Techniques of Early Incident Detection and Traffic Monitoring Centre in VANETs: A Review

Mustafa Maad Hamdi[1], Lukman Audah[1], Sami Abduljabbar Rashid[1], and Mahmood A. Al-shareeda[2]
[1] Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia 86400 Parit Raja, Batu Pahat, Johor, Malaysia
[2] National Advanced IPv6 Centre (Nav6), University Sains Malaysia, Pulau Pinang, Malaysia
Email: meng.mustafa@yahoo.com; hanif@uthm.edu.my; sami.25.6.1989@gmail.com; m.alshareeda@nav6.usm.my

Abstract —The Vehicle Ad hoc networks (VANETs), which provide protection and warning for drivers and passengers, are playing a major role in wireless and connectivity technology and are becoming one of the major research areas in intelligent transport systems (ITS) technology. The features, problems, and deployment of VANETs are very distinct from those of mobile ad hoc networks (MANETs). The early detection of incidents provides information about traffic incidents classified by the Intelligent Transportation System of Traffic Monitoring Centre. In this review paper, we will discuss the concept of a traffic monitoring center and its techniques. Also, we will explain the concept of early incidents detection and show limitations and strong points for each approach used.

Index Terms—VANET, traffic monitoring centre, early incident detection, incident detection

I. Introduction

The Vehicular Ad Hoc Network (VANET) has been attracting the interest of both the scientific and corporate sectors steadily and continuously. The VANET system facilitates early dissemination of roadside and network traffic accident details for end users. VANET can be used for the delivery of a suitable stimulus signal to mitigate systems as a tracking and previous warning method for ITS in the early stages of a based decision accident. VANET, self-arrangement system [1]. The automobiles are designed as hubs for the main intention that each center is used as a centralized change, knowledge target, and information source [2], [3]. The DDSRC-based system equips equipped vehicles with the suggested technologies for transportation around the 5.9-GHz recurrence range. The Vehicle Ad-Hoc Network or VANET is an invention that allows a compact device utilizing vehicles as hubs. Thus, VANET is an ad hoc mobile network of its kind [4], [5]. VANET vehicles can communicate with nearby vehicles and between vehicles and fixed devices close by. VANET 's primary purpose is to give travelers convenience and well-being. Some applications are available for VANET [6], such as incident management, impact preventive measures, tracking vehicles, better driving, resource sensitization, and so forth [7], [8].

Combined media and Internet access for drivers (travelers) can also be available; they have been included within each vehicle remotely. Specific instances of possible outcomes use VANET are configured increments for parking fields and toll accumulation. An on-board unit (OBU) provides the remote cell phone in a vehicle, which interacts via Dedicated Short Range (DSRC) with the corresponding RSU [9], [10]. DSRC offers remote networking networks of short to medium ranges (5.9 GHz up to 300 meters) that are specifically for vehicle use [11], [12]. There are several conventions and fundamental standards relating to the DSRC (IEEE 1609, IEEE 802.11p) [13], [14]. Cars will be ready throughout their travel for subsequent transfer to store valuable information. For traffic details and subordinates, data collected through OBUs and RSUs can be obtained [15].

Two types of scenarios of communication have been defined in vehicular networks: inter-vehicular communication or vehicle-to-vehicle communication (V2V), in which automobiles exchange messages directly, and vehicle-to-infrastructure communication (V2I), in which the exchange is made with the RSU, in addition to tolls and Internet access points [9], [16]. Together, the V2V and V2I communications are known as V2X and their main characteristics are described below in the following points [17]:

- **Highly dynamic topology:** It is especially difficult to be able to define a specific topology for a VANET network because of the very existence of the vehicles. The nodes are traveling and contact between V2I and V2V will occur within a very short time, rendering it difficult for these networks to define the topology.
- **Variable Channels in Time and Frequency:** The communications may suffer from loss of time or frequency more intensively than most cell networks because of the pace of cars, their conditions, and potential barriers to the wireless signal (buildings, trees, etc.).
- **Autonomy:** Refers to the right to connect, send, route, and receive packets from every node in the network without the intervention of a centralized control as

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Corresponding author email: hanif@uthm.edu.my
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necessary. And such functions are separately conducted by the OBU and the RSU [18].

