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Smooth Handoff Process Cluster_Based In Vehicular Ad Hoc Networks

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Abstract

Vehicular Ad-hoc Networks (VANETs) is an attractive, promising technology, which uses automotive industry to improve the services of Intelligent Transportation System (ITS), vehicles exchange important information, e.g., about road conditions and hazardous situations. Having information about danger, the driver can be warned in-time, thus being able to safe life. Unfortunately, VANETs suffer from routing data as a result of mobile wireless ad hoc routing limitations. In this paper a smooth hand-off clustering was proposed to enhance the performance of VANET using ns-2 simulator. The proposed algorithm was compared with one of the scalable clustering routing protocol in MANETs.

Keywords: CH, IVSH, MANET, ST, and VANET

Introduction

Wireless Ad-Hoc Network (WANET) classified into the following categories: wireless mesh networks, wireless sensor networks and Mobile Ad-Hoc Networks (MANETs) as shown in Figure 1. VANETs is a branch of MANETs with a unique characteristic of dynamic nature or node mobility, frequent exchange information, real time processing, self-organizing, infrastructure less nature, low volatility and distance [2]. VANET (Vehicular Ad hoc Networks) is a type of Mobile Ad-hoc Networks (MANETs); in which nodes are vehicles. VANET was developed to help a group of vehicles to set up and maintain a communication network among them without using any central base station or any controller. VANET was developed to improve safety and traffic efficiency. It comprise vehicle to vehicle communication and vehicle to infra communication based on wireless local area network technology Figure 2. A VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to connect and, in turn, create a network with a wide range. As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created [1]. VANET is characterized by the following characteristics: [5] QoS parameters degradation as a result of transmission power levels, interference levels and the relative position of nodes in different wireless environments such as increase in Packet Loss, capacity limitations as a result of Interference, fading, noise and simultaneous accessing of channel. Energy loss as vehicles and RSUs act as a constant supply. Mobility as vehicles moves at high speed. High Dynamic Topologies: Due to the high speed of vehicles, and high changes of connectivity between vehicles. Security becomes a critical aspect as a result of wireless network nature.

