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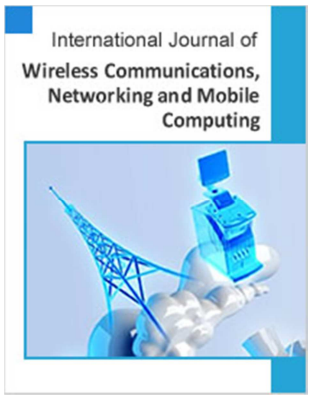

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A Survey on Mobility Based Cluster Using Medium Access Scheme for VANET

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Abstract

Mobility based cluster mechanism addressed some issues such as inter cluster and intra cluster communication, latency of the safety related messages, less channel access and hidden terminal problem. A survey of cluster based medium access for VANET used to analysis the performance and characteristics of the various mobility based MAC protocols in VANET. The goal of this paper is to present a number of mobility based clustering process in order to offer researchers more informed choices when they are choosing a better cluster model to use their performance evaluation.

1. Introduction

Vehicular Ad hoc Network (VANET) are playing important role in Intelligent Transportation System (ITS). It is used for collision avoidance between vehicles o the road. Various medium access control techniques used for scheduling the communication process and provide the clear communication between the clusters. So the cluster members and cluster heads are periodically communicating with each other. The clustering technique in VANET for reducing overhead.

The Cluster Head election process performed by various factors like the id of the VANET, The degree of the network, The speed of the vehicle, stability of the vehicle.

Mobility based MAC protocols perform an important role in VANET. These MAC protocols provide channel utilization, minimize time delay and transfer the speed of safety related applications.

The rest of the paper contains as follows: Section II formulates related works, Section III presents Background, Section IV describes Mechanisms supported by mobility based clustering MAC protocols, Section V contains Comparison, and finally Section VI concludes the paper.

2. Related Works

There already exist several surveys of mobility based medium access control protocols for vehicular ad hoc networks available in the literature [1], [2].

The early survey proposed by Tracy Camp, Jeff Boleng and Vanessa Davies in [1] contains the information about the performance of the entity mobility model and group mobility model. Entity mobility model has seven mobility models such as Random walk mobility model, Random waypoint mobility model, Random direction mobility model, city section mobility model. The entity mobility model classified into the random walk

mobility model and random waypoint mobility model. The random walk mobility model contains past locations and speed values of the vehicle. The random walk mobility model which includes challenges in direction and speed. Group mobility model has exponential correlated random mobility model, column mobility model, nomadic community mobility model, pursue mobility model, reference point group mobility model. This paper concludes performance of the various mobility models in ad hoc networks.

In [2], medium access technique for quality of service in ad hoc networks. Many fundamental service MAC protocols are discussed here. Then analyzing the quality of service of MAC protocols such as CSMA/CA, IEEE 802.11p, TDMA, CDMA and QOS aware MAC protocols. There are many issues affecting QOS in wireless ad hoc networks such as inherent issues, technology based issues, deployment issues, medium access based issues and six mechanisms supported by QOS-Aware MAC protocols such as back off differentiation, inter frame space differentiation, jamming, frame aggregation, frame manipulation, alternating CP/CFP. This paper discusses QOS provisioning at the MAC layer in ad hoc networks. Here perform the comparison of protocol features and supported mechanism.

In [3], Security based issues are discussed as follows, security requirements for VANETs attacks in VANET such as attacks on privacy, confidentiality, availability and non-repudiation.

In [4], Survey on security issues such as VANET challenges and security impact like network velocity, liability vs. privacy, network scale, heterogeneity.

The proposed survey mechanism comparing various factors such as CH selection, throughput of the messages and identify latency of the messages to select better MAC protocol in mobility based clustering technique.

Table 1. *Preliminaries.*

NOTATION	DESCRIPTION
CH	Cluster head
CM	Cluster member
CCH	Control channel
CCI	Control channel interval
c1, c2, c3, c4	Subcarrier set
SCA	Safety critical application
CT	Cluster type
SN	Size of the network
MT	Message type
TM	Throughput of the message
LM	Latency of the message
HTM	Hidden terminal problem
RN	Reliability of the network
OC	Overhead in cluster

3. Background

The basic structure of the mobility based clustering models contains many issues and metrics. The issues can occur during MAC scheme implementation and cluster head selection process. The performance metrics based on cluster member and cluster head communication and reliability of the network and throughput of the safety messages.

