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STUDY ON PERFORMANCE OF VANET ROUTING PROTOCALS AND CHALLENGES

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ABSTRACT

A Vehicular Ad-Hoc Network, or VANET, is a type of Mobile ad-hoc network, which provide communications between vehicles, among nearby vehicles, and nearby fixed units, usually described as a roadside unit (RSU). VANET provide facility for the vehicles on roads to communicate for driving safety. The basic idea is to allow arbitrary vehicles to broadcast ad hoc messages to other vehicles. However, this raises the issue of security and privacy. Here, we have described various existing solutions/protocols that are used in order to satisfy the security and privacy requirement of the vehicular ad hoc network. We have also described security issues and challenges in VANET. The main goal of VANET is to provide safety and comfort for passengers, drivers and other road users. To achieve this special electronic device will be connected to each vehicle which will provide Ad- Hoc Network connectivity to the passengers. In this paper we are going to discuss study the VANET behavior in different routing protocol.

KEYWORDS: Road side unit (RSU), Intelligent Transportation System (ITS), VANET, Routing.

INTRODUCTION

Intelligent Transportation System (ITS) is the backbone of intelligent communication between vehicles. It has effectively laid the framework for computer engineers to develop a "computer on wheels" concept for vehicles. Intelligent Transportation System came into limelight with the introduction of Vehicular Ad Hoc Network (VANET) [1]. VANET led to the development of a more advanced system "computer network on wheels" instead of just "computer on wheels". VANET involves communication between vehicles as well as vehicles and road side base stations. VANET being an ad hoc network presents a communication environment without any visible infrastructure. Also, VANET introduces the concept of Distributed database in Inter Vehicular Communication. VANET was developed mainly to provide safety and comforts to the passengers. With large number of accidents claiming precious lives, it became necessary to develop a system which could prevent accidents by developing an efficient communication system between vehicles. The earliest works in VANET was started in 1980s when organizations like JSK in Japan, PATH in California and Chauffeur in EU came into existence [2]. These organizations provided the coupling of two or more vehicles. With further research, VANET was not confined to avoidance of accidents but also preventing traffic congestion and providing comforts to the passengers. Recent research has extended uses of VANETs to provide a pool of services to the users. The two types of wireless communications exist in VANET, Vehicle to Vehicle i.e. V2V and Vehicle to Roadside Infrastructure i.e. V2I as VANET differs from MANET [3] in terms of following characteristics that are high mobility, dynamic topology, self-organized architecture, distributed communication, path restrictions and variable network size. These characteristics as stated before make the VANETs environment difficult for developing effective routing protocols. A vast number of applications exist in VANETs namely traffic efficiency applications, management applications, infotainment applications, but the two main applications are: passenger comfort applications and safety applications [4]. VANETs system design and implementation come across following difficulties such as: routing, security, privacy, connectivity and quality of services (QoS).

INTELLIGENT TRANSPORTATION SYSTEM (ITS)

VANET uses Intelligent Transportation System (ITS) for vehicular communication where each vehicle acts as sender, receiver, and the router [5] to broadcast information to the vehicular network.

An ITS as shown in figure 1, mainly consists of mobile nodes (e.g. Vehicles), infrastructure nodes (e.g. Roadside units) and certification authorities (CAs) [6]. Roadside units (RSUs) and CAs are static units and vehicles are mobile units. RSUs are fixed and connected to the backbone network and helps in communication. The frequency and distribution of RSUs depend upon the communication protocol used and mainly divided into two types. One is dense RSUs based where regions of RSUs are overlapped with each other and the other one is sparse RSUs region where the ranges of RSUs do not overlap with each other.

HOW VANET WORKS

Vehicular Networks System consists of large number of nodes, approximately number of vehicles exceeding 750 million in the world today [7], these vehicles will require an authority to govern it, each vehicle can communicate with other vehicles using short radio signals DSRC (5.9 GHz), for range can reach 1 KM, this communication is an Ad Hoc communication that means each connected node can move freely, no wires required, the routers used called Road Side Unit (RSU), the RSU works as a router between the vehicles on the road and connected to other network devices. Each vehicle has OBU (on board unit), this unit connects the vehicle with RSU via DSRC radios, and another device is TPD (Tamper Proof Device), this device holding the vehicle secrets, all the information about the vehicle like keys, drivers identity, trip details, speed, rout …etc,.

