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Proficient Mmins Algorithm in Integratedvanet-4G Milieu

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Abstract: This paper envisagehigh data rate IEEE 802.11p based VANET with the wide coverage area of 4G networks and forms VANET-LTE Integrated architecture. VANET issues are pertaining to base station tracing, intermediate node tracing, channel allocation, priority buffer, route discovery, link failure.In proposed Multi Metric Intermediate Node Selection (MMINS) the intermediate nodes are dynamically elected for efficient discovery based on metrics. Encouraging results are obtained in terms of high data packet delivery ratios and throughput, reduced control packet overhead and minimized delay packet drop rates and jitter. Also this paper increases the scalability, reliability, guarantees delivery and minimizes the link failure.

Key words: VANET · 4G-LTE · E-UTRAN · Buffer · Adaptive mobile gateway management

INTRODUCTION

Vehicular networks are receiving a lot of attention due tothe wide variety of services they can provide. The past decade has witnessed the emergence of Vehicular Ad-hoc Networks (VANETs), specializing from the well-known Mobile Ad Hoc Networks (MANETs). VANETs are spontaneously formed between moving vehicles equipped with wireless interfaces that could have similar or different radio interface technologies, employing short-range to medium-range communication systems. VANET provides communications among nearby vehicles (V2V) and between vehicles to nearby fixed equipment on the roadside (V2I). The VANET communication can be either done directly between vehicles as 'one-hop' communication, or vehicles can retransmit messages, thereby enabling multihop communication. To increase coverage and robustness of communication relays stations can be deployed by roadside. Roadside Units (RSUs) can also be used as a gateway to the Internet [1]. Long Term Evolution (LTE) is a cutting edge technology which includes some new extraordinary features that were never before used in wireless and mobile communications and which give LTE an advantage compared to other technologies. Apart from that, some features that were included in older releases of the current mobile telephony standard, called Universal Mobile Telecommunications System (UMTS), were improved and refined in order to provide LTE with the capability of performing better than any other mobile communications standard and in order for it to cover the needs of a great variety of applications. Some of these features areideal for use in the case of ITS applications, where the rapidlychanging environment and the very stringent delayrequirements, pose some very difficult performancerequirements on the communications scheme. With the use ofsome of these features the delays are minimized and theperformance of LTE can be optimized in order toaccommodate the special needs of the vehicular environmentsuch as low latency, transmission of small periodic packets,and reception of a transmission by multiple receivers etc. Inthis section, the features, functionality and capabilities of LTEwill be presented so that its role in a future ITS network canbe evaluated [2].

In this paper, an integration of VANET and 4G networks using mobile gateways (i.e., vehicles) is introduced. Theenvisioned architecture shall enable mobile data access forvehicles, anytime and anywhere. In particular, the integrationof IEEE 802.11-based multi-hop VANETs with 3G shallcontribute to the evolution of Beyond 3G (B3G) wirelesscommunication systems. As an integral part of thearchitecture, E-UTRAN interface enables mobile data accessto vehicles, offering a wide range of communication of around 100 km per BST [3].

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On the other hand, the enhanced versionof IEEE 802.11 networks, which is IEEE 802.11p, forms thestandards for Wireless Access for Vehicular Environments(WAVE). It operates at a frequency of 5.9 GHz, divided into 7 channels, each operating at a frequency of 10 MHz it providesa high data rate, ranging from 6 Mbps to 27 Mbps and a shortrangeradio communication of approximately 300 meters. Byintegrating VANET with LTE, high data rate can be coupledwith wide-range of communication. In the envisioned VANET-4G network, if one vehicle is connected to the LTEnetwork using its E-UTRAN interface, it can serve as a relaynode (i.e., mobile gateway) for other vehicles in its vicinity toaccess the 4G network, by receiving data from them (using itsIEEE 802.11p interface) and relaying the data to the LTE network. With such integration, dead spots in the network canbe minimized to a significant extent [4]. The LTE network is fixed in each vehicle. Each vehicle equipped with E-UTRAN Interface, to link VANET-LTE. The buffer is fixed in each vehicle for storing routing and other information.

Additionally, theenvisioned integration between VANET and LTE shall enablemobile operators to provide users on board vehicles withseamless data access to the operators' services at affordablerates and with minimum investment in the core networktechnology. Furthermore, the overall frequency of handoffoccurrences at base stations and the associated cost can bedramatically reduced [3]. In this paper, the review of existing literature is explained in section II and the envisioned VANET-LTE networkarchitecture is described in detail in section III. Theperformance of proposed system is analyzed for VANET,LTE and its integrated network separately described in sectionIV. The performance of proposed mechanism is devalued in section V. This paper concludes in section VI [4].