- **Unlimited power supply:** The energy usage of the nodes is not constrained since an ample quantity of vehicle battery is required for the OBU and/or AU operation.
- **High computational capacity:** The Node OBUs will handle heavy network traffic (video streaming) or low data speeds at a high-speed speed depending on the task. (Applications for security). It also controls the routing and link to the RSU [19], which implies that the devices can conduct these tasks simultaneously and without high latencies (particularly in critical applications).

II. CHALLENGES IN VANETS

A. Scalability

As mentioned above, high VANET scenarios can lead to other problems than a broadcast storm. this issue can be identified and affected. In the process of traffic detection and traffic intensity to address scalability problems. the VANET researchers are continuing to focus on data distribution that can be developed to reduce accuracy and develop new solutions. Inert solutions have to be found[20].

B. Quality of Service (QoS)

The quality of service (QoS) and traffic characterization are among the most important additional issues to address in VANET when finding deployment methods. The quality of the service requirements is expected to be met for different applications. The VANET QoS metrics are not yet well developed [21].

C. Broadcast Storm

In flood-based protocols for data dissemination, MAC protocols are more popular. Where several forward relay solutions were proposed for the solution of this problem]. As diffusion storm difficulties arise, as many vehicles attempt to communicate concurrently, resulting in heavy data flow, packet crashes, network interference, and excessive MAC layer delays. As can be seen in the following pages, because the proposed approaches discuss the issue of transmitted tempests, they often ignore certain issues such as the instability of the network and the temporary network [22].

D. Routing Issue

There are 3 major routing algorithms in VANET, and it is possible to combine the term “take forward.” Those algorithms are (1) opportunistic propagation, (2) spatial propagation direction. It can be made as hybrid strategies, combining two or more methods. The [23] proposes a zoom-out broadcast routing protocol, which will supply the driver at VANET with safety details. In zebra, a system proposing to detect signals for neighbors is very easy, utilizing a single-hop system quite intelligently for identifying the front, truck, and rear lane, based on vehicle range and size. A neighbor to the left of the person is known as the “front relative,” and behind a relative a neighbor [24]. When the transmission of a multicast protection message is carried out, either an entry or a relay is received if a safety label is lost to non-relatives. For VANET it is considered important to deploy essential data via a real routing protocol. The protocol is introduced in clubs where the nodes are chosen based on mobility details such as node level and distance. The selection method for the radial basis, therefore, depends on the cluster head and density and the amount of transmissions in this analysis.

E. Real-Time System

The area of connectivity impedes the development of apps in real-time. Therefore, alerts to certain apps are challenging to transmit at the correct time before the deadline. The data recovery facility used for safe storage of data on real-time VANET 's cloud vehicle traffic scheme inside the planned MRS. In the MRS, using the data recovery framework [25]. The proposed system requires checking the authenticity of vehicle signatures and the recovery of original traffic signature data. Moreover, the current system supports several batch checks Car signatures [26]. Thanks to the MRS advantages, security measures such as data safety, anonymity, and confidentiality are protected. Another investigator in [27] proposed a method focused on the evidence to incorporate a behavioral model artificially intelligent vehicles. To accurately model the circulation, we combine stability, scalability, and adaptability of SDVN design with machine algorithms. First, we have a smart approach to define cluster algorithms in VANET for congestion sensitive areas and then forecast possible neural traffic densities for each venue. Networks of (RNNs). The recent years have been commonly used to model short-term traffic predictions for neural networks (NNs). Create a long-term LSTM-NN (Neural memory) architecture network to resolve the back-propagated problem Error deterioration that memory blocks with a strong space-temporary traffic dependence. Thanks to this information LSTM can catch traffic flow characteristics both stochastic and nonlinear [7].

