Intelligent Traffic System for VANET-Enabled Vehicle Platoon

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***Abstract* - Vehicular Ad-hoc NETwork (VANET) is a type of Mobile Ad-hoc (MANET) network where the nodes are constrained to move along the road. Vehicles in VANET are equipped with a radio device to communicate with each other and also with the road side units (base stations). Vehicular networks aims to make the driving experience safer, efficient and enjoyable. Traffic Management is one of the most critical issues. Lots of research and management techniques are used by government and city traffic controlling bodies to resolve Vehicle traffic congestion issue. As Vehicle traffic congestion is reflected as delays while traveling. Traffic congestion has a number of negative effects and is a major problem in today's society. Vehicular ad hoc networks (VANETs) can be used to provide traffic management, route planning, and identifying roadside amenities for long-range wireless communication. VANET technology is used as a medium to generate updated information for the vehicle when it heads from source to its destination. In this project, aim is to propose an innovative approach to deal with the problem of traffic congestion using the characteristics of vehicular ad-hoc networks (VANET). Firstly, vehicles that arrive towards traffic signal are grouped into the platoons which are assumed to be equal sized jobs. Then these jobs are scheduled using an online algorithm called Oldest Job First (OJF) algorithm to reduce the delay across the intersection. Second approach is by introducing a new scheme consists of a smart city framework that transmit information about traffic conditions and consist of a warning message module composed of Intelligent Traffic Lights (ITLs) that will help the driver to take proper decisions about current traffic conditions. By utilizing AODV protocol of ad hoc mobile network to deal with the problem of vehicle traffic congestion in vehicular networks. The performance is measured in terms of no. of packets broadcasted, percentage of packets delivered, and percentage of traffic diverted and overhead to manage the problem of data traffic congestion in computer networks.**

***Index Terms* - VANETS, AODV, OJF algorithm, Smart City Frame Work.**

I. Introduction

Vehicular ad hoc network (**VANET**) is categorized as a subclass of Mobile ad-hoc networks (MANETs). In which each node is a vehicle i.e., they are self configuring networks. VANET uses moving cars as nodes in a network to create a mobile network.
VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 250 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 network is created.
Roadside units or fixed equipment (Base stations) can belong to the government or private network operators or service providers. Vanet technologies are widely used by police and fire vehicles to communicate with each other for safety purposes.
Organizations such as automotive industries like General Motors, Toyota, Nissan, Daimler Chrysler, BMW and Ford etc would implement this technology.
An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a vehicular ad hoc network. In ad hoc networks, nodes are not familiar with the topology of their networks. Instead, they have to discover it: typically, a new node announces its presence and listens for announcements broadcast by its neighbors. Each node learns about others nearby and how to reach them, and may announce that it too can reach them.

Routing in VANET

VANETs are a specific class of ad hoc networks the commonly used ad hoc routing protocols initially implemented for MANETs have been tested and evaluated for use in a VANET environment. Use of these address-based and topology-based routing protocols requires that each of the participating nodes be assigned a unique address. This implies that we need a mechanism that can be used to assign unique addresses to vehicles but these protocols do not guarantee the avoidance of allocation of duplicate addresses in the network. Thus, existing distributed addressing algorithms used in mobile ad-hoc networks are much less suitable in a VANET environment.

- ***Proactive Routing Protocols***

Proactive routing protocols employ standard distance-vector routing strategies (e.g., Destination-Sequenced Distance-Vector (DSDV) routing) or link-state routing strategies (e.g., Optimized Link State Routing protocol (OLSR) and Topology Broadcast-based on Reverse-Path Forwarding (TBRPF)).Route updates are periodically performed regardless of network load, bandwidth constraints, and network size. The main drawback of such approaches is that the maintenance of unused paths may occupy a significant part of the available bandwidth if the topology of the network changes frequently. Since a network between cars is extremely dynamic proactive routing algorithms are often inefficient.