Review of Existing Literature: Gateway selection is a process that selects a potential gateway node out of multiple discovered gateway nodes based on network, link and path or gateway node parameters. In the literature, several gateway selection methods [5] have been proposed that consider different parameters to select a potential gateway node. Most of the gateway selection methods consider hop count, delay, link connectivity and residual load capacity of gateway nodes or a combination of these parameters. The gateway selection schemes in [6, 7] select a prospective gateway based on hop count. A gateway discovery message is broadcasted by the gateway and based on that message each node calculates its distance to the gateway. The gateway with the shortest path in terms of hop count is selected for relaying traffic from VANET to the infrastructure network. In [8], Congestion controlled adaptive multi-path routing protocol to achieve load balancing and avoid congestion in VANETs. The algorithm for finding multi-path routes computesfail-safe multiple paths, which provide all the intermediate nodes on the primary path with multiple routes to destination. Thefail-safe multiple paths include the nodes with least load and more battery power and residual energy. When the average load of a node along the route increases beyond a threshold, it distributes the traffic over disjoint multi-path routes to reduce the traffic load on a congested link. In [9], a weight based gateway selection algorithm is proposed. It calculates the weights of gateway nodes by considering residual battery power, speed of a gateway node and number of hops. The gateway with a higher weight is selected as a default gateway. This scheme slightly improves the network throughput; however, the end-to-end delay and packet drop ratio depends on the proper selection of the weighting factors, which is quite difficult in dynamic scenarios. In [10], AODV to resolve the problem through dynamic route switching method. Based on the delay of the multiple paths, a source node selects its route dynamically and checks the quality of the alternative routes according to the change of the ad hoc network. In [11], an adaptive Internet Gateway (IG) selection scheme is proposed that selects a gateway based on two parameters that are the maximum residual capacity of an IG and the minimum hop-count of a path between a node and an IG. In [12], Gateway discovery scheme suitable for real-timeapplications that adjust the frequency of gateway advertisements dynamically. This adjustment is related to the percentage ofreal-time sources that have quality of service problems because of excessive end-to-end delays. The optimal values for the configuration parameters (time interval and threshold) of the proposed adaptive gateway discovery mechanism for the selected network conditions have been studied with the aid of simulations. The scalability of the proposed scheme with respect to mobility as well as the impact of best-effort traffic load has been analyzed. Another gateway selection scheme that considers Mobility-Tracing-Value (MTV) as a basic criterion to select a gateway is proposed in [13]. If a neighbouring node does not receive a Hello message until its duration expires, then the MTV value increases. Hence, the larger value of MTV denotes the higher probability of link failure. A gateway node on a path with the minimum MTV is selected. If two routes have the same

Table 1: Comparison Between Existing and Proposed System

Existing System	Proposed system
Integrated VANET-3G network	Integrated VANET-4G network
Directional Antenna	Non-fixed channel assignment
Congestion control is not considered	Congestion is reduced by using buffer
Scalability and reliability not efficiently used	Scalability and Reliability will be increased
ADOV routing protocol will be used	TORA routing protocol will be used
Delivery packet ratio and throughput is increased.	Delivery packet ratio and throughput is increased
Data and voice services are slow compare to 4G	Fast data and voice services
Uplink and downlink is moderate	Fast uplink and downlink
Data rate is 56 Mbps for downlink and 26 Mbps for uplink	Downlink 1Gbps and uplink 500Mbps.
Average delay and packet drop ratio is considered	Jitter is considered.

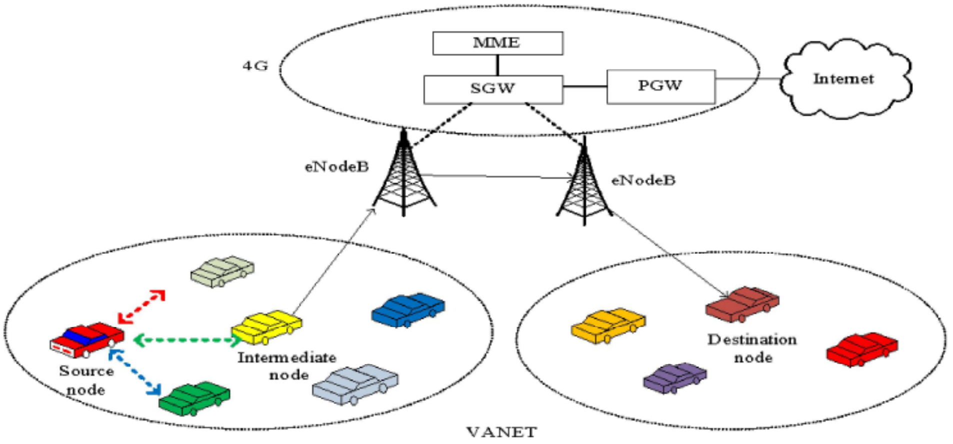

Fig. 1: Architecture of integrated VANET-4G

MTV value, then the hop count is the second option to select a gateway. In the proposed system the gateway is selected based on the algorithm it contains the following parameters such as signal strength, energy and buffer space. The Table 1 debit the comparison of the existing system and proposed system.

