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Position-Based Emergency Message Dissemination Schemes in the Internet of Vehicles: A Review

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***Abstract*— In recent years researchers have shown significant interest in vehicular networks to augment road safety by providing real-time messaging services among vehicles. This work aims to provide a detailed analysis of emergency message dissemination techniques for the Internet of Vehicles (IoV). We explored position-based data dissemination techniques for emergency message dissemination, which is considered the best routing method because it does not rely on predestination entries of the route. Position-based schemes encounter some challenges, such as delay and accurate positioning. Existing survey papers of IoV focused on architecture, technologies, and layers. However, this article examines a brief comparison of subtypes of position-based emergency message routing, beacon-oriented and beacon-less techniques. In the end, we presented the basic challenges of emergency message dissemination; moreover, future directions are highlighted to promote the development of new protocols for emergency message dissemination to enhance the efficiency of IoV in a better way.**

***Index Terms*— IoV, routing, emergency message, position-based routing, beacon.**

I. Introduction

INTERNET of Things (IoT) introduced the concept of connected objects known as "things", embedded with software, sensor, and technologies for communication and exchanging information with devices over the Internet. The Internet of Vehicles (IoV) is an inevitable IoT and mobile Internet integration. It is an important application and one of the reasons for the rapid growth of IoT, which allows a vehicle to communicate and exchange information using a Vehicular Ad hoc Network (VANAT). Over time, the number of vehicles on the road increases, leading to severe traffic glitches, including environmental damage, traffic congestion, and road accidents [1], [2]. The studies [3], [4] provide statistics for road accidents, injuries, and deaths per year in different countries worldwide. According to a WHO report, 1.35 million people lose their lives yearly due to road accidents [5]. Road traffic crashes are becoming a reason for economic loss for individuals, families, and the nation.

Intelligent Transportation Systems (ITS) [6], [7] are deployed to overcome road challenges by integrating advanced tools and applying technologies to transportation for better traffic and improving quality of life. In general, communication in the vehicular network can be sorted into four major types: vehicle-to-vehicle (V2V), vehicle-to-the-roadside unit (V2R), vehicle-to-infrastructure (V2I), and vehicle-to-everything (V2X) [8], [9]. However, IoV supports six types of communication, including intra-vehicle, vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-cloud (V2C), vehicle to Human (V2H), and vehicle-to-sensor (V2S) [10].

The vehicle must be equipped with internet access for these communications to take place inside and outside the vehicle exploiting/employing services of a VANET [11], [12]. Vehicle in V2V communication exchanges data using an on-board unit (OBU) and communicates with other infrastructure entities (V2I) using Roadside units (RSUs) [13], [14].

Message or data dissemination is a general practice in vehicular networks to share messages and resources among all neighbour vehicles in the network [15]. Routing is finding the shortest and best path to exchange information between sender and receiver nodes successfully in time without any error if any event happens on the road. Existing V2I message/data dissemination techniques are categorized into three models: Push, Pull, and hybrid [16], [17]. In the push model, data is dispersed proactively using period broadcast. Whereas in the pull model, data is dispersed on demand. Some protocols combined pull and push models to keep up with different applications. Where V2V does not require infrastructure like roadside units and vehicles communicate in ad hoc manner [18], [19]. A typical depiction of a vehicular network is shown in figure 1. The IoV has several applications (trigger data dissemination) for which data is disseminated to and among vehicles. Still, the major drive is to convey alert safety messages to vehicles on the road in different geographical areas. This safety message is generated and communicated to all vehicles in the vicinity when any accident occurs on

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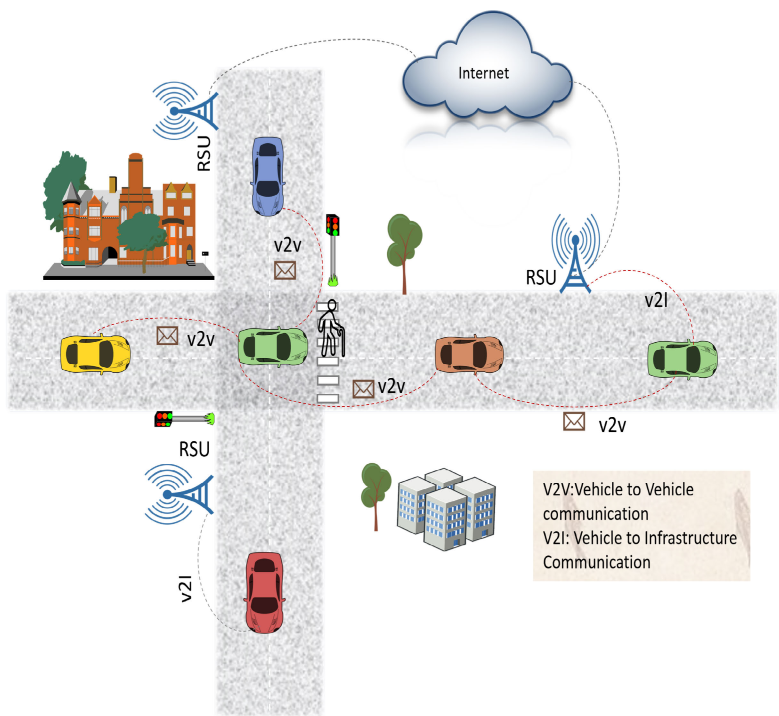

Fig. 1. A Typical depiction of vehicular networks architecture.

the road to avoid any dangerous situation. As vehicles' speed and topology change frequently, vehicles are unable to receive an emergency message well in time which is one of the key parameters in such time-critical applications. Here comes the role of the routing protocols to route messages on the shortest available path to the targeted destination with the lowest possible delay. A broadcast is one of the techniques widely used to disseminate data to all vehicles inside a network. However, simple broadcasting leads to several critical situations, such as broadcast storms, collisions, congestion, and bandwidth consumption [20]. Emergency data dissemination in IoV faces several issues, such as broadcast storm problems, network partition problems, communication overhead, limited bandwidth, end-to-end delay, irregular network connection, three dimensions(3-D) as well as energy resources limitations. Due to the heterogeneous environment, every node has its capability for computation and processing [21]. While having all these issues, successful data dissemination is challenging, and researchers introduced many techniques to alleviate the problems mentioned above. Still, there is a need to design an efficient and reliable solution to fulfil the requirements of emergency message dissemination in a large-scale and heterogeneous environment of IoV to save people's lives by reducing traffic accidents. This paper explores the basic introduction of vehicular networks, including IoV and VANETs, a comprehensive view of applications of IoV, and position-based routing (PBR) beacon and beaconless protocols for emergency data dissemination and challenges of emergency data dissemination. PBR protocols employ vehicle positions, paths, topology, and maps to disseminate messages [22]. PBR is categorized into three types: Delay Tolerant Networks (DTN), non-Delay Tolerant Networks (Non-DTN), and Hybrid, where Non-DTN is further divided into three categories: Beacon oriented, Beaconless, and hybrid schemes (detail is given in section II). We focused only on the beacon and beaconless schemes in our literature. According to our knowledge, there is only one review paper [23] for emergency message dissemination, and our paper is only a survey regarding position-based emergency message dissemination with detailed analysis of NDT approaches along with research challenges and future directions with respect to several parameters that play a role in emergency dissemination procedure with a possible recommended solution. All discussed schemes are grouped and analyzed for efficiency parameters, which will give hands-on experience to researchers in this field.

The major contributions of our paper are:

- To review existing and current techniques proposed to disseminate emergency messages. The techniques are mainly categorized into beacon-oriented and beaconless forwarding strategies.
- To provide a comprehensive critical analysis of discussed approaches (beacon and beaconless) through pros and cons, forwarding strategy, and environment in which these approaches are applicable is performed in the tabular form.
- The current technologies adopted in vehicular networks are also discussed.
- To identify the open challenges of position-based message forwarding schemes with exemplary solution studies and significant future guidelines with issues and recommended solutions are described.

The remaining of this paper is organized as follows: Section II discusses the applications of IoV, Section III describes the current innovations in the field of IoV. Section IV elaborates related survey of beacon-oriented and beaconless emergency message dissemination schemes, Section V is a detailed comparison of literature where Section VI demonstrates the issues of data dissemination of IoV; finally,

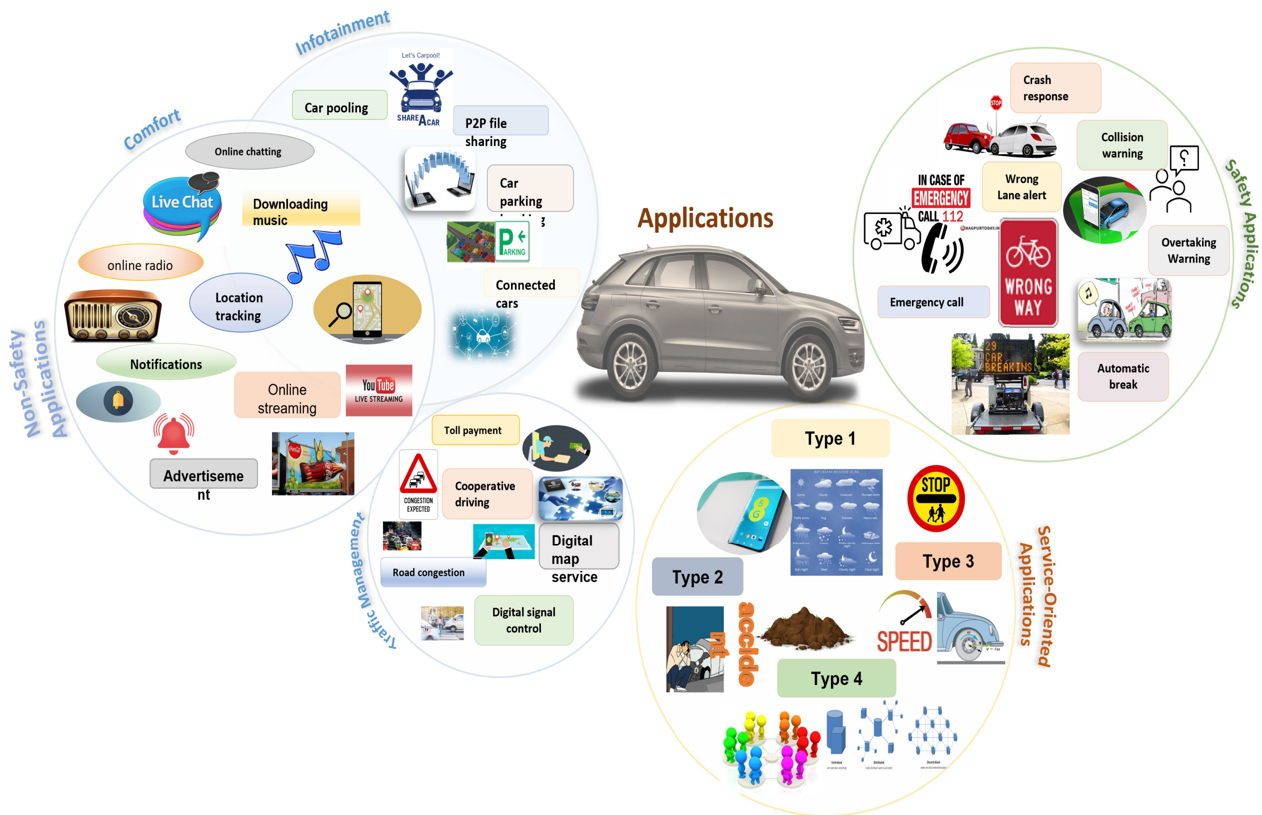

Fig. 2. Applications of IoV.

Section VII concludes the paper and future directions are discussed.

II. Applications of IoV

In this section, we discuss IoV applications based on the relation to safety applications and the service-oriented nature of some applications, as shown in figure 2:

A. Safety and Non-Safety Applications

1) Safety Applications: These applications warn vehicles about upcoming menaces by monitoring the road conditions, approaching vehicles in the surroundings, accidents, road curves, and warning messages for safety awareness like collision [22]. Mainly road accidents occur when drivers fail to communicate and coordinate well on time. Safety applications collect the vehicle or driver's behaviour, which is time-critical, so this information must be delivered reliably within a short time [12], [24]. Safety applications include emergency calls, lane change messages, automatic breaks, overtaking warnings, wrong-way driving alerts, traffic and crash responses, car maintenance, and collision warnings.

2) Non-Safety Applications: These facilitate users, including drivers, to provide entertainment-related applications and other information, such as free parking spaces, restaurants, and car repair stations nearby. These infotainment messages transmit at a high data rate without considering reliability and long delay. Some of the non-safety applications from different studies are:

a) Comfort Information: These applications are designed to facilitate comfort for travellers [25]. It includes P2P file sharing, navigation system, locating and booking car parking area, connected driving, tracking, internet service connectivity, carpooling, etc. [26], [27].

b) Infotainment Applications: Some researchers combine comfort and infotainment information because infotainment is a blend of information and entertainment. Here we are taking infotainment an entertainment-based application, to clarify it. Infotainment or entertainment-based applications provide services for online streaming, listening/downloading music, online radio, advertisement, notification about points of interest, sharing and tracking location, vehicular video streaming, chatting [28], [29], [30].

c) Traffic Management and Efficiency Applications:: Applications provide overall traffic efficiency by allowing vehicles to know about traffic situations like congestion. The driver decides according to the condition of the road using a positioning system [31], [32]. Such applications include road congestion, digital map services, traffic signal control, electric toll payment, intersection management, and cooperative driving [33].

