Detection & Management of Traffic Congestion Using VANET

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ABSTRACT

To avoid accidents and traffic jams on the roads vehicular ad hoc networks (VANETs) is the best solution which provides IEEE 802.11p based wireless communication between vehicles to vehicles and vehicles to infrastructure which operates in the Dedicated Short Range Communication (DSRC), frequency band of 5.85-5.925 GHz. These types of communications allow vehicles to share different kinds of information like traffic safety information, vehicles speed, and position, provided by the number of sensors.

Road safety has become a main issue for governments and car manufacturers in the last twenty years. For every citizen of metropolitan cities getting struck in long traffic jams has been the major concern of the era. The evolution of wireless technologies has allowed researchers to design communication systems where vehicles can participate in the communication networks. This paper aims at creating a healthy communication network among the vehicles so that every other vehicle on the road can get to know the traffic situation ahead on the lane by communicating with the vehicles ahead so that the driver can take a adequate decision of changing the path or staying on the same path. This system will trigger a message every time it faces over traffic situation on the road. This situation will be judged by the traffic simulators on the traffic lights. And the message will be forwarded by a decentralized type of wireless network called ad hoc network generated by taking cars as nodes. The system will be useful in preventing the never ending and annoying traffic jams on roads and will save the precious time of the people.

Keywords— Vehicular ad hoc networks (VANETs), Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), Dedicated Short Range Communication (DSRC)

I.INTRODUCTION

Vehicular Ad Hoc Networks (VANETs) have grown out of the need to support the growing number of wireless products that can now be used in vehicles These products include remote keyless entry devices, personal digital assistants (PDAs), laptops and mobile telephones. As mobile wireless devices and networks become increasingly important, the demand for Vehicle-to-Vehicle (V2V) and Vehicle-to-Roadside (VRC) or Vehicle-to-Infrastructure (V2I) Communication will continue to grow. VANETs can be utilized for a broad range of safety and non-safety applications, allow for value added services such as vehicle safety, automated toll payment, traffic management, enhanced navigation, location-based services such as finding the closest fuel station, restaurant or travel lodge and infotainment applications such as providing access to the Internet.

The growing population of India has created many problems one of the challenging ones being car parking. Besides the problem of space for cars moving on the road, greater is the problem of space for a parked vehicle considering that private vehicles remain parked for most of their time. While residential projects still escape with designated parking, the real problem lie with commercial spaces many a time which is overcome by taking extra open spaces to park.

India is among the fast developing nations in the world which have the highest density of public and private vehicles. It has always been a cumbersome task to manage traffic in India. High traffic density is result of variable predictable and unpredictable factors. Predictable factors include road construction sites or peak hours of travel (i.e. office hours) about which drivers are aware, whereas unpredictable factors include weather conditions, accidents and human behavior. Such congestion problems can be avoided if drivers are pre-aware of these traffic bottlenecks.

II.PROBLEM OF CONGESTION & PARKING IN NASHIK

Nashik has grown from a population of 21940 in 1901 to 1077236 in 2001and and 14.86 lakhs in 2011 and current population of Nashik is approx. 18 lakhs. Population growth rate of Nashik has been constantly more than any of the cities in the Maharashtra state, and is the fourth largest city in terms of existing population. The projected population for the year 2031 is 37.5 lakhs. Nashik is situated on Delhi – Mumbai Industrial Corridor (DMIC) which is being developed by Government of India as dedicated freight corridor between Delhi and Mumbai. Nashik is also one of the important cities of the golden triangle project of Govt. of Maharashtra. The National Highway No.3 i.e. Mumbai Agra road connects Nashik to important cities of Nashik and National Highway No.50 connects Nashik to Pune.

Nashik city traffic consists of mixed traffic of slow and fast moving vehicles Also cycles and pedestrian traffic is encountered in the arterial. Due to inadequate width of carriageway and low vehicle speed, the carrying capacity of the roads is hampered by frequent congestion.

Fig1. Traffic congestion at Nashik

In the year 2001, urban population is 27.8% but it is likely to increase to 38% and 47.5% in the year 2031 and 2051 respectively and provision of transportation infrastructure is a tough task for such huge population. As per survey of City Mayor foundation Nashik is the 16th fastest growing city in the world.

Working Group on Urban Transport for 12th Plan period (2012-17) has highlighted a number of causes leading to urban congestion, including inefficient urban planning and poor implementation of regulations, lack of adequate urban infrastructure. Thus, it becomes imperative to understand the sources of congestion and provide a smart solution for addressing these issues in a comprehensive manner, including policies such as congestion pricing, parking policies, land use planning .

