Modern Investigation of Issues and Ad-Hoc Routing Protocols Applied To VANET

Pawan Kumar Saini, Kapil Bhagchandani, Yatendra Mohan Sharma

Abstract— During the last decade, with the advancement in network technologies and wireless communications, researchers inspired from a new type of network called vehicular ad hoc network (VANET). The Vehicular ad hoc network (VANET) is a new model of Mobile ad hoc network for wireless communication between vehicles on road or in between the vehicle to road side unit to provide the safety and comfort to vehicles in transportation system. Recent research work in VANET emphasis on particular areas like routing, security and quality of service but due to high dynamic nature of this network, designing an efficient routing protocol for all VANET applications is very hard, still there are scope of reconstruction or creation of new design of protocol, services for VANET architectures. The modification in existing approach or proposed a novel way of routing is milestone but a survey of routing protocols based on various parameters of VANET is a necessary issue in vehicle-to- vehicle (V2V) and infrastructure-to- vehicle (IVC) communication for smart ITS. This paper presents modern investigation of ad hoc routing protocols and the approaches that are proposed recently specially for vehicular ad hoc network with their advantages and shortcomings, which can be helpful for researchers to understand the routing protocols of VANET and can be used to enhance of existing protocol or proposed a new approach.

Keywords— VANET, MANET, Ad hoc Routing Protocols

I. INTRODUCTION

Over the last decades, wireless networks have received higher attention and the current advancement in this network has led to the introduction of a new type of network called vehicular network. The vehicular ad hoc network (VANET) is a special and challenging class of mobile ad hoc network (MANET) that enable the communication in moving vehicles like cars, buses, trucks, motorcycles etc. and in between the vehicle to road side unit. In VANET each vehicle behave as a mobile node and for exchanging data e mobile node behave as a router as well as source and destination node. However, VANET is a subclass of MANET but the network nodes in VANET moves in predefined road path and speed affect the network topology. This high dynamicity of network with high speed and mobility make routing even more challenging in VANET and shows the difference from MANET. Schematic representation of a Vehicular Adhoc Network present in fig.1

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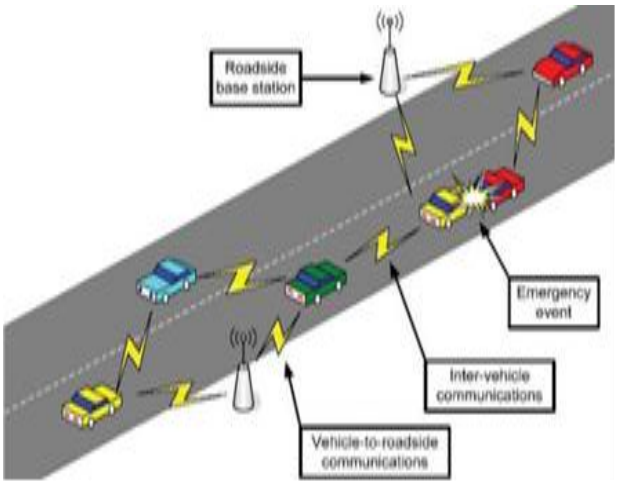

Figure1. VANET Ad hoc Network [5]

The routing protocols in the network basically perform the three main functionality route discovery, maintenance and selection of the efficient path from the various available paths. There are several papers [1, 2, 3, 4] presents information about various VANET routing protocols. The performance of communication depends on how better routing takes place in the network. There are mainly two types of communication scenarios in VANET: Vehicle to Vehicle (V2V) and Vehicle to road side unit (V2R). The taxonomy of vehicular communication system present in fig.2.

