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A Survey on Techniques and Fundamentals of Internet Access in VANET-INTERNET Integration Scenarios

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***Abstract*— Vehicular Ad-hoc Network (VANET) is wireless networking domain, which allow information exchange between vehicles and with the infrastructure without any central administration. VANET allow safety, traffic efficiency and commercial applications to incorporate into modern automobile design. To enhance efficiency applications in vehicular network VANET is connected to Internet. To connect Infrastructure less VANET to Internet either Road Side Units (RSU) or mobile gateway node is elected which act as bridge between two networks. Various wireless technologies such as Wi-Fi, 3G, Wi-Max and more are used with VANET for efficient, robust, flexible internet access solution from a VANET. Performance of mobile gateways affects efficiency of handling request for internet access. So gateway selection, gateway handover, gateway discovery are the key mechanism on which more research has done to increase performance. This paper discusses various fundamentals of VANET-Internet integration techniques. This review paper concludes with the further investigation and points.**

***Keywords*— VANET, Internet, Wireless networks, Routing protocols, Mobile gateways.**

I. INTRODUCTION

VANET is a type Mobile Ad-hoc Network (MANET) where vehicles are the mobile nodes. Network of vehicles using which vehicle communicate with each other to share information and data. There is no central administration and pre-established network. Topology of the network is unpredictable and dynamic. The vehicular communications meet in the centre of numerous initiatives of the research that enhance the security and the efficiency of transportation systems, supplying, for example, acknowledgments of the ambient conditions (snow, fire, etc.), traffic in the road conditions (emergency, construction sites, or congestion),Safety services(Emergency brake light, collision warning etc), Enhanced road services(Toll services, parking space locator, map updates, etc),Entertainment services(Internet surfing, video on demand, on-gaming, vehicular social networks, etc).Data processing applications and systems (Traffic simulation System, Traffic status and incidents reporting Systems etc.). VANET is highly dynamic network causes frequent disconnected networks, the mobility pattern of vehicles depends on traffic environment, roads
structure, the speed of vehicles, driver's driving behaviour, provides enough computing power because battery power and storage capacity is not an issue for current automobiles, routing approaches are different for sparse and dense vehicle network, onboard sensors collect information which helps for effective routing decision and hence communication. VANET consist of two type of communications Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I).

The applications like internet surfing need connection between Ad-hoc vehicles network and a fixed network. But routing and address schemes of both differ from each other; hence connection of VANET to internet is a critical issue. Reliable, real-time data interaction is possible between users and intelligent transport centres, and multimedia data services can be accessed on the Internet. VANET do not have central router. Every node works as router, takes part in route discovery and maintenance. Nodes can have routing information within range of VANET. For internet connection routing protocols cannot go across boundary Hence interoperability or interfacing between IP based network and ad-hoc network needs an attention. In-order to get access to internet a node must be integrated with the internet. Nodes need to configure in a way such that it will act as gateway, then gateway selection, discovery and maintenance mechanisms comes into picture. There are different gateway discovery approaches like proactive, reactive, hybrid, their working enlisted in section II.

The rest of paper is organized as follows. Section II discusses related work and section III concludes the paper.

II. RELATED WORK

A. Wireless Technologies

Major requirement of successful communication with the internet is strong communication range of signal. VANET is short range communication network occupy hence to cover a large area for information dissemination a wide range communication network can be used. To solve this issue VANET is integrated with existing and already deployed wireless networks access points. There exist various wireless technologies used to improve communication between networks such as Wireless-Fidelity (Wi-Fi), Universal Mobile Telecommunication Services (UMTS), Mobile Broadband Wireless Access (MBWA), World-wide Interoperability for Microwave Access (Wi-max), Wireless LAN (WLAN), Bluetooth, Zigbee, LTE, etc.

