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A Study of Routing Protocols Performance for Vehicular Ad Hoc Networks with Urban City Scenario

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***Abstract*- Vehicular ad hoc network (VANET) is a new communication paradigm where the vehicle to vehicle or vehicle to infrastructure communication is involved. Due to its specific characteristics, it is valuable for several applications like traffic signaling, vision enhancement, automotive parking, driver assistance, safety etc. The main approach of VANET is to inform vehicles about roadside traffic conditions dynamically such that an efficient and safe driving transportation system can be achieved. There are several routing protocols are developed for VANET architecture since the faster movement of vehicles makes data dissemination quite challenging. This survey paper presents the study of some specific routing protocols which could be enhanced in urban city scenario for vehicular ad hoc networks. They are evaluated based on basic network parameter to find their appropriateness for such networks.**

***Index Terms* - Vehicular Ad hoc Network (VANET), Routing protocols, Applications of VANET, Survey.**

I. INTRODUCTION

VANETs stands for Vehicular Ad-Hoc Networks, which are self organized networks established among vehicles. The vehicles are equipped with communication facilities due to which each vehicle can act as sender, destination or router. Many people lose their life and/or are injured due to accidents on a road and traffic jams generate a tremendous waste of time and fuel. So, as an effective tool VANETs have recently emerged for improving road safety through broadcasting a safety messages among the vehicles in such networks.

Vehicles move faster in such networks which changes rapidly and communications among vehicles changes frequently, hence such conditions impose great challenge for designing an efficient routing protocols. The design concern for the routing protocol should be robust, reliable, minimize delay and minimize network load. Following figure 1 show the VANET architecture for vehicle to vehicle communication at highway scenario.