B. Service-Oriented Application

Some other service-oriented VANETs applications based on mutual goals, such as safety information services, are categorized into four types [34].

Type-1 applications provide general information services related to advertisement and entertainment with many other

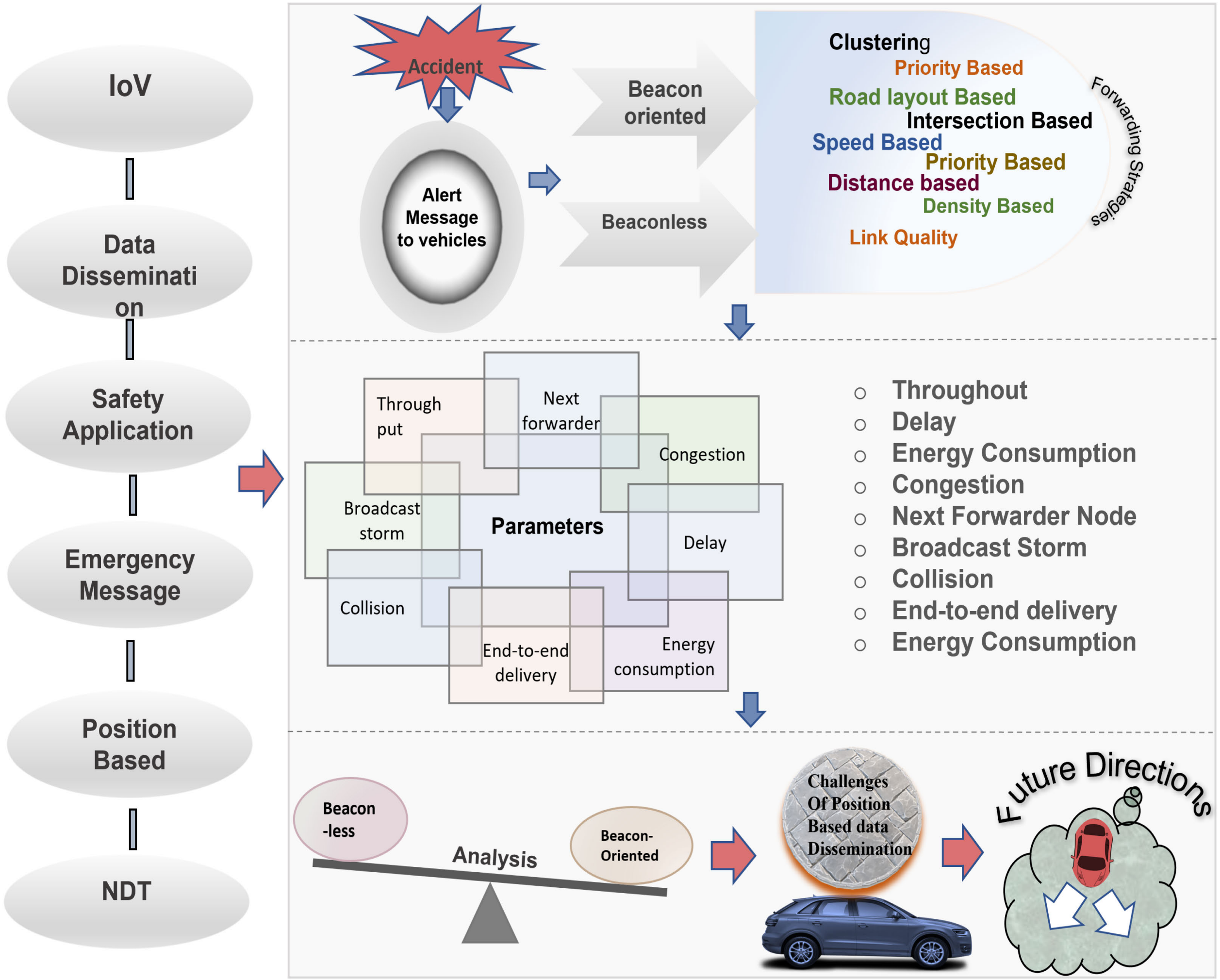

Fig. 3. Organization of paper.

requests like weather updates, road conditions, and mobile internet. If services are lost, these applications do not affect safety.

Type-2 applications are safety-related services, for example, accidents, congestion, obstacles, or notifications of danger on the way.

Type-3 applications deal with individual motion control, which may broadcast the change in position, acceleration, velocity, and actuator state. These applications suffer seriously if the information or service is lost because the information is used in real-time to control vehicles' brakes or acceleration.

Type-4 services deal with group motion control which comprises a relationship between vehicles sharing common characteristics like mission or destination. It involves broadcasting motion-related control messages for centralized or distributed applications.

III. Current Technologies in IoV

IoV is currently in the developing phase, and huge advancements are taking place these days in the field of vehicular networks. In this section, some of the recent developments in this field are scrutinized.

A. Digital Twin (DT)

DT is an appealing technology in the 6G paradigm with the power of connecting real-world assets, an object or a system, with real-time data through a virtual representation, and reasoning to help in decision making [35]. DT in IoV cost-effectively manages complexities; the physical spaces and logical spaces are mapped to track vehicle operations, and situation awareness as DT is updated continuously collecting information and sharing it with the surrounding physical vehicles [36], [37]. State-of-the-art about DT with IoV for offloading is [38] and overcomes delays in routing for road safety architectures are presented in [39] and [40].

B. Edge Computing(EC)

is used extensively in IoV to improve efficiency in terms of low latency, location awareness, high bandwidth, and bring computing and storage devices at the edge closer to the source of data device to reduce the burden of the cloud. **Fog computing** **(FC)** is another EC-based technology employed in IoV, sharing the same characteristics as edge computing to increase the efficiency of vehicular networks in different aspects. Edge computing transfers even raw data collected to the cloud, whereas fog computing plays the role of mediator between edge and cloud computing and shares only important data after analysis; thus, FC transfers less data than EC. Some of the examples of fog and edge computing in IoV are [38], [41], [42], [43], and [44].

C. Software-Defined Network (SDN)

SDN architecture in vehicular networks uniquely manages all network resources and offers flexibility, programmability, and stability [45], [46], [47]. Furthermore, SDN is anticipated to be a keystone for future 6G intelligentization. Some researchers combined SDN with FC and EC to satisfy the requirements of the dynamic nature of IoV. The studies with SDN and FC are [48], [49], and [50], and SDN and EC are [51] and [52]. These technologies are frequently utilized for for "offloading" tasks, which is the leading issue tackled by researchers in [53], [54], and [55].

D. Blockchain

The security, privacy, and management in smart transportation utilizing Blockchain concept is also currently under researchers' excogitation [56], [57]; moreover, blockchain is combined with DT in IoV [58].

E. AI

Artificial Intelligence (AI), particularly machine learning algorithms, is being used extensively in many IoV applications with tremendous success in classification and regression and is becoming some of the most effective tools. Deep and reinforcement learning techniques are employed to solve complicated tasks with low prior knowledge to optimize the productivity of the vehicular network. Some of the example studies are [59], [60], [61], and [62]. Moreover, [63], [64], [65] studies help researchers to know more about current and future trends in this field.

IV. Related Survey

This section describes different emergency message dissemination schemes of IoV based on position or location. Position-based routing, also called the geographic routing or Geo-routing, depends on the geographic position information where each node determines its own location. The source node knows about the destination before sending a packet, so this routing, without knowledge of the network topology or prior route discovery, a message can be routed to the destination. Some of the position-based protocols require an exact position of a vehicle, so the effectiveness of such vehicular applications is dependent on getting an accurate position. These location/position-based protocol routing decisions are based on local parameters rather than global parameters, which is highly effective in dynamic topologies [66], [67]. The position-based solution for safety message transmission is considered the best routing method, but it also encounters several issues to be focused on. There is a lot of literature available regarding data and emergency message delivery in the vehicular network, i.e., 57 articles related to safety or emergency scenario have been available in the past five years. In this section, only position-based emergency/safety message dissemination techniques are discussed. The main problems targeted are emergency messages delivery with minimum latency, the best relay node to rebroadcast messages, end-to-end packet delivery with low delivery loss, and minimum communication overhead. The emergency message dissemination schemes are categorized into two sections, beacon-oriented and beaconless, with different forwarding strategies and parameters. A complete picture of the survey is highlighted in figure 3. Wherein the working of all schemes with positive and negative impacts are reviewed in tables I and II; further, a detailed critical analysis based on performance parameters is discussed in section V and in table III. The general understanding of beacon and beaconless strategy is shown in figure 4:

A. Beacon Oriented Techniques

In multi-hop communication, vehicles forward packets in receiver and sender-oriented ways. The sender-oriented schemes are beacon-based, in which a HELLO packet or Beacon message is utilized to gather information (density, speed, direction, position, etc.) of surrounding vehicles to maintain neighbours' tables and form routes. Overhead is associated with beacon-oriented schemes, increasing network density and resulting in high bandwidth utilization and congestion [68], [69]. Second, beacon packets are small and can pass through weaker links, whereas actual message packets are larger in size. Thus, the message that passes through the link selected by the beacon does not guarantee a successful delivery [24].

1) Cluster-Based Schemes: Ali et al. [70] presented an approach to reduce communication delay in the dissemination of emergency messages. The proposed approach is to share information with the vehicle moving in the opposite direction, and it can cover a large risk zone area. The methodology is based on V2V communication without any extra RSUs. Clusters of vehicles are formed with similar parameters like speed, direction, and location, where CH is the leader and CM is a cluster member. EM is disseminated based on the position of the vehicle, especially a vehicle moving in the opposite direction, and the purpose is an early warning so that vehicles can take an alternate route in a timely fashion to avoid congestion.

Ramakrishnan et al. [71] proposed a cluster-based technique in which a cluster is formed in such a way as to avoid collision in VANET. Three algorithms are defined for cluster head selection, cluster formation, and emergency message dissemination. In case of an accident, the cluster head receives an emergency message and immediately forwards it to other members using the SRV channel. This technique has been evaluated for throughput, energy consumption, delay, and average packet delivery ratio.

Liu et al. [72] proposed a clustering and Probabilistic Broadcasting (CPB) scheme for reliable communication between nodes. In this work, different clusters or platoons are first constructed among vehicles according to their driving directions and geographic locations. After that, the cluster member calculates the forwarding probability depending on the value of a local-installed counter to guarantee the information coverage as well as the packet delivery ratio.

Alkhalifa et al. in [73]introduced a Novel Segment-based Safety message broadcasting in Cluster (NSSC) oriented vehicular sensor network for collision avoidance. The Variant

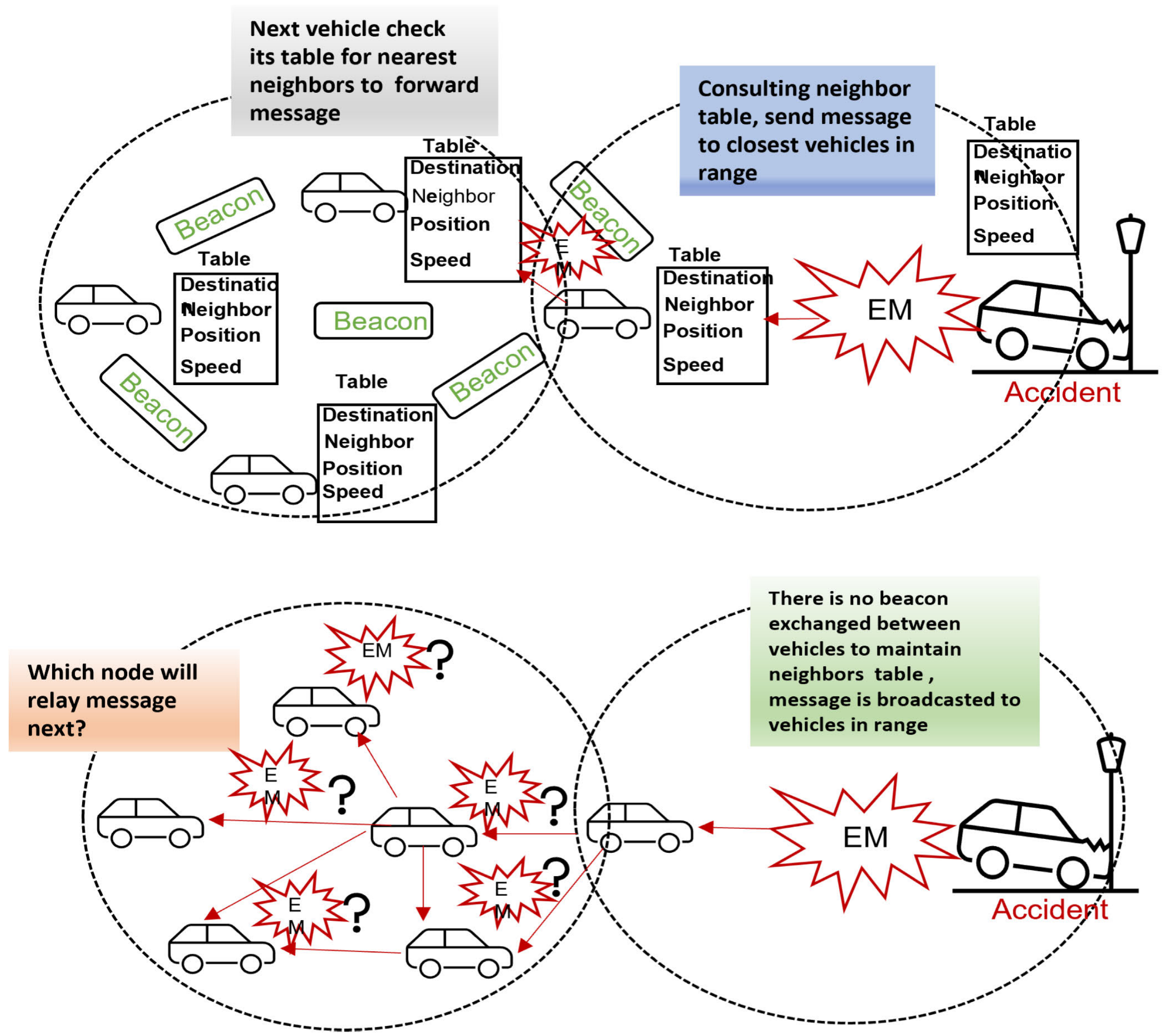

Fig. 4. Beacon and Beaconless strategy of EM dissemination.