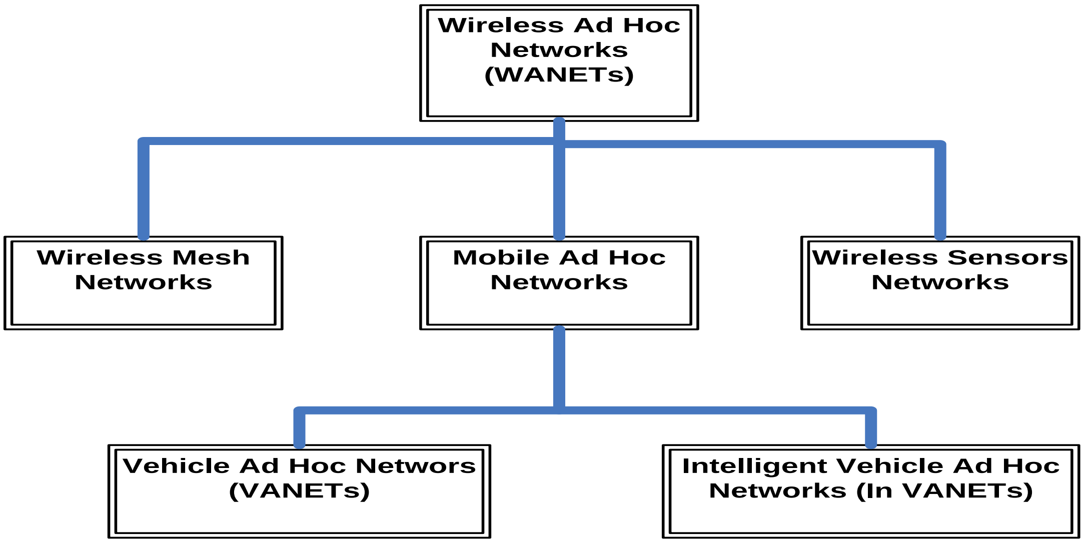

Figure 1 Wireless Ad Hoc Networks Classifications

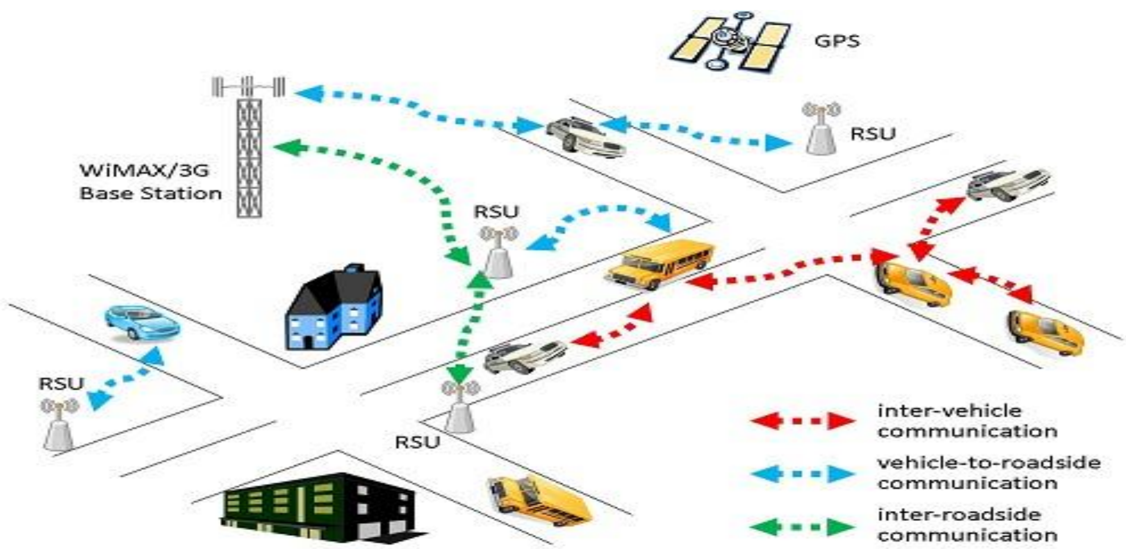

Figure 2 Vehicular Ad Hoc Network Communication

Data dissemination in between VANET components is classified as vehicle to infrastructure (V2I) or infrastructure to Vehicle (I2V) and vehicle to vehicle (V2V). Figure 2 shows the V2I and V2V scenario [6].

RELATED WORK

Broadcasting is used for data transmission, which requires a broadcast routing. Broadcast routing is used to find optimum route to the destination before the actual transmission of data. [7]

Existing broadcasting algorithms are categorized as :

I. Cluster based broadcastings.
II. Ad hoc broadcast algorithms.
III. Partial dominant Pruning algorithms.

Clustering is used in VANET to promote more efficient use of resources in such high dynamic networks, the network is divided into small groups called clusters; the main objective of clustering is to store minimum information about the topology. Nearby vehicles forms a cluster. Each cluster has one cluster-head. Cluster head is used in intra and inter-cluster management functions. Intra-cluster nodes communicate with each other using direct links, whereas inter-cluster communicates with the help of cluster headers. The main goal of clustering is to reduce dynamic and topology less change, cluster models are characterized based on the full status elements: elements: speed difference, location, and direction.

CLUSTERING IN VANETs

Clustering is done in order to use the wireless resources efficiently by reducing the congestion in the network and to manage the routing process. A large variety of algorithms have been proposed for the clustering in VANET. Cluster-based location routing (CBLR) is proposed by [8] in which nodes use HELLO messages to distribute their states. When a node enters the system, it enters the undecided state and then announces itself as a CH if it does not receive a HELLO message within a period of time from other nodes; otherwise it registers at a CH as a member node. CBLR copy dynamic topology changes through using a table in every node that contains nodes' neighbors which can change exchange information with.

Lowest-ID Heuristic [9]: A distinct ID is assigned for each node. The node with the lowest ID will be selected as a cluster head. Any new node enters the cluster has an ID lower than the CH ID will be selected as a CH, and make the old one delegate. A duration time is used as well as the direction in the lowest ID algorithm to determine the node to be a cluster head. A modification to the Lowest-ID (LD) was proposed by [10] by adding the moving direction (MD), the authors introduced the projected distance (PD) variation, which means distance variation of all neighbors over a period of time. Each node is associated with a utility weight (uW) of three parameters (LD, PD, and ID), where the ID is the identifier of the node in which the LD parameter is given the highest weight. Cluster Based Routing (CBR) was based on position and clusters. In this algorithm the geographic area of VANETs nodes are divided into foursquare grids, a vehicle in a grid will a vehicle is elected to be a cluster header, then the data packet is routed by cluster header across some grids one to one [11].