3.1. Issues Affecting Mobility Based Clustering Technique

Vehicular ad hoc networks have multiple characteristics with pose problems for providing in clusters mechanism. The most important of these issues are described below

3.1.1. Inherent Issues in VANET

- Unreliable Wireless Channel - MAC protocol provides less quality of channel related to interference, noise, the near-far problem. All these issues lead to retransmission. The control channel (CCH) providing subcarrier sets to avoid hidden terminal problem.
- Requirements of application - Applications have various requirements of which a mobility based MAC protocol should be aware in order to fulfill them.

3.1.2. Technology Based Issues

- Multiple Channels - Every station equipped with more than one wireless interface which require more complex MAC protocols.

3.1.3. Deployment Based Issues

- Mobility- Station movement can provide in collisions, breakage of the link and variation in contending stations
- Multi-hop topology scheme - A multi-hop approach is to ensure full connectivity due to the limited range of wireless technologies. This results in increased collision, insufficient bandwidth. These problems are explicitly addressed by MAC protocols.
- Network size - The increase of the number of vehicles generates overhead related to the discovery and maintenance of neighboring links

3.1.4. Medium Access Based Issues

- Lack of accessing the shared channel
- Fairness
- Synchronization

3.2. Metrics of Mobility Based Clustering Technique

The metrics defined performance of mobility based clustering technique. These factors to improve the level of clustering operation.

3.2.1. Minimum Throughput of Message

Message throughput required at the MAC layer to assure correct functional process of an application. This metric is related to the information; a single node/vehicle can transmit over the control channel per unit of time.

3.2.2. Maximum Time Delay (Measured in Seconds)

The period of time a safety message waits at the MAC layer until its successful transmission. The waiting period

includes transmission delay, queuing delay and retransmission delay.

3.2.3. Maximum Safety Message Loss Ratio (Measured in Percentage)

The maximum tolerable fraction of safety message loses at the MAC layer. Other performance goals of mobility based clustering technique include minimizing overhead, stability of the network and hidden terminal problem.

4. Mechanisms Supported by Mobility Based Clustering Mac Protocols

The fundamental concept of mobility based clustering MAC protocol to construct a large internetworking with highly dynamic nodes in vehicular ad hoc networks. In dynamic environment, we should make the clustering process for avoiding the overhead and collision but it was very difficult. So we need to know some factors to construct clusters such as speed, reliability, stability and performing proper functionalities of the node. In mobility networks, all nodes are in a moving state and same speeds of the vehicles are grouped into clusters. Then cluster head election also based on factors such as stability and functional process of the node. If the node is not stable in a network that is not considered as a cluster member. Then every cluster using a clustered MAC protocol for communication. The different MAC functional layers are used in various operations. Here, let us discuss about the various MAC layer functions, clustering process and cluster head selection.

4.1. Mobility Based Clustering Process

Mobility based clustering process mainly used to minimize the overhead in VANET. We have to make clustering in VANET based on various factors such as the speed of the vehicles and stability of the network.

Minming Ni et al [13], a proposed clustering scheme contains two stages like initial stage and maintaining stage. In initial stage, all nodes in VANET send HELLO packets periodically and construct their neighbor lists based on receiving HELLO packets from other nodes. Initial clustering is performed when the network is first established; all the nodes are in the orphan state. In maintaining stage, the predicted mobility is used to deal with problem such as stability of the cluster structure and decrease the connection between node lifetimes.

Zaydoun Y Rawashdeh et al [14], introduce a new type of clustering scheme to produce a stable clustering structure by degree of the speed difference between neighboring nodes. Here formation of stable cluster in dynamic environment such as VANET.

Christine Shea et al [8], In Affinity PROpogation for Vehicular networks (APPROVE), each vehicle in the network broadcasts the responsibility and availability messages to its neighbor and the performs a decision on clustering process independently. Every node in clustering has its one-hop neighborhood. This method also provides a stable clustering technique.

Mehrnaz Mottahedi et al [15], introduces intelligent based clustering method in dynamic networks. Here in clustering techniques, the moving vehicles are categorized into different groups and stand together in one single cluster. This process improves the lifetime of the cluster in VANET.

Khalid Abdel Hafeez et al [11], introduces a Mobility aware clustering technique. On dynamic environment, we shall make clustering based on the same speed of the vehicles are grouped as a cluster. After some time period a node moves from one cluster to another cluster.

Ning Gao et al [10], proposed a hybrid mobility based clustering technique. Here cluster depends on the motility factor of nodes/vehicles. Motility factor contains information about link between each vehicle and connection between clusters in the VANET.

