Fuel Consumption and throughput Optimization in Vanet

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Abstract - With the increased development in this fast paced society, vehicles become the primary need rather than a luxury item. Traffic jams have been increasing since then. This increase in traffic jams has been directly proportional to fuel consumption causing discomfort and annoyance to drivers. VANET (Vehicular Ad Hoc Network) provides not only efficient but also safer, comfortable and reliable alternatives to current transportation systems. These networks are considered as ITS (Intelligent Transport Systems). The second most important factor in measuring efficiency of VANETs is throughput. VANET is a real time based system in which vehicles are moving nodes and travel with a very high speed in urban areas. In the present work we used an intelligent route identification approach in which an accident occurs between vehicles. Then the neighbor node performs the route analysis. This paper focuses on the improvements in the fuel consumption and network throughput in that particular case of accident.

Keywords: VANET, WIMAX, MANET, DSRC, WAVE.

I. VANET

Vehicular ad-hoc networks are a subclass of mobile ad-hoc networks providing a different approach for intelligent transport systems. Vehicular ad-hoc networks are wireless networks which provide features such as driver safety and comfort. In VANET the vehicles represent the nodes of a network and these nodes are moving at a very high speed in an urban area. It is an autonomous and self-organizing wireless communication network. 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. Over the last few years, we have witnessed many research efforts that have investigated various issues related to V2I, V2V, and VRC areas because of the crucial role they are expected to play in Intelligent Transportation Systems (ITSs). In fact, various VANET projects have been executed by various governments, industries, and academic institutions around the world in the last decade or so.

1.1 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 communications to occur between vehicles and Road Side Units (RSUs), vehicles must be equipped with some sort of radio interface or On Board 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 networks; 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.

1.1.1 PROTOCOLS

In VANET, routing protocols [9] are classified into five categories:-

Topology, position, cluster, geo cast, broadcast

a) Topology Based Routing Protocols

These protocols utilize link information present in a network to perform packet forwarding. They are further categorized as Proactive and Reactive.

i) Proactive Routing Protocols

The proactive routing means that the routing information, like next forwarding hop is maintained in the background irrespective of communication requests. The advantage of proactive routing protocol is that there is no route discovery since the destination route is stored in the background, but the disadvantage of this protocol is that it provides low latency for real time application. A table is constructed and maintained within a node. So that, each entry in the table indicates the next hop node towards a certain destination. It also leads to the maintenance of unused data paths, which causes the reduction in the available bandwidth. The various types of proactive routing protocols are: LSR, FSR.

ii) Reactive Routing Protocol

Reactive routing opens the route only when it is required for a node to communicate with each other. It maintains only those routes that are currently in use, as a result it reduces the load on the network. Reactive routing consists of route discovery phase in which the query packets are flooded into the network for the path search and this phase completes when the route is found. The various types of reactive routing protocols are AODV, PGB, DSR and TORA

b) Position Based Routing Protocol

Position based routing involves a class of routing algorithm. They share the property of using geographic positioning information in order to select the next forwarding hops. The packet is sent without any map knowledge to the neighbor hop, which is closest to the destination. Position based routing is beneficial since no global route from source node to destination node needs to be created and maintained. Position based routing is divided in two types: Position based greedy V2V protocols and Delay Tolerant Protocols.

i) Position based greedy V2V protocols

In greedy strategy an intermediate node in the route forward message to the farthest neighbor in the direction of the next destination. Greedy approach requires that intermediate node should possess position of itself, position of its neighbor and destination position. The goal of these protocols is to transmit data packets to destination as soon as possible that is why these are also known as min delay routing protocols. Various types of position based greedy V2V protocols are GPCR, CAR and DIR.

ii) Delay Tolerant Protocols.