1. THE PROPOSED HANDOFF ALGORITHM

As the network topology in VANETs changes rapidly, the cluster head will be changed frequently, so a new cluster is needed; as old cluster head may be unsuitable for the new topology or the old cluster head may die or move out of the range of the cluster. Handoff is the process of changing the channel (frequency, time slot, spreading code, or combination of them) associated with the current connection or inter-cluster communication. Handoffs are classified into two main streams: Horizontal Handoff (HHO), and Vertical Handoff (VHO). Horizontal Handoff (HHO) means handoff between two base stations (BSs) of the same system. Vertical Handoff (VHO) means the switching between points of attachment or base stations that belong to the different network technologies [12].

If a cluster head travels to another cluster, it has to elect another cluster head before its traveling. The election of the new cluster head must guarantee connectivity in the structure and at the same time minimizing the delay of communication and decrease the number of packets lost. So because all of communication takes place through the cluster head, which has all the information needed by the nodes within the cluster, the cluster head must pass this information to the newly elected cluster head, to achieve that, a smooth handoff algorithm which will be called Inter-Clustered VANETs Smooth Handoff (IVSH). If a cluster head (CH) transmits to another plane, it has to elect another CH before it transitions and handoff its responsibilities with a new one. The easiest way to elect a new one would be to choose one of its members.

IVSH should follow the CH movement to predict the direction of its movement, and then it will decide when to handoff the information and change its state. Its new state may be as an ordinary node or still as CH but for a new group of nodes. The cluster head will have two groups of nodes, the member nodes which are already available in its cluster and can serve it, and the non-member nodes which the cluster head will see through its mobility. Every cluster head will have a table to store the information about those nodes which are members within its cluster; this table will be called “cluster-table”. This table is filled and will be built after specific time depends on the scenario. The cluster-table information will be compared with the information available in other table every cluster head has, which is used to store all of the nodes it can hear whether members or non-members within its cluster. After accomplish this comparison, the number of non-member nodes the old CH hear through its travel and the number of member nodes the old CH lost through its movement also will be known. A ratio between the non-members and the number of members’ node will be calculated to decide the suitable time to perform the handoff process, and then the old CH will transfer its database to the new elected CH. This database will include any information needed by the new CH to be familiar with the cluster without a need to collect this information from the beginning. But if the old cluster head receives any service packet during transfer process, it will forward it to the new elected CH. Then the old CH will send a trigger message for all its children to tell them about the new elected CH and the old CH will discard its database after completing the transfer process, and change its state from CH to another state. If one of the non-member nodes elects the old CH as CH, then this old CH will not change its state and still as CH but for a new group of nodes. But if there is no node elect the old CH as CH, then its new state will be changed to ordinary. If the old CH during its movement doesn’t hear any non-member node, so this CH transition to the space where there are no nodes, it will still CH but just for itself. To prevent infinite loop election a table is built to save the transferred CH and prevent the nodes from electing any CH found in this table; this table will be called “historical table”, its size is selected to be just one entry, so if any new CH will perform the handoff process, it will enter in this historical table and so the old entry will be replaced with a new one as depicted in Figure 3.

