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VANET CHALLENGES OF AVAILABILITY AND SCALABILITY

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ABSTRACT.*In this large growing world, vehicles on the road have increased in recent years. Due to the huge volume of these vehicles on the road, potential threats and the road accidents are also increasing day by day. To overcome these threats, wireless technology called VANET (Vehicular Ad hoc Network) has been designed. Through this wireless technology, vehicles exchange some messages to avoid bad circumstances. In VANET, a warning message can be generated and propagated to the other vehicles to notify their drivers about the congestion zone or about an accident. There are many issues in the VANET which need to be improved to make the communication fast, secure and effective. In this paper, we have analyzed many issues of VANET including security, scalability, mobility and different types of attacks. In our proposed solution, we have used GSM (Global System and Mobile Communication) technology in combination with WiFi technology to resolve the mobility and scalability issue. We have also implemented AAA (Authentication, Authorization and Accountability) model in our proposed solution.*

Keywords*:* VANET; GSM; WiFi; DSCR; AAA; MIH

1. **Introduction.** Wireless communication is ubiquitous [1] due to its flexible nature to work in different situations. Mobile Ad Hoc Networks is a term which refers to the continuously varying network topology handheld mobile devices. The Vehicular Ad Hoc Network is one of its types. The Vehicular Adhoc Network is considered to be a one of the most successful application of adhoc networks. VANET is also called Wireless Access in Vehicular Environment (WAVE IEEE 1609) [2] which supports Intelligent Transportation System (ITS) [3] through DSRC. Various worldwide projects e.g. [4, 5, 6] in Europe, [7] in the United States and [8] in Japan are actively participating in researching and development of the infrastructure for inter-vehicular communications and applications.

Major goals of the VANET are road safety and efficient transportation. In order to improve road safety and efficiency of the transportation system that enable new mobile applications and services for the traveling public, has been developed called ITS (Intelligent Transportation System.) Traffic congestion on the roads is today is a large problem in big cities. It offers the constant threat of large rate of accidents on the roads. According to WHO (World Health Organization), more than 1.24 million people died in road accident in 2013 [9]. 8th leading cause of the death of young people aged from 15-29 year, is the road traffic injuries all over the world. It is expected that road traffic deaths will become the 5th leading cause in 2030 if no appropriate or quick action is taken.

In existing VANET, dedicated short range communication (DSRC) having the radio signals of the frequency of 5.9 GHz, is being used. Khan et al. In [10] showed that AODV and DSRC don't give an optimal solution for the situation in heavy traffic load. Due to the dynamic changes in the topology and high mobility, current standard 802.11 (WiFi) is not a good choice. IEEE has developed a special version of 802.11, which is 802.11p for the VANET. As the WiFi can only be used for shorter distance communication so there is a limitation of mobility and scalability. VANET which is a subclass of MANET, use vehicles as fast moving mobile nodes. Each vehicle has one OBU. RSU is placed along the road for the communication between V2V and V2I. Intelligent Transport System has referred to the development of many applications which include exchanging of safety messages, collision warning, and driver assistance applications.

For the Global System for mobile communication (GSM) [11, 12] user (2G Technology), General Packet Radio Service (GPRS) [13] technology is used for the services of radio access. In this technology, radio resources are optimized as it reserves the radio resources and use when only the data is required to be sent. GPRS is based on IP which is widely deployed technology. Rest work is organized in the following sections: Section II contains the components of the proposed architecture. Section III elaborates the existing literature and related work. Section IV explains the scalability and its impact on VANET. Section V consists of the proposed architecture and protocol with potential benefits. Section VI contains challenges and conclusion.