III.VANET AS A SMART SOLUTION

The Vehicular Ad-Hoc Network is an emerging technology to achieve intelligent inter-vehicle communications, seamless internet connectivity resulting in improved road safety, essential alerts and accessing comforts and entertainments. The technology integrates WLAN/cellular and Ad Hoc networks to achieve the continuous connectivity. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to connect and, in turn, create a network with a wide range. As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created.

This paper discusses how VANETs have been used in detecting traffic density and parking management solutions in India. The aim of VANET is to provide a safety for drivers and other road users, savings space upwards of 70 percent, reduces total parking cost, environmental friendly and provides higher throughput with faster operations. VANET is a vast subject of study which is used to implement many components of IT. VANETs are blend of both Inter-Vehicular Communication (IVC) and Road-Vehicular Communication (RVC) .Communication in VANET can be facilitated in two ways: (i) Vehicle-to-Vehicle (V2V) (ii) Vehicle-to-Infrastructure (V2I). Every moving car is assumed to be a node which in turn communicates either with nearby node or other nearby fixed equipment.

IV.OVERVIEW OF VANET

4.1 Intelligent transportation systems (ITSs)

In intelligent transportation systems, each vehicle takes on the role of sender, receiver, and router to broadcast information to the vehicular network or transportation agency, which then uses the information to ensure safe, free-flow of traffic. For communication to occur between vehicles and Roadside Units (RSUs) vehicles must be equipped with some sort of radio interface or Onboard Unit (OBU) that enables short-range wireless ad hoc networks to be formed. Vehicles must also be fitted with hardware that permits detailed position information such as Global Positioning System (GPS) or a Differential Global Positioning System (DGPS) receiver. Fixed RSUs, which are connected to the backbone network, must be in place to facilitate communication. The number and distribution of roadside units is dependent on the communication protocol is to be used. For example, some protocols require roadside units to be distributed evenly throughout the whole road network; some require roadside units only at intersections, while others require roadside units only at region borders. Though it is safe to assume that infrastructure exists to some extent and vehicles have access to it intermittently, it is unrealistic to require that vehicles always have wireless access to roadside units. Figures 2, 3 and 4 depict the possible communication configurations in intelligent transportation systems. These include inter-vehicle, vehicle-to roadside and routing-based communications.

4.2 V2V Communication

Vehicle-to-vehicle (V2V) communications comprises a wireless network where vehicle send messages to each other with information about what they're doing. This data would include speed, location, braking, and loss of stability and also the driver is in a sleepy state or not. V2V would be a mesh network, meaning every node (car, smart traffic signal, etc.) could send, capture and retransmit signals.

On below of the situation is of V2V communication wherever the road has been style and on it street road the nodes can create that represent a vehicle. Wherever some general nodes are created that represent a bunch of car to create a cluster. This vehicle node then communicates with one another to send and alert messages.