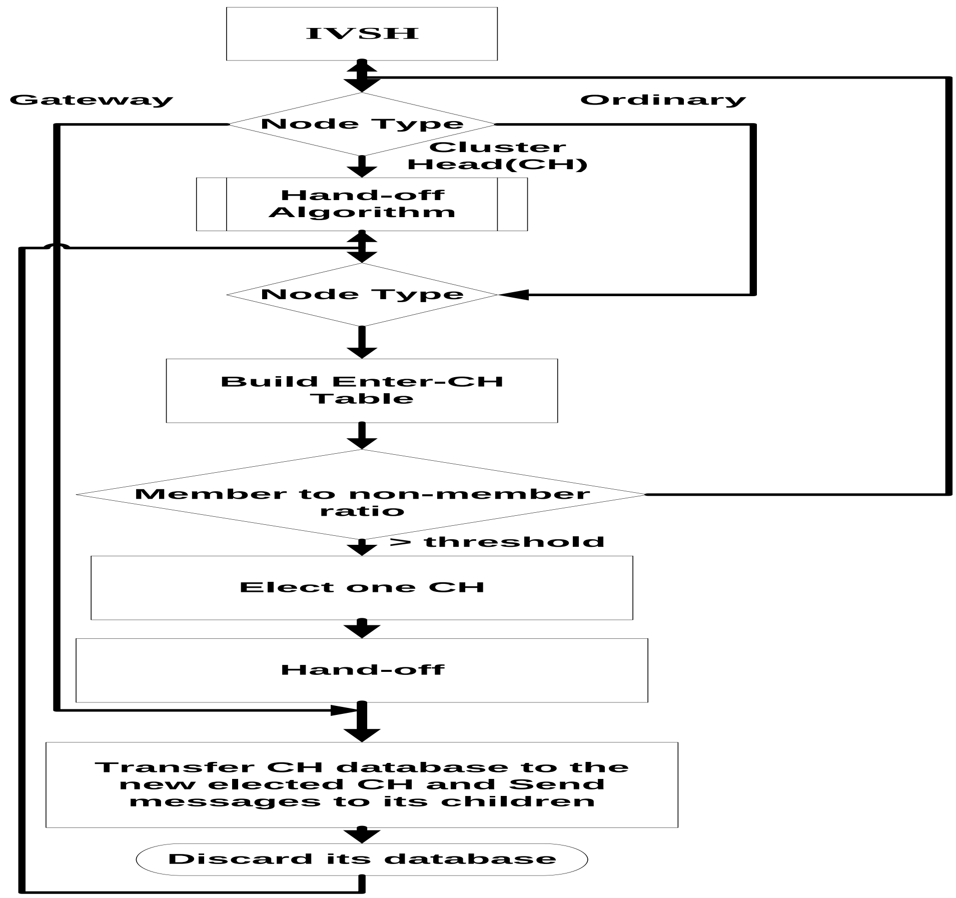

Figure 3 Inter-Clustered VANETs Smooth Handoff Proposed Algorithm

2. SIMULATION SETUP AND PERFORMANCE METRICS

The simulation is performed using Network Simulator 2 (ns2). Ns2 is completely free and open source tool for all kinds of network simulations and researches [13]. There are many versions of NS2 available ranging from ns-2.26 to ns-2.34. In this study, different performance metrics were used to evaluate the performance of the proposed hand-off algorithm, which are average service response delay time or Service Delay, Total number of dropped packet, and packet delivery ratio.

I. Service Delay time (SD): This is defined as the time the client or car waits from sending the request packet until it receives the reply. That means the delay to get reply back. The collision and contention will be embedded in this time also.

II. Total number of dropped packet: It is calculated by counting the Clear To Send (CTS) timeout times and ACK timeout times.

III. Packet Delivery Ratio (PDR): This represents the ratio between the total number of sent packets and the received ones (number of replies received) [16].

Semi mobility was applied by moving just the CHs from each cluster, this is to ensure the study of the actual effect of CH handoff, and any mobility delay will be from the CH mobility not ordinary nodes.

SIMULATION RESULTS

It is noticed from Figure 4 that the packet size and CH mobility have a great influence on the service delay. Service delay increased from 0.2 to approximately 1.81 when CH move; since the odes will send many requests to discover the CH, while when the CH is static it will be available all the time and ready to reply the receiving request. The packet size increase results in increasing the overhead in network, while packet size has no effect when the CH is static.