In urban scenario where vehicle are densely packed locating a node to carry a message is not a problem but in rural highway situation or in cities at night fewer vehicles are running and establishing end to end route is difficult. So in such cases certain consideration needs to be given in sparse networks. The various types of Delay Tolerant Protocols are MOVE, VADD, and SADV.

c) Cluster Based Routing Protocol

In this routing a group of nodes identify them self to be a part of cluster and a node is designated as cluster head will broadcast the packet to cluster. Good scalability can be provided for large networks but network delays and overhead are incurred when forming clusters in highly mobile VANET. In cluster based routing virtual network infrastructure must be created through the clustering of nodes in order to provide scalability. The various Clusters based routing protocols are COIN and LORA_CBF.

d) Geo cast Routing Protocol

Geo cast routing is basically a location based multicast routing. Its objective is to deliver the packets from source node to all other nodes within a specified geographical region (Zone of Relevance ZOR). In Geo cast routing vehicles outside the ZOR are not alerted to avoid unnecessary hasty reaction. Geo cast is considered as a multicast service within a specific geographic region. It normally defines a forwarding zone where it directs the flooding of packets in order to reduce message overhead and network congestion caused by simply flooding packets everywhere. In the destination zone, unicast routing can be used to forward the packet. One pitfall of Geo cast is network partitioning and also unfavorable neighbors, which may hinder the proper forwarding of messages. The various Geo cast routing protocols are IVG, DG-CASTOR and DRG

e) Broadcast Routing Protocol

Broadcast routing is frequently used in VANET for sharing, traffic, weather and emergency, road conditions among vehicles and delivering advertisements and announcements. The various Broadcast routing protocols are BROADCOMM, UMB, V-TRADE, and DV-CAST.

1.2 Standards for Wireless Access in VANETs

Standards are defined to simplify product development, helps in reducing costs and help consumers to compare competing products. Standards are the only means to verify interoperability and interconnectivity

There are mainly two standards for wireless access in vehicular environments:-

1.2.1 DSRC (Dedicated Short Range Communication)

Dedicated Short Range Communications (DSRC) is a short range to medium range communications service that was developed to support V2V (vehicle-to-vehicle) and V2R (vehicle-to-roadside) communications. These communications cover a wide range of applications, including vehicle-to-vehicle safety messages, traffic information, toll collection, drive-through payment systems etc. DSRC main aim is to provide high data transfer rates and low communication latency in small communication zones. DSRC is a free but licensed spectrum. It is free since the FCC does not charge for the usage of that spectrum but it is licensed which means that it is more restricted in terms of its usage. For instance, the FCC requires the use of specific channels and all radios developed should conform to the standard. The DSRC spectrum is organized into 7 channels each of which is 10 MHz wide. One channel is restricted for safety communications only while two other channels are reserved for special purposes (such as critical safety of life and high power public safety). All the remaining channels are service channels which can be used for either safety or non-safety applications. Safety applications are given higher priority over non-safety applications to avoid their possible performance degradations and at the same time save lives by warning drivers of imminent dangers or events to enable timely corrective actions to be taken.

1.2.2 WAVE (Wireless Access in Vehicular Environments)

Wireless connectivity between moving vehicles can be provided by existing 802.11a compliant devices with data rates of up to 54 Mbps being achieved with 802.11a hardware. However, vehicular traffic scenarios have greater challenges than fixed wireless networks, caused by varying driving speeds, traffic patterns, and driving environments. Traditional IEEE 802.11 Media Access Control (MAC) operations suffer from significant overheads when used in vehicular scenarios. For instance, to ensure timely vehicular safety communications, fast data exchanges are required. In these circumstances the scanning of channels for beacons from an Access Point along with multiple handshakes required to establish communication are associated with too much complexity and high overheads (for example, in the case of a vehicle encountering another vehicle coming in the opposite direction, the duration for possible communication between them is extremely short making it difficult to establish communications). To address these challenging requirements of IEEE MAC operations, the DSRC effort of the ASTM 2313 working group migrated to the IEEE 802.11 standard group which renamed the DSRC to IEEE 802.11p Wireless Access in Vehicular Environments (WAVE). In contrast to the regional standards of DSRC, by incorporating DSRC into IEEE 802.11, WAVE will become a standard that can be universally adopted across the world. The operational functions and complexity related to DSRC are handled by the upper layers of the IEEE 1609 standards. These standards define how applications that utilize WAVE will function in the WAVE environment, based on the management activities defined in IEEE P1609.1, the security protocols defined in IEEE P1609.2, and the network-layer protocol defined in IEEE P1609.3. The IEEE 1609.4 resides above 802.11p and this standard supports the operation of higher layers without the need to deal with the physical channel access parameters.