- ***Reactive Routing Protocols***

Reactive routing protocols such as Dynamic Source Routing (DSR), and Ad hoc On-demand Distance Vector (AODV) routing implement route determination on a demand or need basis and maintain only the routes that are currently in use, thereby reducing the burden on the network when only a subset of available routes is in use at any time. Communication among vehicles will only use a very limited number of routes, and therefore reactive routing is particularly suitable for this application scenario.

- ***Hybrid Routing Protocols***

Hybrid routing protocol is a trade-off between proactive and reactive routing protocols. It uses the on-demand mechanism of reactive and table maintenance mechanism of proactive routing protocol. This approach is useful for large networks, for large number of nodes. A large network is divided into a set of zones. Proactive approach is used for routing inside the zones, where as reactive routing approach is used for routing outside the zones.

II. RELATED WORK

PATIL V.P,"Vanet Based Traffic Management System Development And Testing Using Aodv Routing Protocol". International Journal Of Computational Engineering Research (ijceronline.com) Vol. 2 Issue.5

In this paper AODV protocol of ad hoc mobile network are used to deal with the problem of vehicle traffic congestion in vehicular networks. The performance is measured in terms of no. of packets broadcasted, percentage of packets delivered, and percentage of traffic diverted and overhead to manage the problem of data traffic congestion in computer networks.

POOJA O.N," Intelligent Traffic Signal Control System For V2V/V2I Communication Using Vehicular Ad HOC Network I".

In this paper VANET can be used to group vehicles into approximately equal-sized platoons, which can then be scheduled using OJF. First, the vehicles that arrive towards traffic signal are grouped into the platoons which are assumed to be equal sized jobs. Then these jobs are scheduled using an online algorithm called Oldest Job First (OJF) algorithm to reduce the delay across the intersection. The traffic signal timing can be made dynamic by determining the vehicle density of the platoon and depending upon that the green times are calculated and vehicles are evacuated, thereby minimizing the waiting time.

Carolina Tripp Barba, Miguel Angel Mateos, Pablo Regan Soto, Ahmad Mohammad Aguilar Igartua."Smart city for VANETs using warning messages, traffic statistics and intelligent traffic lights"

In this paper author described about a smart city framework has been developed. where intelligent traffic lights (ITLs) set in the cross roads of a city are involved. These ITLs are in charge of gathering traffic information (e.g. traffic density) from passing vehicles, Updating traffic statistics of the city and reporting those statistics to the vehicles.

III. CHALLENGES IN VANETS

- Network Management
- Security
- Social and Economic Challenges
- Mobility
- Volatility
- Privacy VS Authentication
- Privacy VS Liability
- Bootstrap
- Integrity

