MULTI-HOP CLUSTER BASED MESSAGE PROPAGATION WITH CELLULAR-IOT IN VEHICULAR COMMUNICATION

[1]Channakeshava RN, [2]Dr. Ashok Kumar TA
[1]Assistant Professor, [2]Professor and Dean of Sciences
[1]Department of Computer Science,
[1]Government Science College, Chitradurga, India

Abstract: Inter vehicular communication is a research area where a vehicle can send critical messages about its status to the other vehicles in the same geographical region, which will ensure safety of the traffic patterns and reduced traffic delays. 802.11p WAVE-Wireless Access for Vehicular Environments is the most commonly used Communication technology which is also referred to as VANET or Vehicular Ad-Hoc Networks. Using a single communication technology WAVE for vehicular communication may not be feasible always. Similarly communications between a vehicle and road side units are established using cellular IoT, This paper introduces hybrid architecture for vehicular communication which uses VANETs as well as Cellular-IoT. Cellular-IoT is the standard by 3GPP which uses unused channels in existing cellular networks. The proposed system will reduce the message propagation delay as well as high packet delivery ratio. Use of WAVE for VANETs is suitable in urban mobility where vehicles are moving in a limited speed and more number of vehicles within a small geographical area. In a highway environment where vehicles moves with high speeds and speed of the vehicles varies with neighbors rapid change in formation of clusters is required..

Index Terms **- Cellular IoT, Road Side Units, Vehicles, Safety Messages, Hybrid Architecture.**

I. INTRODUCTION:

Intelligent transport systems are the growing concepts in limelight with the researches in the area of driverless cars. May be the car is driverless or with driver some safety messages propagation among vehicles moving in a neighborhood or in a region will enable many advantages such as platooning: where vehicles are moving much closer than a safety limit. Co-operative driving: where the vehicles informs other vehicles about lane changes, Queue warning; about the narrow road ahead and needs to form a queue, and Avoiding Collisions; by alerting Blind curves, Vulnerable road user, Blind Intersections, The usage of low distance communications technologies will be reduced as the cellular IoT technology gets popular. The advantage of cellular IoT is being not limited in distance, and no problem of power failures at intermediate nodes. NB-IoT or Narrow band IoT uses unused communications channels in the existing cellular network. So its advantages are being less power consumption, high availability,

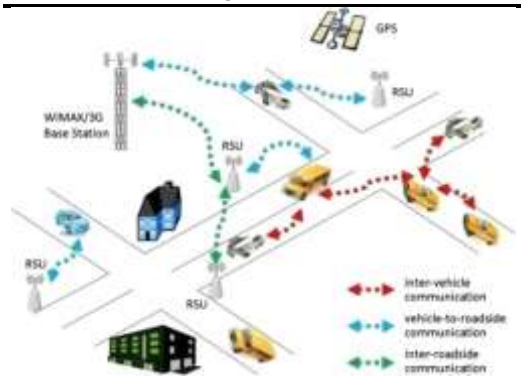
II. LITERATURE REVIEW

3GPP is working hard with Cellular Networks, Cellular IoT come out with a solution for automotive communications for safety transport [5] this paper explains how V2V communications and V2X communications will ensure a safety transports. Vehicular Multi-Hop Algorithm for Stable Clustering VMaSC is proposed by [2] uses a simple traffic module with single lane of traffic. The results are simulated using NS3 SUMO. Methods for designing protocols in vehicular communication are discussed in [4], which also demonstrates a protocol called PULSAR, which acts as a congestion control algorithm. The messages passed on are classified as Basic Safety Messages and Cooperative Awareness Messages.

[3] narrates routing in vehicular communications such as traffic based routing, Location and position based routing, distance and hop based routing, cluster based routing, probabilistic routing, and practical implementation design and development.

III. SYSTEM ANALYSIS

The vehicular traffic information messaging system includes the Moving Vehicles, Road side Units, eNode Base Stations, these are termed as nodes. Communication between these nodes may have any one of the following; 1. Vehicle to Vehicle, 2. Vehicle to Road side Unit, 3. Road side Unit to Road side Unit.



Vehicles Scenario:

Nodes and Mobility: Vehicles will be moving in a particular direction, and road side units will be static without movement.

Network: LTE, WAVE, Ad-Hoc, etc., routing may be IPV4/IPV6, broadcast, unicast, multicast etc.,

VANET: Vehicular Ad-hoc Networks closely resemble MANETs, as both require dynamic routing protocols.

Cellular IoT

The concept of Cellular IoT is to piggybacking the data onto the same network which smart phones uses. Advantages of Cellular networks are; no need of any new physical infrastructure required for building of communication networks, as they can use the same networks as mobile communications.

Cellular IoT Uses two major technologies LTE-M and NB-IoT, usage of those technologies dependent on the availability.