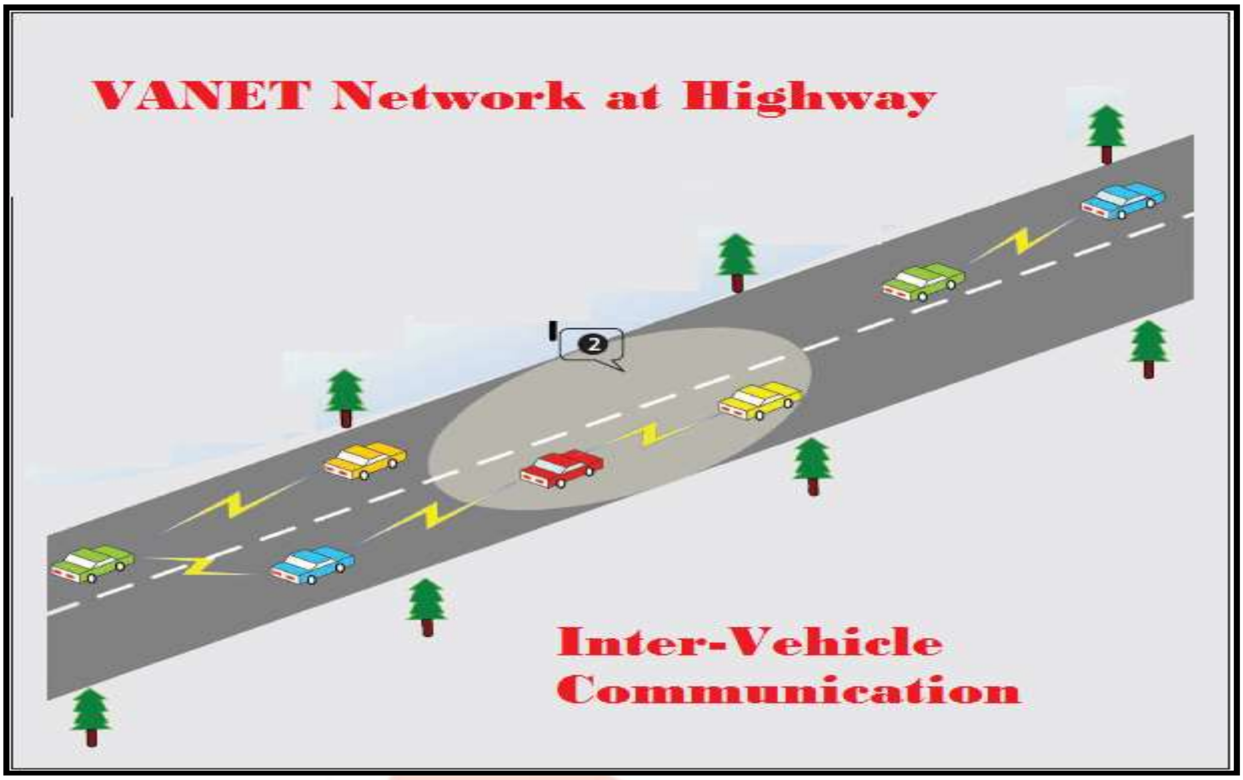

Figure 1: VANET Architecture

II. APPLICATIONS OF VANET

VANET has numerous potential applications that can be classified. In safety oriented application, the monitoring of road, vehicles movement, surface and curves of the road is involved. In convenience oriented application, the traffic jam condition is analyzed. In commercial oriented application, driver with entertainment and services such as web access, streaming audio & video is involved. Other application of VANET is traffic signaling, vision enhancement, weather conditions, driver assistance etc.

A. Traffic Signal: A traffic light can be operated via communication in VANET. A toll collection would be another application that could be part of it for vehicle toll collection at the toll booths [1]. Vehicular networks have been revealed to predominantly helpful for traffic managing. For example, Vehicle to infrastructure solution for road tolling is commonly deployed.

B. Vision Enhancement: This application is mostly used in heavy fog conditions where the drivers are given a clear view of vehicles and obstacles and can gain knowledge of the presence of vehicles hidden by obstacles, buildings, and by other vehicles.

C. Weather Conditions: Weather information can be updated, requested and notified via DSRC by the vehicle or from the vehicle and the information is transmitted to the central unit of the vehicular network. Also an accident scenario messages could be broadcasted as a warning messages to other vehicles so that trailing vehicles can take decision on time to change the lane as well as pass information to the highway patrol for support. Parking Availability Notification (PAN) serves to find the availability of space in parking lot in a certain geographical region as per the weather situation.

D. Driver Assistance: This application could be very useful to support driving military exercises, by providing drivers with information that they might have missed or might not yet be able to see. The driver with vehicles representing abnormal driving patterns, such as a substantial change of direction, send messages to report other cars in their locality, drivers can be notified prior of potential hazards, and therefore get more time to react and keep away from accidents [2].

E. Automatic Parking: This application is used when a vehicle can park itself without the need for driver involvement. In order to be able to act upon an automatic parking, a vehicle needs truthful distance estimators and/or a localization system with sub-meter precision.

F. Safety: Safety applications involves immediate collision warning, frontward obstacle detection and avoidance, emergency message broadcasting, highway/rail collision prevention, left/right turn subordinate, lane changing advice, stop sign movement subordinate and road-condition warning, intersection decision support, cooperative driving (e.g. collision warning, lane merging, etc. [3,4]).

G. Searching Roadside Locations and vehicle's Direction: This application could be used for unknown passenger help to find the shopping center, hotels, gas stations, etc., in the nearby area along the road. GPS, sensors and database from the nearest roadside base station are capable of calculating information.

Applications	Priority	Latency (ms)	Network Traffic	Message Range (m)
Safety Accident	Class 1	100	Event	300
Safety Warning	Class 2	100	Periodic	50-300
Electronic toll	Class 3	50	Event	15
INTERNET Access	Class 4	500	Event	300
Automatic Parking	Class 4	500	Event	300
Roadside Service	Class 4	500	Event	300

Figure 2: Priorities of VANET Application

III. SOME ROUTING PROTOCOLS FOR VANET

A. AODV: Ad hoc On demand Distance Vector [5] is an enhanced version of DSDV, as its name imply, ascertain the route only when demanded or required for the transmission of data. By this mean, it only keeps informed the relevant neighboring node(s) instead of broadcasting every node of the network.

B. DSR: Dynamic Source Routing [6] is an on demand routing protocol. It sustain the source routing, in which, every neighbor maintains the entire network route from source to the destination.

C. AOMDV: Ad hoc On demand Multipath Distance Vector [7], an extension of AODV with an supplementary characteristic of multipath route discovery which put off this on-demand routing protocol to form any loop or alternative paths.

