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SAFETY COMMUNICATION IN INTEGRATED VANETs FOR EMERGENCY SITUATIONs -3G WIRELESS NETWORKS

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Abstract— The main benefit of vehicular ad hoc network (VANET) communication is seen in active safety systems that increase passenger safety by exchanging warning messages between vehicles**.** Safety communication in VANETs is proposed by integrating VANET with UMTS network. Here it envisions VANET-UMTS integrated network architecture are characterized by their high data transmission rates and wide range communication in any emergency situation. We propose the energy dissemination for vehicular environments (EMDV) strategy for energy dissemination for safety communication. Here the vehicles can form in to clusters and selects a gateway candidate and a cluster head by interfacing the vehicles with WAVE, WIMAX are selected as vehicular gateways to link VANET-UMTS. Here we are proposing a cluster based routing for selecting minimum number of optimal gateways and mobile gateway management mechanism is proposed. For simulations we are using NS2. Here results are obtained in terms of high data packet delivery ratio and throughput, packet drop rates and minimized delay. We compared our approach with the existing protocol.

***Index Terms*—VANET, EMDV, UMTS, WIMAX**

I.INTRODUCTION

Today's wireless communication is used for sharing and providing data services for wide range of applications. The enhanced version of IEEE 802.11 networks, which is IEEE 802.11p, the standard for Wireless Access for Vehicular Environments (WAVE)operates at a frequency of 5.9 GHz, divided into 7 channels, each operating at a frequency of 10MHz. It provides a high data transmission rate, ranging from 6 *Mbps* to 27 *Mbps* and a short-range radio communication of approximately 300 meters. The Universal Mobile Telecommunication Systems (UMTS), as a 3G & beyond cellular network technology, operates with a frequency range of around 2 GHz. The UMTS dedicated channel offers a peak downlink data rate of 2 Mbps and a peak uplink data rate of 384 *Kbps*, whereas the UMTS High Speed Data Packet Access (HSDPA) radio service offers peak downlink data rates of 7.2 *Mbps* and uplink rates of 2 *Mbps*. UMTS offers a wide range of communication of around 8 to 10 km per Base Station (BST).

As an attempt to couple the high data rates of IEEE 802.11p and the wide communication range of 3G networks, this paper envisions an integration of IEEE 802.11-based Vehicular Adhoc Networks (VANETs) with UMTS. The need for such integrated architecture stems from the numerous optimality challenges associated with the inter-connectivity of VANETs with static roadside Infrastructure gateway units. The VANET architecture consists of on board units (OBU) and road side units(RSU).

II.Related work

In the area of vehicular communications, there has been a enormous research work. In [1], the authors proposed a new protocol, which selects a route with the longest lifetime to connect VANET nodes to the wired network by using the characteristics of vehicular movements. In general the vehicles are to be stationary or mobile, but the gateways to be purely stationary. we use two metrics, namely Link Expiration Time (LET) between adjacent vehicles and Route Expiration Time (RET) between vehicles and gateways. Communication with gateways is hybrid and gateway handover is also addressed. Communication with the gateways is not purely pro-active. A clustering based approach with a vehicular collision avoidance system in any emergency situation is devised in [2]. Here vehicles are clustered based on their RSS, their direction of movement, and inter-vehicle distances. A risk-aware Media Access Control (MAC) protocol is designed to increase the response of the system by associating an emergency level with each vehicle in its correspondingcluster.