based Clustering (VbC) method chooses the cluster head using the chaotic Crow Search (CCS) algorithm. An Adaptive Carrier Sense Multiple Access/Collision Avoidance is used to mitigate the chances of collision between the cluster head and cluster member. Moreover, the Fuzzy-Vikor method is utilized to choose optimal forwarder selection for safety message dissemination while reducing the broadcast storm problem.

Wang et al. in [74] proposed a cluster-based V2V Mixed Data Dissemination (CMDD) approach to meet the QoS of mixed Emergency Messages (Ems) and service Messages (SMs) transmissions in IoVs urban scenario. This approach comprises two algorithms; one is a bus-based cluster that chooses appropriate buses as cluster heads due to their regular route and enough resources, and ordinary vehicles join the suitable clusters as members. Second, mixed data scheduling; manages the timeliness traits of both EMs and SMs.

2) Probability-Based Schemes: Elnaz et al. [75] proposed a receiver-based adaptive broadcast scheme to choose a forwarder node based on a symmetric volunteer's dilemma game. Vehicles are considered as players, where each player as a participant chose as a volunteer to rebroadcast. The fuzzy logic method is utilized to adjust contention window size according to the forwarding probability and information of network density. Based on game theory, a vehicle decides whether to rebroadcast according to the transmission probability. Good to save bandwidth, but the delay per hop is more than compared schemes.

Li et al. [76] proposed a probabilistic broadcasting protocol for emergent message dissemination (BP-EMD) to select the best next relay node selection in urban IoV, in which a node with the highest weight wins the highest priority to be a relay node. To save network overhead, the Region of Sensitivity (RoS) is defined, which is considered as an affected area by accident. If no vehicle is there to transmit a message, then the sender will retransmit the packet after a specified time.

3) SDN and Fog-Based Schemes: Chakrouna et al. in [77] proposed a Location-based Alert Messages Dissemination (LAMD) with SDN, where the central controller defines rebroadcast points according to the location of the vehicle to avoid a collision. The architecture lies on V2I (RSUs) to broadcast and select V2V for rebroadcast choosing the most appropriate relay node to disseminate an alert message to vehicles in the region. A rebroadcast zone in the region is

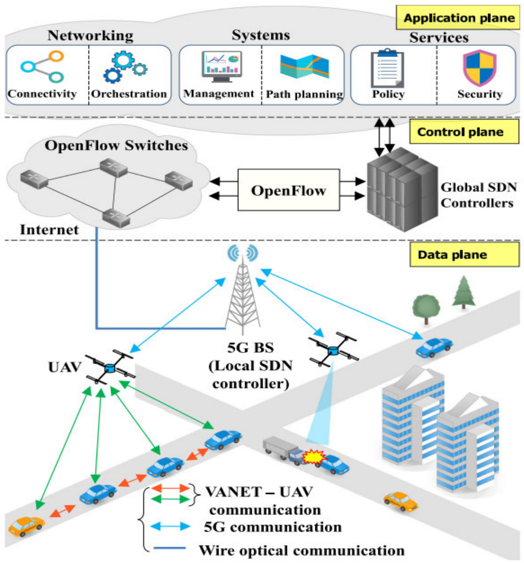

Fig. 5. The three-tier architecture of search [79].

designated, and a vehicle near this zone has a high priority to act as a relay node.

Zhu et al. in [78] proposed a hybrid emergency message transmission (HEMT) by employing an SDN controller to control and network management. The proposed architecture comprises SDN central controller, RUS switches, and OBUs to spread emergency messages rapidly; additionally, the inter-vehicle multi-hop communication method covers the low RSU coverage area to provide V2V communication. In the V2V scenario, a vehicle with a maximum distance between the sender and receiver is designated as the next forwarder vehicle, depending on the calculated waiting time.

Oubbati et al. proposed SEARCH [79] embedding new technologies such as SDN, and UAVs with 5G base stations, as shown in figure 5. A UAV gathers current information on the vehicle that reaches the junction in its coverage area, and transfers collected information to the SDN controller through 5G BSs. The SDN controller calculates the minimum path using Dijkstra Algorithm from the vehicle's current position and forwards to the vehicle. The vehicle continues moving to the destination with the same path if the new path doesn't impact the current path, but if the new path does affect then, the vehicle follows the new shortest path to get to the destination.

Yaqoob et al. in [80] proposed a fog-assisted congestion avoidance scheme, and energy-efficient message dissemination (E2MD), to reduce message overhead and congestion in IoV. All vehicles update their status to the fog server regularly so that the fog server updates the traffic in a timely fashion to slow down in any emergency. Three types of vehicles are considered intelligent vehicles (Iv), smart vehicles (Sv), and basic vehicles (Bv).

4) Adaptive Beaconing-Based Schemes: Yi et al.. [81] proposed Streetcast aim to provide efficient broadcast using street maps to choose relay node, and reliability is provided by adopting multicast Request-to-Send (MRTS) with beacon control approach in urban scenario. Overhead of a number of beacon messages are adjusted with adaptive beacon control heuristic. Streetcast is designed to overcome broadcast storms and collisions but does not consider network connectivity.

Naderi et al. [82] proposed an adaptive beacon broadcast scheme in VANETs with varying beacon transmission rates based on three parameters: motion of the vehicle, the topology of vehicle change around sending node, and a number of vehicles participating in forwarder set. Two rules are proposed for this scheme: A next beacon is forwarded based on link lifetime (LLT), and minimum link quality between the node with its neighbour is assumed based on observation of vehicle moving speed. Second, a node with a higher rank can stay as part of the forwarder set in the future.

Tomo et al. [83] presented a GPS-based protocol to overcome broadcast storm problem, named "Delay Tolerant and Predictive Data Dissemination Protocol (DTP-DDP) "where a receiver of any event reply back to the sender to select an appropriate node for further rebroadcasting the event. Operation success of this protocol depends on two separate messages; a reply to the sender from a receiver and a response from the sender node to a node further elected for rebroadcasting. This protocol is for both urban and highway environments.

Satheshkumar et al. [84] have suggested an energy efficient-fast message distribution routing protocol (EE-FMDRP) to broadcast messages fast from source to define target end in an emergency with efficiency and reliability. The working of EE-FMDRP consists of five phases: initialization of Adaptive Beaconing (AB) to share information, authorization of vehicle direction based on vector-angle oriented classification model to find moving direction and current location of a vehicle, confirmation with message delivery time (MDT) to evaluate message reaching time to destination and energy efficient routing framing. The purpose of this protocol is to improve efficiency by minimizing transmission delay and energy consumption while maximizing throughput.

Ullah et al. in [85] proposed a position prediction-based approach to select a relay node using selected mobility metrics to ensure a stable routing path for Emergency Message Routing in Intermittently Connected Networks (EMR-ICN). This hybrid approach combines V2V and V2I communication, and adaptive beaconing is utilized to gather neighbour information. If there is no vehicle and RSU in communication range to forward a message, then the vehicle store and carry EM till finding the forwarder node is in range.

5) Link-Quality-Based Schemes: Tasneem et al. [86] introduced a Lightweight Intersection-based Traffic Aware Routing (LITAR) protocol to reduce network overhead for V2V communication in the urban scenario while maintaining measurement accuracy. LITAR eliminates unnecessary controlled packets (CPs) by presenting the Enhanced Validity Period Calculation (EVPC) algorithm, which calculates the validity period (VP) to generate new CP only when traffic and network status change. LITAR route data packets are based on directional vehicular density, network connectivity, link stability, and distance to the destination.

Osama et al. [87] proposed a relay node selection scheme called Bi-directional Stable Communication (BDSC) for multi-hop broadcasting protocol. It is a sender-oriented and distributed multi-hop broadcasting approach wherein periodic HELLO packets are exchanged between neighbours in a single hop. A link is established between the sender and receiver node

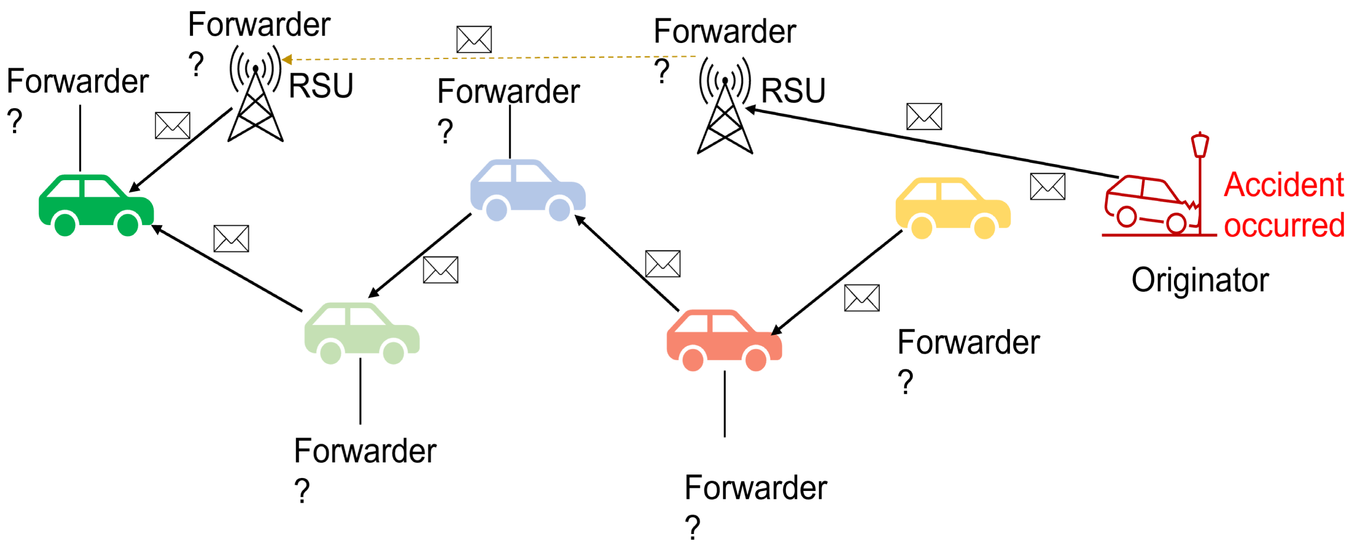

Fig. 6. Forwarding Node Selection.

to forward Hello and data packets. An algorithm measures the estimated link quality between nodes using equation 1:

$$LQ = IAC/T_{BDSC} \times (1/T_h) \quad (1)$$

with successfully received HELLO packets, the ratio ranges from 0 to 1, where a high value represents better link quality. This scheme can provide services for safety-related alerts and traffic management.

A fuzzy logic-based routing protocol is proposed by Alzamzami et al. in [88] to select an appropriate next-hop to forward packets in urban vehicular networks. Different routing parameters are used: distance, direction, and link quality where the Expected Transmission Count (ETX) is utilised to estimate link quality. Carry-and -forward approach is used to overcome the network dis-connectivity issue.