Minming CHEN et al [12], proposed a clustering method more effectively. In VANET each node is assigned unique ID. Vehicles send HELLO messages to its neighbor periodically. Every vehicle maintains a list of its one-hop neighbors. If a node or the vehicle does not receive any information from a neighbor for a period, it will delete the neighbor from the list. The nodes only move in the same direction that is placed in clusters. This method improves the stability of the cluster in dynamic networks.

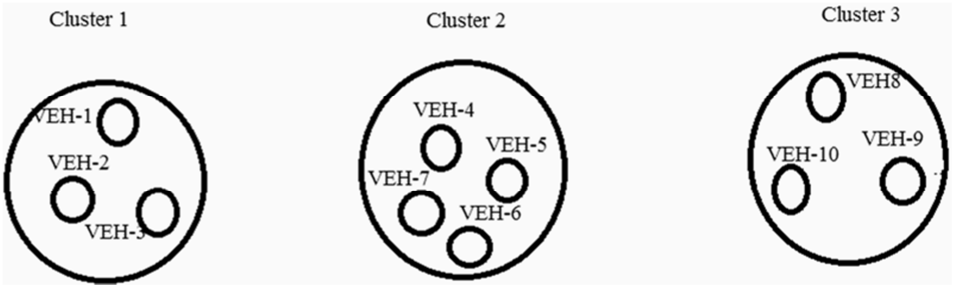

Figure 1. *Mobility based clusters in VANET.*

4.2. Cluster Head Election Process

The cluster head selection process is important in VANET because VANET is a dynamic network. Here all the nodes or vehicles are not in stable condition. It will change periodically. So we need to select CH for every cluster to maintain its cluster member's information. It is the effective technique to improve the performance of every cluster.

Damians Gavalas et al [16], proposed a technique for selecting Cluster Head (CH) and a vehicle that belongs to more than two clusters is called a gateway node. Cluster heads contain routing and topology information. It is responsible for communication between all nodes in VANET.

Hao Wu et al [21] introduces rules and factors of Cluster Head selection and update process. This paper contains a literature survey provide cluster head election based on three algorithms such as Lowest ID clustering algorithm (LID), The highest-degree (HD) clustering algorithm, Weighted clustering algorithm (WCA). In lowest ID (LID) clustering algorithm, initially nodes broadcast their ID and neighbor node receives that ID and maintains the list of neighbors ID. The IDs that were error-free are compared with neighbor ID in the neighbor list. Then the lowest ID elected as a cluster head. In highest degree clustering algorithm aims to minimize the number of clusters. In VANET, every vehicle aware of number of its neighbor vehicles. The node or vehicle having the highest number of neighbors elected as a cluster head. The number of cluster head update increases the network's maintenance overheads. In weight based clustering algorithm, the cluster head elected based on design factors such as transmission power and battery power of mobile nodes. These above factors assign to weight values. The node with the highest weight value, consider as a cluster head, which minimize overhead in the network.

Khalid Abdel Hafeez et al [22], introduces a cluster head selection based on fuzzy logic. Cluster membership is changing the information about the mobility and density of the road between nodes/vehicles. The node is the stable state elected as a cluster head. Then backup cluster head (CHBK) also maintained for future use.

Zaydoun Y Rawashdeh et al [14], proposed a cluster head election process based on mobility information such as velocity, location, node degree and direction. Stable neighbor calculated its suitability value u, using the formula u=(d, v, p). Vehicles having higher number of stable neighbors, maintaining distances of closer to their stable neighbors should have a higher suitability value (u), then they are more limited to be elected as cluster heads (CHs).

Mehrnaz Mottahedi et al [15], proposed a cluster head process in training an artificial neural network. Here artificial neural network. Here artificial neural network has one output that is cluster head level and five inputs such as bios of the network, cluster size, density of the road, the velocity of the vehicle and vehicle in cluster flow position. Then the node maintains these factors in more stable elected as a cluster head.

Khalid Abdel Hafeez et al [11], introduces cluster head election and reelection process based on βWSF (Weighted Stabilization Factor). The node with the highest βWSF value elected as a cluster head. The cluster head will selection CHBK (Backup CH) that has the highest βWSF factor among all vehicles. If some cases when the CH speeds up or slows down. So it will be out of its boundary. More than 10% of the cluster member become out of the current cluster heads range, but are still within the backup cluster heads range.

