Publish/Subscribe Methodology Using Clustering (PSMUC) Algorithm for Increasing Rate of Delivery in VANET

Ankita Verma[#1], Dr Satya Ranjan Patra[*2], Prof. Pankaj Richariya[#3], Aditya Sinha[#4]

[#1] Student of CSE dept., Bhopal Institute of Technology & Science

[#2]Professor, CSE dept., Bhopal Institute of Technology & Science

[#3] Professors, CSE dept., Bhopal Institute of Technology & Science

[#4]Assistant Professor, CSE dept., Bhopal Institute of Technology & Science

Bhopal- M.P. - India

Abstract: - *Vehicular Ad-hoc Network (VANET) is an integral part of Intelligent Transportation System (ITS), in which moving vehicles communicates with each other in autonomous and asynchronous fashion. Speed of vehicles is responsible for dynamic change in topology; due to this efficient and scalable information dissemination is a major challenge in VANET. Publish/Subscribe communication approach provides independence from synchronization of time, space and other information between vehicles or RSU's, which makes it most suitable for VANET like environments. But only publish/subscribe approach is not sufficient for efficient communication because it generates huge amount of packets for dissemination; due to this network load is increases. In this paper, we propose publish/subscribe methodology using clustering for information dissemination in VANET. In our approach, we assumed a VANET consisting of road side units and vehicle nodes where all vehicles can elect their cluster head from its neighbor vehicle nodes; each vehicle can take the role of publisher, subscriber or broker but cluster head is its ultimate place holders for publications and subscriptions with in cluster. Every major crossing of city is equipped with road side units that act as ultimate place holders for publications and subscriptions given by cluster head. Simulation results indicate that our approach performs well which suggests the applicability of our approach.*

I INTRODUCTION

VANET can be viewed as a network of stationary road units and moving vehicles. In which they communicate with each other in autonomous and asynchronous fashion. Because of high speed of vehicle, VANET is suffering from frequently disconnected links in its network, unlike MANET where nodes speed are very slow. Therefore dissemination inn VANET is very difficult as compare to MANET. So VANET needs some different approaches for dissemination. VANET consists two types of applications one is safety related and another is commercial applications (i.e. online gaming , ticket booking, etc). Safety applications are for drivers because they can get information like obstacle on road, post crash or road conditions, current traffic conditions, speed limit of the road, etc.

Publish / Subscribe approach is emerging as the most suitable approach for communication in VANET. Because in it massage is independent of time , space and other information synchronization, I.e. if any vehicle 'A' want to send any massage in a network to provide information to vehicle 'B'. It can just put massage in a network and go anywhere B when ever passes from that region can get this massage.

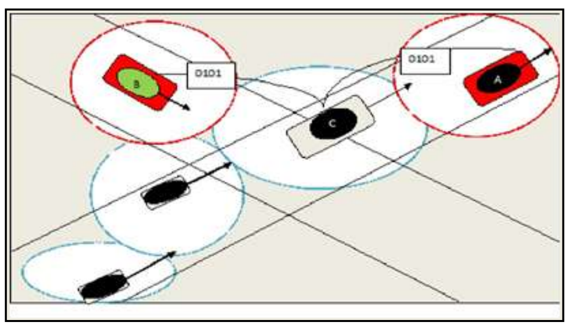


Figure 1 Shows Publish / Subscribe Methodology

In above figure 'A' just Publishes its massage in a network and when 'C' comes to its range. C also publishes same packet in its range because of that dissemination of packet in network is increases and massage will reaches 'B' at different time as compared to time when it is initiated, it means 'A' generates massage for 'B' at 10:00 am but 'B' is not in range of 'A', so simply 'A' had published that packet in a network with address of 'B' and this massage had reached 'B' at 10:02 am so decoupling of time and space had been achieve here.