Ali Ghaffari [89] proposed a hybrid opportunistic and position-based routing protocol for VANETs, based on a greedy forwarding approach to improve packet delivery ratio and end-to-end delay. Hello, packets are periodically broadcast to measure the link's transmission rate. In this protocol, each source vehicle selects a number of neighbour candidates and assigns a fitness value which is measured on the basis of link quality, distance from destination, and density of vehicles in the vicinity. Priorities are assigned to vehicles using a prioritization algorithm, according to which a vehicle with the highest priority will transmit data first. Candidate vehicle "i" priority (Pi) is calculated using equation 2:

$$P_i = D_{sd} - D_{id} + N_i/ETX_i^2 \quad (2)$$

where D_{sd} is the distance between the current and target vehicle nodes and D_{id} is the distance between vehicle I and the target vehicle. In case a higher priority vehicle fails to transmit within the set timer, then the next vehicle will start transmitting data packets.

Rana et al. [90] presented a protocol Opportunistic Directional-Location Added Routing (OD-LAR), which assigns priority to candidate next-hop forwarder (CNHF) by considering geographical location, angular deviation, and link

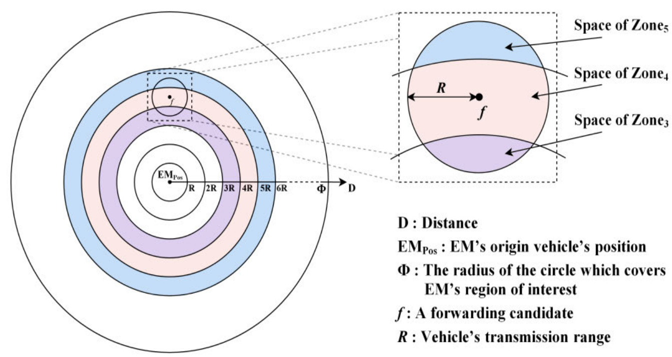

Fig. 7. Illustration of zones definition in TDB [92].

quality. The highest priority is given to the CNHF node with higher link quality, minimal angular deviation, and minimum distance from the destination node. The primary aim of this protocol is to reduce packet overhead and packet drop delay and improve throughput.

Septa et al. in [91] proposed a fuzzy logic-based solution choosing the best relay node to transmit safety messages with less packet loss and link breakage in both MAC and network layer. In the DYCW-MAC model, four parameters; direction, coverage, velocity difference and F-ETX are consumed to dynamically adjust the size of the contention window (CW) and choose the best relay node among neighbouring vehicles.

What is the best relay node to select, scenario is depicted in figure 6

6) Region of Interest (RoI)-Based: Tian et al. in [93] proposed a distributed position-based protocol for emergency message dissemination in vehicular networks on a large scale. The emergency messages are only broadcasted to the Regions of Interest (RoIs) according to the situation, and a message rebroadcast decision is made based on the information collected in the received message. More than one next forwarder can be selected to disseminate the message.

Liu et al. in [94] introduce a temporary warning network (TWN) to disseminate safety messages considering both the spatial distribution and temporal duration of the networking scheme in the urban traffic scenario. Based on the spatiotemporal correlation of vehicle trajectory, a selection of relay vehicle contracts TWN to rapidly disseminate safety messages within the Regions of Interest (RoIs). Two links are utilized: the inter-AA links between Core Vehicles (CVs), used to create the TWN wherein the safety messages are updated and transmitted; the other link, the intra-AA links, manage the periodic broadcast of safety messages within an active area (AA).

Guesmia et al. in [92] proposed an urban vehicular Time Division-based Broadcast scheme (UV-TDB) to relieve the hidden node interference to forward an emergency message. It is a multi-hop broadcast scheme that introduced a forwarder selection method with the mutual decision of sender and receiver and employed the store and carries mechanism. The forwarded candidate is assigned a waiting time for transmission in ROI. This approach also targeted the frequent interruption in connectivity between vehicles. The zone definition of TDB is illustrated in Figure 7.

7) Broadcast Suppression-Based Schemes: Maia et al. [95] introduced a U-HyDi protocol to deal with dynamically changing topology according to traffic conditions in an urban environment. It uses senders- and receiver-based ways for broadcasting data and assumes a Region of interest (ROI) where the only vehicle in this area will disseminate data. The farthest vehicle from the sender and receiver is chosen as the forwarder relay to cover more area. Moreover, the store-carry forward mechanism is adopted when no neighbour node is founded in the region.

Chaqfeh et al. [96] proposed an Efficient multi-directional Data Dissemination Protocol (EDDP) for an urban environment with less communication head. EDDP suppresses broadcasting by selecting fewer nodes as forwarders where each vehicle is assigned timeslots according to traffic conditions. A shorter delay time is assigned to the farthest vehicle, which means it belongs to the first timeslot and has a higher priority to act as the forwarder. This scheme considers urban road layout, including message format, mechanism of broadcast suppression, and delay control.

Khan et al. in [97] proposed a velocity and position-based broadcast suppression approach for VANETs (VP-CAST) to exchange safety messages for the avoidance of accidents and deal with emergency messages efficiently if an accident happened both in a sparse and dense scenario. A suppression mechanism is used to avoid a collision, and if the network is disconnected, vehicle services coming from opposite directions are taken. The waiting time of each vehicle is calculated based on velocity and distance information.

8) Machine Learning-Based Schemes: Liu et al. in [98] proposed a reinforcement learning (RL) algorithm to avoid channel congestion in V2V communication by controlling the message transmission rate using a Markov decision process (MDP). A reward function combining CBR, and transmission rate is defined, to maintain the targeted threshold of channel load, while increasing the congestion control's transmission rate. The transmission power and rate are adjusted according to the vehicle density.

Shah et al. in [99] proposed an Optimal Path Routing Protocol (OPRP) a trustworthy clustering technique for disseminating warning messages on highways. A modified K-medoids algorithm is proposed to choose a cluster head in a bi-directional highway scenario. For conveying warning messages two parameters; position and movement direction are used, where to find the direction of a node by applying hamming distance.

Jasim et al. in [100] used the K-mean clustering method for collision alerts in school zones for road safety in VANETs. This method collects group messages using parameters like vehicle position, messages and collision type and accident region. RSUs are the main component to disseminate an alert message about the collision.

Wang et al. [101] proposed a Rear-end Collision Prediction Mechanism with a deep learning method (RCPM) with a prediction mechanism where the real trajectory data is applied to fine-tune the neural network to solve back-end collision issue. Additionally, to improve the class imbalance problem, the genetic theory of inheritance is utilized.

Chakroun et al. in [102] proposed a Q-learning-based mechanism to calculate a minimum number and optimal locations of rebroadcast zones, in which V2I broadcasts and V2V rebroadcast delivery AMs in an entire area even in low wireless connectivity locations. Based on the Markov decision process, a Q-learning approach is used to manage a centralized architecture and programs running on the controllers.

9) Waiting Time-Based Schemes: Wang et al. [103] proposed a scheme for a fast and low overhead local topology information sensing technology-based broadcast (LISCast) based on sensing of local topology. Problems highlighted slow response and local broadcast storm (farthest first waiting-based broadcast protocol). The last forwarder will retransmit the message to limit retransmission.

Yang et al. [104] proposed a fast and reliable broadcast mechanism for emergency messages in IoV. The communication distance is based on prediction rather than being fixed, and this approach contributed to understanding the role of obstacles, traffic density, and communication distance in the prediction. The transmission area is divided into three areas: forward multi-hops (ambulance etc.) that notify the next vehicle; backward multi-hops, which notify the vehicle behind in case of brake failure; and all directions broadcast in case of any emergency.

Meenakshi et al. in [105] introduced message dissemination with re-route planning (MDRP) scheme to address message and traffic congestion. The proposed scheme is waiting time and distance based; the distance between the last vehicle and sender vehicle based, where RSUs at every intersection forward emergency messages to every enduring vehicle to keep messages for a defined wait time. The non-congested path toward the destination is chosen to speed up the emergency message delivery.

10) Trajectory Prediction and Traffic Condition Based Scheme: Li et al. in [106] introduced an approach in which the message is only disseminated by the vehicle predicted to pass through the accident site to avoid excessive delay and message overhead. A hybrid early warning message system for VANETs in sparse and dense scenarios is organized to deliver an alert message to relevant vehicles based on vehicle trajectory prediction for reliable delivery. Moreover, the communication mode is adaptively selected depending on the vehicle's connectivity, either using V2V multi-hop data dissemination or V2I dissemination whenever a V2V connection is unavailable. Another trajectory-based scheme is proposed by Kezia et al. in [107] for an emergency packet routing algorithm to avoid collision using collected trajectory data in vehicular networks in a highway scenario. A cluster head of a sphere checks the collision possibility of any of two vehicles by comparing trajectory, and a warning message is conveyed to the corresponding vehicles if a collision is predicted, employing the proactive routing protocol.

Hawbani et al. in [108] proposed a network layer multi-criteria decision-making (MCDM) fuzzy-based protocol for V2V communication with Road Segment Selection and relay node selection utilizing parameters such as vehicle density, distance, and network size. The inter and intra paths are modelled, inter path is applied for the next hop junction and the intra path is to select the next vehicle by the sender vehicle.

Figueiredo et al. in [109] proposed an approach for emergency response vehicles in which data is collected using sensors and vehicle communication, primarily through CAMs and RADARs. The ERV's future location is predicted to disseminate warning messages earlier to road users before ERV approaches. Vehicles are categorized into three classes according to their length: heavy vehicle class, light vehicle class, and other class.

A summary of all beacon-oriented schemes discussed, the advantages and limitations are described in Table I below.

B. Beaconless Broadcast Techniques

Beaconless schemes are receiver-oriented, in which the receiver decides to be part of routing. In the beaconless approach, vehicles are unaware of their neighbours, wherein delay as a challenge clearly indicates the beaconless approach [111]. Here beaconless techniques are discussed in detail. Achour et al. [112] combined delay and probability-based dissemination techniques in simple and efficient adaptive dissemination (SEAD) to overcome the broadcast problem by offering end-to-end delay in a highway scenario. Data dissemination decisions consider three parameters: distance, traffic density, and message direction. Each vehicle updates its redundancy ratio continuously to know about neighbours. A Waiting time Wt has given to each message, which is calculated with equation 3:

$$W_t = \lfloor N_t * \left(1 - min\left(D_{ij}, R\right)/R\right) \rfloor * \delta \quad (3)$$

where D_{ij} is the relative distance between the sender "i" and receiver "j". If no redundant message receives from another forwarder till the waiting time expires. This message is rebroadcast with probability "p" otherwise discarded. However, this protocol does not clarify the effect of the road segments on the probability of re-broadcasting in terms of high and low vehicle density. Naja et al. [113] proposed a Dynamic hybrid broadcast protocol (DHBP) in which data is disseminated using the decision-making function (DMF), the distance between receiver and incident, and the number of received messages. Reachability is ensured by a number of more or fewer copies of the message received by a node; if a node receives a few messages, copies of the message must be sent to other nodes. A relay node stops rebroadcasting when its probability reaches zero or distance either the distance to the incident location or a number of messages surpasses a given threshold.

Chaqfeh et al. [114] in a multi-hop data dissemination technique for VANET provides scalable broadcast by evaluating three variations of Speed Adaptive Broadcast (SAB): The Probabilistic SAB(P-SAB), the Slotted SAB(S-SAB) and the Grid SAB(G-SAB). This broadcast strategy detects traffic regime via speed data without collecting density by using a negative correlation between the speed and the density. A vehicle decides to act as a relay forwarder when receiving a message for the first time with probability α. Every vehicle is assigned a timeslot in which scheduled broadcast waits to disseminate or discard a message.

Mostafa et al. [115] suggested Collision-Aware REliable FORwarding (CAREFOR), a probability-based multi-hop protocol to reduce the number of rebroadcasts in the network to overcome collision probability and improve throughput. This possibility is employed by various physical factors derived from the vehicle's environment, including the density of the vehicles in the vicinity, the distance between the sender and receiving vehicles, and the next-hop transmission range. The probability in the result determines whether a specific vehicle is receiving a successful rebroadcast. Thus, CAREFOR is a solution for avoiding collisions and reliably forwarding information packets into VANETs.

Kumar et al. [116] proposed a Beacon Information Independent geographical routing algorithm (BIIR) to reduce the number of broadcasts of messages by making smart use of Information gathered by the vehicle during previous attempts to discover the route discovery to the destination. A localized hybrid algorithm for highway and city scenarios forwards the data packets. For using previous routing information, BIIR uses four distinct messages: Data Message (DM), Reply Message (RM), Select Message (SM), and Acknowledgment Message (AM). In addition, each node maintains a neighbour data table in which an entry for a destination is inserted whenever a vehicle receives AM for the DM forwarded to a certain destination to save previous routing results.

Tizvar et al. [117] presented a density-aware probabilistic approach to overcome the broadcast problems in the content-centric vehicular network in which probability is dynamically computed based on existing neighbours. Vehicles don't share geolocation with neighbour vehicles; no prior topology knowledge is maintained. A local density approximation method is used to calculate neighbours with the help of PIT maintained by each vehicle. Moreover, an interest retransmission mechanism is used to apply the timer-based approach to prioritize the probable forwarders. Two different timers, defer timer and the retry timer, are used to reduce unnecessary broadcasts.