Minming CHEN et al [12], introduces a cluster head election algorithm based on the speed difference between vehicle and position of the vehicle in the cluster. In speed difference vehicles moving on the road have various speeds. Further the speed of the vehicle changes with time. The vehicle with a closer speed to its neighbors should as the cluster head. Node position is another factor that determines the stability of a cluster. The vehicles with the closest distance to its neighbors should be given the highest priority to be selected as a cluster head.

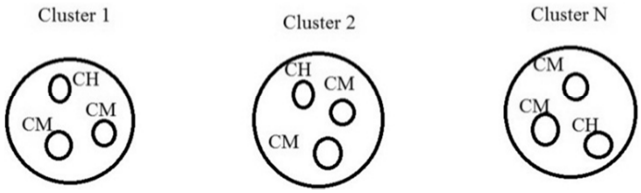

Figure 2. *Cluster Head Selection in VANET.*

4.3. Different MAC Schemes Used in VANET

After electing a cluster head for VANET. We need to provide communication process involved here that is cluster head to cluster head communication and cluster head to cluster head to cluster member communication. This communication process periodically exchanges the information between cluster head and cluster members. The proper communication process avoids collision and improving stability of the cluster. The medium access control protocol used for this communication. In this paper, we have to discuss about various mobility based MAC protocols are as follows.

Yvonne Gunter et al [18] proposed cluster based medium access scheme for VANETs. The basic structure for this protocol is a TDMA (time division multiple access). Here the medium is divided into time slots which can be assigned to the communication nodes. Then time slots are grouped in a frame. Here two phases of communication. In direct link phase cluster head sends HELLO messages (CH-HELLO) message to assignment of the actual frame. Scheduled nodes can send their data using direct link phase. In random access phase cluster heads act as a base station and new nodes to register at the cluster. This MAC protocol minimizes hidden terminal problem and also used to avoid flooding the network.

Zaydoun Y RawashDeh et al [19], introduces new media access techniques that can be used for clustering management and communications. This protocol has cluster management using centralization approach and farthest vehicles forwards backward in an effort to increase the coverage area. Here time is divided into cycles and each cycle is shared between service channel and control channel. Then the service channel will be used for intra cluster management and safety related messages delivered within the cluster. Control channel will be used for exchange, safety messages between neighboring clusters.

Yen-Cheng Las et al [17], proposed a region based clustering mechanism (RCM) for channel access. R-ALOHA

based protocols implement to RCM. Each channel in the radio channel associated with two states such as unused and used with the two rules.

RULE 1: There is no vehicle is transmitting Safety Critical Application (SCA) information on the channel or collision on the channel, the channel is in the unused state.

RULE 2: If one vehicle transmits SCA information on the channel, the channel is in the used state.

A vehicle collects the following information from other vehicles such as the radio channel pool, the state of the channel, the broadcast SCA information. This information can be collected by two functions such as identify_pool, receive. The function identifies_pool determines region and radio channel for particular cluster and receiver function receives each channel SCA information. The other function, contend is used to resolve the contention resolution issue.

Khalid Abdel Hafeez et al [6], proposed OFDMA based MAC protocol. Here COMAC (Cluster and OFDMA based MAC) use OFDMA scheme. OFDMA provide CCH (control channel) and it is classified into four subcarrier sets (c1, c2, c3, c4). The lone state vehicles are using c4 and it is used by temporary cluster head. After some time period lone state node falls again within the range of main cluster head and it releases c4 and use the main CH subcarrier set. c1, c2, c3 are used by main cluster to avoid hidden terminal problem.

Khalid Abdel Hafeez et al [11], introduced DMMAC protocol. This protocol integrates OFDMA and DCF in IEEE802.11p. The proposed MAC protocol adaptable to driver behavior on the road and learning mechanism to predict future speed of the vehicle using fuzzy inference system (FIS). OFDMA provides control channel and subcarrier sets (c1, c2, c3, c4). The first three subcarrier set used by main cluster head and c4 used by lone state vehicle and it is temporary. DCF is a distributed protocol and it utilizes (CSMA/CA). The goal of the DMMAC protocol is to find cluster size and reliability of the network.

J. Jayavel et al [7] introduced a novel TDMA based clustering technique. The TDMA mechanism providing collision-free transmission using time slots. This paper mainly used to improve cluster stability. A novel TDMA based clustering mechanism based on a vehicle on the road time and potential parameters such as connectivity, distance and speed. This MAC protocol used to increase the lifetime of the network.