III. ARCHITECTURE DESIGN

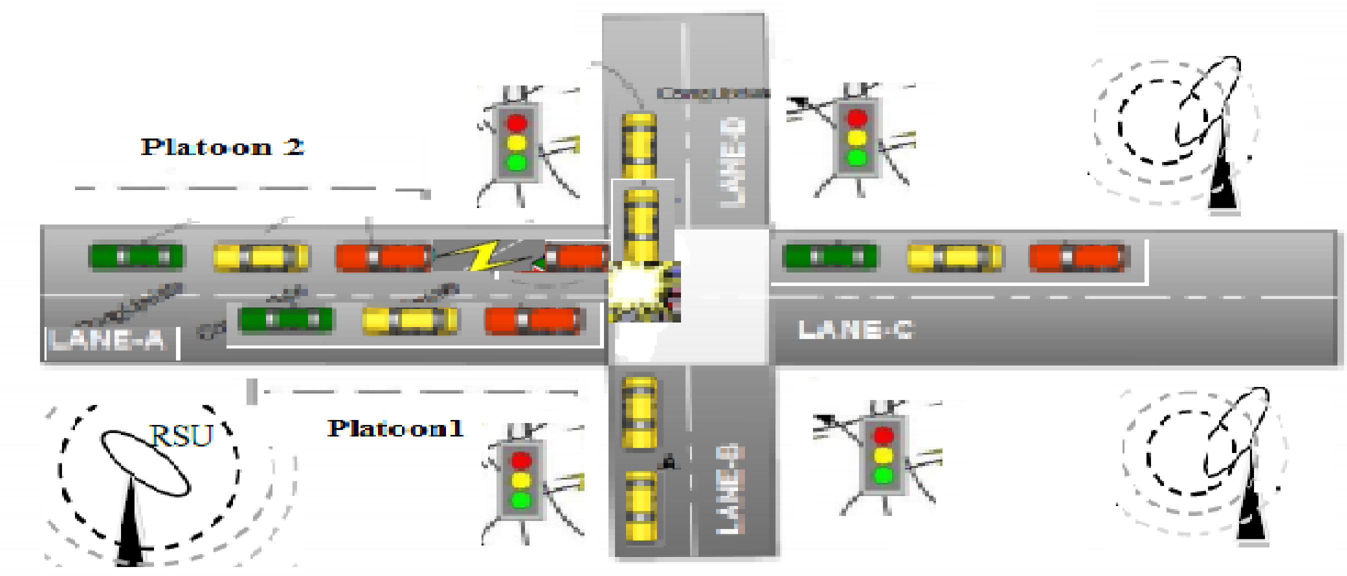

Figure 1: Block Diagram of VANET Communication

V. AODV

Ad hoc On-demand Distance Vector (AODV) routing protocol is one of the important routing protocol used in VANET system. It is known that AODV is a reactive routing protocol which is based on topology based routing protocol. This AODV routing algorithm enables dynamic, self starting, multi-hop routing between participating mobile nodes wishing to establish and maintain an ad-hoc network [1]. As AODV routing algorithm is dynamic so it also allows highly mobile nodes to create a routes very fast for getting new destination, and the nodes which are not connected is not necessary to maintain the routes. As AODV used in VANET system ,so it allows the nodes to break a linkage from a network and can join this node to another network. But during packet delivery time AODV does not allows the loop(closed path) and the shortest path is measured by Bellman-Ford "counting to infinity problem" message and forms multiple forward paths from destination to the source. Therefore, efficient multi-path routing with less overhead is obtained.

VI. (OAF) algorithm

The oldest arrival first (OAF) algorithm, that makes use of the per vehicle real time position and speed data to do vehicular traffic scheduling at an isolated traffic intersection with the objective of minimizing delays at the intersection. This simpl e algorithm leads to a near optimal (delay minimizing) schedule that we analyze by reducing the traffic scheduling problem to a job scheduling problem, with conflicts, on processors. The scheduling algorithm captures the conflicts among opposing vehicular traffic with a conflict graph, and the objective of the algorithm is to minimize the latency values of the jobs. If the condition that all jobs require equal processing time is enforced, we can show that the OAF algorithm becomes the oldest job first (OJF) algorithm in the job scheduling domain with conflicts between jobs and the objective of minimizing job latency values. We present a 2-competitive (with respect to job latencies) online algorithm that does non clairvoyant scheduling with conflicts of the jobs on the processors and then prove a stronger result that the best possible non clairvoyant scheduling with conflicts algorithm is 2-competitive.We leverage a VANET to implement the OJF algorithm. An important requirement for the OJF algorithm is that all jobs require equal processing time. We give an algorithm that uses the VANET to divide up the approaching vehicular traffic into platoons that can be treated as jobs in the job scheduling with conflicts. The traffic signal controller can then use the conflict-free schedule from the OJF algorithm to schedule platoons of vehicles in a safe conflict-free manner. This two-phase approach, where we first use the platooning algorithm to divide up the traffic into platoons and then treat each platoon as an equal-sized job and then apply the OJF algorithm on the jobs to generate a conflict-free schedule, leads to what we call the OAF algorithm.