Heissenbüttel et al. [118] proposed a beaconless routing protocol (BLR), is routing protocol to reduce routing overhead with the use of location information. It is MANET based protocol but claimed to be suitable for VANETs too. A Source node determines the destination's position before sending the data packet and stores geographical coordinates in the data header and its current position. When the destination receives

TABLE I
SUMMARY OF BEACON-ORIENTED DATA DISSEMINATION SCHEMES

Scheme	Basic Idea	Mechanism	Advantages	Limitations
Wang et al. [103]	Sensing of local topology Information	Receiver based broadcasting	Improved broadcast storm, and end-to-end delivery	Communication Overhead
Ali et al. [70]	Broadcast message using vehicle moving opposite direction	Position and cluster based	Improved broadcast storm, Reduced Communication delay	Overhead of regular beacon messages, packet delivery error with high speed
Ramakrishnan et al. [71]	Cluster formation to avoid Collison	Cluster based broadcast	Increased reliability, throughput, and packet delivery ratio	takes time to select a new cluster head, decrease effectiveness
Yang et al. [104]	Reliable broadcast taking all obstacles into account	Broadcast based on roads layout	High reception ratio	High redundancy
Liu et al. [72]	Forming cluster based on same driving direction	Clustering and probability based	Improve packet delivery ratio, information coverage	Regular beaconing and computation at every node may leads to more delay
Tasneem et al. [86]	Two processes working, RTNSM phase, and data routing phase in parallel.	Direction, Road condition and destination based	Reduce overhead, maintain accuracy	Efficiency may decrease with no or less vehicles on interaction
Yi et al. [81]	Relay node selection, MRTS handshaking, and adaptive beacon control	Position Based, street maps	Reduced broadcast storm, collision, and beacon message overhead	doesn't take network connectivity into account which may affect reachability
Guilherme et al. [95]	One hope neighbor information in dense network and store-carry-forward approach for sparce network	Sender and receiver based	Reduce broadcast storm, and delivery delay	Using beacon messages to collect neighbor's information without control mechanism may leads to overhead
Osama et al. [87]	Relay selection node based on link quality over vehicle's platoon	Single hop neighboring, link estimation	Reduced End-to-End delay in dense network	takes a long time to estimate link quality [110]
Tomo et al. [83]	Next relay node is chosen from different directions to rebroadcast	GPS based with integrated map	solves broadcast problem and achieve high delivery ratio	it costs delay, and more numbers of retransmission packets
Ali Ghaffari, [89]	Neighboring nodes selected optimal candidate node using some parameters and priorities are assigns	hybrid opportunistic, position based	improves packet deliver, throughput and end to end deliver	periodically Hello messages may generate congestion, overhead and bandwidth utilisation
Elnaz et al. [75]	Fuzzy logic based, one player should pay cost and act as volunteer to rebroadcast	Dilemma game, fuzzy logic, probability and receiver based	good reachability, improved rebroadcast issue	Costs more delay
Chaqfeh et al. [96]	broadcast with selecting fewer nodes as forwarder, shorter delay time is assigned to farthest vehicle	Position and road condition based	Minimise communication overhead and redundancy, improve packet delivery	More than one vehicle in area may transmit simultaneously
Rana et al. [90]	The candidate next-hop forwarder (CNHF) nodes prioritised at broader area to destination node.	Geographical location based, link quality, angular derivation	Improved packet delivery ratio, reduce communication overhead	This protocol cannot assure optimum result when vehicles are out of the range
Naderi et al. [82]	A next beacon is forwarded based of link lifetime (LLT), a node with higher rank can stay as part of forwarder set in future	Position based	Minimise PDR, routing overhead, and end-to-end delivery	Quite a few control messages to regulate and coordinate next forwarders
Satheshkumar et al. [84]	Optimum forwarding neighbors are designated on the basis of position, direction, and message delivery time of vehicle.	Time and direction routing model Current location	Reduces transmission delay and energy consumption and maximise throughput	Communication overhead
Li et al. [76]	Relay node selection based on highest weight and priority	Probability and waiting based broadcast	Maximise PDR, end-to-end delivery, dissemination efficiency	Computation at every node and waiting may lead to extra delay

TABLE I

(Continued.) SUMMARY OF BEACON-ORIENTED DATA DISSEMINATION SCHEMES

Meenaakshi et al. [105]	Re-route planning in emergency based on wait	Distance, boundary matric and road traffic based	Reduced message transmission delay and delaying instances	More system resources and message exchange are used, the actual message may be delayed
Chakrouna et al. [77]	Relay node selection based on highest weight and priority	Location Based	Reduced collision, delivery delay with high information coverage	Computation at every node and waiting may lead to extra delay
Zhu et al. [78]	A fast and reliable hybrid emergency message transmission employing SDN controller	Waiting Time, distance and position based	Fast emergency message delivery with better coverage ratio and lessen the controller overhead	with the increased traffic density, the message coverage ratio is significantly decreased which indicates this architecture is not appropriate for high density traffic regimes
Oubbati et al. [79]	Collect current information to calculate shortest path to destination	Location , road information based	Provides rapid path discovery between source and destination, high bandwidth	Cost of deploying infrastructure, and failure of path planning when accident occurs in front of vehicle moving on road segment appropriate for high
S Yaqoob et al. [80]	Fog-assisted congestion avoidance scheme for emergency	Priority and group based	Minimize message congestion and increase packet delivery ratio	Computation overhead and uncertainty to determine the types of vehicles, plus delay during fog server failure
Li et al. [106]	The message is only disseminated to vehicle passed through accident site	Trajectory data and and position based	Improve packet delivery delivery ratio, reduce latency and communication overhead	trajectory data may not accurately gather increase ratio of congestion
Kezia M et al. [107]	Emergency packet routing using trajectory data	Trajectory information , position based	Minimize collision	Communication overhead, possibility of overlap choosing next forwarder node
Alkhalifa et al. [73]	A cluster-based approach for safety message broadcasting using Forwarder node ,selected using Fuzzy-Vikor method	Connectivity, position, and speed based	Reduce broadcast storm problem, collision, and latency of broadcasting SM	Computation complexity may affect the performance in dense network
Liu et al. [94]	Rapid safety message dissemination in region of interest	Trajectory information, Position and time based	Timely delivery of safety message in larger coverage area	trajectory data may not accurate gathered in dynamic urban environment, increased complexity in dense network with more intersections
Wang et al. in [74]	Cluster based mix safety and non-safety data dissemination	Position, speed, and road condition based	Minimize data download delay, ratio of emergency warning and service response	Cost of data communication, the speed difference between bus and car may have impact on cluster endurance
Figueiredo et al. [109]	An edge-based approach warns road user earlier for emergency vehicle	vehicle's class, position, velocity, and direction	Low latency, end-to end warning message delivery	Use of static tables and accuracy issue to predict ERV mobility
Ullah et al. [85]	A relay node selection to disseminate emergency message in dense and sparse network	distance, movement direction, and speed variation based	Improves Message delivery ratio and reduces latency	Error in location precision and high mobility can reduce the efficiency of this approach
Liu et al. [98]	Controlled message transmission rate to avoid congestion	Vehicle density and channel load based	Balanced performance in terms of packet delivery and channel congestion	Computation overhead
Shah et al. [99]	Reinforcement Clustering method to deliver alert message	Median technique, position and movement based	Increased throughput, decrease delay and packet loss	Precision needs to form clusters, communication overhead

TABLE I
(Continued.) SUMMARY OF BEACON-ORIENTED DATA DISSEMINATION SCHEMES

Jasim et al. [100]	A K-means clustering method for collision alert	Position, priority , accident region based	Reduce time and cost of message delivery	Varying density size may lead to improper clustering
A. Khan et al. [97]	A dynamic waiting time calculated for each vehicle on the basis of velocity and distance	Velocity, position, waiting time based	Reduced Broadcast storm problem, problem, improve end-to-end delivery	More than one vehicle in area and waiting time ends overlapping, may become reason to transmit simultaneously
Chakroun et al. [102]	Q-learning based alert message delivery	Network coverage, , road traffic based	Fast delivery of alert message with good coverage	Link quality may affect in selecting rebroadcast zone
Alzamzami et al. [88]	A greedy forwarding of packet to the next hop with shortest distance	Link quality, ETX and distance based	Improve Packet delivery ratio and throughput with reduced end-to-end delay	propagation channels loss rate may increase due to nodes mobility
Guesmia et al. [92]	Time division-based scheme to mitigate the problem of hidden nodes while broadcast emergency message	Position, sender, and receiver based	Improve the broadcast storm problem, and frequent disconnection problem	Congestion due to the periodic beaconing while sharing frequent information, delay due to additional waiting time

the packet, it sends an acknowledgement back, and if the position is inaccurate, AODV is applied in the destination vicinity. BLR works in two modes: greedy and backup. In greedy mode, BLR uses the recovery strategy when a vehicle does not locate a neighbour node that's closer than it is to the destination. The recovery strategy includes finding a planar graph from current knowledge of roads and neighbours. Backup mode is used to locate the node which doesn't send passive acknowledgement using a recovery strategy.

Bakhouya et al. [119] presented an adaptive approach for information dissemination (AID), a counter-based technique that allows a node takes appropriate action for rebroadcasting or discarding message on the number of messages received from the neighbour. Each vehicle used local parameters like inter-arrival messages along with values of two counters, c and s. if the value of inter-arrival time is large, a vehicle can rebroadcast, and if the value of inter-arrival time is small, the node will discard the message.

Villas et al. [19] presented a data dissemination protocol in a vehicular network (DRIVE) proposed to target broadcast storms without beacon messages. This protocol disseminates data in an Area of Interest (AoI) where a "sweet spot" is used, and vehicles located in this sweet pot in more likely to disseminate data. The sweet spot area is considered in a circle, and the communication area is further divided into four quadrants.

Prathiba et al. in [120] proposed SDN-based critical energy infrastructure for emergency message dissemination in vehicular networks. A continuous moving cluster framework migrating consignment region (MiCR) is proposed to achieve the desired outcomes. The CRs in MiCR are created using the central controller group AVs named consignment regions (CRs) and the centralized federated K-means algorithm. The Working of MiCR is presented in figure 8

Cao et al. in [121] to overcome beaconing flooding issues, proposed a Relay Selection method based on the black burst for Bi-layer Straight road scenarios (RSBS) for decreasing hop counts and increasing delivery ratio without using beacon messages. The horizontal distance between the farthest inter-level and intra-level neighbour and sender is measured to choose a relay node. A summary of all beacon-less schemes discussed and the advantages and limitations of these schemes are described in Table II below.

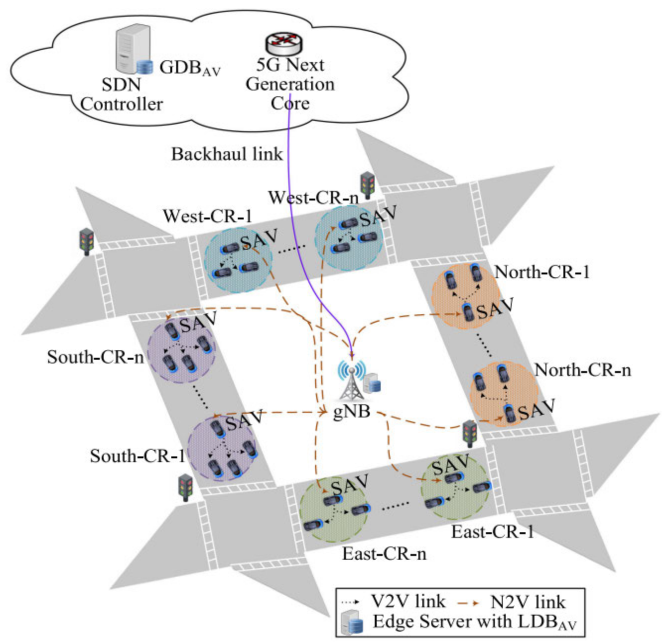

Fig. 8. MiCR architecture for SCM dissemination [120].