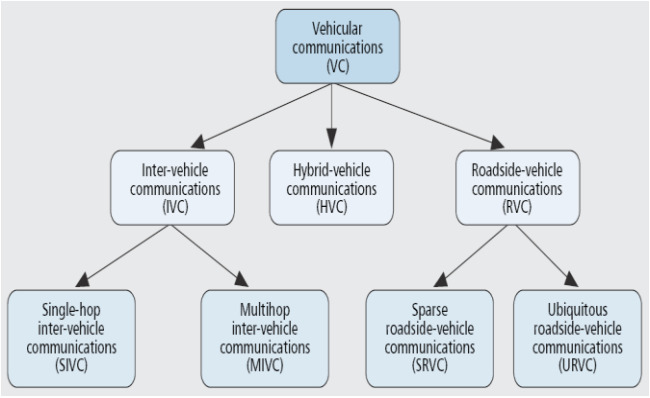

Figure 2. VANET Communication Taxonomy [6]

Most of the researchers in previous studies on routing protocol applied to VANET focused more on single ad hoc routing method, traditional ad hoc topology based routing, while some other focused on position based ad hoc routing method. The selection of routing method heavily depends on the nature of the network. Thus single ad hoc routing method is not sufficient enough in meeting all the different types of ad hoc networks. In this study we focus on modern approach proposed to improve the network routing performance with the discussion of traditional routing protocol exist for VANET.

Rest of this paper is organized as, section 2 present the application, characteristics and the challenges of VANET. The existing ad hoc routing protocol is present in section 3. Issues of routing protocols in VANET present section 4. Section 5 Present the modern routing approaches for VANET and finally paper is concluded in section 6.

II. VANET APPLICATIONS, CHARACTERISTICS & CHALLENGES

With the advancement of mobile communication the researchers take interest in development of ad hoc routing protocol for VANETS but as the feature of MANET and VANET are different in way of that vehicle are likely follow a road path or can be say structured way. With the wireless technology becoming pervasive and cheap, several innovative vehicular applications are being discussed. These applications can be classifying into five categories (i) Public Safety Applications (ii) Traffic Management Applications (iii) Traffic Coordination and Assistance Applications (iv) Traveler Information Support Applications (v) Comfort Applications [7].

A. VANET Applications

Public Safety Applications like collision alert, road conditions warning, merge assistance, deceleration warning, etc. are geared primarily toward avoiding accidents and loss of life of the occupants of vehicles. Collision warning systems have the potential to reduce the number of vehicle collisions in several scenarios where the main emphasis is on timely insemination of safety critical alerts to nearby vehicles.

Traffic Management Applications tries to control and improve the performance of traffic flow and reduce the time of travelling for smart ITS. This application mainly focused on application to related to Traffic monitoring, Traffic light scheduling, Emergency vehicles.

Traffic Coordination and Assistance Applications have been the main research topics of many IVC projects. These applications also have addressing based on ZOR; for example, immediately behind, in the right lane, or in the reverse direction. Penetration directly influences the usability of these systems.

Traveler Information Support Applications support applications provide updated local information, maps, and in general messages of relevance limited in space and/or time.

Comforts Applications focus on make travel more pleasant. this application primarily provide the vehicle to infrastructure (gateway) communication (v2i) in the context of vehicular communication,

B.Characteristics of VANET

The vehicular ad hoc network VANET characterized by their unique characteristics that distinguish them from MANET. These can be categories as [32]

Frequently changes in Topology and high mobility: The VANET is formed with vehicle network that can move anywhere with varying speed which generate high dynamicity in topology and make unsuitable of existing mobile ad hoc routing protocol for the high dynamic network such an VANET and present the difference in between MANET and VANET.

Geographic position System availability: The Global Positioning System (GPS) is used in vehicle for providing the comfort to driver to identify their location and use the services for routing packets.

Restricted Mobility: As in MANET the node can move anywhere but in the VANET the nodes can be move on the path that already exists that is roads that make node movement predictable.

Hard delay constraints: In a vehicular ad hoc network it is important that broadcast messages are received with a high probability. Broadcast messages such as emergency warnings should be received by all vehicles in the proximity of the endangered. In VANETs applications, such as the collision warning or Pre-Crash Sensing, the network does not require high data rates but has hard delay constraints, and the maximum delay will be crucial.

No power constraint: Since nodes are cars instead of small handheld devices, power constraint can be neglected thanks to always recharging batteries.