2. Components of proposed VANET. Following figure represents all the components of the proposed architecture:

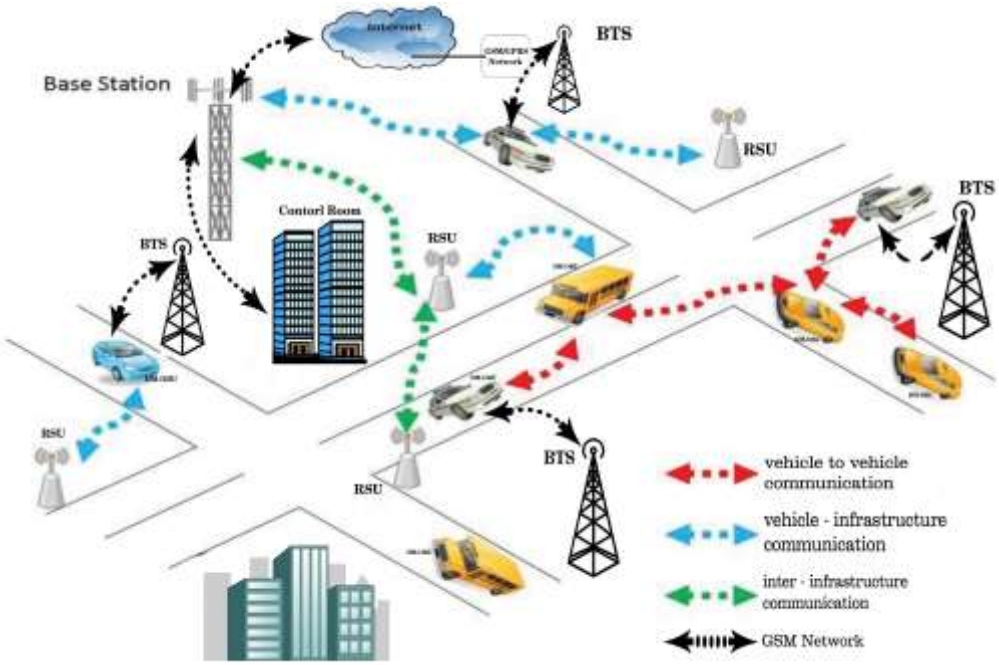

Figure-1: Represents the compononets of proposed VANET

Vehicles: Vehicles are the primary node which have to move around the dynamic topology. It consists of an on board unit having dual interface. One for WiFi network and one for GSM network.

RSU (Road Side Unit): RSU [14] is the node which connects all the vehicles in a specified region with each other and to the base station.

Dual Mode OBU: Each registered vehicle contains a dual band OBU with two wireless network interfaces, namely IEEE 802.11P and IEEE 802.21. UMA (Unlicensed Mobile Access technology refers to a mobile centric version of 802.21. UMA provides roaming and handover among GSM, UMTS, Bluetooth and 802.11 networks [15].

CS (Communication Server). The component ensures the AAA model.
GSM Network: GSM (Global System for Mobile Communication) is a standard of ETSI (European Telecommunication Standard Institute) which refers to the protocol for digital cellular network in 2G. It was based on a circuit switched network in start but later on it was developed for the full optimized telephony transformation using packet switched network.
Temper Proof Device. This device is used in every vehicle to store the secret information about the identity of the driver. It also stores the private keys for the authentication of the messages and senders. This device also signs outgoing messages for communication. It has its own battery which is normally charged by the vehicle itself. This device is made to synchronize with the Road Side Units. Only the authorized people have its access.

3. Related Work. Various scenarios have been analyzed and applications have been suggested. Kumar et al. [16] used Learning automata (LA) to assume cars as game players to share information on the basis of coordinates. Lu et al. in [17] define solution of the loss of power and interference which are always present in wireless communication. Farah et al. in [18] proposed belief functions for V2V (Vehicle to Vehicle) communications. Eltahir et al. in [19] have investigated the VANET and cellular network for different classification. Different beaconing approaches have also been discussed in [20]. Lloret et al. in [21] explained the communication architecture for vehicle to vehicle (V2V), Vehicle to Roadside Unit (V2R) and Roadside Unit to Vehicle (R2V). The above mentioned applications are problem indicators to the drivers to avoid accidents and rushy routes. These applications also provide advanced navigation systems through which shortest route can be determined from the current location to the destination. Some additional features of entertainment like surfing internet, multimedia and games are also available in these applications. One of the biggest issues is the continuous change in topology due to the high mobility of the network nodes, so that protocols are unable to perform in the concerned area of interest in VANET. To overcome this issue, information packets are broadcasted instead of disseminated in one dedicated direction.