But as we know that every coin have its either side. In publish/ subscribe method when number of vehicle node are increases load in a network is also increases, it causes delay in delivery and high routing load. So we need to use this approach in a systematic way therefore one more approach is been introduced is clustering of a network. This approach can give power to break network in a small network by which network route load and delay time can be reduces. We have simulated our approach for synthetic scenarios and initial results suggest the applicability of our approach. The rest of the paper is organized as follows. Section II gives the brief background of Data dissemination in VANET. In Section III we define procedures used in our approach. Section IV & Section V respectively presents simulation environment, results followed by conclusion.

II BACKGROUND OF DATA DISSEMINATIONS IN VANET

In VANET data is exchanged among vehicles to support comfortable and safe driving. Number of applications are developed for rely on distributing data in a geographic region. Apart from routing in which delivery of data packets from source to destination via intermediate nodes over long distance is the main concern. Its main focus is to disseminate safety applications data particularly on real-time for warning and collision avoidance. On the other hand to reduce the overload of the network is also a responsibility of dissemination with the guarantee of minimum delay. Different types of approaches for data dissemination are as follows:

A) Flooding-based Approach: In flooding nodes are broadcasts its data in a network until data life (TTL) gets expired. This approach is based on broadcasting; each node in a network participates in this process. This approach is suitable for scattered connected network and also for delay sensitive applications. Problem with this approach is that rebroadcasting of each received message is leads network to congestions. Especially this problem arises when the network is dense. The flooding of data is also limited by the ability of the system to handle properly new arrivals and dealing with the scalability issues.

B) **Relay-based Approach:** Relay based approach is tends to a smart flooding algorithm which is used to eliminate unnecessary retransmissions of data. In this approach a set of nodes are selected to forward the data packet further in an effort to maximize the number of reachable nodes, instead of having all nodes disseminate the information to its neighbors. Scalability problem of high density nodes can be handling by this approach. However the main challenge of these approaches is how to select the suitable relaying node in the algorithm. Different algorithms were developed under the smart flooding techniques as follows: the time-based algorithms, the location-based algorithms.

i) **Time-based algorithms approach:** This type of dissemination algorithms is designed to eliminate unnecessary retransmissions caused by classical flooding. This mechanism gives the nodes that cover more area and maximizes the number of new receivers the chance (high priority) to forward the received message. In [12], nodes calculate the distance between themselves and the sender of the message. If the message is received for the first time, each node sets a countdown timer and starts decrementing until a duplicate message is overheard or the timer is expired. The value of the timer is proportional to the distance from the sender. The higher the distance, the lower the timer value as shown in the following equation.

$$WT(d) = -\frac{MaxWT}{Range} * d! + MaxWT$$

Where Range is the transmission range, MaxWT is the maximum waiting time, and d! is the distance to the sender.

The node whose timer expires first (timer value reaches zero), forwards the received message. The other nodes, upon receiving the same message more than once, stop their countdown timer. The same process is repeated until the maximum number of forwarding hops is reached; in this case the packet is discarded.

ii) **Location-based algorithm:** This approach relies on the location of the nodes with respect to the sender node. The node that reaches a large number of new receivers in the direction of the dissemination is selected to forward the messages. The goal is to reach as many new receivers as possible with less number of resources. The authors of [13] proposed a new dissemination approach called Urban Multi-hop Broadcast for inter-vehicle communications systems (UMB). The algorithm is composed of two phases, the directional broadcast and the intersection broadcast. In this protocol, the road portion within the transmission range of the sender node is divided into segments of equal lengths. Only the road portion in the direction of the dissemination is divided into segments. The vehicle from the farthest segment is assigned the task of forwarding and acknowledging the broadcast without any apriori knowledge of the topology information. However, in dense scenarios more than one vehicle might exist in the farthest segment. In this case, the farthest segment is divided into sub-segments with smaller width, and a new iteration to select a vehicle in the farthest sub-segment begins. If these sub-segments are small and insufficient to pick only one vehicle, then the vehicles in the last subs-segment enter a random phase. When vehicles in the direction of the dissemination receive a request form the sender to forward the received data, each vehicle calculates its distance to the source node. Based on the distance, each vehicle sends a black-burst signal (jamming signal) in the Shortest Inter Frame Space (SIFS) period. The length of the black-burst signal is proportional to the distance from the sender. The equation below shows the length of the black-burst in the first iteration.