VII. SMART CITY FRAMEWORK

The smart city framework we have designed includes ITLs set in some of the crossroads. These ITLs collect real-time traffic data from the passing vehicles and calculate traffic statistics such as traffic density in the adjacent streets (between consecutive crossroads). At the same time, these ITLs can communicate the traffic information to passing vehicles and alert them with warning messages in case of accidents. These ITLs also form a sub-network that allows ITLs to share the collected information and calculate statistics of the whole city. Thus, vehicles are well informed of the traffic situation in the city. The following sections describe how this smart city framework is designed and which use the ITL will have. In the smart city projected, blocks have a regular square design and buildings on its four sides. ITLs are responsible of managing the traffic of the vehicles, which form a VANET. These ITLs do not have to be located at each intersection. Within all the traffic lights that are traditionally located in a city, only a few will be replaced by ITLs. This is because each ITL covers a whole intersection and the 4 streets that converge on this intersection. ITLs are placed as shown in Fig. 1. To cover all this area the antenna pattern used is an omni-directional propagation pattern. Therefore, each ITL receives data from all passing vehicles on its cover range (the four streets and the intersection). Not having an ITL on each intersection is more economic when implementing this framework.

Every ad-hoc node (i.e., ITLs and vehicles) set on the scenario was configured with Ad hoc On-Demand Distance Vector (AODV) [8] routing protocol. AODV was selected because of its simplicity. Although it is well known that AODV is not suitable as routing protocol of general use in VANETs, there are some applications that might work well with AODV. The advantage of AODV is its simplicity and widespread use. The main drawback is that AODV needs endto-end paths for data forwarding, which is difficult to handle because in VANETs end-to-end paths last not much due to high speeds of vehicles. Other routing protocols that use other strategies like greedy forwarding and geographical routing. For instance, GPSR (Greedy Perimeter Stateless Routing) [9] and GOSR (Geographical Opportunistic Source Routing) have shown good performance in VANETs, but at the cost of greater complexity and increased delay. Nonetheless, for some applications that require a short delay AODV can perform well. In this paper we are considering smart city services where vehicles send warning messages (weather conditions and traffic density) to the closest ITL, so it is not necessary to establish long paths that last long. Instead, vehicles need to establish very short paths (1-2 hops) to the nearest ITL. Besides, the communication must be quickly since vehicles move fast and the period in coverage range of the ITL is short. Thus, AODV is suitable for our purposes.

VIII. SIMULATION ANALYSIS

The simulation was carried out using the simulator NS2-2.35. The routing protocol AODV was used, with OJF algorithm and smart city frame work to control the traffic with signals in the network.

It provides substantial support for simulation of TCP, routing, multicast protocols over wired and wireless (local and satellite) networks, etc. The simulator is event-driven and runs in a non-real-time fashion. It consists of C++ core methods and uses Tcl and Object Tcl shell as interface allowing the input file (simulation script) to describe the model to simulate.

Also, the overhead was reduced, delay to transmit or receive the packets was also reduced. High packet-delivery ratio was obtained with respect to TCP/ UDP connections separately.

Simulation parameters used for case study are mentioned in TABLE 1. Results are analyzed for the same.

TABLE 1

Simulator used	NS - 2.35
Number of nodes	40
Dimensions of the area	1000 × 1000
Routing Protocol	AODV
Simulation Time	40 sec
Traffic Type (TCP)	FTP
Traffic Type (UDP)	CBR
Packet Size	512 Bytes
Speed of the mobile node	40 m/s
Transmission range	250 m
Transmission Energy	5.0 Joules
Receiving Energy	1.0 Joules
Idle Energy	0.005 Joules
Sleep Energy	0.0001 Joules

Packet Delivery Fraction (PDF)