A significant qualification, for the development of VANET, is scalability of the messages disseminated design. This article reflects improved version of scalability in the domain of VANET.

4.Scalability Problem Of VANET: Neumann recognized the term in [22] and defined that scalability refers to the capacity of handling new nodes without losing the performance or to increase the organizational density. In the design of VANET, scalability has diverse issues. An increase in the number of vehicles offers congestion in wireless channel and connectivity issue. It has great impact on scalability to design protocol. Bandwidth limitation is also a big critical section.

Li et al. proposed in [15] the capacity limitations for ad hoc networks. Limited bandwidth decreases by the poor channel utilization between the distant nodes due to the shared wireless channel with multi-hop communication and CSMA/CA medium access scheme. In a light VANET, an intelligent store and forward techniques are required to manage the load of the network which is an important challenge in the populated dense scenario. Number of vehicles and their applications have great impact on the messages that have to be sent to the shard medium. Safety messages are rebroadcast for the duration of their validity. Stored Geocast scheme presented in [23] leads to additional message to make information available.

The fundamental dissemination scheme used to forward the data packets in VANETs is flooding, where every node rebroadcasts each single message that it receives. The main problem of the flooding is congestion. This congestion increases with the increase in network size causing scalability problem. Limited network resources become unavailable due to the redundant traffic. Williams and Camp propose a complete fundamental algorithm to reduce redundant rebroadcast messages in [24]. In [25, 26], for example, Tonguz et al. proposed a distributed vehicular broadcasting protocol (DV-CAST), in which on the basis of connectivity of vehicles, local routing decisions are made. An important routing protocol which is mostly used in ad hoc networks is, Ad hoc on Demand Vector (AODV). It is a reactive protocol which is used when to search various paths for message transmission on demand due to limited bandwidth and topology changes. Packets are always exchanged among neighboring nodes for routing. Greedy perimeter stateless routing (GPSR) [28] is a typical greedy-forwarding protocol for a VANET. It uses greedy forwarding to send data packets to nodes that are always more and closer to the destination.

Based on IEEE 802.11 standard, dedicated short range communication, has been suggested which offer low cost but high data transmission rate to the vehicles. To deal with the time variations in wireless channels, two mechanisms are used. 1: Performing link layer retry, 2- using different PHY modes in which

each mode has specific data rate and modulation scheme.

A. IEEE 802.11p Based Technology: For effective among vehicles or between vehicles and RSUs (road side units), IEEE is continuously working on the class of standard of IEEE 802.11 for the vehicles having speed up to 200 km/h and distance range of 1km. Both PHY and MAC layers, based on IEEE 802.11a are shifted to 5.9 GHz Band.

B. Combined Wireless Access: CALM M5 [29] (Continuous air interface for a long or medium range) is the most considerable effort to combine wireless technologies by ISO TC 204 WG16. It contains some additional interface protocols on the top of IEEE 802.11P. At present, supported standard interfaces are: Cellular System (GSM/GPRS for 2/2.5G or UMTS for 3G), infrared communication system at 60 GHz. Combining all interfaces in one unit would result in more flexible but redundant interface having improved performance of applications. In [30], the author proposed a protocol that chooses the route with the largest lifetime to connect with the VANET network. In this work, vehicles are considered to be stationary or mobile but the gateways are only mobile. The authors use two matrices LET (Link Expiration Time) and RET (Route Expiration Time) for the network communication. The LET is used between adjacent vehicles and RET is used between the vehicles and gateways. Pro-active technique is used to communicate with gateways. Clustering approach is proposed in [31] in which clusters are made on the basis of velocity, direction and inter-vehicle distance. Also, a risk aware Media Access Control Protocol is used to increase the reaction by associating an emergency level with each vehicle in its cluster. In [32], the authors use stable routing protocol to address scalability issue and routing of data in a safe manner. In this scheme, vehicles are clustered on the basis of same direction to ensure stable path among them. Within the cluster, LET values are used for communication. Moreover, in VANET, vehicles cannot move randomly as mobile objects move in MANAETs. In [33], an adaptive distributed gateway discovery mechanism has been introduced. This scheme is a hybrid in which proactive and reactive approaches are combined. In [27], author suggests an algorithm for intersystem handover of 2G, GSM and 3G systems.

