An Improved Stable Multi-Hop Clustering Algorithm (ISMC) for Vehicular Ad-Hoc Networks

Madhusudhana .B .N[1] Ms. P. Devki[2]
[2]Associate Professor
[1,2]Department of Computer Network Engineering
[1,2]The National Institute of Engineering, Mysore

Abstract— An Improved Stable Multi-hop Clustering Algorithm (ISMC) for Vehicular Ad-Hoc Networks "has been developed to create a stable and efficient cluster, with minimum number of Cluster Heads (CHs) and minimum number of cluster head changes, which minimize the overhead of fast topology changes and finally selects a node as CH which can last for longer duration, i.e the node which is in contact with all other nodes within the cluster. Vehicular Ad-Hoc Networks (VANET) is a type of ad-hoc network which contains many number of nodes which are vehicles moving with some speed in the same direction, and VANETs are highly dynamic in nature, since each node is mobile. The main objective is to select a node as cluster head, which is having least average relative speed with respect to its neighbors and implement multi-hop clustering. This is done by implementing STATE_ELECTION algorithm. First we propose a novel mobility metric; it is periodically exchanged and used for similarity calculation among vehicles. Second we implement multi-hop clustering with stable mobility metric in highly dynamic scenario. Third we simulate the proposed approach under realistic vehicle mobility. VANETs enable numerous applications such as dynamic route discovery, gaming and entertainment, decrease the cost of communication over cellular network, can be deployed in war fields for the use of military application as the data transmitted should be safe and secure.

Key words: ISMC, Vehicular Ad-Hoc Networks

I. INTRODUCTION

The fundamental characteristic of wireless Ad-Hoc networks is there will be no fixed infrastructure and all the nodes are mobile in nature, all the nodes are connected via bi-directional radio link.

VANET is a type of Ad-Hoc network in which each node is a vehicle moving with certain speed. Clustering is a technique in which a number of nodes are grouped into a single cluster, Clustering is an effective mechanism to handle the fast changes in the topology of VANETs using local coordination, within each cluster there will be a Cluster Head(CH) which will be maintaining information about each and every node present within that cluster, since the nodes are mobile in nature , if a Cluster Head (CH) goes out of reach from the nodes in the cluster then another node within the cluster has to be selected as the Cluster Head(CH), so the network is dynamic in nature.

In existing system the number of Cluster Head (CH) changes will be more, there by increases the overhead and does not support multi-hop clustering. Due to this data loss will be more. As per proposed system we provide a solution to reduce the number of Cluster Heads(CH) and Cluster Head(CH) changes and implement multi-hop clustering in VANETs.

A. Objective:

The main objective of this project is to create a stable and efficient cluster with minimum number of Cluster Heads (CHs) and minimum number of Cluster Head(CH) changes, minimize the overhead of fast topology changes, then finally selecting a node as Cluster Head(CH) which can last for longer duration i.e the node which is in contact with all other nodes within the cluster.

Our main objective is to select a node as Cluster Head CH) which is having least average relative speed with respect to its neighbors and implement multi-hop clustering.

B. Problem Statement:

In the existing systems of VANETs multi-hop clustering is not supported ,they are all limited to one hop clustering, and selection of Cluster Head (CH) is done randomly without any metric.

The number of CH and number of CH changes will be more, thereby increasing the overhead.

As the number of CH changes increases there by throughput decreases, delay increases, packet delivery ratio decreases.

C. Existing System:

In the existing systems ofMobile Ad-hoc Networks (MANETs) the CH selection is done using these metrics.

– Node unique id, where the node which is having lowest-id is selected as CH.
– Received signal strength, where mobility is estimated by comparing received power of consecutive messages and less mobile one is selected as cluster head.
– Without any metric, where a mobile node becomes CH when it has something to send.

1) Drawbacks of Existing Systems:

– The above methods are not suitable for VANETs. Because their performance will degrade in VANETs because of high speed mobile nodes and randomly changes time to time.
– Another reason is the stationary assumption where mobile nodes are assumed to be static in the cluster formation which contradicts with highly mobile characteristics of VANETs.
– Because of these metrics the number of cluster head changes will be more and thereby increases the overhead and the cluster head duration will be less.

D. Proposed System:

Clustering is an effective mechanism to handle the fast changes in the topology of VANETs using local coordination .The main goal of our system is to implement an algorithm to construct stable multi-hop clusters with minimum number of cluster heads in VANET and reduce the number of CH changes in the cluster,

The proposed system involves mainly three key steps.

