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Establishing Parameters for Comparative Analysis of V2V Communication in VANET

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In vehicular ad-hoc networks (VANETs), information dissemination plays vital role in establishing the cooperation among the vehicles. This cooperation and information exchange is needed for proper performance of safety and other VANET applications. Broadcasting is the most suitable method for information dissemination over the network. The simplicity of the broadcast mechanism in such a highly dense and mobile network leads to network contention, broadcast storm and network partition problem. To keep all nodes updated and gather neighbourhood information broadcasting protocol use beacon messages. A non-trivial scientific contribution is required in broadcasting techniques to cater to the need of a network. In this paper, we establish a system model and parameters responsible for efficient information dissemination for VANETs. We implemented three major techniques for information dissemination which are, simple flooding, counter-based and probability-based techniques. These three techniques are simulated with established parameters. The work also analysed the impact of beaconing in the network. The simulation is carried out on Veins framework and the results are then analysed on the basis of established parameters. The analysis of result shows that an integrated approach will suit the needs whereas the use of independent techniques might not yield the result which we expect. The paper concludes by outlining the future research directions in information dissemination in VANET.

Keywords: V2V, Information Dissemination, Veins, SUMO, Omnetpp, DSRC, IEEE 802.11p, VANET

Introduction

Selection and implementation of information dissemination techniques in VANETs[1 2 3] is a long standing question and over the past few years many approaches and techniques have been proposed to achieve the same.[4 5]Since information has to be exchanged in a highly mobile environment, broadcasting has come out as a favourable choice for VANETs. In this paper we have shown the experimental results of the standard broadcasting algorithms of VANET such as Flooding[6], Probability based[7] andCounter Based[5], these experiments carried out on beaconing[8] and non-beaconing approaches.The rest of the paper is divided as Section II which defines the assumptions and system model. Section III describes performance evaluation and analysis followed by Section IV discussing results. Finally, Section V outlines the future research dimensions of our work and outlines other directions for people to work upon.

Assumptions and System Model

In literature, mostly all system models are based on square area[9] which have various road segments having intersections and are very theoretical in nature. In this section, we describe the requirements of the system model, all work forward is carried on by following assumptions.

Assumptions

Assumption in this paper are as follows:

- All vehicles participating in network areequipped with DSRC radio modules supporting WAVE Application Layer.
- Global Positioning System (GPS) receivers by which vehicles can determine its geographical locations. This has been assumed equivalent to coordinates in simulation.
- Vehicles are moving across the straight and curved path in the each lane till we introduce an accident message in the network.
- The communication range of the On Board Unit equipped vehicles is circular.

System model

In our model, we are using the realistic road map, extracted from OpenStreetMap[10], the city environment of 5 x 5 km has been taken for analysis, which commonly has high density vehicle moving around on

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a city road and also a lot of intersection and junctions are available in the city. We define a curved road segment which merges onto a two lane highway to have the effect of signal loss in DSRC.

The control channel is used for all communication, Multi-Channel operation is not considered in this work. The work is focused on V2V communication and hence no RSU or V2I are considered. We identified following four parameters which effect the information dissemination in VANET [11]. These are the four parameters that needs to be optimized for different needs of application.

- **Rebroadcasting Probability (P_{rb}):** In most of the cases information needs to disseminate in multi hop and rebroadcasting is required by the receiving node upon reception of the message. This parameter defines the probability to rebroadcast the message. Higher the probability, a greater number of packets would be in the network.
- **Number of Rebroadcast (N_{rb}):** This parameter defines how many times the rebroadcasting should be performed on each node. There might be a case in low density network that there is no neighbour receiving the packet when sent for the first time or if density is higher there is a probability of a packet being lost in collision. Adjustment of this parameter to an optimal value would help the message propagation without stopping in either case.
- **Delay between Rebroadcast (D_{rb}):** This is only applicable when (N_{rb}> 1), A short delay will result in collision while a long delay may stop/delay the broadcast. Network density defines this parameter.
- **Maximum Hop Count (MHC):** This parameter defines the coverage of message to be disseminated.Once the generated packet reaches the defined number hops, the packet will be stopped for rebroadcasting. This is generally used to ensure the lifetime of a packet within a network.