D. DSDV: Destination Sequence Distance Vector [8] is a proactive routing protocol where every node sustain a table of information (which updates periodically or when change occurred in the network) of presence of every other node within the network. Any amendment in network is broadcasted to every node of the network.

E. LAR: Location-Aided Routing (LAR) bound the search for a new route to a smaller "request zone" of the ad hoc network. This characteristic presents a noteworthy reduction in the number of routing messages [9].

F.D-LAR: it is the extension of LAR protocol, Directional-location aided routing protocol, it is most suitable position based routing protocols which is meant for highly dynamically dense network [10].

G. ZRP: Zone Routing Protocol is the combination of both proactive and reactive protocols by sustaining an up-to-date topological map of a zone centered on each node; routes available within the zone. ZRP utilizes a route discovery procedure for destinations node outside the zone which can take advantage from the local routing information of the zones [11].
Following figure 3 shows the performance trade-off of chosen routing protocols based on different approaches like packet delivery ratio, delay, normalized routing load, packet duplication and throughput.

Approaches	AODV	DSR	AOMDV	DSDV	LAR	D-LAR	ZRP
Packet Delivery Ratio	GOOD	FAIR	FAIR	FAIR	GOOD	GOOD	GOOD
Delay	AVG.	GOOD	AVG.	FAIR	FAIR	GOOD	AVG.
Normalized Routing Load	FAIR	GOOD	AVG.	AVG.	FAIR	FAIR	AVG.
Packet Duplication	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Throughput	GOOD	GOOD	GOOD	AVG.	GOOD	GOOD	FAIR

Figure 3: Performance trade-off of Routing Protocols

IV. RELATED WORK

This section will seek to sum up some author's work on the subject of protocol performance with realistic road side conditions for VANETs architecture. Very few comparative studies [12], [13], [14], [15] have been carried out to evaluate performance of both proactive and reactive routing protocols in VANETs.

With reference [12] the performance of AODV, DSR, TORA and FSR is assessed. The simulation was carried out an urban scenario; it shows that AODV achieved better performance than others protocols. The routing protocol TORA endure due to high routing overhead, resulting in low throughput. The routing protocols DSR and FSR showed approx similar performance except that DSR had higher average delay than FSR protocol.

With reference [13], another study was carried out comparison of AODV and OLSR in urban environments and initiated that OLSR performs better than AODV in VANETs. The research article considered many performance metrics such as Packet Delivery Ratio (PDR) against average velocity, Constant Bit Rate (CBR) data generation, node density, Routing Overhead Ratio (ROR) against CBR data generation and node density, delay and average number of hops, etc. and evaluated protocols performance using them. Also this paper paying attention only on the urban scenario and they fail to analyze the effects of emergency events during communication. The routing protocol OLSR was able to cope with node density, end-to-end delays and has less ROR and high PDR than AODV.

With reference [14] AODV, DSR and OLSR protocols are simulated to measure their performance in urban environment with traffic signals and stop signs. The Simulator for Urban Mobility (SUMO) is used to create both urban and rural topologies. The routing protocol OLSR have better performance of throughput, little or no delay and jitter over other ad hoc routing protocols. After getting the results, OLSR outperforms both AODV and DSR in the urban environment.

With reference [15] authors have discussed ad-hoc, geographic based and clustered-based routing protocols. After getting results, it was found that geographic routing protocols perform better than ad-hoc routing protocols. Urban scenario is setup for simulation with high obstacles such as buildings.

With References [16] and [17] describe ad-hoc network implementation using NS2. Reference [18] and [19] explain mobility generators for VANET. Authors of [20] and [21] explore routing performance for VANET. This paper deals with analysis of existing routing protocols for VANET using real world city map like Bangalore. GPSR shows better performance and is well selected routing protocol for the considered city map.

V. CONCLUSION AND FUTURE WORK

Vehicular Ad-hoc Networks (VANETs) experience dynamically changing topology due to high speed of nodes mobility, consequently network route path changes regularly and depends on urban road infrastructure. That's why, it is necessary to consider realistic and specific road map topology. In this survey paper it is tried to sum up some specific routing protocols performance based on network parameters that could be implemented and enhanced to be able to use in real world urban scenario.

As a future work, a real world map conditions of Naya Raipur, Chhattisgarh is taken into consideration that would be simulated using SUMO simulator and routing protocols would be tested using network simulator 2.

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