Proposed Vanet-4G Integrated Network Architecture: The envisionedVANET-LTE integrated network architecture is shown in Fig. 1. The vehicles in the VANETs are equipped with IEEE 802.11p radio interfaces. An LTE Evolved Node B (eNB) base station transceiver is deployed along each road and the two VANETs are assumed to be under the coverage region of different eNBs. The Evolved Universal Terrestrial Radio Access Network (E-UTRAN) interface enables the vehicles communicate to the eNB so as to access the core components of the LTE [6]. The main purpose of our paper is to analysis theperformance of integrated VANET-LTE wireless networks for effective group communication between the spatially-apart VANETs through the LTE network, making the best use of E-UTRAN and eNB resources. Optimal end-to-end group communication requires effective lower-level multicasting within VANETs and upper-level communication with the LTE eNB. The architecture focuses on clusterless environment for selecting the gateway. Referring to the architecture shown in Fig. 1, the region within the LTE eNB's coverage, where the LTE received signal strength is intense. Vehicles in the VANET, which are lying in or moving into the 4G a region and equipped with the E-UTRAN interface, are termed as the Gateway Candidates (GWCs). The E-UTRAN interface is enabled on the GWCs. Rest of the vehicles that are either not instantaneously present in the 4G region or unequipped with LTE E-UTRAN interfaces are termed as Ordinary Vehicles (OVs). The E-UTRAN interface is either absent or disabled on them. In group communication scenarios, multi-casting within VANETs is controlled and co-ordinated by the gateway. A minimum number of gateways (GWs) are adequately electedout of them. Only the GWs are activated with their E-UTRAN interfaces to communicate with the LTE eNB. Based on these requirements, the LTE eNB broadcast data to GW, which shall further multicast data to the intended destination vehicles. It is to be noted that the 4G region is only a portion of the entire coverage boundary of the LTE eNB [14].

Features of E-Utran: Peak download rates of 299.6 Mbit/s for 4×4 antennas and 150.8 Mbit/s for 2×2 antennas with 20 MHz of spectrum. LTE Advanced supports 8×8 antenna configurations with peak download rates of 2,998.6 Mbit/s in an aggregated 100 MHz channel, Peak upload rates of 75.4 Mbit/s for a 20 MHz channel in the LTE standard, with up to 1,497.8 Mbit/s in an LTE Advanced 100 MHz carrier.Compared with UTRAN, the E-UTRAN OFDM-based structure is quite simple. It is only composed of one network element: the eNodeB (for evolved Node B.). The 3G RNC (Radio Network Controller) inherited from the 2G BSC (Base Station Controller) has disappeared from E-UTRAN and the eNodeB is directly connected to the Core Network using the interface. As a consequence, the features supported by the RNC have been distributed between the eNodeB or the Core Network MME or Serving Gateway. Evolved Universal Terrestial Radio Access eUTRAN Node B is eNodeB. It is a radio base station that is in the control of all radio related functions in the fixed part of the system. eNodeB are distributed throughout the network coverage area. It is also responsible for header compression, ciphering and reliable delivery of packets. MME main function is to manage the users' mobility. In addition is also to perform authentication, authorization and user tracking.Serving gateway forwards the routes packets to and from the eNodeB and the Packet Data Network Gateway (PDN GW).The SGW also serves as the local mobility anchor for inter-eNodeB handover and roaming between two 3GPP systems.The PDN GW act as a interface between the LTE network and the PDN. The PDN GW is the mobility anchor point for mobility between 3GPP and non 3GPP access System. The function is responsible for IP address allocation, charging, deep packet inspection and other services [15].

Gateway Selection in Clusterless Environment: The clusterless system contributes to effective broadcasting and relaying of messages and increases the stability of inter-vehicular links within the VANET. In this paper, gateway selection in clusterless is performed following three steps, based on the direction of vehicles' movement (θ), LTE Received Signal Strength (RSS) and inter-vehicular distance (IVD), buffer size respectively.

Gateway Selection Based on Direction of Movement: Cluster less is performed on the basis of direction of movement in two stages. Initially, it is carried out relative to their moving directions and then relative to the position of the LTEeNode B. The directional-antenna-based MAC protocols can be utilized to accurately group vehicles on the basis of the direction of their movements in the Cartesian space. In such MAC protocols, thetransmission surface of vehicles is split into M transmission angles ($D1, D2,. ., DM$) of equal degrees ($360/M$). In a Cartesian space, each group is characterized by a vector $SN = (Cos\theta_{Ni}, Sin\theta_{Ni})$, where θ_{Ni} denotes the angle of inclination. A vehicle uses its GPS device to determine its angle of inclination θ_{Ni} and then determines its vector co-ordinates (SN) in the Cartesianspace. Then, vehicles, in each angle formed as above, are elected as a vehicles moving towards the BST and another group moving away from the BST [16].

Gateway Selection Based on Lte Signal Strength: To refine the clusterless operation, the LTE Received Signal Strength (RSS) is used. The rationale behind using the LTE signal strength lies in its better consistency compared to metrics such as mobility speed. Additionally, the mobility speed of vehicles, moving along a particular direction, is implicitly reflected in their LTE RSS. Irrespective of the variation in the mobility speed of the vehicles, the LTE RSS keeps increasing if the vehicles move towards the base station and vice versa. However, the faster a vehicle moves towards the BST, the faster will be the increase in its received LTE signal strength. Similarly, the faster the vehicle moves away from the base station, the faster will be its decline in the RSS. This is characterized by the rate constant a and the variation in the velocities, as shown in the equations below. In case a vehicle is moving towards the BST, the equation LTE RSS of the vehicle at a time instant t can be expressed as follows:

$$\mathrm{RSS}_{ti} = \mathrm{RSS}_{ti-1} + (1 - e - |\mathrm{v}_{ti} - v_{ti-1}|\, a) \tag{1}$$