F. Node Velocity

The prospective knot speed is one of the main components of VANET stability. Either roadside units (RSUs) or vehicles are nodes in this situation. For inactive RSU's, there may be node speed from zero or if vehicles in traffic jams are stuck on highways to 200 km / h or more. Such two contrasts pose an extraordinary threat to the coordination network. When node velocity is elevated, a comparatively lower amount of hundred meters is present in the wireless communications window. Two cars per hour of 90 kilometer’s Communication is most expected for 12 seconds, if feasible in the opposite direction, and a 300 m wireless range is presumed. This question has been discussed by several researchers. The first solution is to classify the vehicle nodes on the same road and to choose the cluster heads in this study [28] suggested effective V2V clustering based on (particle optimization) in VANETs (CRBP). Secondly, road particles have been engineered for the required speed coding functionality, iteration legislation, and exercise feature. Optimizing routing. Thirdly, solutions will significantly boost the cluster's and within-cluster routing efficiency. Another job is to use our two-stage hierarchical mobility model in the probabilistic method for the estimation of route frequency. However, multiple theoretical templates for various protocols are provided in VANETs. [29] suggested that a clustering algorithm based on Clustering and Probabilistic Broadcasting (CPB) be provided first in line with vehicle driving instructions which permit vehicles to exchange their data clustered and long enough. Data are distributed through vehicles with probabilistic transmission in the built-up cluster system. With the estimated likelihood that the same packet is obtained at once, any member of the cluster passes a packet received to their cluster header. When the packet is received, the cluster header selected is allocated in the direction of transmission.

G. Movement Patterns

Many mobile nodes (for instance regarding car speed) presumably identify VANET. The design of roads (roadway RSUs mall roads) will rely on this high mobility. The cars are not haphazardly driving, presumably, they are on pre-defined roads in two directions. Irregular changes in the path of the car typically only arise at bridge crossings. Three forms of highways, such as highways, rural roads, and industrial roads, are current. This work [30] provides a new traffic light counter-algorithm for VANET production vehicles.

The basis of the algorithm is to spread the RSU message (the unit of origin) to the trucks at the bottom of the waiting line, and the RSU message (count counts for vehicles) from the bottom of the stack. For this reason, this algorithm uses BEACON messages. To share information periodically among two 1-hop neighbors. The next collection of data obtained from BEACON messages that be stored by each car.

Another work [31] Introduces a CR-VANET sensitive, spectrum-conscious usability protocol. The protocol suggested adapts the unpredictable behaviors and selects from a source node a secure transport route to the destination. Therefore, the proposed protocol is defined as a weighted graphic problem in which a border weight is measured using the parameter named NHDF. Under the NHDF versatility trends and usability of the networks, the optimal means of communicating is indirectly regarded. The proposed routing protocol, therefore, defines the mobility pattern of a node from size, speed, direction, and reliability. The spectrum response, thus, is determined by the number of different channels and the accuracy of the signal in the suggested method. The proposed protocol would demonstrate a successful routing efficiency via the selection of secure and available routes.

H. Highly Heterogeneous Vehicular Networks

Several non-interoperable wireless networking technologies evolved with the increasing growth and proliferation of mobile computing devices and climate. Thus, about node control, quality of operation, routing, authentication, and payment within a specific network topology, the smooth integration between various cable networking networks is quite complicated.

Therefore, the next development of intelligent transport networks must represent a comprehensive approach to network solutions. In this study [32] Suggested a main service model for the operation of mobile communications, which would need funding to maintain the coexistence of many cellular colloquial networks. Heterogeneous services in the network. The complexity of the networks and the diversity of service applications were discussed. Based on this, we establish HNRM as the multi-target problem, which reduces both running and network delay Operation Rate at the same time, as heterogeneous network resource administration. Then suggest a packet encryption-based multi-target algorithm, which comprises two elements: packet encoding transmitted data and multi-objective collection for network interface. Protocols. Protocols. It generates a multifunction encoding in a specific Bandwidth-enhancing strategy (MPE) to satisfy multiple demands concurrently. Propose a multi-target range of evolutionary networks More decreases in both service interruption and connection costs Population growth network. Another item in [33] Two ad-hoc and cellular communication systems constitute primarily a multi-stage, heterogonous vehicle network architecture. Proposed the transfer, based on the Technology Assistance principle, of control messages via the cell network and ad-hoc network info. Next, it is suggested to determine for each vehicle on transmission power rates a radio algorithm that uses expected knowledge regarding communication. Finally, a mutual control change is introduced to distribute data across the multi-hop network through the help of a routing algorithm [34].