$$L1 = \left[\frac{1}{R} * d! * Nmax\right] * SlotTime$$

Where L1 is the length of the black-burst signal, d! is the distance from the sender, R is the transmission range, Nmax is the number of segments in the transmission range, and SlotTime is the length of a time slot.

The farther the node, the longer the black-burst signal period. Nodes, at the end of the black-burst signal, listen to the channel. If the channel is found empty, then they know that their black-burst signal was the longest, and thus, they are the suitable nodes to forward the message.

In the intersection phase, repeaters are assumed to be installed at the intersections to disseminate the packets in all directions. The node that is located inside the transmission range of the repeater sends the packet to the repeater and the repeater takes the responsibility of forwarding the packet further to its destination. To avoid looping between intersections, the UMB uses a caching mechanism. The vehicles and the repeaters record the ID's of the packets. The repeaters will not forward the packet if they have already received it. However, having the vehicle record the ID's of the packets will be associated with a high cost in terms of memory usage. Moreover, the packet might traverse the same road segment more than one time in some scenarios, which increases the bandwidth usage.

III Procedures Used In Our Approach

Vehicle node in a network has to elect cluster head node, which is able to do proper publication and subscription operation on the behalf of initiator node. This cluster head is an ultimate place holder in cluster for other nodes. Type of communication strategy which used in this algorithm is publish / subscribe for both internal as well as external, but communication responsibility is all in the shoulder of cluster head. Algorithm is as follows:

Cluster Head Selection: For finding the cluster head, vehicle sends a hello packet containing (Speed, Last Info-station Passed, and Connecting Link) in the network at regular time interval and wait for its reply. When reply come, OBU counts the number of reply; these replies are refer as connection links. These packets were collect in a queue where OBU compare them with its last info-station information if information matched send information in to next array. Now this OBU compare this array with its connecting links; after comparing if two or more values are same than those values are again send to the next array and this time comparison employed on the basis of their speed if speed of OBU is greater than other one it is selected as cluster head else it will wait for cluster head notification.

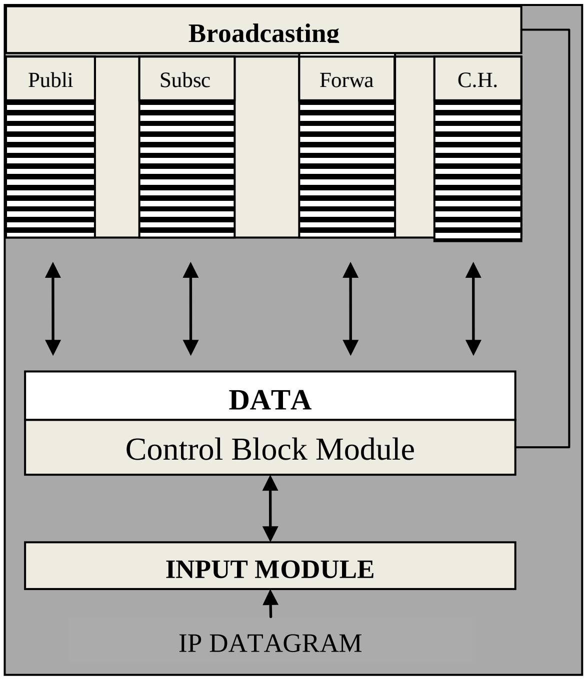
Input Module: When any data packet comes to onboard unit of vehicle it checks its source address if this address is same as the cluster head address then onboard unit check what kind of data is it publication, subscription or forwarding and match this data with its tables if value is true discard regarding entry from table else follow regarding procedure for dissemination.