WAVE defines two types of devices:

RoadSide Unit(RSU), and OnBoard Unit (OBU) which are essentially stationary and mobile devices respectively. RSUs and OBUs can be either a provider or a user of services and can switch between such modes. Normally stationary WAVE devices host an application that provides a service, and the mobile device which hosts a peer application that uses such a service. There may also be applications on devices remote from the RSU whose purpose is to provide services to the OBU. This WAVE standard describes applications that resides on the RSU but is designed to multiplex requests from remote applications thus providing them with access to the OBU. WAVE uses Orthogonal Frequency Division Multiplexing (OFDM) to split the signal into several narrowband channels to provide a data payload communication capability of 3, 4.5, 6, 9, 12, 18, 24 and 27 Mbps in 10 MHz channels.

This paper is organized as follows:-

Section 2 contains related work, section 3 defines the problem, section 4 illustrates experimental set up, section 5 provides result and discussion and section 6 gives conclusion.

II. RELATED WORK

Arash Ghorbannia Delavar, Emetis Niazmand, Javad Bayrampoor and Vahe Aghazarian [1] presented an algorithm in 2014 named DRAFS (A Routing Algorithm based on Distributed Food Sources using Ant Colony Optimization). DRAFS algorithm helped in find the shortest path in order to generate a competence function, with the help of index parameters, provided an optimal solution compared with other algorithms. Observing the distance and time parameters in finding the optimal solution, a target function was introduced which was accompanied by an increase in the algorithm efficiency. Comparing DRAFS algorithm with the previous routing algorithms, we had enjoyed the ants' collaboration mechanism that results in the ants with high efficiency guiding the ants with low efficiency. Consequently, an optimal quality was achieved in the algorithm compared with the existing solutions. Finally, these two techniques helped to improve the efficiency and reliability of the algorithm and, in comparison with previous algorithms, provided a distributed food source to reduce time accessibility to the source in large datasets.

Catalin Fratila, Ciprian Dobre, Florin Pop, Valentin Cristea [2] illustrated A Transportation Control System for Urban Environments in 2012 in which a We present a traffic control and congestion avoidance system was presented which was developed over a vehicular ad-hoc network created between the cars in traffic and the road infrastructure. A solution was proposed for monitoring traffic using not only sensors within the road infrastructure, but also the cars themselves acting as data collectors. The traffic control decision, provided by the road infrastructure was scalable, load-balanced, and used correction decisions for the route adjustment based on local areas. Evaluation results were presented that show the capabilities of the proposed congestion avoidance model.

Masaya Yoshikawa, Kazuo Otani [3] in 2010 introduced Ant Colony Optimization Routing Algorithm with Tabu Search. The route search problem was applied to various engineering fields. Many researchers study this problem. In this a new hybrid routing algorithm was proposed which combined Tabu search with Ant Colony Optimization. The proposed hybrid technique enables to find the shortest route including the blind alley. Experiments proved the effectiveness incomparison with conventional routing algorithm such as Dijkstra algorithm.

Amiour med tahar, Bilami Azeddine [4] represented a paper on VANET vehicular ad-hoc network where vehicles like car, bus, truck can assume as nodes of the network. Recently for driver comfort and road safety, the inter-vehicle communication became increasing a subject of much scientific research. On VANETs routing protocol have a great consequence where AODV is one of the most popular routing protocol dedicated to ad-hoc network, it can use the flooding techniques for locating the destinations and possibly cause an overhead in the network.