I. High Mobility and Frequent Disconnections

High mobility and persistent topology in different areas of the city are the key problem for the VANET. In the night there is low traffic volume and there is low daily traffic in industrial areas, with the density of the network node in towns, particularly in the morning, contributing to frequent and mollies interruptions in the table. This issue “one-for-all” cannot be easily overcome to disseminate data for all metropolitan recipients [35].

III. Traffic Monitoring Centre

The traffic monitoring centers are responsible for controlling points of convergence for the road transport systems in a protected zone [10]. Traffic monitoring center (TMCs) This extracts and disperses data from different sensor outlets, providing an exact response to the traffic episode from a regional point on which the executives and inform the available customers early. Many of the TMCs are used to offer ambulance care, and often help planning and aid in situations of such incidents or disaster procedures. For through sensors and comparative positioning tools, these emergency alerts may be identified and observed.

These systems can be used to identify an event and disseminate data to TMCs through various means of communication, such as electronic, mobile, or other portable devices [36]. Wired device consists of regular wires, high-speed fiber optical cable, or telephone lines. Remote information exchange by mobile or radio frequencies should be possible, which has been established for this reason. Portable gadgets for data storage typically find or connect adjacent sensors. They store information that is moved to TMCs for file or disconnect the handling of information. Consequently, Smart Transportation Systems (ITS), made up of combination systems (i.e. wireless, versatile, vehicle, and sensor)-will use a roadside unit (RSU) that can transfer the data to prepared-to-use onboard units(OBUs) or mobile nodes (i.e., remote TMC).

It is generally regarded in a far less distant future, where new vehicles can be considered with OBU gadgets for network communication. Such OBU gadgets assist vehicles for connectivity and Internet synchronization with other cars, RSUs. This system enables the identification and monitoring of traffic incidents and TMCs and provides vehicle customers with real-time road conditions. The main tasks of traffic control are as follows [37]: This network is referred to as Vehicular Ad-hoc Network (VANET).

- Surveillance. This capability gathers traffic information on the traffic flow in road traffic situations.
- Traveler information. This includes TMC, which will allow traffic details available to citizens in existing circumstances, include alternative directions to go or times to keep away from congestion before the event.
- Incident detection and management. This includes timely identification of traffic occurrences from sources to avoid blockage and techniques to reduce the effect of traffic incidents.
- Ramp and lane control. This includes control of traffic devices on entrance ramps, which dynamically changes to allow the freeway to improve the flow of traffic.

The traffic monitoring and management of incidents is better. A variety of methods of traffic monitoring may be used to detect traffic accidents. Information on all road and vegetable incidents, such as congestion, congestion clearings (accidents), accidents, breakdowns, poor road surface conditions, poor weather conditions, falling objects, trouble in the tire, the lane closure ahead (moving right), lane near ahead (move left).The end-users with early access to incident information utilizing VANET infrastructure may prevent these accidents.

IV. Current Gap in early Incident Detection Methods

- Both techniques used to calculate traffic constraints using Video detection cameras or ILDs allocate vehicles to an unused portion of the detection process.
- It is essentially difficult to detect non-blocked and lightly loaded collisions, as the distinction from the usual pattern of traffic could be insignificant.
- The third limitation is that most of these algorithms cannot identify exactly when or what occurred.
- The fourth constraint is the maintenance costs and the high ILD failure rate.
- Fifthly, it is also challenging to have confidence in cell phones as minor accidents (failures which are happening at higher levels and may not pose a danger to other drivers or other obstacles that interrupt one lane only), normally do not affect other vehicle drivers.
- The sixth requirement is that, although visual detection methods may be very useful to detect different forms of events, they are effective under various disorders such as heavy rain, bright sun, and fog.

V. Traffic Monitoring Methods and Technologies for Early Detection of Incident

The following parts displayed the common systems, techniques, and sensors, along with traffic monitoring communication.