Performance evaluation and analysis

Simulation setup and parameters

The Simulation is carried out in OMNET++[12]and VEINS[13] framework. The mobility model is generated through SUMO[14].We consider real world mobility model using the simple obstacle model[13], which has 50 vehicles traveling with random speed on a curved road.The simulation is executed for 300 seconds. An accident message is introduced in the network at time 200 second during simulation. To observe the crucial information dissemination over the network in respect to the reachability and propagation time. Table 1 describes the simulation parameters used in SUMO[14] and OMNET++[12].

The experiment is carried out on three different scenarios as detailed in Table 2, Inthese three scenarios we have set $P_{rb}$to 1 and to introduce randomness in processing, the rebroadcast is scheduled with a random delay, the same delay is used for interval (D_{rb})between two rebroadcast wherever applicable. The delay is defined in equation (1),

$$delay = uniform(0.01,0.2)ms \qquad \dots (1)$$

Results and Discussions

This section provides the graphical representation and interpretation of our experiment detailed in previous section. To analyse the experiment results, we considered parameters such as Propagation time, Reachability, number of retransmission and collision.

Table 1 — lists the simulation parameters used in SUMO and Omnet++

Sumo Parameters		Omnet++ Parameters	
Parameter	Value	Parameter	Value
Acceleration	2.6 m/s^2	txPower	20mW
Deacceleration	4.5m/s^2	bitrate	6Mbps
Sigma	0.5	sensitivity	-89dBm
Length	2.5m	Thermal Noise	-110dBm
MiniGap	2.5m	Use Propagation Delay	True
Max Speed	14m/s or 50kmph	dataOnSch	false

Table 2 — lists the Algorithms and Parameters in different Scenarios

	Scenario 1			Scenario 2			Scenario 3		
	N_{rb}	D_{rb}	MHC	N_{rb}	D_{rb}	MHC	N_{rb}	D_{rb}	MHC
Flooding	1	Uniform	1	2	Uniform	1	3	Uniform	1
Counter Based	1	Uniform	3	2	Uniform	3	3	Uniform	3
Probability based	0.3	Uniform	3	0.5	Uniform	3	0.7	Uniform	3

a) Propagation Time

Propagation time (PT) is calculated based on difference of time between the message generated and message received by all the nodes in the network. PT is calculated using given equation (2)

$$PT = ReceiveMsgTime - InitTime \quad \text{... (2)}$$

Figure 1 shows the holistic view of algorithm in different scenarios vs time. We can see that counter technique in Scenario 1 and probability technique in Scenario 3 are not converging. In case of counter technique, network partition occurred while in case of probability technique no suitable node found to rebroadcast. We can clearly see that flooding technique in scenario 3 work best in this case, because in scenario 3 for flooding technique the N_{rb} is set to 3 which resulted message propagation more intensely in the network. In simple flooding environment as N_{rb} increases the propagation time is decreased and number of packet generation is increased, which resulted in packet collision. So we can clearly see that flooding is the best case to disseminate information in the network but at the cost of network bandwidth. The interesting part is that beaconing is not hampering the performance in scenario 3. Moving ahead in scenario 3 we observed counter techniquehas generated only 13 packets, in comparison with flooding technique the number of packet generation are significantly less in number.With the above observations in respect to the propagation time we can conclude that if the message is received from many neighbouring nodes then that message can be dropped from rebroadcasting. The optimal results are obtained in Probability based algorithm, which is generating lesser number of packets and still converging in acceptable time. From these observations, we can conclude that if we find a good probability model then an efficient information dissemination can be achieved over VANETs.

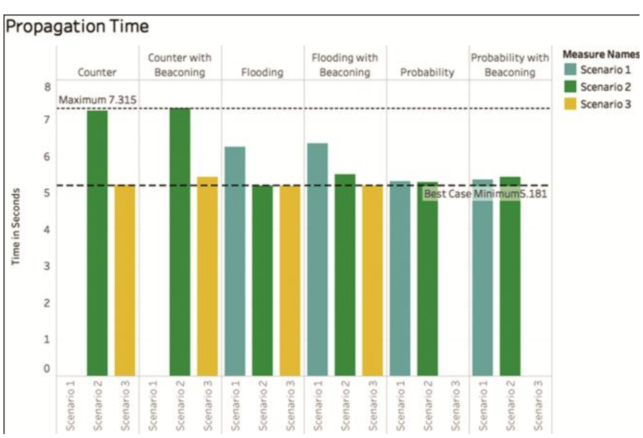

Fig 1 — Plot between Different Scenario vs Algorithms and Propagation Time

b) Reachability

Reachability is calculated by counting the successful number of nodes receiving the packet in the network using below given equation (3).