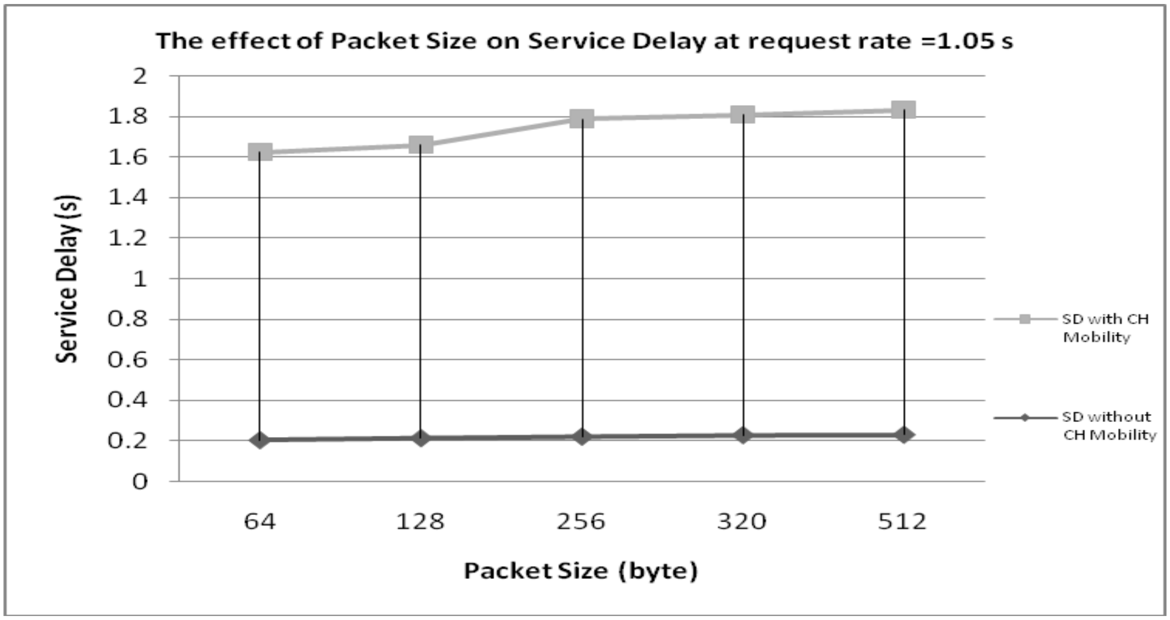

Figure 4: Average SD with CH mobility and without mobility on request rate 1.05 s

Figure 5 and Figure 6 depict the effect of request rate on the number of dropped packets and PDR, it is noticed when nodes send service requests less than or equal to 0.5 second, they will not have enough time to discover that their CH is leaving so they will spend more request causing increase in service delay and consuming of the bandwidth which will increase the number of dropped packets.

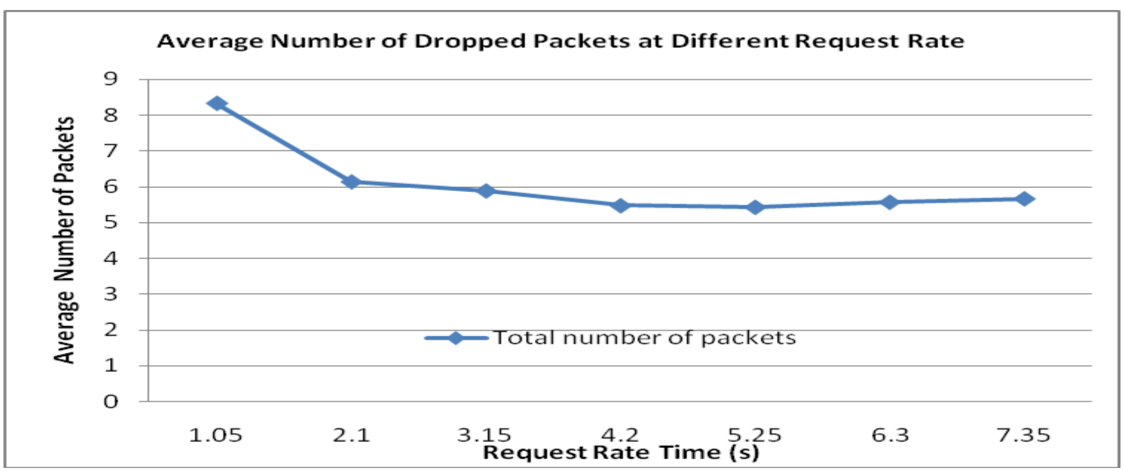

Figure 5: The average number of dropped packets on varied request rates with CH mobility