V. CRITIQUE

The scheme discussed in [70], [71], [72], [73], [74], [99], and [120] are cluster-based, in which a cluster of vehicles is formed based on different parameters. The main advantage of clustering is router mechanism does not need to discover, and it also provides security against different threats [122]. However, the disadvantage of cluster-oriented schemes does not consider direction and velocity, and forming clusters with periodic beacon messages is an additional overhead. The techniques discussed in articles [72], [75], [112], [114], and [115] are probability-based techniques in which vehicles with high

TABLE II

SUMMARY OF BEACONLESS DATA DISSEMINATION SCHEMES

Scheme	Basic Idea	Mechanism	Advantages	Limitations
Achour et al. [112]	Distance,direction, and density parameters are used to compute rebroadcast probability	Delay & probability based	Minimize Broadcast storm problem, and end-to-end delivery, improved packet delivery	Ambiguity in decision making
Naja et al. [113]	Data is disseminated using decision-making function (DMF), the distance between receiver and incident, and number of received messages	DMF, distance between sender, receiver,priority of message	Reduce rebroadcast, delay, increase reachability	The value of assessment in low density area,if increased while vehicle is moving in high velocity may decrease the performance of this scheme in terms of delay
Chaqfeh et al. [114]	This broadcast strategy detects regime of traffic via speed data without collecting density, by using negative correlation between the speed and the density	SAB-P, Slotted SAB,and G-SAB	Scalable broadcast with less communication overhead	Computation complexity
Mostafa et al. [115]	Two phases: collision assessment and reliable forward. Message will rebroadcast by vehicle with highest RF probability	Probability based	Limit rebroadcast and Collison, improve throughput	Less broadcast efficiency
Kumar et al. [116]	BIIR uses four distinct messages, and each node maintains a neighbor data table in which an entry for a destination is inserted	Geographical routing	Reduce Rebroadcasting, and end-to-end delivery, improve packet delivery	Maintaining neighbor information table create extra overhead
Tizvar et al. [117]	A local density approximation method is used to calculate neighbors with the help of PIT maintained by each vehicle	Density aware, Time -based	Improved Broadcast storm problem	Acknowledgement messages degrade it performance in terms of overhead
Heissenbüttel et al. [118]	A Source node determines the position of destination, destination send Acknowledgment message, AODV applied if position is inaccurate	Broadcast based	Reduce overhead in MANET, high packet delivery	More duplicate message may create overhead
Bakhouya et al. [119]	A vehicle takes action to rebroadcast or discard message based on message numbers received from neighbor.	Counter-based	Rebroadcasting with less delay and maximum reachability	High latency
Villas et al. [19]	Data is disseminated in Area of Interest where “sweet spot” is used and farthest vehicle in sweet pot will transmit first	Position based, distance based, timer based and, carry forward based	Improved Broadcast storm problem	High communication overhead offered by the total amount of transmissions
Prathiba et al. [120]	SDN based continuous clustering federated K-means algorithm to disseminate safety message	Direction and velocity based	High reliable message dissemination with low latency, low network overhead	High connectivity is required , communication overhead
Cao et.al. [121]	Beaconless selection of relay node in 3D scenario	Distance, sender and receiver based	Decrease hop counts and increased delivery ration, less channel congestion	Overlapping may arise selecting relay node, , not applicable in dense network

TABLE III

PERFORMANCE COMPARISON OF BEACONORIENTED AND BEACON-LESS PROTOCOLS

#	protocol	Enviroment Applicable	Architecture	Forwarding Strategy							Beaconing	Broadacst	Collision	End-to-End	Comm.Overhead	Packet Delivery	Reachability	Delay
				Clustring	Position	Topology	Distance	Probability	Road Layout	Others								
1	Ali et al. [68]	Urban	V2V	✓	✓	×	×	×	×	×	✓	✓	×	×	×	×	×	✓
2	Ramakrishnan et al. [69]	Highway	V2V	✓	×	×	×	×	×	×	✓	×	×	×	×	✓	✓	×
3	L. Liu et al[70]	1 linerer Road like highway	V2V	✓	✓	×	×	✓	×	×	✓	×	×	×	×	✓	×	✓
4	Alkhalifa et al.[71]	Urban, road with intersections	V2V	✓	✓	×	✓	×	×	✓	✓	✓	✓	✓	×	✓	✓	✓
5	Wang et al.[72]	Urban	V2V	✓	✓	×	✓	×	×	✓	✓	✓	×	✓	×	✓	×	✓
6	Elnaz et al[73]	Hibrid	V2V	×	✓	×	×	✓	×	✓	✓	×	×	×	×	×	✓	×
7	Pu Li et al. [74]	Urban	V2V &V2I	×	✓	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓
8	Chakrouna et al. [75]	urban	V2I & V2V	×	✓	×	✓	×	×	×	✓	✓	✓	×	×	✓	×	✓
9	W Zhu et al.[76]	urban	V2I & V2V	×	✓	×	✓	×	×	✓	✓	✓	×	×	✓	✓	×	✓
10	Oubbati et al.[77]	urban	V2I	×	✓	×	✓	×	✓	×	✓	×	×	×	✓	✓	×	✓
11	Yaqoob et al. [78]	1 way road with three lanes	V2I & V2V	×	✓	×	✓	×	×	×	✓	×	×	×	✓	✓	×	✓
12	Yi et al. [79]	Urban	V2V &V2I	×	✓	×	×	×	×	✓	✓	✓	✓	×	×	×	×	×
13	Naderi et al[80]	Urban	V2V	×	✓	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×
14	Tomo et al. [81]	Hibrid	V2V	×	-	×	×	×	×	✓	✓	✓	×	×	×	×	×	×
15	Achour *et al.* [102]	Highway	V2V &V2I	×	×	×	×	✓	×	✓	×	✓	×	✓	×	✓	×	×
16	Naja *et al.* [103]	Hibrid	V2V	×	×	×	✓	×	×	✓	×	×	×	×	×	×	✓	×
17	Chaqfeh *et al.* [104]	3 Lane of Highway a5km	V2V	×	×	×	×	✓	×	✓	×	×	×	×	✓	×	×	×
18	Mostafa *et al.* [105]	Highway	V2I	×	×	×	×	✓	×	×	×	×	✓	×	×	×	×	×
19	Satheshkumar et al. [82]	highway,city traffic Model	V2V &V2I	×	✓	×	×	×	×	✓	✓	×	×	×	×	×	×	✓
20	Ullah et al. [83]	urban dense and sparse	V2V, I2V	×	✓	×	×	×	×	✓	✓	✓	×	×	×	✓	×	✓
21	Tasneem et al. [84]	Urban	V2V	×	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	✓
22	Osama et al. [85]	Hibrid	V2V	×	✓	×	✓	×	×	✓	✓	×	×	×	×	×	×	×
23	Ali Ghaffari [86]	Hibrid	V2V	×	✓	×	×	×	×	✓	✓	×	×	✓	×	✓	×	×
24	Rana et al. [87]	City Traffric	V2V	×	✓	×	×	×	×	✓	✓	×	×	×	✓	✓	×	×
25	Kumar *et al.* [106]	Hibrid	V2V &V2I	×	×	×	×	×	×	✓	×	×	×	✓	×	✓	×	×
26	Tizvar et al. [107]	urban & 2 Lane road with 2km length	V2V	×	✓	×	×	×	×	✓	×	✓	×	×	×	×	×	×
27	Heissenbüttel *et al.* [108]	Urban	V2V	×	✓	×	×	×	×	✓	×	×	×	×	✓	✓	×	×
28	Daxin et al. [89]	Hybrid	V2I	×	✓	×	✓	×	×	✓	✓	✓	✓	×	×	×	×	✓
29	Bingyi et al.[90]	Urban	V2V	×	✓	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	×	✓
30	Guesmia et al.[88]	Urban	V2I	×	✓	×	✓	×	×	✓	✓	✓	✓	×	✓	✓	×	✓
31	Maia et al. [91]	Urban	V2V	×	×	×	×	×	×	✓	✓	×	×	×	✓	×	×	✓
32	Chaqfeh et al. [92]	Urban	V2V	×	✓	×	×	×	✓	×	✓	×	×	×	✓	✓	×	×
33	A. Khan et al. in [93]	sparse and dense network	V2V	×	✓	×	✓	×	×	✓	✓	✓	✓	✓	✓	✓	×	✓
34	Wang et al. [94]	Urban	V2V	×	✓	✓	×	×	×	✓	✓	✓	×	✓	×	×	×	×
35	J Yang et al [95]	Urban	V2V	×	✓	×	×	×	✓	×	✓	×	×	×	×	×	×	✓
36	Meenaakshi et al. [96]	road with streets	V2I &V2V	×	✓	×		×	×	✓	✓	✓	×	×	×	✓	×	✓
37	Hantao Li et al. in [97]	City road layout	V2I & V2V	×	✓	×	✓	×	×	✓	✓	✓	×	✓	✓	✓	×	✓
38	Kezia et al. in [98]	Highway	V2V	×	✓	×	✓	×	×	✓	✓	✓	✓	✓	×	✓	×	✓
39	Figueiredo et al.[99]	urban	V2V, I2V	×	✓	×	×	×	×	✓	✓	×	×	×	×	✓	×	✓
40	Bakhouya *et al* .[109]	Urban	V2V	×	×	×	×	×	×	✓	×	×	×	×	×	×	✓	✓
41	Villas *et al.* [19]	Highway,Manhattan grid	V2V &V2I	×	✓	×	✓	×	×	✓	×	✓	×	×	×	×	×	×
42	prathiba et al. in [110]	Highway	V2V, V2I	✓	✓	×	✓	✓	×	✓	×	×	✓	✓	×	✓	×	✓
43	Cao et.al. in [111]	Bi layer straight road	V2V	×	✓	×	✓	✓	×	✓	×	×	×	×	×	✓	×	×

probability have a high priority to rebroadcast message first. Probability-based techniques reduce redundancy with the cost of inefficient broadcast and reachability. Most of the schemes discussed are position and geolocation-based schemes, which require the physical location of the relay or participating node with mapping services like GPS. Some of the schemes belong to other categories like counter-based, topology-based, road condition, timer based, etc. We mentioned those in table III.

The proposed solutions for the broadcast storm problem are discussed here. LISCast [103] is a topology based, where period beacon messages are used to collect neighbour vehicles' information. LISCast improves end-to-end delivery, but communication overhead and forwarding efficiency are low even with compared schemes. In [70], members of the cluster communicate through the cluster head, and the emergency message is forwarded using the position of a vehicle. This scheme reduces broadcast storms and communication delay, but the limitation of this scheme is overhead with regular beacon messages to manage cluster and packet delivery errors with the fast speed of the vehicle. Streetcast [81] reduces broadcast storm, collision, and overhead of beacon with adaptive beacon control heuristic. It does not take network connectivity into account, which may affect reachability. In [83], DTP-DDP solves the broadcast problem and achieves a high delivery ratio. Yet, it costs delay and suffers from more numbers of retransmission packets are two drawbacks of this scheme because the sender waits for a larger time to collect replies. SEAD [112] is a combination of delay-based and probability-based schemes to solve broadcast storm problems by reducing retransmissions. It is an efficient broadcast protocol that provides high packet delivery and application independence. However, there is no mechanism to distinguish between advertisement messages and safety messages, and it is a simple protocol that cannot fit into complex scenarios. Density aware [117] approach reduces broadcast storm with some reachability; however, acknowledgment messages degrade its performance in terms of overhead, especially when density increases. DRIVE [19] solves broadcast storm problems with high coverage and less delay. Despite that, the communication overhead offered by the total amount of transmissions is still high. Reference [97] improves end-to-end delivery and reduces broadcast storm problems, but the calculation for each vehicle may create computation overhead. Reference [73] reduces broadcast storm problem with less collision and more reachability, and [92] also targeted broadcast storm problem with the less disconnected network, at the cost of computation complexity and delay due to additional wait time, respectively.

The communication delay problem is tried to solve by researchers in [70], [72], [84], [86], [95], [104], and [119], where [104] takes into account all types of obstacles and disseminate data in multi hops and directions. But the use of beacon messages increases overhead, and the redundancy rate is high. CPB [72] solves high latency problems and high probability collision. But this scheme is cluster-based, where beacon messages are used on a regular basis to maintain the cluster, creating extra overhead and computation at every node may lead to more delay. LITRA [86] is good for reducing network overhead and maintaining measurement accuracy, but at intersections, data routing decisions are made based on the performance of data dissemination with each road segment without taking into account the vehicle's availability at intersections which may degrade the efficiency of this scheme when no or less vehicles at intersections. U-HyDi [95] reduces overhead, broadcast storm, and low delivery delay, but beacon messages used to collect one-hop information without any control beacon mechanism may increase overhead. EE-FMDRP [84] reduces transmission delay and minimizes energy consumption at the cost of communication overhead. AID [119] saves rebroadcast and reachability, but latency is high due to waits for some receptions to decide whether to retransmit the message or not. The communication overhead problem is resolved by [82], [90], [95], [96], which are beacon oriented scheme and [118] is the beaconless scheme. EDDP [96] communication reduced delay in the multidirectional scenarios and lessen redundancy. It assigns high priority to the furthest vehicle, but there may be more than one vehicle in the area that allows simultaneous transmission. It is useful for urban but not suitable for highway traffic. Authors in [82] and [90] both improved packet delivery ratio and reduced routing and communication overhead. Both use beacon messages to collect information about neighbors, topology, etc. BRL [118] is for MANET, but can be used in VANET to. It is good for achieving high packet delivery with less communication overhead. It has the limitation that more duplicate messages may create overhead while finding the next-hop selection process.

The packet/message delivery ratio is improved by different researchers in [74], [77], [78], [80], [82], [85], [89], [90], [92], [94], [96], [105], [109], and [116] where all schemes except [116] are beacon oriented techniques. Most of these schemes like [74], [82], [89], [94], and [116] are also improved end-to-end delivery including [112], which is discussed earlier in broadcast storm problem segment. The schemes in [82], [90], and [96] are already discussed in a section on communication overhead. Reference [96] improved packet delivers, throughput, and end-to-end deliver. But periodically, Hello messages may generate congestion, overhead, and bandwidth utilization. BIIR [116] improves the packet delivery ratio and reduces the number of broadcasts. It maintains history, which is good in a highway scenario but may not be useful in an urban environment. Also, maintaining a neighbour information table creates extra overhead, especially in a dense network. Reference [77] uses an SDN controller to reduce collision with high information coverage, but retransmission may create congestion in a dense environment. Reference [74] is an approach that provides both safe and non-safety message transmission with rapid delivery of warning and service, with more communication cost.