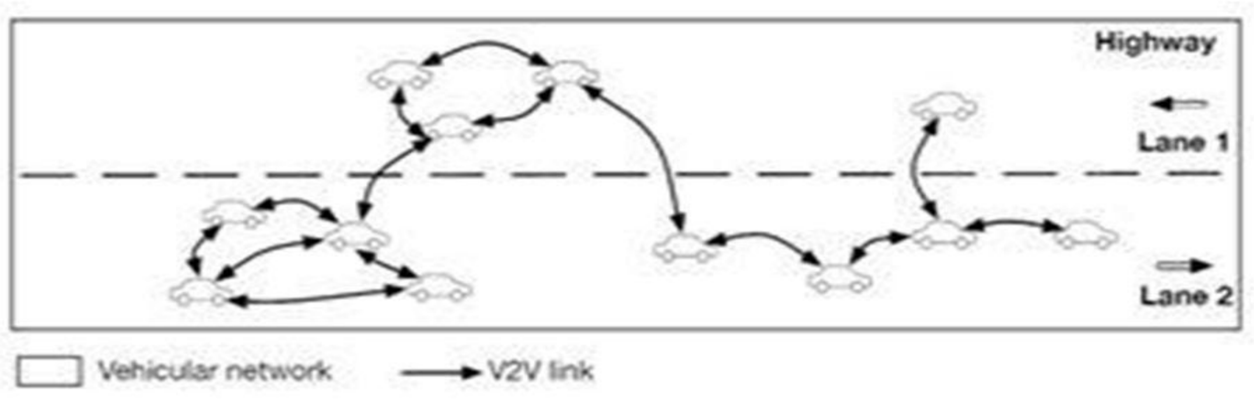

Fig.2. V2V Communication

4.3 Vehicle-to-roadside communication

The vehicle-to-roadside communication configuration (Fig.3) represents a single hop broadcast where the roadside Unit sends a broadcast message to all equipped vehicles in the vicinity. Vehicle-to-roadside communication configuration provides a high bandwidth link between vehicles and roadside units. The roadside units may be placed every kilometer or less, enabling high data rates to be maintained in heavy traffic. For instance, when broadcasting dynamic speed limits, the roadside unit will determine the appropriate speed limit according to its internal timetable and traffic conditions. The roadside unit will periodically broadcast a message containing the speed limit and will compare any geographic or directional limits with vehicle data to determine if a speed limit warning applies to any of the vehicles in the vicinity. If a vehicle violates the desired speed limit, a broadcast will be delivered to the vehicle in the form of an auditory or visual warning, requesting that the driver reduce his speed.

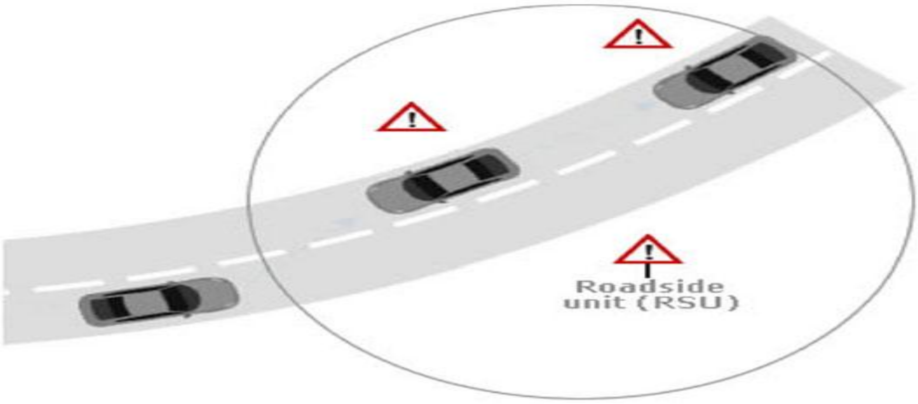

Fig.3. Vehicle-to-roadside communication

4.4 Routing-based communication

The routing-based communication configuration (Fig. 4) is a multi-hop unicast where a message is propagated in a multi-hop fashion until the vehicle carrying the desired data is reached. When the query is received by a vehicle owning the desired piece of information, the application at that vehicle immediately sends a unicast message containing the information to the vehicle it received the request from, which is then charged with the task of forwarding it towards the query source.

Fig.4. Routing-based communication

V.ARCHITECTURE OF VANETs

Organizations like IEEE, ISO and C2C-CC have been proposed VANETs architecture that varies from region to region. The IEEE introduces WAVE for single hop, unicast vehicular communication using DSRC. Whereas, ISO’s proposed CALM i.e. Continuous Air Interface for Long to Medium Range which supports uncast as well as broadcast communication among vehicles and between vehicles and road infrastructure. European car industry proposed the Car-to-Car Consortium (C2C-CC) which became the main driving force for Vehicular Communication in 2007. It focuses on Car to Car multi-hop and geo-networking using DSRC and other WLAN standards. The communication modes of C2C-CC are unicast, broadcast, geo-unicast and geo-broadcast. Figure 5 depicts the VANET architecture consisted of in-vehicle, ad-hoc and infrastructure domains.

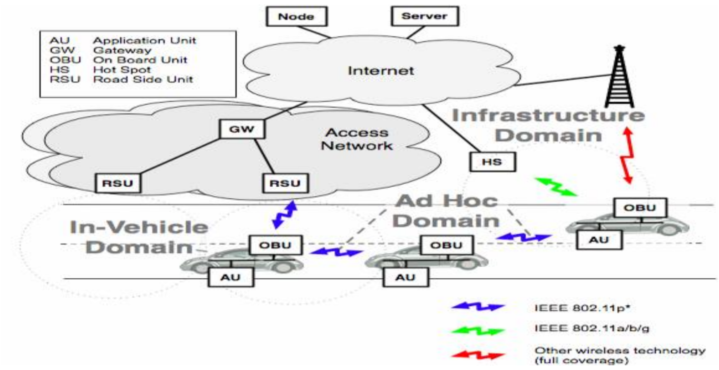

Fig.5. Architecture of VANET

The in-vehicle domain is comprised of an on-board unit (OBU) and one or multiple application units (AUs) that connect either with wired or wirelessly. Though, the ad-hoc domain represents the vehicles that are equipped with OBUs and RSUs. Here, OBU act as a mobile node of MANET whereas RSU is fixed at a location that connects with internet via Gateway. In, infrastructure domain, OBUs can communicate with internet via RSUs and hot spots (HSs). In this domain, OBUs can also communicate with each other by using cellular radio networks (GSM, GPRS, UMTS, WiMAX, and 4G) in absence of RSUs and HSs.