The ratio of number of packets delivered to the total number of packets sent

PDR =no. of delivered packets / total no. of sent packets

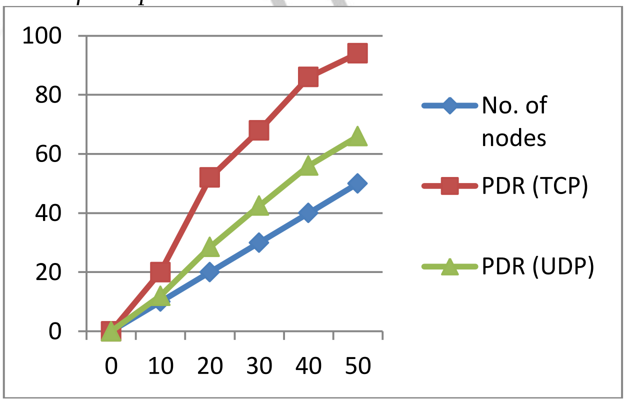

Fig 1.1 : Comparison of PDF of TCP v/s UDP with respect to No. of nodes

Throughput:

The number of bytes per second, and is measured in kbps.

Throughput = (Received size × 8) / ((Stop time - Start time) × 1000)

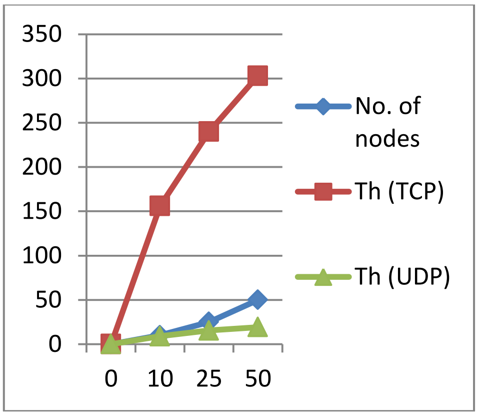

Fig 1.2: Comparison of Throughput of TCP V/s UDP with respect to No. of nodes

Overhead:

The amount of information needed to describe the changes in the dynamic topology.

Routing Overhead = (total no. of routing packets received / total no. of data packets received).
Delay = ∑ (End time- Start time)
Total Delay = Delay / count
Average Delay = Total Delay × 1000

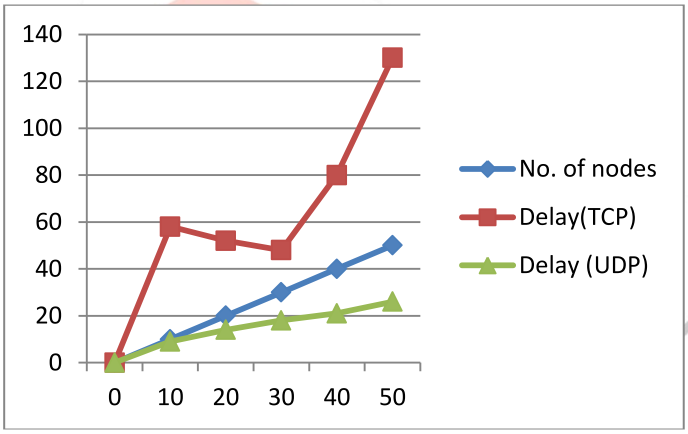

Fig 1.3: Comparison of Delay of TCP v/s UDP with respect to No. of nodes

IX. CONCLUSION

Traffic management is the most critical issues in big cities. Our solution of implementing VANET can help in addressing the traffic issue to large extent. Benefits of our project are:

- More systematic traffic management in the city.
- Vehicles that arrive towards traffic signal are grouped into the platoons which are assumed to be equal sized jobs. Then these jobs are scheduled using an online algorithm called Oldest Job First (OJF) algorithm to reduce the delay across the intersection.
- Using smart city framework that transmit information about traffic conditions and consist of a warning message module composed of Intelligent Traffic Lights (ITLs) that will help the driver to take proper decisions about current traffic conditions.
- By utilizing AODV protocol of ad hoc mobile network to deal with the problem of vehicle traffic congestion in vehicular networks.

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