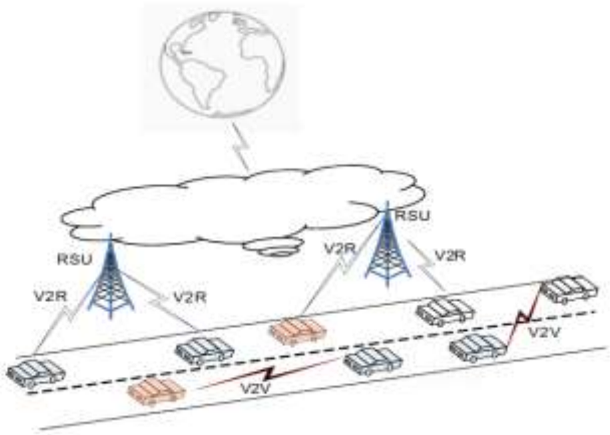

Fig. 1. Basic VANET Communication diagram

III. PROPOSED VANET-3G INTEGRATED NETWORK ARCHITECTURE

A. *Architecture Description*

Fig. 1 explains the architecture, considering two different tracks over a road (e.g., highway), with a track for each direction. The architecture of WAVE and WIMAX-based VANET vehicles, a UMTS Node B and the main components of the UMTS core network. Communication over the VANET network is multi hop. VANET is linked to UMTS via selected VANET mobile gateways using the Universal Terrestrial Radio Access Network (UTRAN) interface. The main purpose of our paper is to select only a minimum number of vehicles to communicate with the UMTS network as gateways. The region under the coverage of UMTS BST, where the UMTS Received Signal Strength (RSS) is intense, is termed as the 3G active region. The vehicles, equipped with both the WAVE, WIMAX and UMTS interfaces, lying within or moving into the 3G active region, are called Gateway Candidates (GWCs).The rest of the vehicles, that do not lie in the 3G Active Region, are not equipped with the UMTS interface, or do not have their UTRAN interfaces enabled are called Ordinary Vehicles (OVs). Among the gateway candidates, a minimum number of Cluster Heads (CHs) per direction are elected as optimal gateways (GWs) using different metrics. The number of gateways is required to be minimum, so as to avoid bottleneck at the UMTS BST and save UTRAN resources. Gateway candidates are grouped into clusters using dynamic clustering mechanism, and only the selected gateways will have their 3G UTRAN interfaces activated. However, the IEEE 802.11p interface is enabled and activated on all the VANET vehicles.

B. *Dynamic Clustering Operation*

For the sake of effective relaying of messages and enhanced stability of inter-vehicular links, we cluster vehicles using three metrics, namely the direction of vehicles' movement, UMTS Received Signal Strength. Moving direction clustering is initially carried out using the direction of vehicles in the Cartesian space and then relative to the position of the UMTS BST. Vehicles are then grouped into two sub-clusters: vehicles moving towards the BST and vehicles moving away from the BST and the UMTS Received Signal Strength (RSS) together form a single gateway candidate sub-cluster. These vehicles are called gateway candidates (GWCs), and their UTRAN interface is enabled. The other vehicles behave as Ordinary Vehicles (OVs) and a pair of gateway candidates, whose inter-vehicular distance is less than or equal to their IEEE 802.11p transmission range, form a new sub-cluster or join an existing one (i.e., if one of the gateway candidates is already a member of a cluster). The transmission range of a GWC is determined as follows:

$$R = T_r \cdot (1 - a) \qquad (1)$$

where, T_r denotes the maximum IEEE 802.11p transmission range and a reflects the wireless channel fading conditions in the current location. After the clustering operation, the final stage is to elect a Cluster Head (CH) for each cluster. A CH is in charge of Initiating communication and controlling the flow of signaling messages among GWCs within the cluster. To determine the CH, the leading edge GWC broadcasts its position in the opposite direction of its movement and the tail edge GWC broadcasts its position in the same direction of its movement whose relative distances to both edge GWCs are almost equal, is closest to the centre of the cluster and deems itself to be the Cluster Head. Computation of *TTL* is then followed by CH. It is set to the maximum number of hops from the CH to the tail or to the leading edge GWCs. The *TTL* value is used to restrict the flow of signaling messages pertaining to a particular cluster within the same cluster.