Similarly, in case a vehicle is moving away from the BST,the equation(2) describes the LTE RSS of the vehicle at an instance $ti$is given by:

$$\mathrm{RSS}_{ti} = RSS_{it-1} - (1 - e - |v_{ti} - v_{it-1}|\, a) \tag{2}$$

where,

- RSS_{ti} and RSS_{it-1} denote the values of the LTE signal strength received at time instances t and (ti - 1), respectively, $v_{ti}$and v_{it-1} denote the values of the mobility speed of the vehicles at time instances t and (ti-1) such that $0 < v_{ti-1}, v_{ti} < v_{MAX}$, where $v_{MAX}$is the maximum speed of the vehicle,

- $|v_{ti} - v_{ti-1}|$ represents the magnitude of the difference in the mobility speed of the vehicle at t and (ti-1),
- $(1-e- |v_{ti} -v_{ti-1}|\ a)$ is the function denoting the variation inthe UMTS signal strength by the corresponding variation in the mobility speed of vehicles and
- a is a constant that defines the rate of variation of the LTE signal strength for a unit increase or decrease in the mobility speed, in a particular movement direction, relative to the position of the LTE BST. In general, the LTE RSS of a vehicle, relative to its initial signal strength value RSS_0 and the position of thee quation(3) describes[17],

LTE BST, is given by:

$$RSS = RSS_0 \pm \_ v_{MAX}(1 - e^{-va})\ dv \tag{3}$$

Using the LTE RSS, vehicles in each sub-cluster, formedat the first step, equipped with the E-UTRA network interfaces and lying within or moving into the 4G region, become Gateway Candidates (GWCs). They would receive intense LTE RSS (i.e., greater than a specific Signal Strength threshold SS_{Th}). Their E-UTRA interface is enabled.

Gateway Selection Based on IEEE 802.11p Wireless Transmissionrange: Having cluster less vehicles based on their directions of movement and the LTE signal strength, the next stepis using their IEEE 802.11p wireless Transmission range: a pair of GWCs, whose inter-vehicular distance is less than or equal to their IEEE 802.11p transmission range. The equation(4) describes transmissionrange of a GWC vehicle is determined as follows:

$$Rang = T_{rg}.(1 - \_{}_i) \tag{4}$$

where, T_{rg} denotes the maximum IEEE 802.11p transmission range andreflects the wireless channel fading conditions in the current location. For instance,can be set to small values in environments with no major obstacles (e.g., highway) and takes high values in urban areas with tall buildings. Amapping function between the geographical locations and the values of can be provided by the used positioning system (e.g., GPS, Galileo), while taking into account, the weather conditions.

Gateway Selection Based on Buffer Technique: G/G/1 System -Same as M/G/1 but now the packet interarrival time distribution is also general, with mean l and variance g^2. We still assume FIFO and independent interarrival times and packet transmission times .Heavy traffic approximation: Average time in queue ~ $l(s^2 + g^2)/2(1- r)$ Becomes increasingly accurate as r®1.

Multi Metric Intermediate Node Selection Algorithm:

Algorithm: MMINS

Input: Metrics Output: Best Node

```
MMINS
{
Sn=Source node sends broadcast messages to all nodes within the range in the VANET milieu
Sn
        Retrieve following metrics
       {
       Check Direction (Dr)(Towards base station or Away base station (BS)
        Or Destination(Dt))
       {
       Return Positive if Dr towards the BS or Dt
       Select positive node
       Scanning energy level and buffer space of the positive node
       }
       }

       Intermediate node=Max (Energy, Buffer space)
ACTIVATE 4G E-UTRAN interface for newly elected INTERMEDIATE NODE to
Communicate with LTE BASE STATION and then send to DESTINATION.
}
```

The source node sends broadcast messages to all nodes in the VANET environment. There are many intermediate node but the best intermediate node is selected. It can be selected based on the following metrics such as direction, energy and the buffer space. The direction is based on the movement of vehicle. Check direction of the node that is towards the base station or away from the base station. Towards the base station the value is positive and away from the base station the value is negative. The value is positive negative based on the signal strength of eNode because if the node direction is towards the base station the signal is high and away from the base station signal is low. Select only the positive node. Scanning the energy level and the buffer space of the positive node. Energy is calculated based on the battery life of the vehicle. Buffer is fixed in each vehicle hence the vehicle with high buffer space is elected. Select the maximum of the energy and buffer space of node as intermediate node. Then the intermediate nodes act as a gateway and activate its 4G E-UTRAN interface to communicate with LTE Base station. The base station checks its coverage area for destination if it does not found it communicates with another base station and finds the destination to deliver the packet.