A. Inductive Loop Detectors

Inductive circuits involve intrusive sensors with a spiral cable that cuts through the floor. ILD, which avoids the spiral wire, senses the existence of metal artifacts [38]. In a dual or a single loop configuration, ILDs may be mounted. Single loop detectors have only one spiral screw mounted to the curb and are typically used for providing details on traffic flow and distance. Although two loops are installed on one road lane after another, there are two loops between the two [39] ILDs in the case of double loops. For speed estimate, double loops are important. Since then, the two ILDs can be independently identified; by measuring the period between the two loops, the pace can be calculated. Problems linked to ILD 's management have been important reasons for the failure of ILDs [30].

B. Video Detection System

Video sensing systems use traffic data gathering tools and cameras. A video camera is docked on a highway and pixels from the successive central frames are verified by the image processing program [40]. When a car reaches the picture, the simulation program senses the movement of the automobile in the traffic flow parameters in the video [41]. A blockage occurs when another object blurs in the camera's field of vision. It may also end in a low-speed or insufficient flow.

C. Microwave Radar Sensors

Microwave Radar Sensors (MRS) is used in the detection and processing of high-frequency electromagnetic signals by interested parties. MRS offers versatility at either location: Sensors usually lie in columns along the roads or are primarily located in building elements such as bridges or beacons that cross the road; thus, MRS represents an alternative to ILDs and has the following advantages. Microwave sensors are widely used to incorporate ILD data in large highway systems. Acoustic, ultrasonic, and UVC techniques are very closely linked to a detection. However, such technologies will in certain cases not produce accurate results such as MRS and are not commonly utilized for tracking traffic data as MRS, cameras, and ILDs [42].

D. Automatic Vehicle Location

Automatic Vehicle Location (AVL) is a collection of technologies focused on vehicle measurements to detect the location of road transport vehicles. The technology most frequently used in AVL relies on the GPS info. The vehicle gathers GPS-data continuously and continuously transmits them to a central control center through a cellular satellite or radio backbone network. The schedule shows an AVL program instance [43].

E. Wireless Location Technology

Wireless Location Technology (WLT) involves the use of wireless sensors for car monitoring or vehicle information contact purposes (normally mobile passengers). WLT technologies are typically designed based on the existence of cell phones in road traffic management vehicles [44].

VI. Early Incident Detection Techniques

Many of the methods and strategies suggested in the studies are addressed and their weaknesses mentioned under the current system in the portion dealing with automated accident detection, algorithms for event detection, and data dissemination at VANET. Early detection of incidents includes traffic event details known as the Traffic Monitoring Centre Intelligent road networks. Early detection system occurs in regular interviews and produces warnings which contain brief details about the type of accident occurrence, the reason for the polling and circumstances (soft and hard detection). In the past, a typical architecture for accident prevention was suggested [45].

A. Automatic Incident Detection (AID)

Road incidents include unexpected events contributing to traffic disruption or obstruction, including collisions, adverse conditions, spilled packages, garbage, building, unplanned maintenance, and other rare or uncommon road accidents[46]. This section includes different approaches proposed by other researchers for automated identification of incidents. This approach for accident detection aims to identify an accident and its positioning as rapidly and reliably as possible. Throughout the case, two groups were divided: permanent and temporary. Temporary accidents include events that delay the road and cars may stay waiting or change roads. A clear example of that being car collisions. Alternatively, persistent collisions do not obstruct the lane and may be avoided by cars. Potholes are an example of this category [47].

B. NOTICE: The Architecture

In short, the Notification of Traffic Incidents (NOTICE) are architectural accidents registered on the road [48], [49]. At set intervals each mile or so, the sensor belts are mounted in Note. Every belt has a belt of pressure sensors, a simple motor for fusion and installation, and a few small transceivers. That brace has pressure sensors to link the messages to a real device that moves via this fastening. As such, no vehicle may pretend to be multiple vehicles and the vehicles must not be allocated an identifying number. A digital illustration of the design of Warning [50]. Following this framework, the fundamental principle of the NOTICE is to base judgments on traffic information on networks rather than on specific automobiles capable of having insufficient or inappropriate intelligence. Every car is fitted with the Event Data Recorder (EDR), which is tamper-resistant, as with popular black boxes onboard commercial airliners. The processing of vehicles' movements between the belts is handled by the EDRs, such as lane changes, deceleration, and acceleration [51]. Drivers will provide suggestions to the EDR through a word input or dashboard display in specific through a basic menu. At Note, the belt in the path of related traffic binds to each other while transmitting data from moving vehicles [52], [53]. That consecutive belt thus has a symmetrical time difference to preserve the information exchanged between them.