Procedure for Publish: This module defines that how vehicle node can publish its information in a network. Publish primitive is defined as Publish (publication specification, TTL, vehicle id); TTL is stands for time to leave or is the time for which a publication is considered to be active.

Procedure for Subscribe: This module defines that how vehicle node can subscribe its desired information from a network. Subscribe primitive is defined as subscribe (subscription specification, TTL, vehicle id); TTL is stands for time to leave or is the time for which a publication is considered to be active.

Procedure for Forwarding: This module defines that how vehicle node can forward their incoming data packet in a network. Forwarding primitive is defined as Forwarder (publish / subscribe /

notification, TTL, vehicle id); TTL is stands for time to leave or is the time for which a publication is considered to be active.



IV Simulation & Results:

In order to validate the proposed approach a number of simulation experiments have been performed by using network simulator version 2.34. Table 5.1 shows the parameters used in the simulation experiments. The proposed approach is tested in busy traffic conditions using a rectangular scenario of 1000 × 1000 m square area; the network topology consists of different number of vehicle nodes. There are two types of communication traffic are used in the NS-2(CBR and FTP), CBR (Constant Bit Rate) traffic is used to generate UDP packets for the simulation. In the simulation, start on 0ms and end on the 300ms. The Cluster head algorithm will start on 0.001ms in the simulation and recheck on 0.5ms. There are different packets sizes are used in the NS-2, for this simulation 1024KB packets are used. There are four way highways and they have two lines each direction. There are four crossings through which vehicles may cross each other in highway. To have a fixed number of vehicles in the simulation, assume that the exit vehicles will enter the highway at the nearest highway end and immediately start to send messages. We have selected 20 % of vehicle randomly that publish information and remaining 80% are subscriber. A simulation has been carried out to evaluate the performance of the proposed method. Each vehicle is first randomly scattered on one intersection along the paths. Each vehicle is driven at a randomly fluctuating speed along different streets. Simulation parameters are listed in Table 6.3.

Table 6.3 Simulation Configuration

Parameter	Default Value
Simulation Area	1000m * 1000m
Simulation Time	300 minutes
Number of vehicles	60
Communication range	400m
Node Speed	60km/hr
Visualization Tool	NAM
MAC layer	IEEE 802.11 p

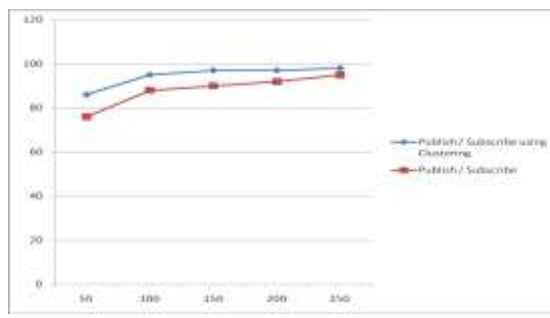


Figure 5.6 (a) Graph-Packet delivery ratio of “Publish / Subscribe” & “Publish / Subscribe using Clustering”

In the Figure 5.6 (a) Blue line shows Publish / Subscribe methodology using clustering in VANET & red line shows Publish / Subscribe methodology without clustering. Horizontal plane represents time in seconds and vertical plane represents packet delivery in percentage.