Performance Evaluation:

- The proposed Clusterless gateway selection mechanism is implemented in the Network Stimulator NS2.33 We use the IEEE802.11p Wireless Access in Vehicular Environment (WAVE) protocol which is defined in order to enable communication among high-speed vehicles or between a vehicle and a roadside infrastructure network. Papers [14, 16] give insights on some measurements of the WAVE protocol using NS2.The conducted measurements pertain to the aggregate throughput, average delay and packet losses. Integration of IEEE 802.11p and UMTS-UTRAN network interfaces, resulting in a B3G network, is implemented using Multi-interface Cross Layer Extension for NS2 [15]. It is a set of libraries which enhance the functionalities offered by NS2 for handling cross-layer messages and enabling co-existence of multiple modules within each layer of the protocol stack. For creating a mobile terminal with dual interfaces, the IEEE 802.11 and the UMTS libraries of NS-Miracle were used. The scenario consists of a VANET connected to the UMTS network via the UTRAN interface. Tables 2 and 3 list the simulation parameters of the VANET and UMTS networks, respectively.

The performance of the integrated network is evaluated in terms of Data Packet Delivery Ratio (DPDR), Control Packet Overhead (CPO), throughput, Packet Drop Fraction and delay and Jitter parameters, defined as follows:

- Packet Delivery Ratio: It is defined as the ratio of the total number of successfully transmitted data packets to the total number of data packets sent from the source to the destination.
- End-End Delay: It refers to the time taken for a packet to be transmitted across a network from source to destination.

Table 2: NS2 Stimulation Parameters for Vanet

Parameters	Value
Area	7000 x 1000(m^2)
Channel	Channel/Wireless Channel
Propagation model	Propagation/Nakagami
Network Interface	Phy/WirelessPhyExt
MAC Interface	Mac/802_IntEXT
Peak Wireless Transmission Range	300m
Interface Queue Type	Queue/DropTail/PriQueue
Interface Queue length	30 packets
Antenna Type	Antenna/Omni Antenna
Routing Protocol	MMINS
Total number of VANET Vehicles	40
Peak Mobility speed	20ms^{-1}
Mobility Model	Manhattan mobility model
LTE RSS Threshold	-94 Dbm
Transport-Layer protocol	TCP/Newreno
Application	FTP
Packet Size	1 KB

Table 3: NS2 Stimulation Parameters for Lte

Parameters	Value
Uplink Frequency	1.732 GHZ
Downlink Frequency	2.225 GHZ
Peak E-UTRAN Uplink channel Bit Rate	324 K bps
Peak E-UTRAN Downlink channel Bit rate	3 Mbps
Transmission Range of e Node B	15 Km
Node B Interface Queue length	20 packets
LTE Node B – RNC Data Rate	720 Mbps (Transmission Time Internal (TTI): 1 ms)
RNC-SGSN Data srate	722 Mbps (TTI: 1 ms)
SGSN-PGSN Date rate	722 Mbps (TTI:10 ms)
PGSN-External IP network data rate	20 Mbps (TTI:20 ms)
Routing Protocol	4G pro-active routing

- Through put: It is the sum of the data rates that are delivered to all terminals in a network. It is essentially to digital bandwidth consumption and can be analysed mathematically by means of queuing theory.
- Control Packet Overhead: It measures the ratio of the total number of control packets to the total number of packets generated within the integrated network.
- Packet Drop Rate: It is the ratio of the number of unsuccessfully transmitted packets to the total number of packets sent from the VANET sources.
- JITTER: It is defined as the deviation in time of the received signal.

In the simulations, the clusterless mechanism is dynamically performed every, CMGM mechanisms can be implemented on top of any VANET routing protocol, we consider the usage of the reactive Ad-hoc On-demand

Distance Vector (AODV) as it copes efficiently with the highly dynamic nature of VANETs. As comparison terms, we implement Multi-metric Gateway Selection Algorithm(MGSA) over AODV+ and Dynamic MANET On demand(DYMO) routing protocol, which has been also tested in integrated VANET-Internet scenariosand Whilst our proposed Multi Metric Intermediate Node Selection (MMINS) is over AODV and it can be performed for very efficiency. AODV+ enables the usage of AODV as an ad hoc routing protocol for simulation of wired-cum-wireless scenarios, especially for internet connectivity to an ad hoc network. DYMO is a new reactive routing protocol, tested in a VANET environment providing enhanced features such as covering possible MANET-Internet gateway scenarios. The major difference between DYMO and AODV is that DYMO stores information for each intermediate hop, whereas AODV stores information about only the source and destination nodes. In Algorithm, migration from a serving gateway to a newly elected one takes place if the serving gateway gets its optimality downgraded by a specific ratio. Without any purpose in mind, we set this ratio to 50% in the simulations. Additionally, the priorityfactors for the three metrics, used in Algorithm of MMINS, are assigned equal values (i.e., $Xi = 1/3$ for i=1, 2, 3).

The graph, shown in Fig. 2, demonstrates the good performance of the proposed MMINS in terms of higher MGSA, 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, MGSA generally tends to decrease along with increase in the number of sources. The curves show a negative trend. Indeed, the number of sources increases, the packet drops subsequently increase, especially when the gateway is on the average of losing its optimality. By handover, another gateway assumes responsibility to proceed with the transactions and hence the good performance of CMGM.