C . *VANET Challenges*

The high mobility is the main challenging factor of vehicular ad hoc network. The factor that challenge this network can be categories as

- High Dynamicity: Nodes frequently changes positions that make high mobility.
- Overhead: The high rate of dynamicity increases the overhead.
- Packet Loss and High Delay: Due to the high node movement the path not remain constant, break and establish frequently in VANET so the packets are loss in high rate and increase delay.

Some other issues may be count as security, Broadcast and Routing problem, Information Dissemination and Address configuration.

III. TRADITIONAL AD HOC ROUTING PROTOCOLS

There are hundreds of routing protocols which have been proposed for ad hoc networks but with the highly dynamic characteristic of VANET the existing routing protocols designed for Mobile Ad hoc Network is not suitable and cannot be directly apply for communication to the network of VANET. In VANET, the routing protocols are classified into five categories: Topology based routing protocol, Position based routing protocol, Cluster based routing protocol, Geocast routing protocol and Broadcast routing protocol. These protocols are characterized on the basis of area / application where they are most suitable [1]. A broad view of VANET routing protocol can be seen in figure 3.

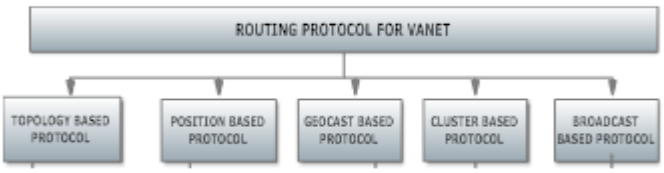

Figure 3 VANET Routing Protocols

A. Topology Based Routing Protocol

The topology based routing protocols use link's information and stores that information in table before sending data from source to destination node. Several of

approaches proposed on the base of this routing approach [7]. Topology based routing approach can be further categorized in to three groups:

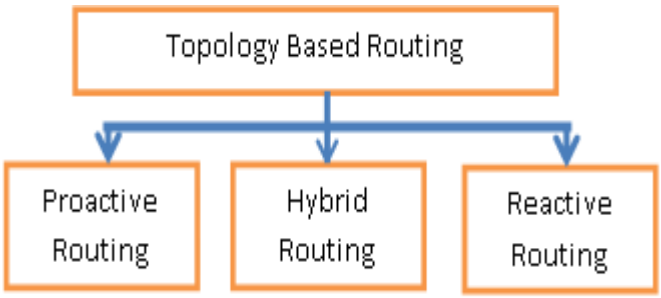

Figure 4 Topology Based Routing Protocol in VANET

Proactive Routing Protocol: These types of protocols are mostly based on shortest path algorithms and also known as table driven routing protocol because they store the information of all connected nodes in form of tables [8]. Whenever any change present in network the node shared the information with their neighbors. Strategies implemented in proactive algorithms are Link-state routing (OLSR), Destination Sequence Distance-vector routing (DSDV), Fisheye State Routing (FSR), Cluster head Gateway Switch Routing(CGSR), Wireless Routing Protocol (WRP), Topology Dissemination Based on Reverse Path Forwarding (TBRPF), Global State Routing (GSR), Source Tree Adaptive Routing (STAR) discussed in various papers [.9- 15].

Reactive Routing Protocol: The Reactive routing protocol developed to overcome the overhead of proactive routing protocol. The Reactive routing protocol also called on-demand routing protocol because these protocol establish the route only when it is necessary and only for those nodes that are currently being used to send data packets from source to destination. The reactive routing protocol can be further classified as source routing or hop-by-hop routing. The data packet contain the whole routing information in the source routing and the nodes between the sources and destination which perform as intermediate node for communication can takes route information from the data packet and stores it in the header of data packet. As a result, each intermediate node does not need to update all route information in order to send packet to the particular destination [16]. The various types of reactive routing protocols are Ad Hoc On Demand Distance Vector(AODV), Preferred Group Broadcasting(PGB), Dynamic Source Routing(DSR), Temporally Ordered Routing Algorithm (TORA), Junction-based Adaptive Reactive Routing (JARR), Associativity Based Routing (ABR) and Signal Stability Based Adaptive Routing (SSA), discussed in various papers [17-23]