Cristina Rico Garcia, Andreas Lehner [5] represented a paper on efficient design and reliable broadcast MAC layers for wireless mobile ad-hoc networks (MANET) especially high user speeds are allowed is a current challenge. Despite the absence of infrastructure, it would permit channel allocation, awareness techniques allow a certain channel assignment. In this paper the MAC layer protocol designed for broadcast MANETs called COMB cell based orientation-aware MANET Broadcast. The COMB allowed the realization of collision free transmission, high speed is supported and no handshake is required. COMB is based on the localization aware cross layer dimensioned CDMA cell and it uses the SOTDMA protocol as intra cell scheme.

Rakesh Kumar and Mayank Dav [6] (2012) represented a paper based on the VANET vehicular ad-hoc networks are upcoming wireless network environment for intelligent transportation system. In VANET applications build upon the data push communication models where information is disseminated to a set of vehicles. There are so many types of VANET applications and their communication protocol needs a systematic literature survey. This paper mainly defined the VANET applications based on the various broadcasting data dissemination protocols which are surveyed separately and their fundamental characteristics are revealed. At the end of this paper comparison of all the protocols was done.

III. PROBLEM DEFINITION

VANET works on the basis of real time system where the vehicles are acting as the moving nodes and travel with a very high speed on the roads in the urban areas. Routing in VANET is a complex task.

So an improved routing technique is discovered which is based upon the distributed food processing system. DRAFS (A Routing Algorithm based on Distribution of Food Sources) algorithm helps to find the shortest path that generate a competence function with the help of index parameters and provides an optimal solution compared with other algorithms. By observing the distance and time parameters for optimal solution, a target function is introduced which is accompanied by an increase in the algorithm efficiency. By comparing DRAFS algorithm with the previous routing algorithm the ant's collaboration mechanism gives results in the ants with high efficiency guiding the ants with low efficiency. In TSIACO (Two-stage updating pheromone for invariant ant colony optimization) algorithm, ordinal update rule is introduced. Compared with standard ACO algorithms, the quality function uses the solution order as it is independent variable in iteration. Using independent variable with problem dimension as a replacement for of solution as an independent variable for quality function can get an invariant ACO algorithm inherently. Standard ACO algorithms with random proportional rule are independent of the scale of the problem under some conditions. TSIACO algorithm also employs the random proportional rule. But the pheromone trail is updated stage by stage.

In the vehicular ad-hoc network where number of vehicles communicate with each other and also communicate with the infrastructure side around the road. We want to use a protocol so as to reduce the risk of road accident. On the other side number of RSUs are placed on the side of road where information is updated from time to time with the help of distributed system so that maintaining replication and data consistency are two primary motives, so accident does not block the traffic and changes the traffic direction on other road.

IV. EXPERIMENTAL SETUP

Define the structure of the road and vehicle are defines on the road. Around the road define the RSU (road side unit) which sent information and between the vehicle on road side, vehicle to vehicle work them.

Vehicles are deployed on the network it moves on the road side.

In this scenario all the vehicles are moving on the road it moves around the road. It shows in the blue color.

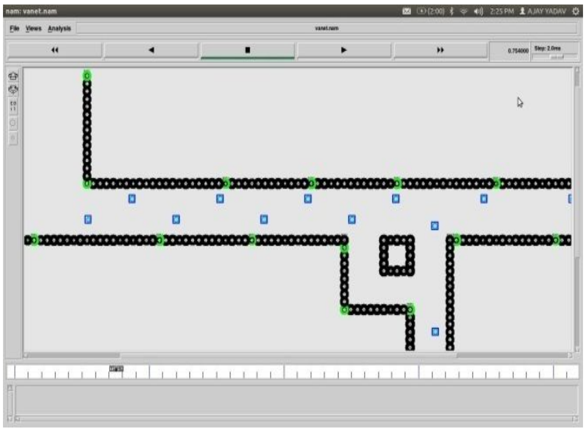

Fig 1 Moving Cars in VANET.

In the scenario an accident happen on the road between two vehicles, one more vehicle collides with the accidental vehicles leading to jam on the road and wait for path.