Fig. 3 shows increase in DPD against the number of sources generating data. Though this is generally the trend, CMGM over AODV shows less CPO compared to the other protocols. This is due to the fact that only minimum numbers of adequate gateways are elected for carrying on the transaction, which significantly reduces CPOdue to multiple gateways, as in the case of MGSA. However, a small amount of overhead is involved during handover. Indeed, MMINS exhibits 12.07% and 23.39% decrease in CPO compared to ”AODV+ in MMINS” One of the main differences between MGSA, CMGM and our proposed MMINS mechanisms consists in the fact that mobility is considered as a highly important metric in MMINS whilst it is overlooked in CMGM.

In Fig. 4, we plot achieved by the protocols for different mobility speed variances of VANET vehicles. Concerning our proposed MMINS, we consider both the case when the selected gateway is moving towards the base station and when it is moving away from.In the figure, depending on the movement direction of the gateway with respect to BST, our proposed MMINS mechanism shows 20.79% and 4.96% improvement in terms of DPDR over ”AODV+ in MGSA” and 22.75% and 10.65%improvement in MMINS over CMGM.

The performance of the three protocols in terms of CPOconsidering different mobility speeds is illustrated in Fig. 5. In case the serving gateway moves towards BST, it keeps receiving good LTE RSS, maintaining its optimality and therefore minimizing the number of control messages that could be, otherwise, associated with gateway reselection and handover. This is also applicable to CHs. As a result, the trend in CPO is negative when the gateway moves towards the BST and positive when it moves away from the BST. On average and depending on the movement towards or from BST, the proposed MMINS yields 18.71% to 24.24%improvement in reducing CPO compared with ”AODV+ in MGSA” and 24.97% to 29.45% improvement compared to DYMO in VANET-Internet integrated network.

The graphs of Figs. 6 and show the performance of the three simulated protocols, in terms of MGSA and DPD respectively, for different values of the IEEE 802.11p wireless transmission ranges. In the graphs, 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. 7. Short IEEE 802.11ptransmission ranges result also in frequent gateway handoffs and consequently loss of in-flight packets during the migration process.

In Fig. 8, the achieved average individual throughput at the LTE BST is plotted for different numbers of clusters. In case there are many VANET clusters, MMINS would be able to select optimal gateways and to support service continuity. Indeed, in AODV in MMINS shows an improvement of 15.22% and 7.09% in throughput over AODV+ in MGSA and DYMO in integrated VANET-Internetscenario, respectivelythe selected gateways will be overloaded with data packets;

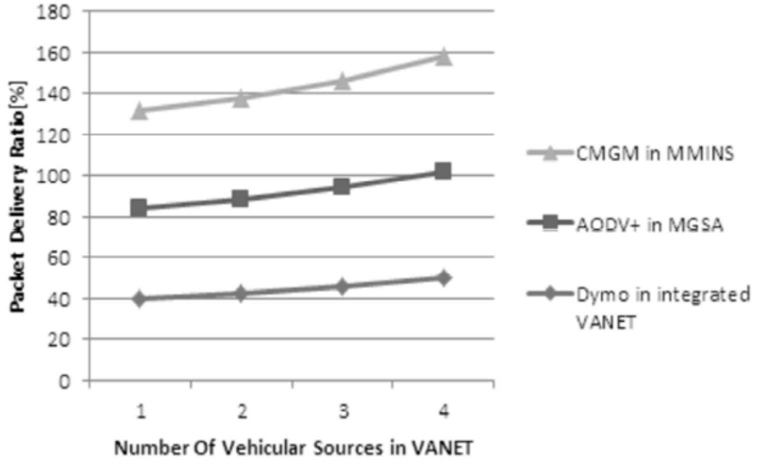

Fig. 2: Performance of the three protocols in terms of data packet delivery For different numbers of vehicular sources in VANET

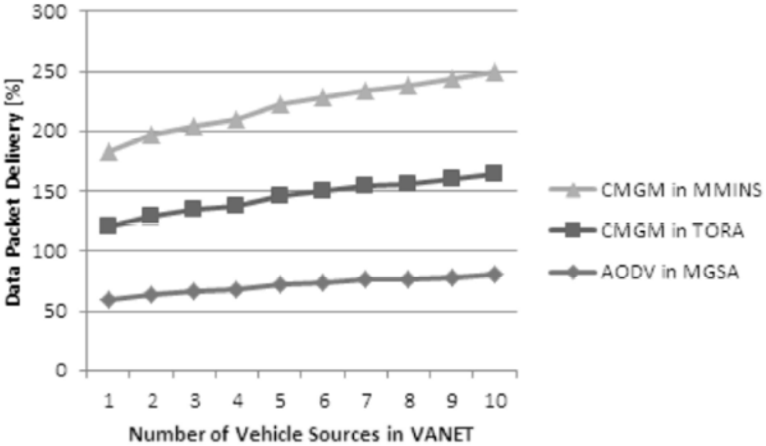

Fig. 3: Performance of the three protocols in terms of data packet delivery for different numbers of vehicular sources in VANET