5. Proposed VANET GSM Integrated Architecture. In our proposed VANET architecture, we have divided the whole network into two zones. First zone is hybrid in which both DSRC (Dedicated Short Range Communication) and GSM (Global System for Mobile Communication) Networks are being used. With the use of DSRC, IEEE 802.11p is being used among the communication between Vehicles and between vehicles to Infrastructure. To work with GSM, its GPRS service is used. This service is used only for communication between vehicles and infrastructure. The GSM network is used only when there is be too much congestion in RSU or there is a problem of Line of sight in urban area causing to weaker the signals. This zone is preferred for the transmission of safety messages and emergency messages to avoid bad circumstances.

In the second zone, only the GSM network is used. This network is activated automatically when there is no WiFi access. This zone is preferred for the infotainment messages. Following algorithm and the Figure 2, represents the working of both segments through proposed NSA (Network Selector Agent). This agent selects the network according the feasible requirements.

A: Algorithm. The Following is the algorithm of the Selection of the zone:

Algorithm Begins:

On sensing the event through OBU

```
If the segment is hybrid then
        If WiFi signal strength > threshold then
                If no congestion on DSRC then
                        Data packet is transmitted
                else
                        Switch to GSM network
        else
                Switch to GSM network
else
        Switch to GSM network
```

Algorithm Ends

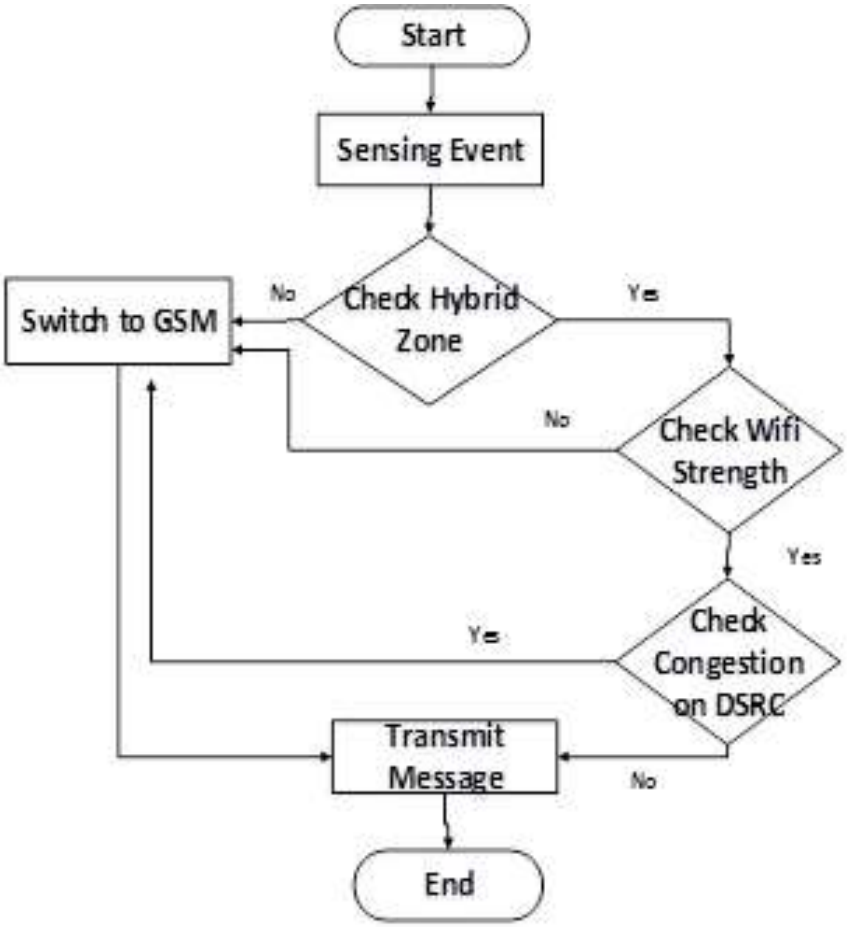

Figure-2: Working of Proposed VANET Architecture

B: Working of Proposed Protocol. As in our proposed solution, there is a communication handover between two wireless technologies. So we have proposed the use of Media Independent Handover (IEEE 802.21) between Layer 2 and Layer 3

C: Architecture of Media Independent Handover:There are three services of MIH. Event Service, Command Service & Information Service.