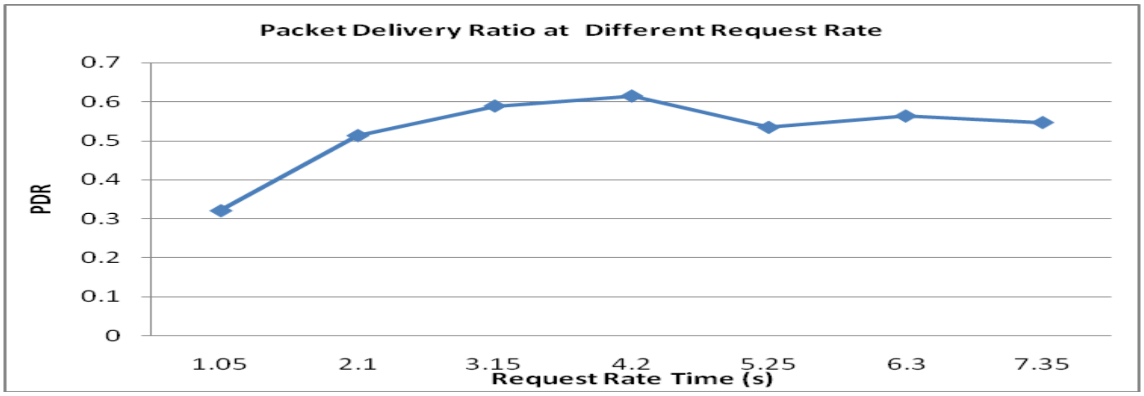

Figure 6: Packet Delivery Ratio on varied request rates with CH mobility

Link cluster architecture (LCA), in which each node is, a cluster head, an ordinary node or a gateway node. Initially, all nodes have status of ordinary node; periodically each node in the network broadcasts its ID, and its neighbors IDs. Subsequently, the node with the smallest ID is selected as cluster head. A node which can hear two or more cluster heads is a gateway. The process repeats until every node belongs to at least one cluster. Nodes with a small ID are more likely to be selected as cluster heads [14] [15], so it .is chosen to be compared with IVSH as LCA is a scalable for VANET. Figure 7 describes a comparson between IVSH and LCA using a request rate of 1 s , it is noted that the proposed algorithm is superior to LCA.

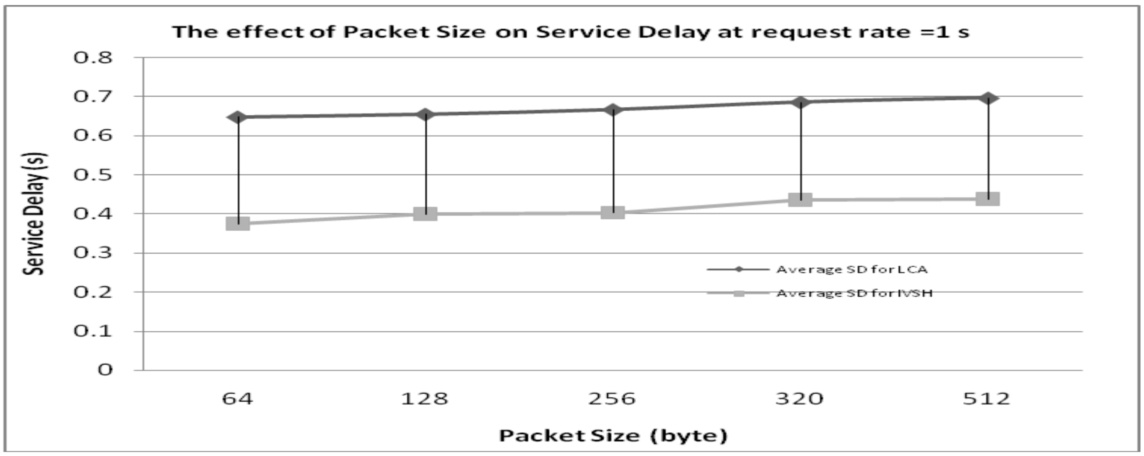

Figure 7: Average service time response on different request rates for IVSH and LCA (packet size 256 bytes).

Figure 8 shows the effect of request rate on service delay for LCA and IVSH, it is noted that IVSH has less service delay compared to LCA and the minimum service delay is obtained at a request rate of 3 s; This is because the cluster head will be light loaded as the request rate increases; this is because the IVSH resolves the problem by determining the threshold for handoff from the request rate of 0.5s which gives the highest SD in both LCA and IVSH. For that the IVSH gives a lower SD in request rate of 1s than 0.5s case, but the difference is not significant between them. This is true also for request rates of 2s and 3s.