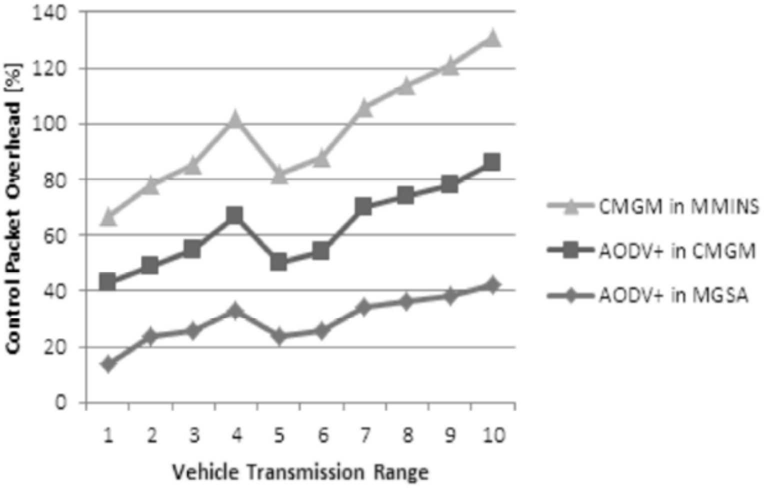

Fig. 4: Performance of the three protocols in terms of control packet overhead and Vehicle transmission range sin VANET

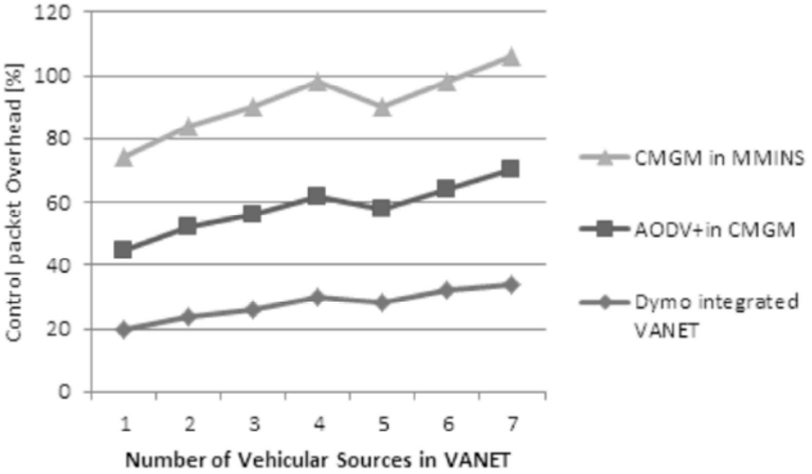

Fig. 5: Performance of the three protocols in terms of control overhead for different number of vehicular sources in VANET

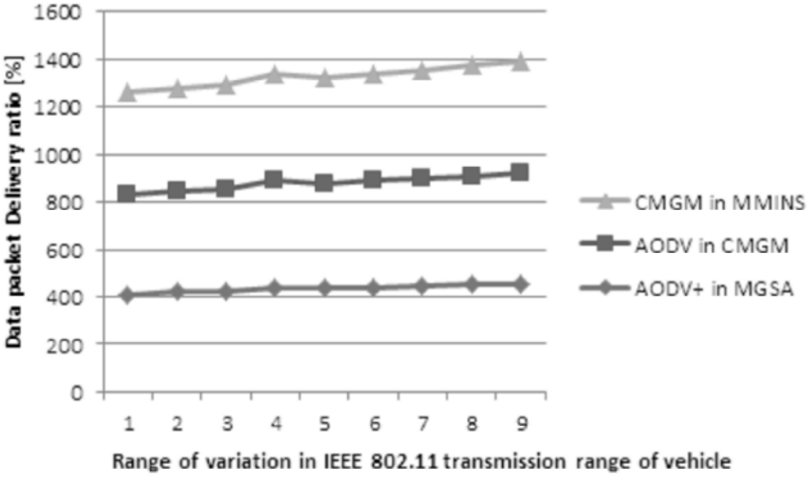

Fig. 6: DPDR for different average IEEE 802.11p wireless transmission ranges

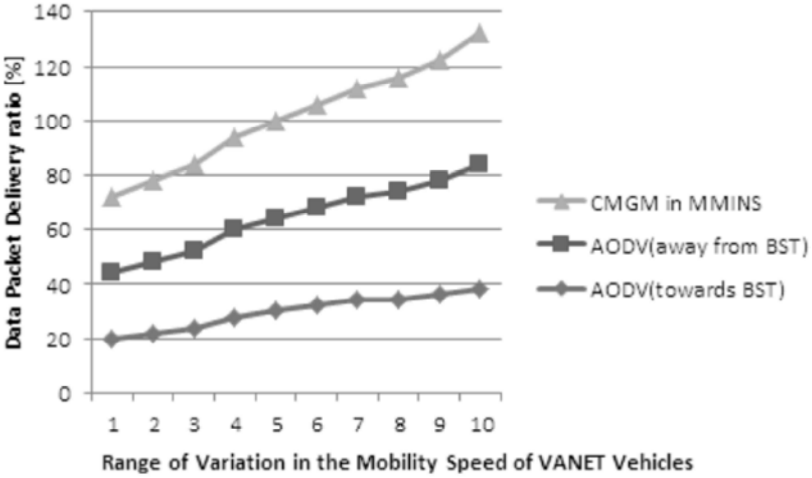

Fig. 7: Performance of the three protocols in terms of data packet delivery for different mobility speed of vehicles