VI.VANET AS A SOLUTION FOR INDIAN NON-LANE BASED ROADS

6.1 A case study of Maharashtra traffic

The total number of motor vehicles on road in the State as on 1st January 2017 was 2.9 crore (24,411 vehicles per lakh population), showing an increase of about eight per cent over previous year. Of the total vehicles in the State, about 29.7 lakh vehicles (10.1 per cent) were in Brihanmumbai alone. The number of vehicles per km road length in the State is 98. The category wise numbers of motor vehicles on road are given in Table I.

TABLE 1. Category wise number of motor vehicles on road in Maharashtra

Category	*2016*	*2017*	*Per cent change*
Two wheelers	9,881.5	21,476.7	8.0
Auto rickshaws	726.1	744.2	2.5
LMV	24877	4,433.4	8.8
Buses	4,074.8	127.7	10.6
Goods vehicles	1,422.8	1,505.2	5.8
Tractors	603.6	639.2	5.9
Trailers	384.5	396.2	3.0
Ambulances	14.3	15.0	4.9
Others	47.0	56.8	20.9
Total	**27,270.1**	**29,394.4**	**7.8**

The number of vehicles in the Nashik region has gone up by about 10 per cent in the past one year. As on December 31, 2013, the Nashik regional transport office (RTO) has a record of 11, 27,224 vehicles in the city, which is 9% more than the population of vehicles by the end of 2012. The Nashik region comprises 10 talukas under the Nashik RTO, with the exception of Malegaon, Nandgaon, Satana and Deola. These talukas are under the Malegaon RTO.

RTO officials said the total population of vehicles in 2011 was 9, 33,454. In 2012, it increased to 10, 30,332, which was a rise of 10.38% rise. In 2013, it increased to 11, 27,224, a rise of 9.40%.

From the data above it is evident that the number of motorized and non-motorized vehicles on road in Maharashtra increases significantly.

a) Maharashtra has non-lane based roads. With low breadth of roads and high volume of traffic, traffic congestion becomes inevitable.

b) Intelligent Transportation system will be implemented till 2020 in four metro cities of India i.e. Delhi, Mumbai, Kolkata and Chennai.

c) Wireless communication between two vehicles will lead one of them to find out if there's any jam or not. It would also minimize the number of accidents on road as India has a notorious figure in road accidents

High numbers of motorized forms of transport include auto rickshaws, two-wheel vehicles and buses, and non-motorized forms including pedestrians, cyclists and cycle rickshaws

6.2 Challenges for implementing VANET on Non-lane based lanes

a) Congestion and collision Control: - Uneven traffic load in Indian rural and urban areas divides network in many partitions.

b) Environmental Impact: - VANET works on electromagnetic particles' transmission. Due to improper infrastructure, it becomes difficult to process hurdle free transmission.

c) Security: - As VANET provides the road safety applications which are life critical therefore security of these messages must be satisfied.

d) Infrastructure: India along with other developing economies still lack the required infrastructure for development of Intelligent Transportation Network.

6.3 Routing techniques in VANETs

6.3.1 Ad-Hoc Routing: Some of the well known ad hoc routing protocols such as AODV (Ad Hoc on demand distance vector) and DSR (Dynamic source routing) are therefore can be applied to VANET as well. However, the simulation of these algorithms in VANET brought out frequent communication break which is mainly attributed to high dynamic nature of its nodes. To meet the VANET challenges, these existing algorithms are suitably modified.

Namboodiri et al. (2004) considered the following application in their model:

- A highly partitioned highway scenario is used where most path segments are relatively small.
- The initial simulation with AODV algorithm resulted in frequent link break as expected, owing to dynamic nature of node's mobility.

- Two predictions are added to AODV to upgrade the algorithm.
- In one, node position and their speed information are fed in AODV to predict link life time.
- The simulation on both showed improved packet driving ratio.
- However, the success of this algorithm largely depends on the authenticity of node position and mobility.

6.3.2 Position Based Routing

The technique employs the awareness of vehicle about the position of other vehicle to develop routing strategy. This algorithm has some advantages and constraints e.g. *Advantages:* It works best in open space scenario (Highways) with evenly distributed nodes. The absence of fewer obstacles in highway scenario is attributed to its good performance. The comparison of simulation result of GPSR from that of DSR in highway scenario is generally considered to be better.