The reachability problem is targeted by [73], [75], [113], and [119] in which two schemes are beacon oriented and two are beaconless. The scheme in [75] is providing very good reachability but at the cost of more delay. DHBP [113] is a beaconless technique that achieves noticeable reachability and maintains a number of rebroadcasts. The value of assessment in low-density areas, if increased while the vehicle is moving at high velocity, may decrease the performance of this scheme in terms of delay.

Different forwarding strategies are used to disseminate emergency messages, such as cluster-based, position-based, probability-based, distance-based, etc., with their own pros and cons. If it is achieving one dimension, the other one is neglected, which as a result, would reduce the total efficiency of routing. The broadcast storm problem, communication delay problem, communication overhead problem, packet delivery ratio, and reachability problem are covered by the schemes discussed in the literature review. Some techniques used beacon messages to gather neighbours' information for smooth communication, and some schemes used a beaconless strategy by finding relay nodes without prior information. All schemes have some advantages with some limitations discussed above, but there is a need for a scheme that

Table3: Performance comparison of beacon oriented and beacon-less protocols

#	protocol	Enviroment Applicable	Architecture	Forwarding Strategy							Beaconing	Broadacst	Collision	End-to-End delivery	Comm.Overhead	Packet Delivery	Reachability	Delay
				Clustring	Position	Topology	Distance	Probability	Road Layout	Others								
1	Ali et al. [70]	Urban	V2V	✓	✓	×	×	×	×	×	✓	✓	×	×	×	×	×	✓
2	Ramakrishnan et al. [71]	Highway	V2V	✓	×	×	×	×	×	×	✓	×	×	×	×	✓	✓	×
3	L. Liu et al[72]	1 linerer Road like highway	V2V	✓	✓	×	×	✓	×	×	✓	×	×	×	×	✓	×	✓
4	Alkhalifa et al.[73]	Urban, road with intersections	V2V	✓	✓	×	✓	×	×	✓	✓	✓	✓	✓	×	✓	✓	✓
5	Wang et al.[74]	Urban	V2V	✓	✓	×	✓	×	×	✓	✓	✓	×	✓	×	✓	×	✓
6	Elnaz et al[75]	Hibrid	V2V	×	✓	×	×	✓	×	✓	✓	×	×	×	×	×	✓	×
7	Pu Li et al. [76]	Urban	V2V &V2I	×	✓	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓
8	Chakrouna et al. [77]	Urban	V2I & V2V	×	✓	×	✓	×	×	×	✓	✓	✓	×	×	✓	×	✓
9	W Zhu et al.[78]	Urban	V2I & V2V	×	✓	×	✓	×	×	✓	✓	✓	×	×	✓	✓	×	✓
10	Oubbati et al.[79]	Urban	V2I	×	✓	×	✓	×	✓	×	✓	×	×	×	✓	✓	×	✓
11	Yaqoob et al.[80]	1 way road with three lanes	V2I & V2V	×	✓	×	✓	×	×	×	✓	×	×	×	✓	✓	×	✓
12	Yi et al. [81]	Urban	V2V &V2I	×	✓	×	×	×	×	✓	✓	✓	✓	×	×	×	×	×
13	Naderi et al. [82]	Urban	V2V	×	✓	×	×	×	×	×	✓	×	×	✓	✓	✓	×	×
14	Tomo et al. [83]	Hibrid	V2V	×	-	×	×	×	×	✓	✓	✓	×	×	×	×	×	×
15	Achour *et al.* [112]	Highway	V2V &V2I	×	×	×	×	✓	×	✓	×	✓	×	✓	×	✓	×	×
16	Naja *et al.* [113]	Hibrid	V2V	×	×	×	✓	×	×	✓	×	×	×	×	×	×	✓	×
17	Chaqfeh *et al.* [114]	3 Lane of Highway a5km	V2V	×	×	×	×	✓	×	✓	×	×	×	×	✓	×	×	×
18	Mostafa *et al.* [115]	Highway	V2I	×	×	×	×	✓	×	×	×	×	✓	×	×	×	×	×
19	Satheshkumar et al. [84]	Highway,city traffic Model	V2V &V2I	×	✓	×	×	×	×	✓	✓	×	×	×	×	×	×	✓
20	Ullah et al. [85]	urban dense and sparse	V2V, I2V	×	✓	×	×	×	×	✓	✓	✓	×	×	×	✓	×	✓
21	Tasneem et al. [86]	Urban	V2V	×	×	×	×	×	✓	✓	✓	×	×	×	×	×	×	✓
22	Osama et al. [87]	Hibrid	V2V	×	✓	×	✓	×	×	✓	✓	×	×	×	×	×	×	×
23	Alzamzami et al. [88]	Hibrid	V2I	×	✓	×	✓	✓	×	✓	✓	×	×	✓	×	✓	×	✓
24	Ali Ghaffari [89]	Hibrid	V2V	×	✓	×	×	×	×	✓	✓	×	×	✓	×	✓	×	×
25	Rana et al. [90]	City Traffric	V2V	×	✓	×	×	×	×		✓	×	×	×	✓	✓	×	×
26	Septa et al. [91]	Urban	V2V	×	✓	×	✓	×	×	✓	✓	✓	✓	×	×	✓	×	×
27	Kumar *et al.* [116]	Hibrid	V2V &V2I	×	×	×	×	×	×	✓	×	×	×	✓	×	✓	×	×
28	Tizvar et al. [117]	Urban & 2 Lane road with 2km length	V2V	×	✓	×	×	×	×	✓	×	✓	×	×	×	×	×	×
29	Heissenbüttel *et al.* [118]	Urban	V2V	×	✓	×	×	×	×	✓	×	×	×	×	✓	✓	×	×
30	Guesmia et al.[92]	Urban	V2I	×	✓	×	✓	×	×	✓	✓	✓	✓	×	✓	✓	×	✓
31	Daxin et al. [93]	Hybrid	V2I	×	✓	×	✓	×	×	✓	✓	✓	✓	×	×	×	×	✓
32	Bingyi et al.[94]	Urban	V2V	×	✓	×	×	×	×	✓	✓	✓	✓	✓	✓	✓	×	✓
33	Maia et al. [95]	Urban	V2V	×	×	×	×	×	×	✓	✓	×	×	×	✓	×	×	✓
34	Chaqfeh et al. [96]	Urban	V2V	×	✓	×	×	×	✓	×	✓	×	×	×	✓	✓	×	×
35	Khan et al. [97]	sparse and dense network	V2V	×	✓	×	✓	×	×	✓	✓	✓	✓	✓	✓	✓	×	✓
36	Shah et al.[99]	Highway	V2V	✓	✓	×	✓	×	×	✓	✓	×	✓	✓	×	✓	×	✓
37	Chakroun et al. [102]	Urban	V2V &V2I	×	✓	×	✓	✓	×	✓	✓	✓	✓	✓	×	✓	×	✓
38	Wang et al. [103]	Urban	V2V	×	✓	✓	×	×	×	✓	✓	✓	×	✓	×	×	×	×
39	J Yang et al [104]	Urban	V2V	×	✓	×	×	×	✓	×	✓	×	×	×	×	×	×	✓
40	Meenaakshi et al. [105]	road with streets	V2I &V2V	×	✓	×		×	×	✓	✓	✓	×	×	×	✓	×	✓
41	Hantao et al. [106]	City road layout	V2I & V2V	×	✓	×	✓	×	×	✓	✓	✓	×	✓	✓	✓	×	✓
42	Kezia et al. [107]	Highway	V2V	×	✓	×	✓	×	×	✓	✓	✓	✓	✓	×	✓	×	✓
43	Hawbani et al in [108]	Urban	V2V	×	✓	×	✓	✓	✓	✓	✓	×	×	✓	✓	✓	✓	✓
44	Figueiredo et al.[109]	Urban	V2V, I2V	×	✓	×	×	×	×	✓	✓	×	×	×	×	✓	×	✓
45	Bakhouya *et al.* [119]	Urban	V2V	×	×	×	×	×	×	✓	×	×	×	×	×	×	✓	✓
46	Villas *et al.* [19]	Highway,Manhattan grid	V2V &V2I	×	✓	×	✓	×	×	✓	×	✓	×	×	×	×	×	×
47	Prathiba et al.[120] [120]	Highway	V2V, V2I	✓	✓	×	✓	✓	×	✓	×	×	✓	✓	×	✓	×	✓
48	Cao et.al. [121]	Bi layer straight road	V2V	×	✓	×	✓	✓	×	✓	×	×	×	×	×	✓	×	×

Fig. 9. Performance comparison of beacon-oriented and beacon-less protocols.

provides an optimum solution for the problem discussed in VI. Therefore, the researchers must focus on all directions for smooth transmission to meet the requirement of the heterogeneous and dynamic nature of IoV.

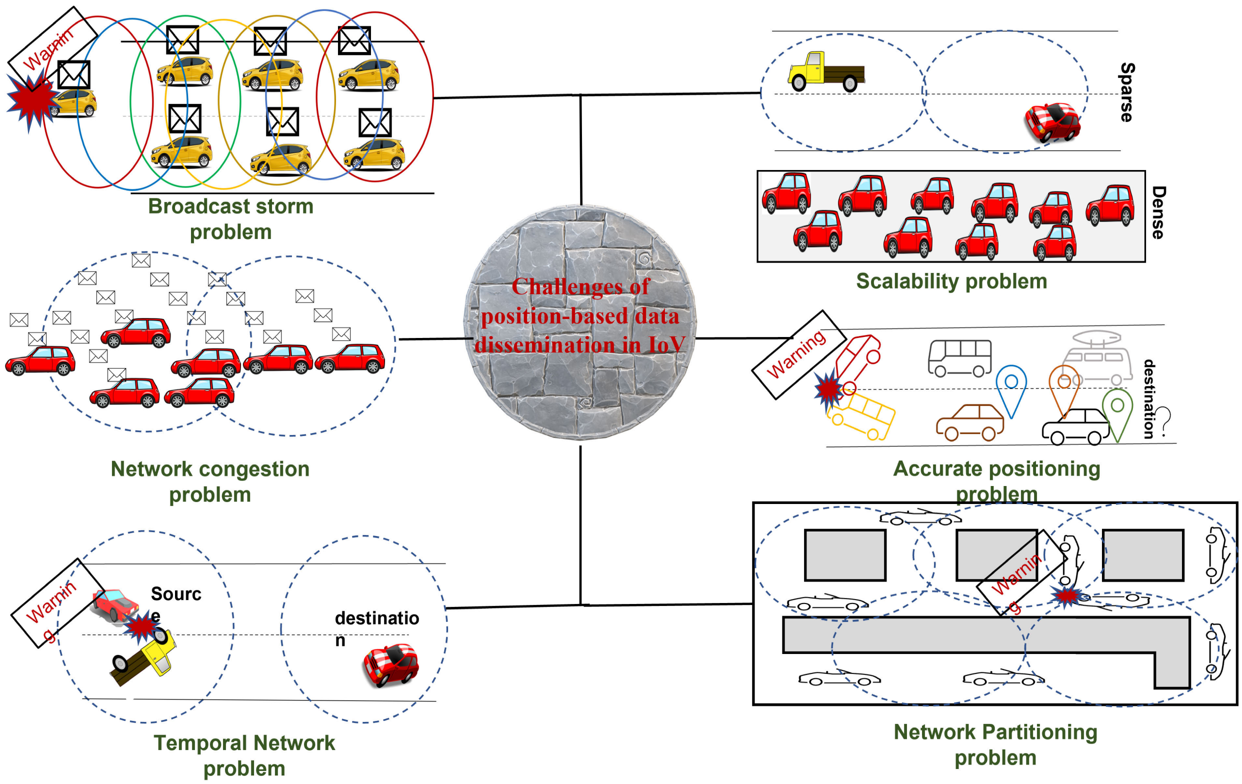

Fig. 10. Challenges of position-based data dissemination in IoV.