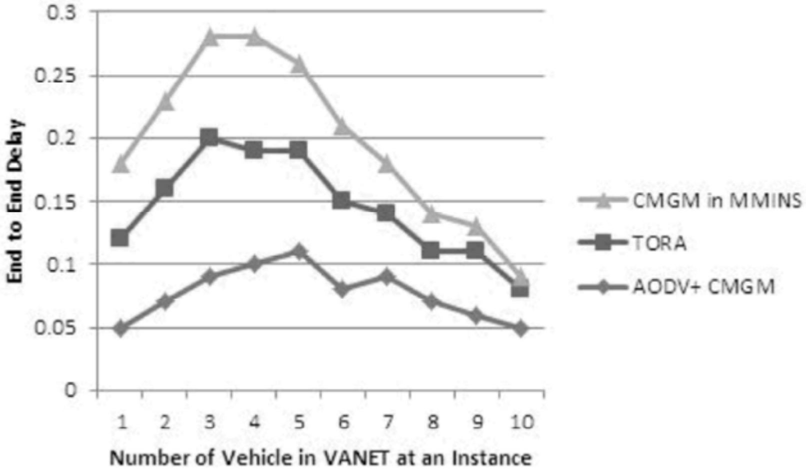

Fig. 8: Performance of the three protocols in terms of End to End delivery and number of vehicle in VANET

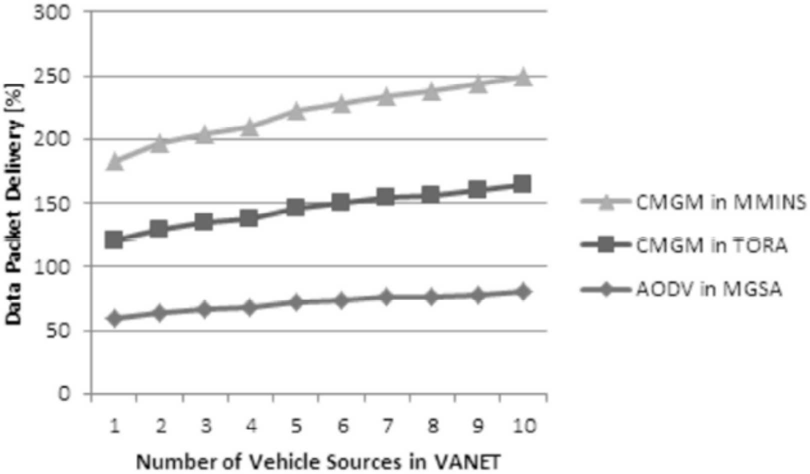

Fig. 9: Performance of the three protocols in terms of data packet delivery and number of vehicle in VANET

some of which will be discarded, ultimately impacting the throughput. Hence, the first set of readings in the figure does not show a big difference in the throughput achieved by the three protocols.

Italso emphasizes the importance of having an optimal value of the number of sub-clusters. As stated above, with an increase in the number of clusters, the generation of control packets increases during selection of gateways from the CHs. This may result in congestion within the network, resulting in unwanted consumption of available bandwidth, as a result ofwhich error messages are flooded within the network. Hence, the trend of Packet Drop Fraction is generally positive. AODV in CMGM shows an improvement of 8.75% over AODV+ in MGSA and 16.4% over DYMO in integrated VANET-Internet network.we proposed our MMINS is improvement of 10.75% over AODV in CMGM.

In Fig. 9, the time elapsed since the broadcasting of a GWSOL message (by a particular source) till the establishment of a path between the source and an adequate gateway is plotted for varying numbers of VANET clusters. The difference between CMGM and MGSA, as stated earlier, isthat CMGM selects a minimum number of CHs as gateways. A new gateway is elected for handover support, provided that the optimality of the serving gateway downgrades by a certain ratio. On the other hand, in MGSA, each vehicular source selects its own gateway without checking the threshold values of the metrics. This may result in the selection of multiplegateways, more than the optimal number of gateways. As thereare more gateways in MGSA, the experienced delay becomes longer. Hence, on average, our existing CMGM mechanismexhibits 9.17% less delay in establishment of a path towards the gateways than

AODV+ in MGSA.but, we proposed in our MMINS and TORA is exhibits 7.15% less delay in establishment of a path towards the gateway than CMGM.

CONCLUSION

In this paper, we introduced a new architecture that integrates 4G/LTE networks with VANET networks. In this architecture, all vehicles able to connect the LTE network.Direction of the vehicle, Buffer space, Energy, inter vehicle distance and signal strength of vehicles are all taken into consideration. The MMINS algorithm is used for selecting the best intermediate node. The intermediate node act as a gateway.The proposed algorithm reducesthe end-to-end delay, packet drop rate, increase the throughput. On other hand, by selecting the mobile gateway to operate at an instance, bottlenecks and congestion can be eliminated. The performance of the overall architecture was evaluated using computer simulations and encouraging results were obtained.

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