$$\text{Reachablity} = \frac{\text{NumberVehicleReceived}}{TotalVe\ hiclesinNetwork} \quad \text{...(3)}$$

We can observe in Figure 2, that the counter based technique in scenario 1 and probability based technique in scenario 3 are not converging. This is because of counter based technique is affected by network partition and probability based technique affected by high probability value computed for not to rebroadcast.

c) Number of Retransmissions and Collision

Number of Retransmission is calculated using below given equation (4).

$$NoOfRetransmission = \sum_{x=1}^{TotalVe\ hicles} PacketGeneratedat(x) \quad \ldots (4)$$

Number of collision is calculated using equation (5) as given below.

$$NoOfCollision = \sum_{x=1}^{TotalVe\ hicles} RxLost(x) + TxLost(x) \quad \ldots (5)$$

The results shown in Figure 3 are majorly the outcome of beaconing process.We observed no packet loss when beaconing was off, the reason is very simple that maximum number of packet generated went to 150 only which is very low figure for DSRC

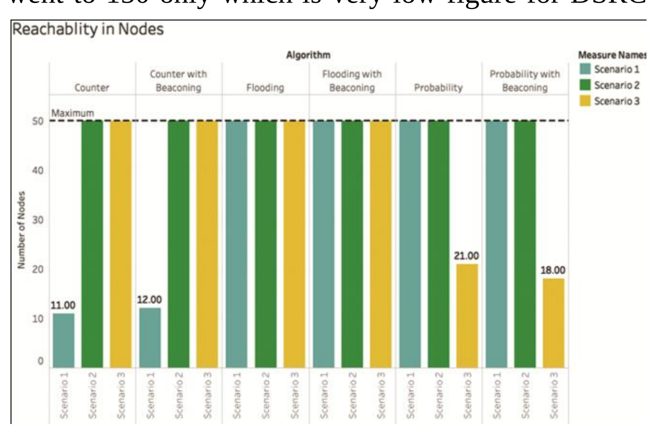

Fig 2 — Plot between different scenarios vs the algorithm used and Reachability

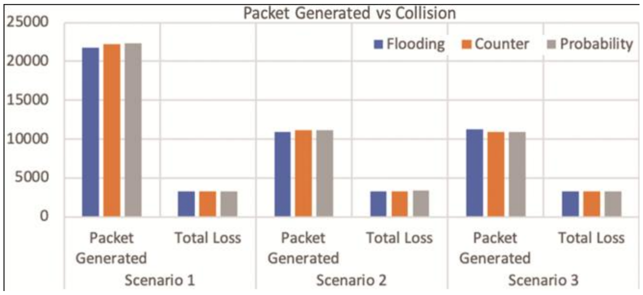

Fig 3 — Plot between different scenarios vs Packet Generated and Packet Loss in different algorithms

spectrum and IEEE 809.11p WAVE protocol[15]. So, we tried forward to test the throughput of the communication medium by turning beaconing on, and we observed that total loss was approximately equal in all the scenarios.

Conclusion and Future Work

In this paper, we implemented three major techniques and analysed the results obtained from simulation. The results clearly demonstrate that no particular technique can yield optimum result. However adaptations such as using dynamic probability calculated based on changing parameters, using adaptive beaconing with respect to number of packets received may lead to an efficient and optimal results. We can conclude from simulation experiments and results that flooding is best suited to deliver critical information but at the cost of bandwidth whereas if we can create a strong connected network with the help of adaptive beaconing we can get similar results in counter based approach. The probability model impressed us due to a consistent and optimal solution. We also conclude that beaconing do not affect the network significantly. Keeping all this in mind we look forward to find a good probability model that take density into consideration to calculate the rebroadcast probability, number of repetitions and delay between two rebroadcasts.

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