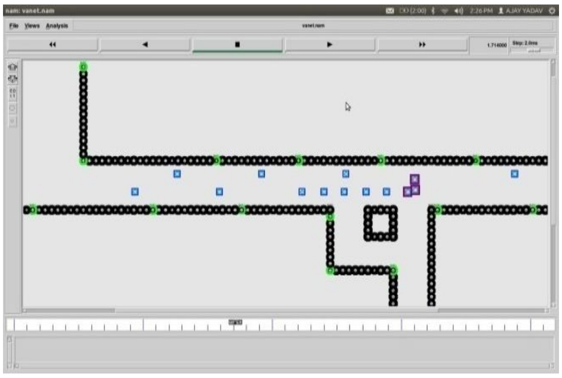

Fig 2 Accident occurred in VANET scenario.

In the scenario accident happen and information sent to all the nodes that are connected along the road in the green color that update the information to all the nodes related to accident.

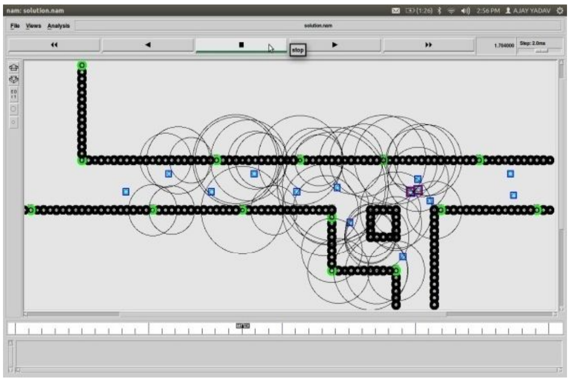

Fig 2 Accident status information sharing.

Whole traffic passes on the road without any jamming in the network and traffic reaches to destination stage.

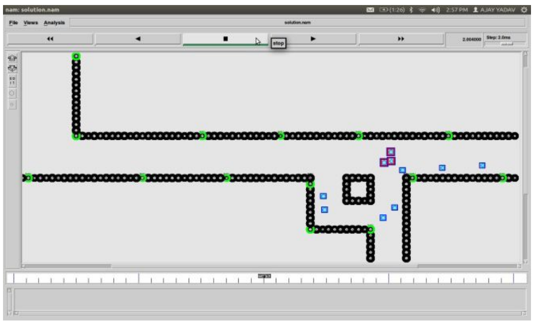

Fig 4 New Route followed

V. RESULTS AND DISCUSSION

There is a reduction in fuel emission by using a new approach as shown in figure 5. The red line in x graph shows the old fuel emission while the green line shows new fuel emission.