C. *Adaptive Mobile Gateway Management*

The Adaptive Mobile Gateway Management mechanism consists of three mechanisms, namely "multi-metric mobile gateway selection", "gateway handover" and "gateway discovery/advertisement, EMDV" mechanisms. The gateway selection mechanism is used to select the minimum number of adequate gateways to optimally communicate with the backhaul UMTS network. It is based on the Simple Additive Weighting (SAW) technique using metrics such as the mobility speed of the CH, its UMTS RSS, and the stability of its link with the source vehicles (i.e., LET and RET metrics [1]).In this paper, the first vehicular source broadcasts a Gateway Solicitation (GWSOL) message within the VANET, using the TTL value (TTL_S) as discussed below. In the gateway selection mechanism, the UMTS RSS and RET are metrics with positive criterion the mobility speed metric is concerned, if the direction of movement is towards the BST, it is positive; whereas if the movement is away from the BST, it is negative (i.e., less optimality with increase in value).Hybrid gateway discovery mechanism is employed, every GWC belonging to a cluster tends to know information about its CH, using *TTl* Hence, it is sufficient for the GWSOL to reach a GWC of any cluster to get information about its CH, instead of reaching the CH. Each metric of the CH has its own threshold value. After a time instance Δt, if another vehicle becomes an active source for communicating with the UMTS BST, that source checks if the UMTS RSS of the serving gateway and its RET with the gateway are greater than the respective threshold values. If yes, the active source uses the same GW for communicating with the UMTS BST. Gateway handover is performed to elect a new gateway and handover the responsibilities of the serving gateway to it, when the serving gateway starts losing its optimality. A loss of optimality is accounted when either the value of the UMTS RSS of the serving gateway or its RET with any one of the vehicular sources goes below the respective threshold values. Handover, aims to sustain the inter-connectivity of the integrated network to pursue the data transaction. In this, the serving gateway broadcasts METRIC REQUEST packet within the VANET. Some of the CHs/GWCs which receive this packet respond, transmitting the metric values of their respective CHs. Of course, there is no common GWC between any two clusters. As a result of dynamic clustering, GW, which was the CH when it got elected, may not be the CH at another instance, as it may become a part of a new cluster. If its optimality, with respect to its sources, is affected, then the CH of the cluster in which the GW is present, may also respond to the METRIC REQUEST broadcast by the GW. The serving gateway elects one or more CHs with the maximum weights with respect to each of its vehicular sources. The vehicular sources are informed of the new gateway(s) by hybrid gateway discovery mechanism the vehicles communicate to the backhaul UMTS network using the newly elected GWs from them we integrate the periodic pro-active Gateway Advertisement (GWADV) and the on-demand reactive Gateway Solicitation (GWSOL). The gateway broadcasts its GWADV message within the cluster using *TTL* and every GWC within this cluster gets information about the GW. In case the CH is not the Gateway, it then broadcasts Cluster Advertisement (CA) about the CH/GW. Furthermore, once it seeks information about the GW, it should broadcast the information among the OVs in the VANET so that each OV gets information about the GW. Consequently, the TTL value of the source (TTL_s) should be the maximum of these hop distance values (i.e., maximum of hop distances between source and at least one GWC, and between source and the first OV (OV_1) in the VANET). It should be also noted that the nearest GWC will be at one-hop distance from the last OV (OV_n). Therefore, TTL_s is computed as:

$$TTL_s = MAX(d_{(s,b)}R_s, d_{(s,c)}R_s + 1) \qquad (2)$$

where, *b* and *c* denote the leading edge ordinary vehicle and the tail one, respectively,$d_{(s,b)}$ denotes the distance between a source vehicle *s* and a destination vehicle *m*. R_s is the wireless transmission range of the source vehicle *s*.