1) Media Independent Event Services: It contributes to the detection and notification of events that are relevant to the selection and maintenance of the link over which the vehicle obtains network access. The main idea of the event service is to show the transmission behavior and state changes of layer 2. Information flows in the protocol stack from lower layers to MIH layer and then from MIH layer to the upper layer.

2) Media Independent Command Services: These commands are used to control all the mechanisms of the layer-2 on the basis of decisions made by upper layer3. Command services can either be link command and MIH commands which can either be further more local or remote.

3) Media Independent Information Service: The MIH information service provides the information to the link layer-2. This information may include the MAC addresses of all the heterogeneous types of network, neighbor reports, channel information or neighbor reports.

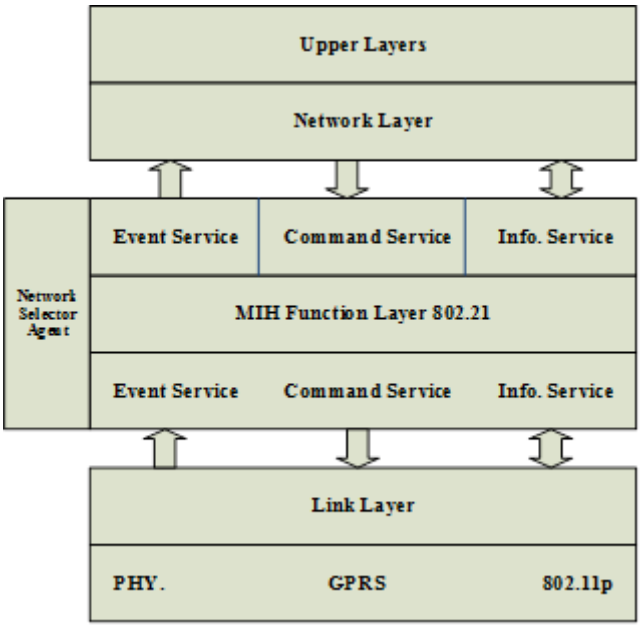

Figure-3: MIH Architecture

D. Benefits of Proposed Solution. With the use of our proposed solution we have following benefits:

1. We can make a vehicle a part of the GSM / GPRS network through which internet facilities can be availed.
2. Safety messages can also be transferred to the vehicles which are present at long distance away.
3. Connectivity is made ensure for the maximum time through either of the network (DSRC or GSM).
4. If DSRC Signals are weak, then messages can be transferred through the GSM network.

Conclusion. In the VANET architecture, it is most important feature to provide the connectivity of the vehicles to the related network so that we can avoid from the worst circumstances by exchanging the safety or warning messages. In this paper, we have concluded that availability can be made assured for the maximum time by merging two wireless technologies: DSRC (dedicated short range communication) and GSM (Global System for mobile communication). Our proposed solution has also provided the users of VANET the facility of internet streaming and infotainment messages. As GPRS has many security issues, so researchers have a big domain to improve it. Due to the dual mode of on-board unit, (one for DSRS and one for GSM) there can be unnecessary delay in the communication that should be vanished in the future.

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