It is clear from figure 9 that, the PDR for LCA will increase at higher request rates (i.e. on request rates of 2s and 3s). The values for PDR between LCA and IVSH will be close on higher request rates. This is due to, the light load of cluster heads on both cases, with superiority of IVSH over LCA

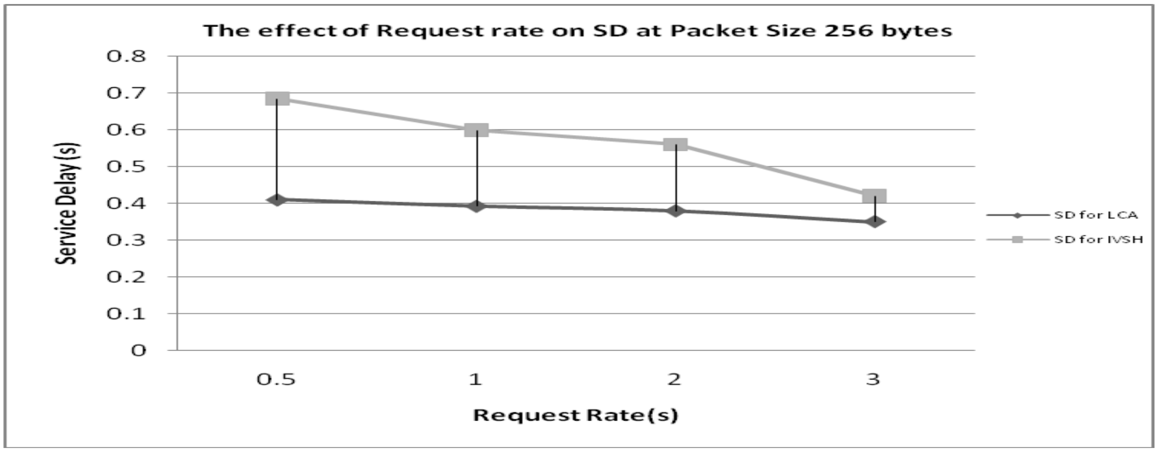

Figure 8: Average service time response on different request rates.

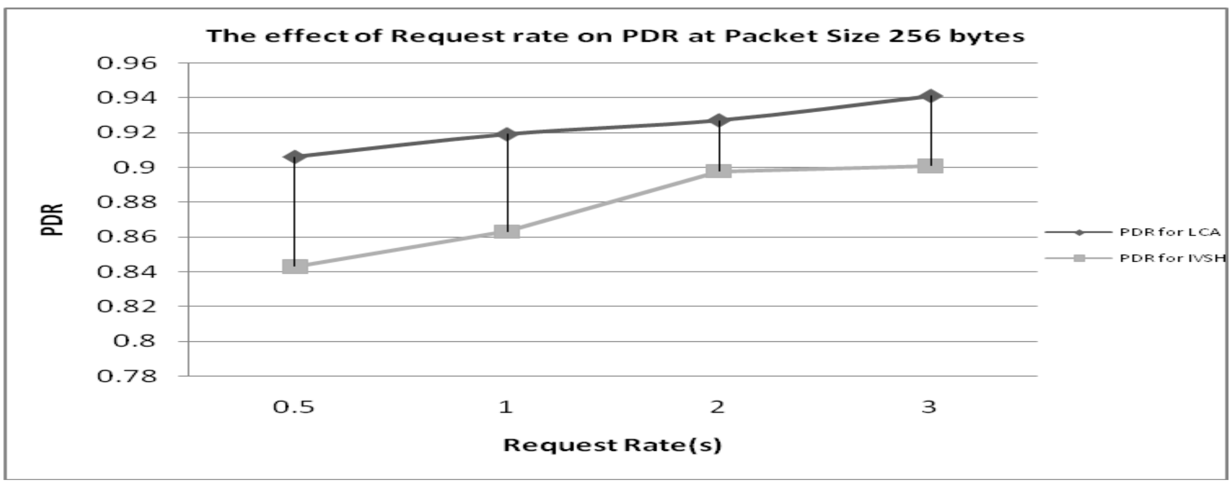

Figure 9: PDR on different request rates for IVSH and LCA (packet size 256 bytes)

CONCLUSIONS AND FUTURE WORK

VANET is a promising wireless mobile communication technology for improving highway safety, and managing traffic congestion by enabling the diver to have information about danger, the driver can be warned in-time, thus being able to safe life and reduce traffics and accidents. This paper described VANET, clustering to promote more efficient use of resources in such high dynamic networks, and it proposed a smooth handoff algorithm that is called it Inter-Clustered VANETs Smooth Handoff (IVSH). Different performance metrics were used to evaluate the performance of the proposed hand-off algorithm, which are average service response delay time or Service Delay, Total number of dropped packet, and packet delivery ratio and these metrics were compared with LCA. The obtained results showed that clustering and the proposed algorithm can enhance the performance of VANETs. It is recommended to apply complete mobility on the proposed algorithm and test it at different practical scenarios.

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