D.*EMDV STRATAGEY*

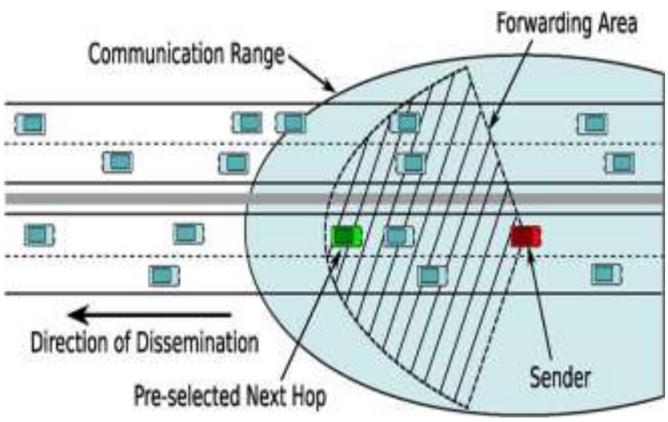

Fig 2: Emergency response for vehicle communication

Sensor networks offer the vehicular community of the capability to capture, process and communicate critical data through low-power, low-cost wireless devices. Applicable to various vehicle areas such as vehicle monitoring, disaster response, and road monitoring. During an emergency situation, sensor nodes must be able to adapt to a very large volume of traffic and collisions due to simultaneous transmissions. Nodes must accurately deliver the important information to the sink in no time. Moreover, in this emergency situation, energy efficiency of the communication protocol can be traded for the necessity of high throughput and low latency. In WSNs, Medium Access Control (MAC) plays an important role in a successful communication.

Motivated by the idealistic environments assumed to design existing forwarding strategies and by the findings in and , we propose the emergency message dissemination for vehicular environments (EMDV) strategy for the dissemination of safety critical information. EMDV is based on the following three design principles.

1) A contention scheme is used after the broadcast transmission of the message to deal with uncertainties in terms of reception failure caused by node mobility, fading phenomena, and collisions.

2) To minimize the delay, the contention strategy is complemented with the selection of one specific forwarder made at transmission time, referred to as the next hop. This step is possible due to the status information acquired from safety beacons. The specific forwarder, in case of correct reception, immediately forwards the message.

3) The reliability of the dissemination process is increased by the following factors:

I. Assuming a forwarding range shorter than the communication range and

II. A controlled message retransmission scheme within the dissemination area.

IV. *PERFORMANCE EVALUATION*

The proposed Clustering-based Multi-metric adaptive mobile Gateway Management mechanism (CMGM) is implemented in the Network Simulator NS2.33 using WAVE [11] and NS-Miracle [12]. The performance of the integrated network is evaluated in terms of Data Packet Delivery Ratio (DPDR), Control Packet Overhead (CPO) and packet drop fraction parameters. We used the AODV routing protocol incorporating our proposed CMGM mechanism, and evaluated its performance against AODV+ [14]] and DYMO [15]. For simulation purposes, the threshold values of the metrics for Gateway Migration are set to 25% of the initial values of the metrics possessed by the vehicles, when they were elected as GWs. The graph, shown in Fig. 3, demonstrates the good performance of the proposed CMGM in terms of higher DPDR, compared to the other two protocols, and that is for different numbers of vehicular sources in the VANET. The graph indicates that regardless of the underlying protocol, DPDR generally tends to decrease along with increase in the number of sources. The curves show a negative trend: as the number of sources increases, the packet drops also subsequently increase, especially when the gateway is on the verge of losing its optimality. By handover, another gateway assumes responsibility to proceed with the transactions. This explains the good performance of CMGM. Fig. 4 shows increase in CPO against the number of sources generating data. Though this is generally the trend, CMGM over AODV shows less CPO compared to the other protocols due to the fact that only minimum number of adequate gateways are elected for carrying on the transaction. Indeed, CMGM exhibits 12.07% and 23.39% decrease in CPO compared to AODV+ and DYMO, respectively. In Fig. 5, we plot DPDR achieved by the three protocols for different mobility speed variances of VANET vehicles. Concerning our proposed CMGM, we consider both the case when the selected gateway is moving towards the base station (Positive Criterion) and when it is moving away from it (Negative Criterion). In the figure, depending on the movement direction of the gateway with respect to BST, our proposed CMGM mechanism shows 18.79% and 2.96% improvement in terms of DPDR over AODV, and 22.75% and 10.65% improvement in DPDR over DYMO. In the graph shown in Fig. 6, performance of CPO is evaluated against the IEEE 802.11p wireless transmission range of vehicles. IEEE 802.11p transmission ranges of less than 225m may correspond to urban scenarios whereas transmission ranges exceeding 250m may correspond to highway scenarios. Intuitively, with short transmission ranges, many clusters of small sizes may be formed. This leads to high CPOs as indicated in Fig. 6. Short IEEE 802.11p transmission ranges result also in frequent gateway handoffs and consequently loss of in-flight packets during the handover process. Fig. 7 emphasizes the importance of having an optimal number of clusters. The packet drop fraction increases with the increase in the number of clusters. This is because the generation of control packets increases during the selection of gateways among CHs. This may result in congestion within the network resulting in wasteful consumption of available bandwidth, as a result of which error messages are flooded within the network. AODV in CMGM shows an improvement of 8.75% over AODV+ and 16.4% over DYMO in integrated VANET-Internet network, as gateway handover increases DPDR and hence, reduces the packet drop fraction.