Hybrid Routing Protocols: The hybrid routing protocol combines characteristics of both reactive and proactive routing protocols and proposed to reduce the control overhead of proactive routing protocols with decreasing the initial route discovery delay in reactive routing protocols [16]. In Hybrid vehicle communication system vehicles communicate with roadside infrastructure even when they are not in direct wireless range by using other vehicles as mobile routers. Typically the hybrid routing protocols are area based; it means the number of nodes is divided into different zones to make route discovery and maintenance more reliable for MANETs or VANETs. The main advantage is that it requires less roadside infrastructure. However, one disadvantage is that network connectivity may not be guaranteed in scenarios with low vehicle density. The routing protocols that fall under this category are Zone Routing Protocol (ZRP) and Hybrid Ad hoc Routing Protocol (HARP) [24, 25].

B. Position Based Routing Protocols

The position based routing protocol or geographic routing protocol use nodes location information rather than link information to determine the optimal path for communication. In this type of network each node having whole information about source, destination and the intermediates nodes. With the low overhead and the dynamic connectivity of node the position based routing protocols usually perform better than topology based protocols. A position based routing protocol consists of many major components such as “beaconing”, “location service and servers” and “recovery and forwarding strategies” [24]. The position based routing protocol perform better in the network performance in comparison of topology based routing protocol because these protocols not need for route maintenance process and the path establish only whenever any node want to send data to another node. Although these routing protocols are most suitable for the vehicular communication but these protocols still have some challenges.

Position based routing is broadly divided in two types: Position based greedy V2V protocols, Delay Tolerant Protocols [4]. In the greedy forwarding strategy, an intermediate node in a route forwards packet to the farthest neighbor in the direction of the next anchor or the destination. This approach requires the intermediate node to have three important data points: the position of itself, the position of its neighbors, and the position of the destination. Typically, a node’s own position is acquired through GPS. Its neighbors’ positions are obtained through message exchanges, and the position of the destination node is usually found through the use of a location service. Location servers may be periodically placed external to the system, but this offers no guarantee that such a server will be within range. To alleviate this problem, quorum-based location services may be built into nodes, or fully-distributed location services may be utilized [25].

C. Geocast Routing Protocols

Geo cast routing is basically a location based multicast routing protocol and use to send a message to all vehicles in a pre-defined geographical region. The philosophy is that the sender node need not deliver the packet to nodes beyond the Zone of Relevance (ZOR). The scheme followed a directed flooding strategy within a defined ZOR so that it can limit the message overhead. The various Geo cast routing protocols are IVG, DG-CASTOR and DRG [2]. However these protocols perform well but distributing the packets to all the nodes within the geocast region with high probability with low overhead is challenging problem because a clear trade-off between the proportion of nodes in the geocast region that receive the packet and the overhead incurred by the geocast packet especially at low densities and irregular distributions.

D. Cluster Based Routing Protocols

It’s a routing protocol which based on position and clusters. Each cluster has one

cluster-head, which is responsible for intra and inter-cluster management functions. Intra-cluster nodes communicate each other using direct links, whereas inter-cluster communication is performed via cluster headers. In cluster based routing protocols the formation of clusters and the selection of the cluster-head is an important issue. In this protocol, the geographic area is divided into some foursquare grids. Only if there is a vehicle in a grid will a vehicle be elected to the cluster header, and the data packet is routed by cluster header across some grids one by one. In VANET due to high mobility dynamic cluster formation is a towering process. The various cluster based routing protocol are COIN [26], LORA-CBF [27], CBDRP [28].

E. Broadcast Based Routing Protocols

This protocol most frequently used in VANET especially to sharing, traffic, weather and emergency, road conditions among vehicles and delivering advertisements and announcements. Broadcasting is used when message needs to be dispersed to the vehicle beyond the transmission range i.e. multi hops are used. Simplest of broadcast method is carried by flooding in which each node rebroadcast the message to other nodes. Broadcast sends a packet to all nodes in the network, usually using flooding techniques, ensuring the delivery of the packet but bandwidth is wasted and nodes receive duplicates. This routing technique performs better for a less number of nodes but has a higher overhead cost. The various Broadcast routing protocols are BROADCOMM, UMB, V-TRADE, and DV-CAST [29].