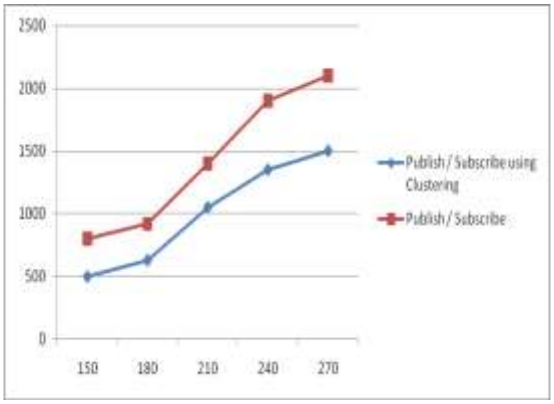


Figure 5.4 (b) Routing overhead graphs, shows comparability of “Publish / Subscribe” & “Publish / subscribe using Clustering”

In the Figure 5.6 (b) Blue line shows Publish / Subscribe methodology using clustering in VANET (routing over head) & red line shows Publish / Subscribe methodology without clustering (routing over head). Horizontal plane represents time in seconds and vertical plane represents routing over head.

V Conclusion:

We have proposed a hybrid technique for structured data dissemination by which any information in a network shall be spread in a network without increasing a routing load in a network as well as without compromises with delay time. This method employs on each vehicle’s on-board unit (OBU), in which OBU elect their cluster head and then only communicate with cluster head or info-stations. Communication paradigm which is used in our approach is publish/ subscribe. The technique is localized, requires only a small overhead, and does not have special requirements such as special hardware etc. The technique was tested through simulations for different distributions of vehicles in dynamic connectivity models. Under all the evaluated scenarios, the technique demonstrates excellent dissemination. The results of the proposed approach are batter then the previous approaches in order to reduce routing load as well as decreasing a delay time of a packet in a network.

REFRENCES

[1] Tamer Nadeem, Pravin Shankar, Liviu Iftode, “A Comparative Study of Data Dissemination Models for VANETs” in 2012, research gate.

[2] Mishra, T.; Garg, D.; Gore, M.M., "A Publish/Subscribe Communication Infrastructure for VANET Applications," Advanced Information Networking and Applications (WAINA), 2011 IEEE Workshops of International Conference on, vol., no., pp.442,446, 22-25 March 2011doi: 10.1109/WAINA.2011.87

[3] Feng Zhang; Jianjun Hao; Shan Li, "Traffic information aggregation and propagation scheme for vanet in city environment," Broadband Network and Multimedia Technology (IC-BNMT), 2010 3rd IEEE International Conference on, vol., no., pp.619, 623, 26-28 Oct. 2010.

[4] Yi Qian; Kejie Lu; Moayeri, N., "A Secure VANET MAC Protocol for DSRC Applications," Global Telecommunications Conference, 2008. IEEE GLOBECOM 2008. IEEE, vol., no., pp.1, 5, Nov.302008-Dec.42008.

[5] N. Wisitpongphan, O. K. Tonguz, J. S. Parikh, P. Mudalige, F. Bai, and V. Sadekar, “Broadcast storm mitigation techniques in Vehicular Ad hoc Networks”, IEEE Wireless Communications, vol. 14 (6), pp. 84-94, 2007.

[6] J. Zhao, Y. Zhang and G. Cao, “Data Pouring and Buffering on the Road: A New Data Dissemination Paradigm for Vehicular Ad Hoc Networks”, In IEEE transactions on vehicular technology, Vol. 56, No. 6, 2007, pp. 3266-3277.

[7] J. Zhao and G. Cao, “VADD: Vehicle-Assisted Data Delivery in Vehicular Ad Hoc Networks”, In proceedings of IEEE Infocom, 2006, pp. 1-12.

[8] Korkmaz, G. et al. (2004). Urban Multi-Hop Broadcast Protocol for Inter-Vehicle Communication Systems, *Proceedings ACM Int’l. Wksp. Vehic. Ad Hoc Networks,Philadelphia*, PA, Oct. 2004.

[9] Briesemeister, Linda; Sch¨afers, Lorenz and Hommel, G¨unter (2000). Disseminating Messages among Highly Mobile Hosts based on Inter-Vehicle Communication., *Proceedings of the IEEE Intelligent Vehicles symposium*, Detroit, USA 2000.

[10] The Network Simulator - ns-2; www.isi.edu/ nsnam/ns.