A vast amount of research has been established concerning integration of VANET and wireless networks. The author[1] studies VANET and Wi-max networks and explains purpose of integration of two networks. Proposes

architecture of integration and simulation is carried in NCTU further result studied using throughput and packet drop ratio for different real time situation like highway, urban, sub-urban areas.[2] Worked to improve the connectivity between the vehicle and roadside units using Wi-max and obtained minimum latency period while sending packets and discuss the challenges facing future vehicular networks. [3] Surveyed and compared various wireless technologies for integration with VANET. Author explains advantages and disadvantages of all technologies. [4] Authors proposed a multi-hop connectivity model between VANET and existing cellular systems. Compares proposed model with existing systems, perform theoretical analysis and simulation experiments in NS2 and developed a Markov chain model in order to determine the MAC of proposed connectivity model. [5] Authors studied performance of 3GPP LTE and IEEE 802.11p for VANET safety applications. Authors present mathematical models for the evaluation of the considered protocols in terms of successful beacon delivery probability. [6] Author uses LTE for vehicular networking instead of IEEE 802.11p, evaluation of performance of LTE for safety and traffic application is carried. [7] Author has focused on the use of Wi-fi and Wi-max in VANET for media distribution and vehicle connection with the internet. Experimental setup uses laptop enabled with different wireless adapters and an ad-hoc network established and results calculated using Iperf tool. [8] Proposed an integrated network of VANET and 3G for emergency situation communication, an EMDV strategy for energy dissemination in safety communication is performed by clustering and gateway management. All simulation carried in NS2. Routing protocol AODV is used and for performance evaluation Packet Drop Ratio (PDR), Control Packet Overhead (CPO), Data Packet Delivery Ratio (DPDR) are used. [9] Proposes a mechanism for seamless internet connection via integrating 3G and Opportunistic WLAN in vehicular communication. Model checked for urban and suburban scenarios, connectivity is improved by using vehicular-aware adaptation of the 802.21 MIH service and smart flow handoff procedures.

B. Routing Protocols of VANET

Many routing protocols have been proposed for VANET environment based on network protocol characteristics, techniques used, routing information, Quality of Service (QoS), routing algorithms, and network structures. Based on routing characteristics and techniques some authors classified routing protocols into five categories as: topology-based, position based, broadcast, geo-cast, cluster-based routing protocols [10][11][12]. Some paper considers network structures and classifies protocols as hierarchical, flat and position-base routing. On the basis of routing strategies they are classified as pro-active and reactive. Geographic – based and topology based are two categorization based on routing information used in packet forwarding. Based on QoS hierarchical, flat and position-aware are three types. Considering route discovery, most of papers classify routing protocols as proactive, reactive, hybrid and predictive [13].

1) Topology Based Routing Protocols

Topology based routing protocols which discover the route and maintain routing information in a table before the sender starts transmitting data. They are divided into Proactive, Reactive and Hybrid protocols.

Proactive protocols: The proactive protocol is also known as table driven routing protocol. Each node has route table containing path information with other node. Thus when a node need communicate with other node it has path defined in its route table hence no initial route discovery delay. But as VANET is fast moving network path, topology keep changing and hence updating route table increases control packet overhead, consumes more bandwidth for updating information. Various types of proactive routing protocols are Source-Tree Adaptive Routing (STAR), Cluster Head Gateway Switch Routing **(**CGSR**),** Destination Sequenced Distance Vector Routing (DSDV), Fisheye State Routing (FSR), Optimized Link State Routing protocol (OLSR) [14]**.**

Reactive protocols: Reactive routing protocol is also known as on-demand. Route information is propagated when a source request (demand) for it; hence reduce the network overhead; But include delay in route discovery. Reactive routing protocols are applicable to the large size of the mobile ad hoc networks which are highly mobility and frequent topology changes. Many reactive routing protocols have been developed, such as Ad-hoc on-demand distance vector (AODV), Dynamic source routing (DSR), Dynamic MANET On demand (DYMO), and Temporally Ordered Routing Algorithm (TORA) [14]**.**

Hybrid protocols: Hybrid protocol is developed to overshadow shortcomings of proactive and reactive protocols. It minimizes the proactive routing protocol control overhead and reduces the delay of the route discovery process within on-demand routing protocols. Usually the hybrid protocol divides the network to many zones to provide more reliability for route discovery and maintenance processes. It reduces the number of rebroadcast messages which achieved by allowing network nodes to work together and the most appropriate nodes are used to setup a route. It has higher scalability Types of hybrid protocols are: Zone routing protocol (ZRP), Zone-based hierarchical link state (ZHLS)[15] [16]**.**

2) Position Based Routing Protocol

Position or geographic routing protocol is based on the positional information in routing process; where the source sends a packet to the destination using its geographic position rather than using the network address.