IV. ISSUES IN VEHICULAR AD-HOC NETWORK

The Vehicular ad hoc network (VANET) is a new model of Mobile ad hoc network for wireless communication between vehicles on road or in between the vehicle to road side unit. Due to the nature of dynamic network topology, routing in VANET play a vital role for the performance of the networks. There are various studies and researches in this field in attempt to propose more efficient routing protocols. However, there is not a routing protocol that can perform efficiently in every situation. The existing routing protocols are effective only when the node population is small. The Reactive routing schemes will fail to discover a complete path due to frequent network partition. The proactive routing protocols will be overwhelmed by the rapid topology changes and even fail to converge during the routing information exchange stage. The Position-based routing schemes generally require additional node physical position information during the routing decision process. A location service is needed as well to provide the position information of nodes. Due to the high node mobility and the movement constraints of mobile nodes the conventional topology-based routing schemes are not suitable for VANETs. There are several paper [30, 31, 32] present the issues of existing ad hoc routing protocol to apply in the environment of VANET.

V. INVESTIGATED MODERN AD-HOC ROUTING APPROACH FOR VANET

Vehicular ad hoc networks (VANETs) can be expected to improve traffic safety and transportation management in the near future. This is realized by letting vehicles exchange their sensed traffic environment changes with other vehicles. Such exchanges also create privacy concerns since the vehicle-generated reports contain much private information on the vehicle and its driver. A security and the privacy solution in VANET are proposed in [33]. They show the sketch of security requirements for the vehicular communication systems and provide models for the system and communication, as well as models for the adversaries. Another research proposed a security approach [34] to identify the stakeholders and their responsibilities and after that they emphasis on the functional layer view and highlight the concepts which jointly secure the vehicular communication. On the basis of these concepts, they present an implementation of proposed approach which introduces the security concepts into the protocol stack of vehicular communication system. Unlike the wired counterparts the networking scenario is far more distributed in nature in vehicular ad hoc wireless network, which adds a substantial responsibility upon the nodes and the Traffic congestion has been plaguing motorists for years, and it progressively continues to get worse as the population continues to increase, resulting in an increase in the number of vehicles on the road.

In [35], protocol “edge node-based directional routing (E-DIR)” is proposed that uses edge nodes with DIR protocols. In this authors examine the significance of position-based routing using edge nodes for forwarding the data in a vehicular ad hoc network. This approach minimizes the path length by minimizing the number of hops between source and destination vehicles. Unlike MANETs, VANETs nodes are moving very fast. It becomes quite challenging to maintain a stable path for broadcasting Emergency and Warning (E/ W) messages from a risk zone. So routing takes an important role in VANETs. Reducing network overhead, avoiding network congestion, traffic congestion and increasing packet delivery ratio are the major issues of routing in VANETs. In [36] a novel routing protocol is proposes in VANET for sparse environment called Vehicle Second Heading Direction Routing Protocol (VSHDRP), which is designed to leverage the probability of delivering a data packet to its destination and to increase connectivity and route stability by utilizing the knowledge of the Second Heading Direction (SHD) in the process of selecting the next-hop node. This new routing protocol contains two modes; the highway straight mode and the roundabout\intersection mode. Moreover, the two modes of VSHDRP protocol are formalized in the Calculus of Context-aware Ambient (CCA) and simulated using the CCA interpreter ccaPL in order to analyses and validate the behavior of the protocol. The another approach for traffic management is proposed in [37], they show the higher improvement in the safety and efficiency of communication by emerge the technology of GPS and the inter-vehicular wireless communications with in-vehicle computation and sensing capabilities.

VI. CONCLUSION

As a result of the substantial advances in the wireless technology, vehicles are becoming a part of the global network. The high dynamic nature of VANET makes it different from other ad hoc network and present the challenge for routing. In this paper we present the ad hoc routing protocol that applied by many researchers with the issues of VANET and the modern approach to overcome the

traditional routing protocol challenges. Although many problems are not yet solved, the general feeling is that vehicles could benefit from spontaneous wireless communications in a near future, making VANETs a reality.

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