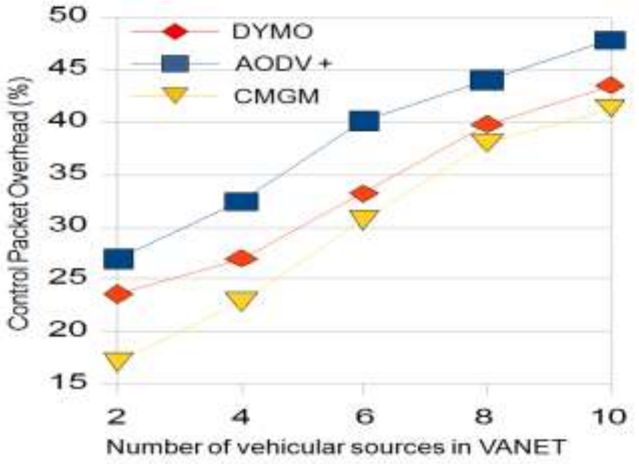

Fig. 4. control overhead for different number of vehicular sources in VANET.

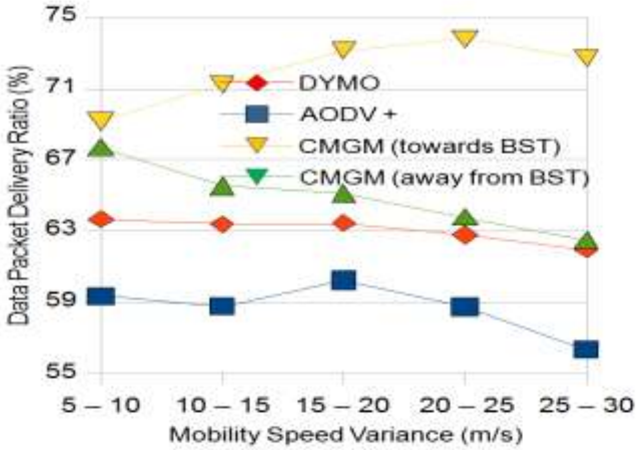

Fig. 5: data packet delivery for different mobility speed variances.