Ning Gao et al [10], proposed a hybrid clustering MAC protocol. In this paper, intra-cluster communication and inter-cluster communication implemented using different protocols. In intra-cluster communication using TDMA/CSMA MAC scheme. This process performed between cluster head to cluster members. Then the inter-cluster communication process using the CSMA MAC scheme. This process performed between one cluster head to another cluster head. This process is to improve throughput and reducing transmission delay of safety related messages.

5. Comparison

We should compare all the mobility based MAC protocols described in the survey and then proceed to examine the protocols. The following table summarizes the advantages and disadvantages of mobility based clustering mechanisms (CT-Cluster Type, SN-Size of the Network, MT-Message Type, TM-Throughput of Message, LM-Latency of Message, HTM-Hidden Terminal Problem, RN-Reliability of Network, OC-Overhead in Cluster). Comparison of Mobility Based MAC Protocols is shown in table 2.

The following diagram represents the mobility based MAC protocols used from 2007 to 2014.

6. Conclusion

Our proposed scheme survey of mobility based cluster using the MAC scheme in VANET. This process used to compare various mobility based MAC protocol to find advantages and disadvantages for analysis. This survey scheme used for choosing suitable clustering technique and cluster head selection process and efficient MAC scheme. Further in future, this mobility based clustered MAC schemes used to construct hybrid clustering process; hybrid cluster head selection process is an effective technique to improve an efficiency of vehicular ad-hoc network.

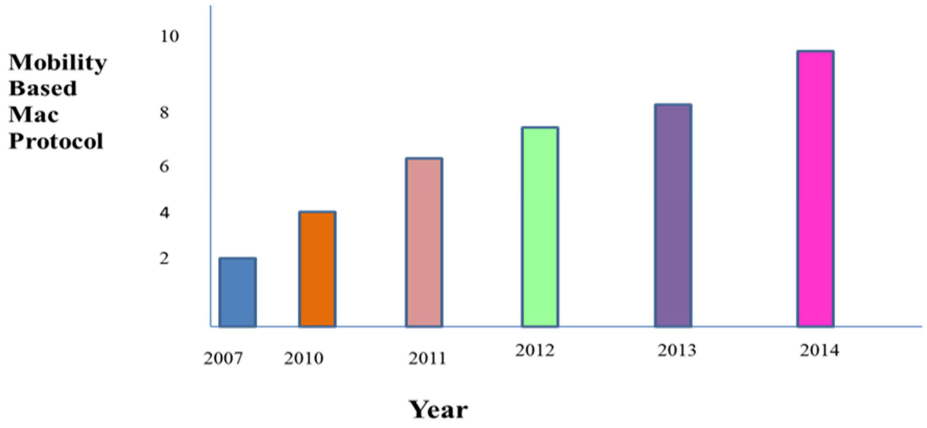

Figure 3. *Mobility based MAC Protocol Vs Year.*

Table 2. *Comparison of Mobility Based MAC Protocols.*

S No	Protocol	Year	CT	SN	MT	TM	LM	HTM	RN	OC	Stability
1	CBMAC	2007	mobility	large	Safety	high	low	avoided	high	avoided	High
2	Hybrid TDMA	2008	schedule and contention	medium	Safety	high	low	avoided	-	avoided	High
3	Type based cluster protocol	2010	mobility	large	Safety	high	low	avoided	high	-	High
4	IEEE802.11p	2010	mobility	large	Safety	medium	low	-	-	-	Medium
5	R-ALOHA	2011	region based	large	SCA	high	medium	-	-	-	High
6	Node Weight based protocol	2011	node weight	medium	HELLO	medium	medium	-	medium	avoided	Medium
7	Doppler Shift based protocol	2011	mobility prediction	large	HELLO	medium	medium	-	-	avoided	Medium
8	OFDMA	2011	mobility	medium	safety	medium	low	avoided	medium	-	Medium
9	DSRC	2012	mobility	large	safety	high	low	avoided	medium	minimized	Medium
10	Routing protocol	2013	intelligent	medium	safety	high	low	-	-	avoided	Medium
11	DMMAC	2013	mobility	large	safety	high	low	avoided	high	minimized	High
12	TDMA	2014	mobility	medium	HELLO	high	low	-	high	minimized	High
13	Routing protocol	2014	mobility	large	safety	high	low	-	-	-	High
14	TDMA/CSMA and CSMA	2014	mobility	large	HELLO	high	low	avoided	high	minimized	High
15	CDMA	-	affinity propagation	medium	HELLO	high	high	-	high	-	High
16	Weight based protocol	-	weight based	medium	MAC Address	medium	low	-	-	-	Medium

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