This protocol required each node is able to decide its location and the location of its neighbors through the Geographic Position System (GPS) assistance. The node identifies its neighbor as a node that located inside the node's radio range. When the source need to send a packet, it usually stores the position of the destination in the packet header which will help in forwarding the packet to the destination without needs to route discovery, route maintenance, or even awareness of the network topology. Geographic routing protocols commonly classified into three classes: Delay Tolerant Network (DTN) Protocols,

Non Delay Tolerant Network (Non DTN) Protocols and hybrid [17][18].

3) Broadcast Routing Protocol

Broadcasting in VANET is very critical issue because network topology, mobility patterns, demographics, traffic patterns at different times. These kinds of protocols are used for sharing traffic, weather, emergency, road condition, delivering announcements and advertisements. Broadcasting in VANETs can disseminate assistant traffic condition messages to all vehicles within a certain geographical area. Broadcasting is implemented using flooding mechanism. The various Broadcast routing protocols are BROADCOMM, UMB, PGB, V-TRADE, and DV-CAST.

4) Multicast Based Routing Protocol

Multicast is defined by sending packets from a single source to specific group members by multi hop communication [19]. Multicast routing in VANETs can be classified into two categories: geo-cast and cluster-based routing, Robust vehicular routing (ROVER).

5) Cluster Based Routing Protocol

All vehicles in network are grouped in different groups based on certain characteristics like direction of movement, LET, RET, and signal strength. Each cluster has a cluster head; cluster head manages all communication within group and communicate with cluster head from other group. This protocol provides a good scalability for large networks; however it may increase network overhead and delays in highly dynamic network [20].Clustering for Open IVC Network (COIN), Cluster-Based Directional Routing Protocol (CBDRP).

C. Mobile Gateway

IP protocol (TCP/IP suite) and VANET protocol architecture and corresponding languages are different. Gateway must understand both languages and able to translate both languages. Internet gateway may be internal (mobile gateway), Static gateways are nothing but Road-Side Units (RSU), deployed road-side at fixed distance which makes system costly.

Shortcomings of static gateways:

1) Deployment cost of RSU is high.
2) Dynamic topology nature of VANET communication affects stability of links between nodes and gateways.
3) Mainly proactive routing algorithms are used and hence also influenced with disadvantages of proactive routing.

To overcome these shortcomings Mobile gateways are introduced. Mobile gateway is a dual-interfaced node is equipped with radio interfaces for communication with both networks. One interface for communication within VANET and other interface for wireless technology used for connection with internet. Gateway management includes three mechanisms like gateway selection, discovery and handover.

1) Gateway Selection

In order to find mobile gateway node all vehicle are arranged in group called as cluster. Clustering takes place based on metric values. Metrics are nothing but some network characteristics such as UMTS signal strength, Direction of movement, Link stability, route stability, TTL, inter-vehicle distance, residual energy, vehicle speed, IEEE 802.11p coverage range. Vehicles with similar metric values or metric which satisfies particular conditions are grouped together. For each group a captain or leader or controller is selected, which is called as cluster head. A cluster head is node which has capability to work as mobile gateway. All the cluster heads from network are with dual interfaces operating. Whenever network calls for gateway, it gets ready to flow traffic from VANET to internet and vice-versa. Among all available cluster heads, one of cluster head is selected to work as mobile gateway. The node with high weight is selected as gateway. Weight is calculated using metric values. A simple additive technique explained in [21]. There are different research paper which uses set of metric and based on these metric weight of node is calculated and then node with highest weight is selected as gateway. S. Barghi, A. Benslimane, and C. Assi in [22] have considered static gateway for internet connection and metrics like inter-vehicle distance, residual energy are considered for clustering and gateway selection mechanism. K. V. Dinesh Kumar, B. Swathi, K. Suresh, M. Suneetha Rani [23] consider residual energy, 3G signal strength, mobility speed to calculate node weight. Direction of movement, inter-vehicle distance, mobility speed etc is considered in [24]. In recent research the problem of gateway selection is widely studied. In [25], a adaptive gateway management mechanism for B3G network is proposed. For selection of gateways they used multi-attribute decision making theory and simple additive weighing [26] based on residual energy, UMTS signal strength, mobility speed of gateway vehicle. It also proposed gateway migration technique in case of loss of optimality but as VANET is highly dynamic in nature the speed of vehicle metric cannot give stable cluster. The cluster creation itself are so dynamic that causes overhead of continuous cluster formation and today with high technology residual energy of vehicles is not matter to worry. It also uses pro-active routing protocol that will increase the packet overload and delays. In [27], adaptive discovery of gateway management mechanism is proposed, that includes a hybrid mechanism which includes proactive and reactive routing protocols together. In [27], UCAN uses either proactive or reactive protocol for discovery and nodes only search for gateway when their transmission rate goes below threshold. In Opportunity Driven Multiple Access (ODMA) architecture there is no concept of gateway every node from network relays the packets to another network but this causes bottleneck for the both network interfaces. In [1], authors proposed a routing protocol which increases stability of route using RET and LET values as metrics to connect VANET to wired network. But it considers gateway purely stationary which