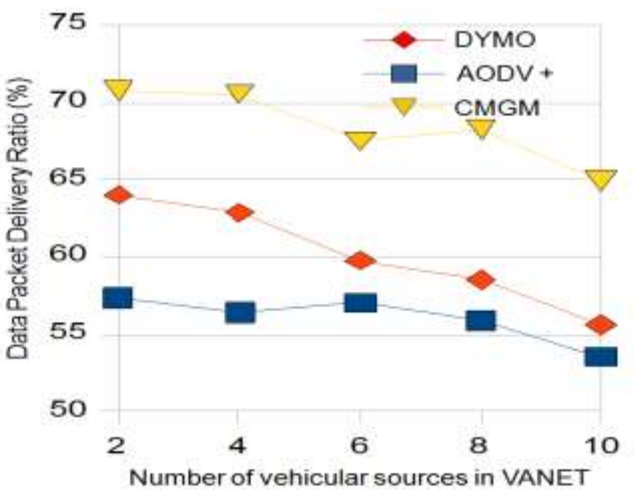

Fig. 3. data packet delivery for different numbers of vehicular sources in VANET

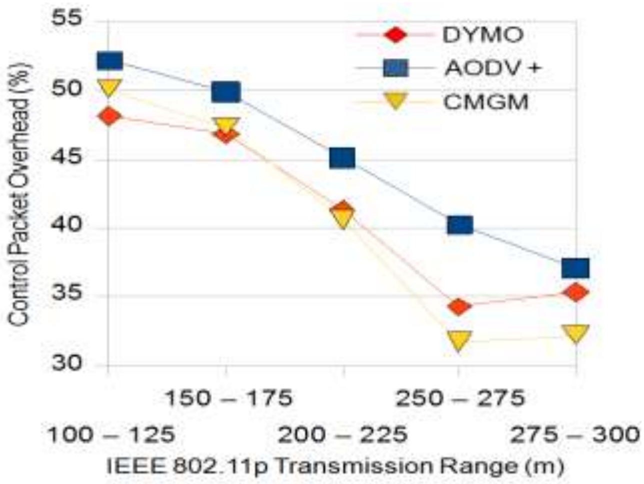

Fig. 6. CPO for different average IEEE 802.11p wireless transmission ranges.

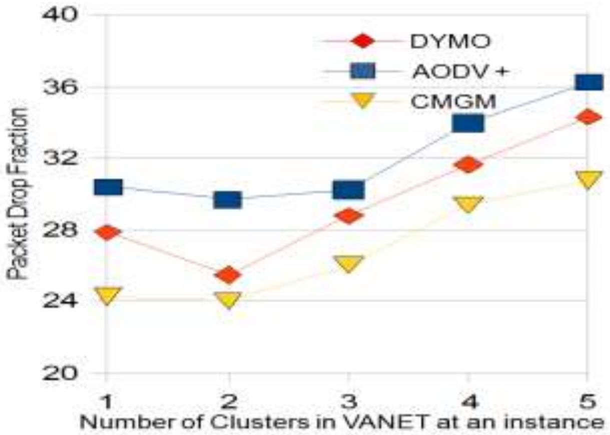

Fig. 7. Packet drop fraction for different numbers of clusters

V. CONCLUSION

In this paper, we introduced a network architecture that integrates VANET with UMTS and WIMAX. To enable such an integrated architecture, vehicles are clustered according to different metrics. A minimum number of adequate vehicles is selected to connect VANET and UMTS. Gateway management and selection is also performed in a dynamic manner using different metrics and in any emergency situation sensor nodes can deploy a high traffic to avoid that am EMDV strategy is used and CMGM is proposed. The performance of the overall architecture was evaluated using computer simulations and interesting results were obtained. As future research direction, we would like to investigate how QOS requirements can be reflected in the clustering of vehicles and the selection of vehicle gateways. This is to ensure that vehicles perform safety communication with each other to be maintained between vehicles. Moreover, certain vehicles such as ambulance, fire service vans, police patrols need to be given a high priority in our envisioned network architecture, as their requirements are crucial during emergency situations. In the proposed approach, the road conditions and speed of the vehicles are not considered. So In our future work, we consider all the other parameters to produce best solution.

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