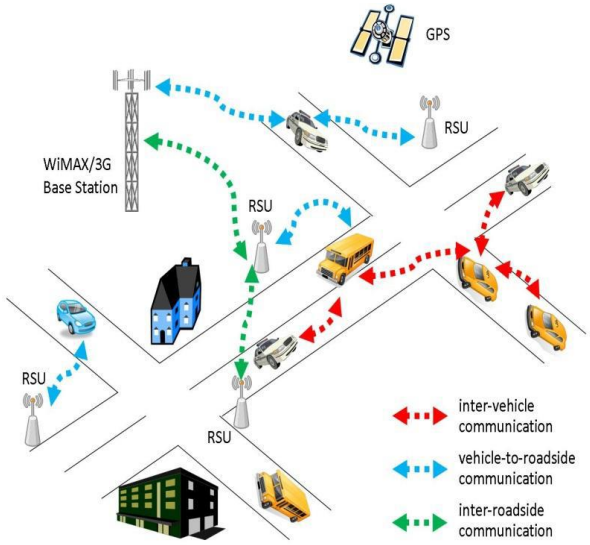

Fig.1 Basic VANET Architecture

An ITS as shown in figure 1 mainly consists of mobile nodes (e.g. Vehicles), fixed nodes (e.g. Roadside units) and certification authorities (CAs). Roadside units (RSUs) and CAsare fixed units and vehicles are mobile units. RSUs are static and connected to the backbone network for communication. The frequency and distribution of RSUs depend upon the communication protocol used which is divided into two types.

- Dense RSUs based where regions of RSUs are overlapped with each other.
- Sparse RSUs region where the ranges of RSUs do not overlap with each other.

Nodes (vehicles) are equipped with On Board Unit, Trusted Platform Module, sensors, Global Position System device etc. On Board Unit helps in communication like vehicle to vehicle, vehicle to infrastructure, and routing based communication. Various sensors are used to measure status like fuel consumption and environmental condition like slippery road, safety distances.GPS is used to provide information about the vehicles current position and TPM provides secure communication. Road side units which are static acts as an intermediate between vehicles and CA and also transfer information about road conditions and traffic information to the vehicles(nodes) of its region.

DISCUSSION ON ROUTING PROTOCOLS IN VANETS

Based on routing information, routing protocols are broadly categorized as topology-based and position-based routing protocols as shown in fig. 2. In topology-based routing mechanism, we deal with the network layout/architecture of the nodes such that packet forwarding is possible using the information that is available about the nodes and links

within the network whereas, location of nodes should be known in position based routing mechanism for packet forwarding.

Topology-based Routing Protocols
Topology-based routing protocols make use of routing tables for storing the link information as a basis of packet forwarding from source node to destination node. These protocols are further categorized into two types based on the network architecture [8]: Proactive and Reactive routing protocols.

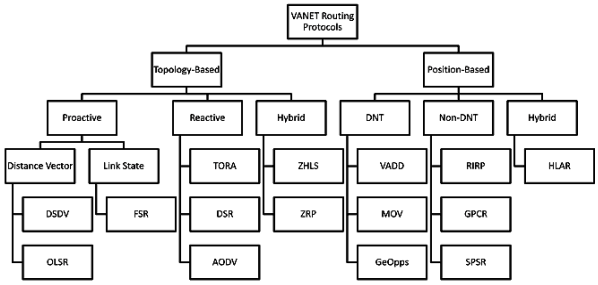

Fig.2. Routing Protocols tree representation.

Proactive Routing Protocols:
Proactive routing protocols, also known as table-driven protocols, allow every network node to maintain a routing table for storing the route information to all other nodes, every next hop node is maintained in the table entry that comes in the path towards the destination from the source.

Reactive Routing Protocols:
Reactive routing protocols, also known as on-demand routing protocols. They are called so because on requirement of a route that does not exist from source node to destination node, the route discovery starts. This reduces the network traffic and saves bandwidth.

Geographic (Position-based) Routing
In geographic routing, the forwarding decision by a node is primarily made based on the position of a packets destination and the position of the nodes one-hop neighbors. The position of the destination is stored in the header of the packet by the source. The position of the nodes one-hop neighbors are obtained by the beacons sent periodically with random jitter (to prevent collision) [9]. Nodes that are within a nodes radio range will become neighbors of the node.

Delay Tolerant Network (DTN) Routing Protocol:
DTN [8] routing protocol is an efficient protocol for networks with characteristics such as rapid disconnectivity during communication, massive/huge scalability, large unavoidable delays, restricted bandwidth, high fault tolerance rates and power constraints.

Non Delay Tolerant Network (Non DTN) Protocols:
The Non-DTN [8] protocols are a type of position-based routing protocols that do not take into account the dis-connectivity problem instead assume that a large amount of nodes exist to attain successful communication, which implies that the protocol is more appropriate for dense networks. The source node forwards the message to the closest neighboring node to the destination node. This strategy can also fail, if no such nearest neighboring node exists but only the current/forwarding node.

VANET APPLICATIONS
VANET play major role in two broad categories:

Safety Related Application

These applications are used to increase the safety on the roads. These applications can be categorised in following way.

i. Collision Avoidance: If drivers were aware half a second before collision, 60% accidents can be avoided.
ii. Traffic optimisation: signals like traffic jams, road accidents etc. can be send to the vehicles so that they can choose their alternate path and can save time.
iii. Cooperative Driving: Signals for traffic related warnings like speed warning on the curves, or while changing Lane etc. Such signals can co-operate the driver for the safe driving.