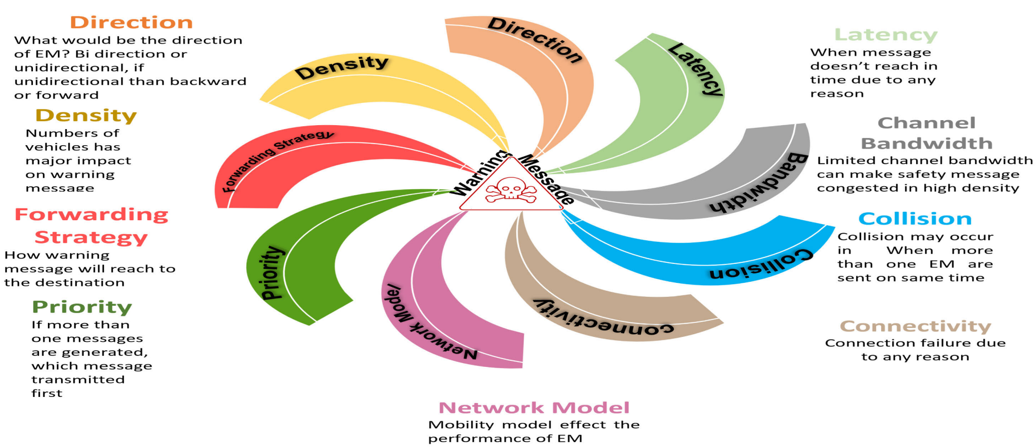

Fig. 11. Factors involved in the performance of Emergency/Warning Message.

A complete analysis of all schemes in terms of forwarding strategy and performance parameters table III is presented in figure 9.

VI. Open Research Challenges of Position-Based Data Dissemination in IoV

There are several issues associated with IoV, and many of them have not yet been solved properly, like security, environmental issues, the complexity of protocol, adaptability, scalability, and dynamicity. Researchers put their efforts into fulfilling the required gaps, but due to recent technology augmentation, more work needs to be done immeasurably. In this section, we emphasized some of the emergency message dissemination challenges considered in different studies, with a pictorial view of each problem, shown in figure 10.

A. Broadcast Storm Problem

In a vehicular network, a broadcast storm problem ensues when several vehicles attempt to transmit safety messages at the same time. These excessive safety messages may lead a network contention and delay in the MAC layer, congestion, packet collision, redundancy, and service disruption [123]. A broadcast storm is a common issue in VANETs, typically

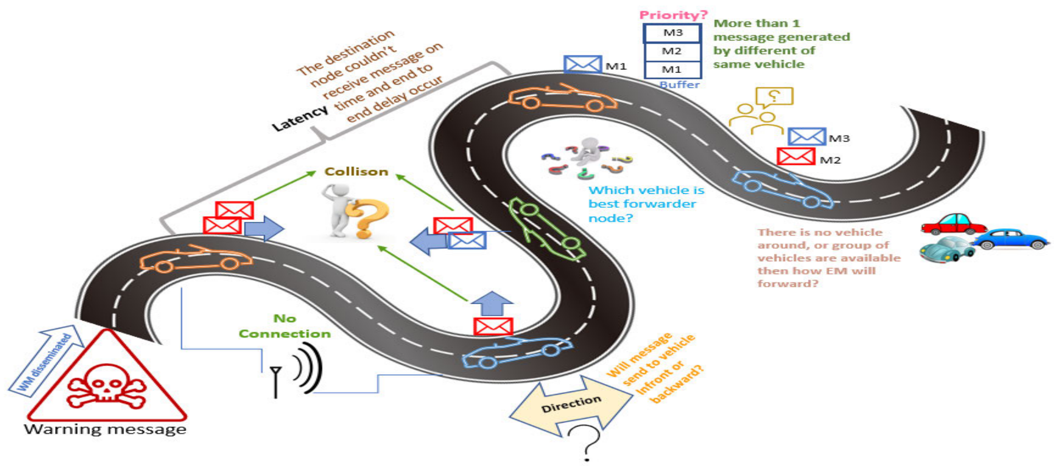

Fig. 12. Pictorial representation of factors of emergency/Warning message.

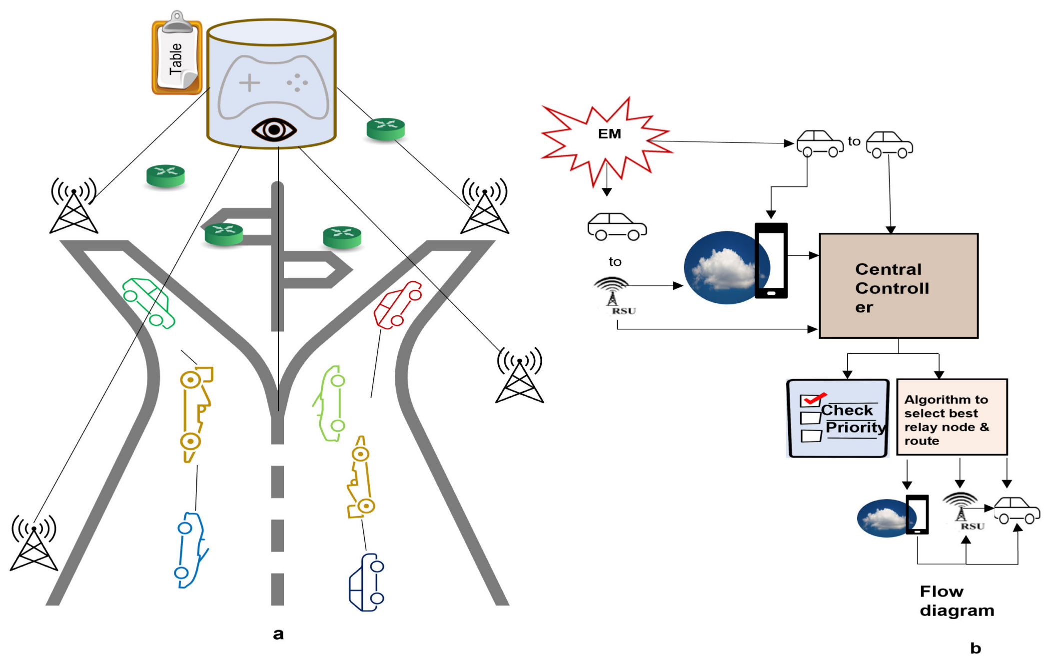

Fig. 13. The proposed central solution of EM dissemination.

caused by protocols based on flooding [124]. Many researchers provided solutions for broadcast storm problems as discussed in the literature, and some are presented in [19], [72], [97], [123], [125], and [126].

B. Network Partitioning

Network partition problem occurs because of sparse or uneven vehicle distribution, which may bring VANETs into a situation where data cannot be delivered over the partitions, and it's a threat to data dissemination for emergency or warning messages. When the number of vehicles in an Area of Interest (AoI) is inadequate to disseminate data with the respective group of vehicles, this situation is known as a network partition problem [127]. Some of the techniques proposed as solutions to overcome this problem are presented in [18], [19], [128], [129], and [130].

C. Temporal Network Fragmentation

Temporal network fragmentation is temporary compared to network partition problem, which arises due to vehicles' high mobility or speed. It mostly occurs in sparse environments where fewer numbers vehicles are located, vehicles are not directly connected in communication range of each other, or some of the vehicles become unreachable. Some vehicles in networks without transverse may also lead to frequent network fragmentation [131]. The articles [19], [97], [132], and [133] focus on temporal network fragmentation issue.

D. Scalability Problem

Scalability issue arises when the number of active vehicles/nodes is changed in a network. Less number of vehicles in the network is a sparse network, and a network with a greater number of vehicles is a dense network. When a smaller number of nodes are present to select an appropriate forwarder, then a network connectivity problem occurs, and congestion may occur in dense networks when many nodes are present to be selected as forwarder nodes. The solution to the scalability problem is to propose an algorithm with dynamic nature that can efficiently handle sparse and dense networks [134]. Some researchers tried to overcome scalability issues, e.g., [112], [113], [135], and [136].

E. Network Congestion

Network congestion is a critical issue that exists in the network, which can cause severe accidents or traffic jams. Network congestion arises if a greater number of vehicles access the channel or send frequent beacon messages or event driven messages (ED messages) broadcasted multiple times. The control channel (CHH) may easily be congested [137]. Congestion in a network leads to frequent long delays in safety message dissemination which may degrade network performance in terms of packet loss, network connectivity, and collision. Many researchers addressed this issue like [115], [138], [139], [140], and [141].

F. Accurate Positioning

In position-based routing protocols uses the position of the vehicle to disseminate emergency messages, and false position measurement results in performance degradation in vehicular network [66], [142]. The position is usually determined using a global positioning system (GPS); however, position accuracy may affect if GPS is not working properly or if it is out of coverage due to atmospheric effects, satellite signals lost, etc. Other factors include erroneous computational models, malicious nodes disseminating incorrect position information, etc. If position is not accurately obtained, safety messages cannot deliver to accurate vehicles well in time which expedites crucial situations in the vehicular network. This problem is covered by the techniques in [143], [144], [145], [146], and [147].

VII. Conclusion and Future Directions

In this study, we explained the basic concepts of vehicular networks, including the characteristics of IoV and the challenges of data dissemination. The primary aim of this study is to discuss position-based emergency message dissemination protocols under two categories: beacon-oriented and beaconless techniques. Both have their own pros and cons, which are analyzed and compared in detail. Beacon-oriented schemes face extra overhead with bandwidth wastage, while the delay is associated with beaconless approaches. Analysis of both approaches reveals that there is even now a need to develop an optimum solution for the in-time delivery of emergency or warning messages.

Many challenges in warning message transmission have been covered by researchers in different studies, but there is no complete and optimal solution yet presented. There are several factors that affect the performance of warning message transmission. Major factors are highlighted in figure 11, and these factors are also presented in the road scenario for better understanding in figure 12.

When a warning message is disseminated, it could fail to reach the destination due to poor network connectivity [148]. The ***network connectivity*** may be low in underpasses, signals restricted areas, and a large number of devices connected to the same access point because of bad weather or any obstacles. ***Latency*** is another very significant factor of an emergency message which may occur as a result of poor connection, finding not an appropriate forwarder relay, or collision. If a message is not transmitted to the target, then an end-to-end delay occurs, and the message loses its worth because receiving a message about any emergency after an accident happens is useless. Many researchers have shed light on this issue, but it still needs improvement. Fog or edge computing can reduce latency and improve the performance of the network in terms of scalability, and mobility [149], [150], [151]. Afterward, in the figure bfitcollision is highlighted, when more numbers of vehicles send an emergency message at the same time, or more than one message is generated by a vehicle, then which message should be transmitted first? This is the point where priority must be defined for the normal and warning message. Some of the messages are large if these messages are forwarded before the warning message can inhabit the network capacity, and other messages would lose their worth.

Most of the studies focused on transmitting safety message in one ***direction*** backward, but safety message needs to disseminate on all sides in the case when an ambulance or fire brigade takes the pass or a car should inform another car in front about a sudden break then a message will convey from backward. The same is the case when a vehicle is about to change the lane, and a warning message must transmit in the surrounding. A few studies, as [104], provided a solution focusing on all directions, howbeit it is highly required to introduce solutions to cover all directions.

Selecting ***next forwarder node*** is a major challenge to conquer because if an appropriate communication node is not selected, then a warning message will not deliver to the destination node. A carry forward approach is suggested as a solution of finding no relay node in the vicinity, in which a vehicle holds a message till it finds a vehicle in range to pass the message [152]. But a node can hold a message for a limited time, and if no node is found in a defined time, the message is discarded. Working on this issue is needed. But how to select the best relay node issue is yet under consideration.

The next forwarder node cannot also be selected properly due to the local view of the network. Some vehicles, if selected, can leave communication range as before receiving warning messages. If the global view of the network is available, all nodes with destinations are clearly seen. Therefore, the best node for forwarding can be selected. Software Define Network (SDN) can be one of the solutions [153], SDN controller act as the central controller to provide a global and abstract view of vehicular network [154]. It also provides a solution for interoperability and scalability problems by providing communication between different vendors' hardware architectures and a separate data plane from the control panel, which helps in easy network management [155], [156]. Hence, the best route and relay node can be chosen for message dissemination. The researchers used the SDN controller as a single entity to control the whole network, and some used the controller to manage roadside units (RSUs) [157]. If a single entity in the network fails can bring down the whole network; similar to if more controllers are suggested, management and load balancing would be a concern. Thus, a hybrid solution is yet required to overcome the highly mobile vehicular network for delivering warning messages well in time to overcome accidents.

We proposed a tentative solution to major problems faced by emergency message transmission in figure 13, in which there is a central controller that manages resources and receives a message from a vehicle or RSU when a vehicle wants to communicate with another vehicle or RSU. It is a part of our ongoing research. Fewer messages will be communicated to maintain vehicle records, and if the vehicle leaves the communication range, its stored data will be deleted from the buffer to minimize data load. The controller checks the priority of the received message and chooses the best relay node and route to forward the message immediately before its expiration. An algorithm is designed according to the data-passing mechanism. The fog or edge node can be placed between vehicles and the controller, but RSUs can also select as fog nodes, keeping the cost factor in view. A message is passed between the vehicle to the fog node, the fog node to a controller, and vice versa, or the vehicle can directly forward a message to the controller. The controller can directly communicate with a vehicle as well. The controller also prioritizes the best RSU to forward a message. In the future, we will propose emergency data dissemination using both beacon and beaconless approaches with SDN hybrid scenarios to minimize latency and confirm an end-to-end delivery in a real-time scenario.

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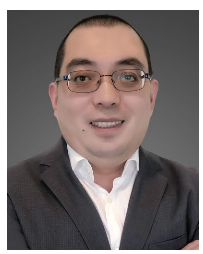

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