NB IoT: Third Generation Partnership Project 3GPP has developed NB-IoT to enable cellular services in a wide range. Narrow band IoT is a low energy consuming communication channel and Physical layer signals. This technology can co exist along with 2G, 3G, 4G or even supposed with 5G which is in the offing. Narrow Band signal uses single 200KHz band width and is designed to cover larger geographic area with high altitudes also and to cover deeper indoors. Initial cost of the IoT devices to be used in NB IoT are estimated at par with current GSM/GPRS Devices. IoT Devices which require permanent deployment such as health care devices inserted into the body, or a device moulded on to a wall or concrete requires at least battery life of 10 years. Such type of devices are expected to use NB-IoT.

LTE-M is also a 3GPP Technology for Low power wide area LTE-Machine Type Communication. It is having all the properties of NB-IoT but It reuses LTE installed base for communication. Battery life can be as long as more than 10 years, and modem costs will be 25% of the EGPRS modems. LTE-M is also known as LTE Cat-M1.

5G: In the offing of 5G technology, communications happening in the older iot ecosystems which provides private area networks are getting ready for migrating to newer NB IOT, there are two major issues in allocating resources to sensors by nodes.

1. Allocating time slot for receiving incoming requests.

2. Allocating heterogeneous resources to sensors.

IV. HYBRID ARCHITECTURE

Safety message communication is very much required more in Highway traffic than urban traffic as vehicles in highways are moving in a high speed than in urban. Communications between Vehicle to Vehicle may be using, VANETs, but the communications between vehicle to Road side Unit and communications between Road side Unit to Road side Unit should be implemented using Cellular IoT.

VANETs deal with problems like highly changing network structure, Cluster Head may have to be changed regularly as vehicles in the cluster maybe moving with different speeds and hence the cluster members may have to be added and removed, this nature of VANETs makes it necessary to consider NB-IoT or cellular IoT.

Communication model in VANETs: nodes (vehicles) in the VANETs forms a cluster to communicate with each other, Cluster Head will be formed based on some accessibility to all the members. A cluster Head should be reachable by cluster members within a predetermined maximum number of hops. MAX_HOP is the number of hops from CM Cluster Member to CH Cluster Head. If MAX_HOP is greater than or equal to 2 then this model becomes multi-hop clustering. In a multi-hop clustering cluster members may have to re broadcast packets from and to cluster head.

At a given time state of a vehicle may be one of the following;

IN-INITIAL: Initial state of the Vehicle.

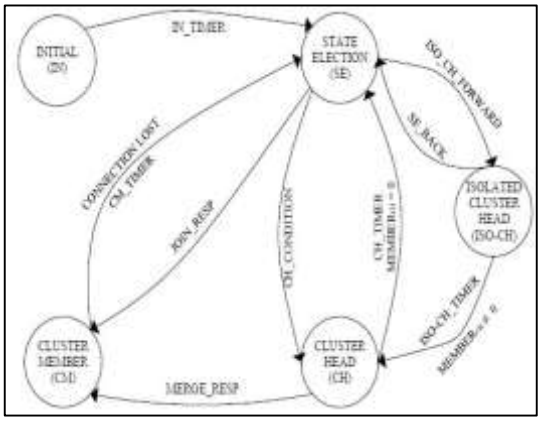
SE- STATE ELECTION: Vehicle makes a decision to change its state, based on the input information.

CH – Cluster Head,

ISO CH- ISOLATED CLUSTER HEAD: A vehicle makes transition in its state, when it cannot connect to any of the existing clusters, and there are no potential neighbors nearby.

CM-Cluster Member: This specifies that this node is attached to a cluster and can be communicated through CH.

Clusters are formed by using the metrics of vehicles; direction of movement, current state, current speed, current hop counter, MAX_HOP, connected cluster head ID. Etc.,



Life time of the cluster depends on the speed differences between the vehicles in the cluster. If vehicles are moving nearly same speed, then the cluster life time will be longer. Timers are maintained in controlling connections between CH and CM. If a CH does not receive any packet from CM during interval of time, CH assumes that CM has moved far and it will be detached from the cluster. Similarly CM also assumes CH has lost, if any packet is not received from CH during the time interval.

Cluster formation and network dynamics change rapidly as the speed of the vehicle increases.

Application of cellular IoT in Vehicle to Road Side Unit: When the vehicles in the cluster move in different speed, vehicles in the cluster moves apart quickly leading to the cluster timeout. There by increasing the formation and destruction of clusters very frequently, this leads to the sense that the communication from vehicle to Road side unit will lead to better communication. With the evolution of cellular IoT, communication from vehicle to Road Side Unit would be better than vehicle to Vehicle communication.

A vehicle in a cluster member or cluster head keep on sending a presence signal to the nearby RSU, based on the delay encountered in the reply each node calculates its distance from the nearby RSU. The presence signal is also useful in identifying its current location and in formation of the cluster. Each vehicle then broadcasts its cluster and its distance with RSU, and this information is accepted by each vehicle that is within a predefined distance from the RSU. All the vehicles that come under a single RSU will form a cluster. The vehicle with least distance from the RSU and minimum hops from other members will be designated CH. And others will act as CM.