User Based Application

VANET can also provide following services to the user apart from safety:

i. Peer to peer application: Services like sharing music, videos etc. among the vehicles in the network can be provided through these applications.
ii. Internet Connectivity: People always want to be on Internet all the time. Hence VANET can be used to provide the constant connectivity of the Internet to the users.
iii. Supplementary services: VANET can also provide other user based application such as payment service to collect the tall taxes, to locate the fuel station, parking slots, restaurant etc.

CHARACTERISTICS OF VANET

In addition to the similarities to ad hoc networks such as MANET, VANETs possess unique network characteristics that distinguish it from other ad hoc networks and influence research in this area.

i. High Mobility: The vehicles in VANETs usually are moving at high speed. This makes harder to predict its position and making protection vehicles privacy.
ii. Rapidly changing network topology: Network topology in VANETs tends to change frequently because due to random speed of vehicles, the position of the vehicle changes frequently.
iii. Unbounded network size: Network size in VANET is geographically unbounded because it can be implemented for single city, several cities or for countries.
iv. Frequent exchange of information: The vehicular ad-hoc networks motivate the nodes to gather information from the other nodes and road side units. Hence the information exchange among vehicles becomes frequent.
v. Wireless Communication: Vehicles are connected and exchange their information via wireless environment.
vi. Time Critical: The information in VANET which is transferred wirelessly must be delivered to the vehicles with in time limit so that a decision can be made without delay and perform action accordingly.
vii. Sufficient Energy: In VANET vehicles have no issue of energy and computation resources.

VEHICULAR NETWORKS CHALLENGES

Mobility

The basic idea from Ad Hoc Networks is that each node in the network is mobile, and can move from one place to another within the coverage area, but still the mobility is limited, in Vehicular Ad Hoc Networks nodes moving in high mobility, vehicles make connection throw their way with another vehicles that may be never faced before, and this connection lasts for only few seconds as each vehicle goes in its direction, and these two vehicles may never meet again. So securing mobility challenge is hard problem. There is many researchers have addressed this challenge but still this problem unresolved.

Volatility

The connectivity among nodes can be highly ephemeral, and maybe will not happen again, vehicles travelling throw coverage area and making connection with other vehicles, these connections will be lost as each car has a high mobility, and maybe will travel in opposite direction. Vehicular networks lack the relatively long life context, so personal contact of user's device to a hot spot will require long life password and this will be impractical for securing VC.

Privacy VS Authentication

The importance of authentication in Vehicular Ad Hoc Networks is to prevent Sybil Attack that been discussed earlier [9].To avoid this problem we can give a specific identity for every vehicle, but this solution will not be appropriate for the most of the drivers who wish to keep their information protected and private.

Privacy VS Liability
Liability will give a good opportunity for legal investigation and this data can't be denied (in case of accidents)[1], in other hand the privacy mustn't be violated and each driver must have the ability to keep his personal information from others (Identity, Driving Path, Account Number for toll Collector etc.).

Network Scalability
The scale of this network in the world approximately exceeding the 750 million nodes, and this number is growing, another problem arise when we must know that there is no a global authority govern the standards for this network for example: the standards for DSRC in North America is deferent from the DSRC standards in Europe, the standards for the GM Vehicles is deferent from the BMW one.

Bootstrap
To make a communication we have to assume that there is a limited number of cars that will receive the communication, in the future we must concentrate on getting the number higher, to get a financial benefit that will courage the commercial firms to invest in this technology.

CURRENT VANET PROJECTS

In recent years, several intelligent transportation system initiatives and projects have been undertaken by different countries and organizations. For example, in 2006 the European Commission implemented a new safety program which was designed to reduce road fatalities by 50% by 2010 as well as to improve the efficiency of traffic flows [10]. These research and development trials are in progress and gives an important step towards the goals of improving road safety and traffic efficiency as well as providing Internet services to vehicles. Several organizations such as the automotive industry, highway control authorities, toll service providers and safety organizations are now involved in different projects all of whom main objective is to provide safety to the people and drivers. So in order to reduce the no of accidents, provide safety for people, control congestion on roads, various Vehicular Ad Hoc Network (VANET) projects have been carried out by various governments, car industries and academic institutions around the world [11]. Current Projects like WAVE, IVI, VSC, IVI, etc. In the USA, DEMO, JARI, ASV1, ASV2, etc. In JAPAN and C2C-CC, FleetNet, PReVENT, Carlink, etc [15]. At European Union are in progress, which main objective is to provide safety and service to the people. Besides providing safety and service to people, VANET also provide different commercial applications, data access to people. Due to these large number of applications, it becomes an active area of research.

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