again cause high deployment cost, bottleneck at RSU. It uses proactive communication between vehicles and gateways. In [24], metrics such as velocities, direction of movement and inter vehicular distance. But the velocity metric do not support stable cluster, it causes increased overhead of cluster formation.

2) Gateway Discovery Schemes

When a vehicle wants to connect to internet it needs to find or discover gateway. On discovery of gateway, updating of routing table in source node takes place. Packet transfer between VANET source node and internet takes place via gateway node. These discovery schemes are divided into three types as proactive, reactive and hybrid gateway discovery schemes.

Proactive gateway discovery scheme: This scheme makes use of gateway advertisement message (GWADV). Gateway discovery is initiated by gateway itself. Gateway sends advertisement message within its coverage for time equal to TTL. Accordingly all nodes which received GWADV message update their routing table that is keep path information with them. when a node want to connect with internet, it do not need to find gateway as it has path information with it so it directly communicate with gateway via path entered in its routing table; hence proactive routing protocols avoid delays. But it increases the signalling overhead because gateway keep on sending control packets containing gateway route and as we know VANET has dynamic topology gateway handover are also more. And more the topology changes more route changes exist hence gateway keep on broadcasting advertisement messages and accordingly all nodes within coverage need to update their routing tables which leads to performance degradation at nodes and overall signalling overhead . Every time node need update routing table hence increases control packet overhead.

Reactive gateway discovery scheme: In this scheme when a vehicle (source) want a internet connection then a request message (RREQ) is broadcasted in the network and when gateway node receives RREQ message it replies to that with RREP message. In this way source-to-gateway path or route is discovered on demand or on request. It helped in reducing signalling overhead because route information messages transfer in network only on demand. But it increases route discovery time and hence efficiency affects.

Hybrid gateway discovery scheme: This scheme is combination of proactive and reactive gateway discovery schemes. It worked on disadvantages of both schemes and comes with hybrid solution containing combination of proactive and reactive discovery schemes. Gateway broadcasts GWADV messages within its coverage range called as proactive zone, all nodes neighbour to it has route information of gateway. A node outside range of gateway requests for route information using RREQ message broadcasting. Then that message is multi-hoped in network. When that message received by nodes who has current gateway path information, reply back path. Hence it causes less delay and less signalling overhead.

III. CONCLUSIONS

Integration of VANET with different wireless technologies includes research on strong and weak features, handling shortcomings and usage of advantages of both networks which will be helpful for further on road social development. A vast amount of research carried for routing protocols specially designed for VANET. 3G wireless networks are widely deployed and provide strong communication range for consumer compare to others. For internet access use of RSU as base station causes weak service and communication link failures, RSU as bottleneck, short range communication. Hence instead use of static base station as a gateway between two different networks a dynamic gateway can be used. One of vehicle on road only will be designed in such a way that it will serve as gateway for other vehicle and it is called as mobile gateway. My research will focus on improving performance of this mobile gateway by 2-level integration architecture and data aggregation for giving priority to emergency messages dissemination. So that it will be helpful to reduce work load at the mobile gateway node and prioritization of emergency messages will help in faster transmission for emergency vehicles.

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