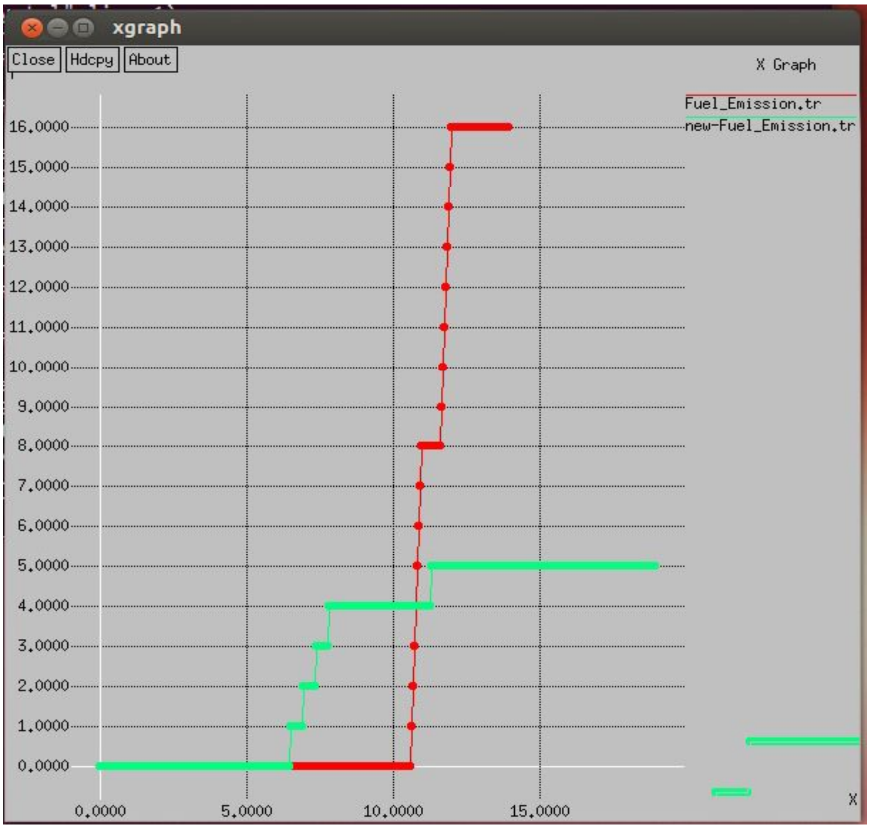

Fig 5 Fuel Emission

Also there is rise in the overall throughput. The green line shows the old throughput and the red line shows the new throughput.

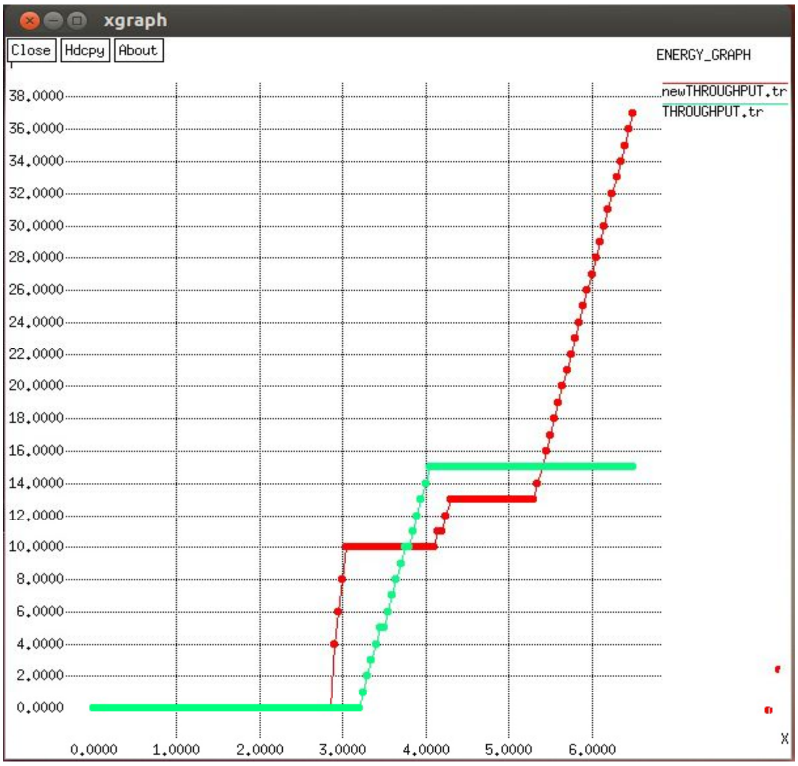

Fig 6 Throughput

VI. CONCLUSION

We presented a new technique to optimize the delay problem in VANETs. Two other parameters throughput and fuel emission are evaluated. Various studies previously had done show the importance of need for effective, efficient and fast communication between vehicles and road side units.

By optimizing the delay fuel emission is reduced and throughput has increased. In this paper we conclude that the ant colony optimization is efficient approach for VANETs. The accident information will be flooded in the city roads as soon as possible .The accident information is exchanged between the road side sensors using WI-MAX [8] .The simulation results shows that the proposed technique is more efficient than the previous techniques. We evaluated this approach using network simulator 2 [7]. We demonstrated that the vehicles communicate faster and thus reduces the overall delay to a measured extent compared with the delay without using ant colony optimization and throughput is improves while fuel emissions are decreased to a great extent.

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