyond 100 nodes the performance of MVCSH improves significantly.

B. Total Delay

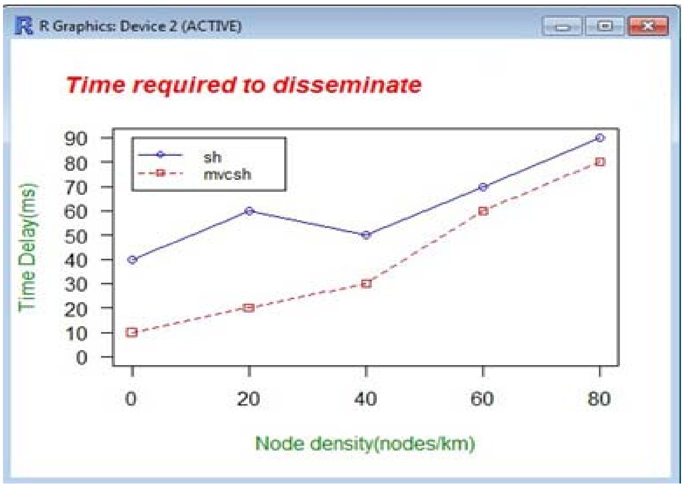

Fig.7 R-graph for Reliability ratio versus Node density

Figure 7 shows the graph between the mechanisms Summary Harvesting and MVCSH. In this graph the X-axis represents number of nodes per km and Y-axis represents Time Delay. Red line is for MVCSH and Blue line is for Summary Harvesting. From the graph, it is analyzed that the Time Delay is different for both the techniques up to 40 and beyond that the total delay of MVCSH slightly decreases in comparison to Summary Harvesting.

V. CONCLUSION

The proposed *Multi-Vehicular Collaboration for Summary Harvesting based on Priority* architecture enhances the performance of Summary Harvesting by increasing message reliability and reducing redundancy. Distance based Priority broadcasting saves the network resources during data transmission and provides high performance. It also reduces the overhead on the base station as the vehicles take care of sending the missed information to the base station and multicasting the acknowledgement to all the vehicles connected to the base station. As the mobility of the vehicles in VANET's are very high this paper can be further enhanced to reduce data distortion during multicasting of data between vehicles. Also efficient multicasting techniques can also be used for reliable data transmission between vehicles.

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