- First, we propose a novel mobility metric, that is periodically exchanged and used for similarity calculation among vehicles.
- Second, we implement multi-hop clustering with stable mobility metric in highly dynamic scenario.
- Third, we simulate the proposed approach ISMC under realistic vehicle mobility which is generated by realistic mobility generator like Simulation of Urban Mobility (SUMO).
- Fourth, the selection of CH is done by choosing a node which is having least relative speed with respect to its neighbours within the cluster.

E. Methodology:

The development of the proposed system took many stages. In the first stage, the problem of existing system was studied. Then the analysis the project requirements were carried out. Further the system was developed stage by stage from requirement analysis to the implementation.

II. SYSTEM REQUIREMENT AND SPECIFICATIONS

A. Requirement Specification:

This section shows the functional requirements that are to be satisfied by the system. The entire requirement exposed here are essential, that is, a system would not be acceptable that does not satisfy some of the requirement presented here.

1) Software Specification:

- Operating System: Ubuntu or Linux.
- Tool: Network Simulator-2.35
- Language: TCL (Tool Command Language), AWK.
- Front End: NAM (Network Animator window)

2) Hardware Specification:

- Processor: Pentium 4 and above.
- Ram: 512Mb and above.
- Hard Disk: 40 GB.
- Input device: Standard Keyboard and Mouse.
- Output device: VGA and High Resolution Monitor.

III. SYSTEM DESIGN PHASE

Design is the process of converting a user oriented description of the data into a computer based system. This design is an important to avoid errors in the data input process and show the correct direction to the management for getting correct information from the computerized system.

A. System Architecture/Model:

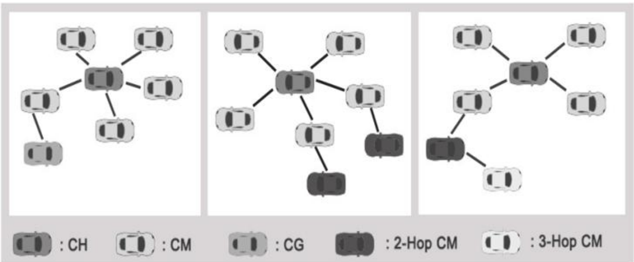

Fig. 3.1: System Architecture

System Architecture provides a high level overview of how the functionality and responsibilities of the system were partitioned add then assigned to subsystems or components. And it is described in the Figure 4.1.This architecture consists of n number of nodes (vehicles) made into different clusters.

- CH: Cluster Head
- CM: Cluster Member
- CG: Cluster Guest

In our system architecture as shown in fig 3.1 , the first cluster shows 1-hop cluster in which the centre node is CH and all other 1-hop CMs are connected to it,

Here when a node cannot communicate to CH and cannot access CH related information it declares itself as a CH but we avoid it from having un-necessary CH by calling it as a CG, and providing it the CH related information through CM.

In the second cluster the nodes are connected to the central CH in 2-hop structure, the nodes which are directly connected to CH are 1-hop CM and the nodes which are connected to 1-hop nodes are called 2-hopCM.

Finally in the third cluster the nodes are connected to the central CH in 3-hop structure,, the nodes which are directly connected to CH are 1-hop CM and the nodes which are directly connected to 1-hop nodes are called 2-hop CM , the nodes which are directly connected to 2-hop CM are 3-hop CMs.

IV. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

A. Advantages:

- Stable and efficient cluster with minimum number of Cluster Heads (CHs) and minimum number of Cluster Head (CH) changes can be implemented.
- Selecting a cluster head whose duration is more can be done using STATE_ELECTION algorithm.
- As the number of Cluster Head (CH) changes is reduced the throughput and packet delivery ratio is increased.
- Decrease the cost of communication over cellular network.

B. Disadvantages:

- If the vehicles are moving in random directions then this method is not suitable.

C. Applications:

- This is more suitable in Emergency operations as this reduces the delay.
- Can be deployed in war fields for the use of military application as the data/information transmitted should be safe and secure, where no data loss should occur in that scenario this system is the best choice.

V. CONCLUSION

We introduced a stable multi-hop clustering technique based on the changes in the relative mobility of the vehicles which is calculated by finding the average of the relative speed of all the same direction neighbors.

We modeled our approach ISMC in ns-2 using mobility values that we are taking dynamically from the trace files and comparing its performance to previously proposed multi-hop cluster approach called N-hop clustering that uses the variation in the packet delay metric. Simulation results show that the clustering of ISMC outperforms the N-hop clustering in terms of cluster head duration, cluster member duration and cluster head change metrics at various transmission range and vehicle velocity scenarios.

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