VII.THE PROPOSED PARKING BASED SCHEME FOR MAHARASHTRA

To facilitate data dissemination, the roadside parked vehicles are to be organized into clusters. Generally, this proposed parking-based data dissemination scheme is divided into two phases: a) data forwarding from the data source to appropriate parking clusters within the target area and b) data dissemination from the parking cluster to passing by vehicles.

7.1 Parking Cluster

Due to the high stability and utilization of roadside parking, clustering parked vehicles is feasible in urban areas of India. A realistic survey carried out by A. Adiv et al (1987) provides a quantitative understanding of roadside parking in cities, in which the on-street parking meters in the Ann Arbor city (US) are continuously monitored during six midweek days. It showed that the parking time is 41.40 minutes in average, with a standard deviation of 27.17. The occupancy ratio, defined as occupied space-hour/available space-hour, averages 93.0% throughout one day. Even the occupancy ratio during off-peak time reaches almost 80%.

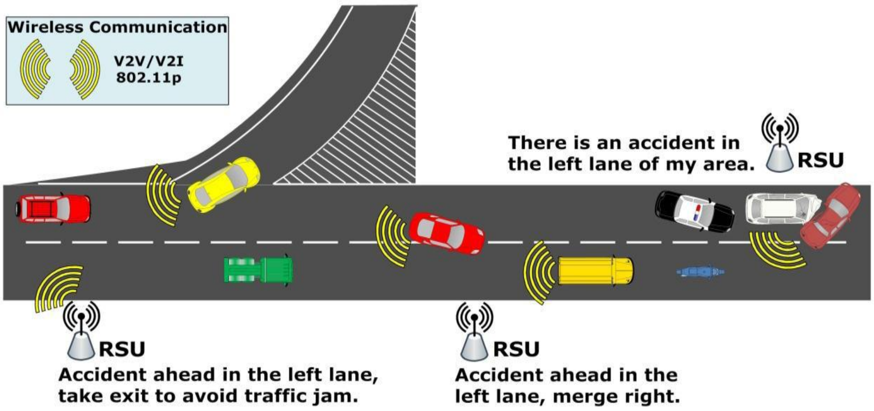

Fig.6. VANET equipped with RSU

In the proposed parking-based scheme, the vehicles have been grouped which are parked along the same road segment and are mutually reachable into a cluster and take it as data buffering unit at street level. Considering the fact that vehicle mobility is strictly constrained by traffic rules and street layout, buffering each data at some clusters in the target area is enough. Therefore, how to elect data buffering units from the existing clusters and then give the cluster management scheme has been shown as following:

In some road segments, the parked vehicles form one cluster while on the other road segments, the parked vehicles are isolated from each other and form different partially distributed groups. To determine whether it should act as data buffering unit, let each cluster be periodically report its distribution to other clusters along the same road (with the help of vehicles travelling across the road). After obtaining the distribution of other clusters along the same road, a cluster decides whether it would work as buffering unit according to following rule: if there is only one cluster along the road, this cluster is selected as data buffering unit; if there are two or more than two clusters along the road, the two clusters located at the two ends of the road are elected as data buffering units. After elected as data buffering unit, a cluster needs to be responsible for the cluster management, including head election and membership management.

In the proposed scheme, the following head selection mechanism is specified. In a scenario in the two vehicles located at the two ends of the cluster are elected as cluster head. In a two-way road, the two cluster heads, respectively, provide services for the vehicles coming from the nearest intersection. In another scenario, the vehicle which locates at the end of the road segment is elected as cluster head in each cluster; this is also to ensure that a vehicle moving into the road could encounter the cluster head in a short time. After the cluster head is determined, the cluster members periodically report their position to the cluster head. Thus, the cluster head is able to manage all parked vehicles, act as local service access points, and perform the data dissemination operation. Considering the fact that the vehicle works as cluster head might leave at any time, then the following rule is specified: while the cluster head is leaving (the engine is started), a new round of head selection is triggered, and the data to be disseminated as well as the cluster state are transferred from the old cluster head to the new one.

VIII.CONCLUSION

This paper put emphasis on the need of Intelligent Transportation System and the importance of Vehicular Ad-hocNetworks. Overall in Maharashtra the parking-based scheme is needed to apply urgently uniformly all over the state especially in highly congested areas which will involve a data source system such as computer with a wireless interface and access point with a data forwarder which will help to forward the received data to the target parking clusters (a group of vehicles parked on same road and belong to same cluster) and end users (vehicle users who will receive the message and work accordingly).

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