Use of cellular IoT in communication between node to RSU will allow a vehicle to be up to more than a kilometer, this will enable vehicles up to 1 kilometer apart to form cluster.

Vehicles moving with low speed may be clustered with a messaging service that uses low distance transmission, but the vehicles in a highway moves with a speed such that it has to change its RSU within one minute. And probably the cluster also if the vehicles in the cluster moves in a different speeds.

SUMO and NS3: SUMO is used to simulate coordinated systems, Maps can be created for traffic models and vehicles movement can be simulated via SUMO.

NS3 Simulation with LENA: LENA is a LTE/EPC open source simulation module in NS3, which enables small cell vendors to test their algorithms and solutions. Some of the popular applications of LENA are;

DL & UL Schedulers

Radio Resource Management Algorithms

Inter-cell interference coordination solutions

Load Balancing and Mobility Management

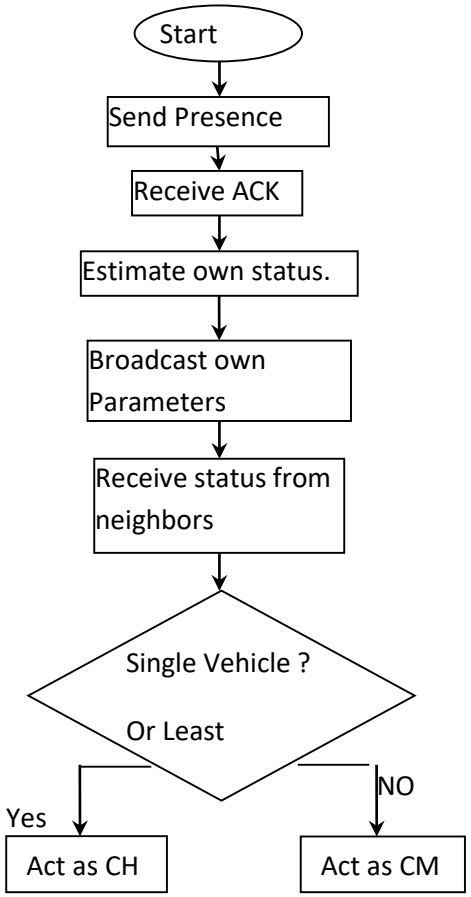
Heterogeneous Network (HetNets) solutions

End-to-end QoE provisioning

Multi-RAT network solutions

Cognitive LTE systems

Use of Cellular IoT enables vehicles to send and receive messages to and from roadside units, but also precise location sharing enables other vehicles to drive safely.



V. CONCLUSIONS

Hybrid Algorithm for using VANETs and cellular IoT will enable vehicles to participate in both high density city traffic and high speed highways traffic. VANETs are very useful in city traffics where more or less all vehicles moves in less than 30Kmph speeds and almost maximum traffic will be between most important places. In such a scenario each cluster may have more number of vehicles with 1 or 2 as MAX_HOP. Usage of cellular IoT will be useful in highway traffic where density of vehicles is too low and CH to CM distances will also increases as speeds of the vehicles varies from 30Kmph to 150Kmph. Using VANETs will take much of the time in establishing and closing the clusters of vehicles.

Advantages:

A Cluster member can establish connection with neighbor who is already a member or head, this reduces minimum overhead during cluster connection. Reactive clustering reduces packet transmission overhead. Reduces inter cluster interference by introducing hop aware cluster merging mechanisms.

A technology which continuously checking its distance with nearby road side unit, will increase the efficiency of communication and reduce the delay and increase the success rate of packets delivery. But the disadvantages being increased power constraint and network usage for constantly checking distance with the road side units and comparing itself with the other nodes in the cluster.

Challenges: communicating with more data and frequent change in clusters formation will require consumption of more power and require more computation. Algorithms that simplify computational load and consume less power are required.

VI. REFERENCES.

[1] Roopa AM, Shobha Biradar, Multi-Hop Clustering Hybrid Architecture in VANET for Safety Message Propagation- Asian Journal of Engineering and Technology Innovation

[2] Seyhan Ucar, Sinem Coleri Ergen, Oznur Ozkasap - VMaSC: Vehicular multi-hop algorithm for stable clustering in Vehicular Ad Hoc Networks, 2013 IEEE Wireless Communications and Networking Conference (WCNC): NETWORKS

[3] Rex Chen, Wenlong Jin, and Amelia Regan, *University of California, Irvine* , Broadcasting in Vehicular Networks: Issues and Approaches, Article *in* IEEE Network · January 2010

[4]Tess a Tielert, Daniel Jiang, Qi Chen, Luca Delgrossi and Hannes Hartenste, Design Methodology and Evaluation of Rate Adaptation Based Congestion Control for Vehicle Safety Communications.

[5] Cellular Vehicle-to-everything (C-V2X) enabling intelligent transport- GSMA white paper June 2017