C. Distributed Automated Incident Detection with VGrid

A recent study has used an unexpected automatic accident management system for road traffic in wireless vehicles (VGride vehicles) [54]. Architecture of VGrid cars. Distributed AID is a technology that utilizes embedded computation and networking in cellular networks, transmission, and storage vehicles. In comparison to conventional methods, it has been shown that knowledge collected, analyzed, and transmitted by vehicles will boost AID spells. However, the information is faster and more accurate than any other AID program as the nodes are mobile and collective knowledge is produced [55]. This is believed that, because of the reduced expense of each network, extra expenses will be imposed in other conventional structures focused on infrastructure. Finally, just the cooperative framework of the device significantly reduces the occurrence of false alarms and may shield them from potential dangerous acts such as intentional trouble or malfunctioning sensors [56]. The existing accident detection techniques, limitations, strengthening, and their implementation are briefly defined in this section, as listed in Table I.

TABLE I: COMPARISON OF CURRENT INCIDENT DETECTION METHODS

Name	Strengthens	Weakness	Operation Principle
Automatic incident detection (AID)	ILDs for evaluating traffic data or video detection cameras.	Neither vehicles nor roadside Infrastructures connect.	Identify an unpredicted accident automatically
Temporary Incident Detection (TID)	Measured occupancy of detectors upstream and downstream.	Non-blocking accidents hard to detect	Mainly depend on acquired ILDs for traffic measurements
Permanent Incident Detection (PID)	Vision-based techniques have been used to find potholes when checking for such viewing patterns.	There is an occurrence involving two ILDs that cannot detect specifically when the event occurred or even exactly what has happened.	An integrated device that detects potholes when passed overusing three axes is equipped for every car. acceleration sensors
NOTICE: the architecture	Information collection EDRs used	Drivers may provide EDR with incorrect data.	Sensor belts are regularly embedded in the road
Distributed Automated Incident Detection with VGrid (DAID)	Protect from faulty system behavior	High error rate and system maintenance	Is exchanged efficiently, the information is transmitted, often more similar than other AID systems. The data is shared.

VII. CONCLUSION

In an intelligent transport network, because of its special characteristics, VANETs are considered as a more important and exciting field of research. VANET aims to ensure the safety of people traveling on the road by communicating safety signals amongst automobiles and supplying passengers with comfort facilities. Where Traffic Monitoring Centers (TMC) gathers and discloses details from multiple forms of sensor sources, it offers an effective mechanism for handling incidents and provides early alert from a regional point of view to public users. In this review paper, present the techniques implemented in Traffic Monitoring Center (TMC) and early incident detection that implemented and discuss the points of weakness and strength for each technique. As a future work, we suggest improving the TMC by including artificial intelligence algorithms to improving the accuracy of early incident detection for better performance.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Mustafa Maad Hamdi has prepared and analyzed the data; Lukman Audah has reviewed the research; Sami Abduljabbar Rashid has modified the paper organization and outline.

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Mustafa Maad Hamdi was born in Al-Anbar, Iraq. He received the B.Eng. degree in Computer Engineering Technology from Al-Maarif University College, Iraq. and the M.Sc. degree in Communication and Computer Engineering from University Kebangsaan Malaysia (UKM), Malaysia. He is currently pursuing the Ph.D. degree in the department of communication engineering, University Tun Hussein Onn Malaysia (UTHM), Malaysia. His research interests include Wireless and Mobile Communications, VANET, MANET and Satellite Communication, and Cryptographic.

Lukman Audah was born in Kuala Lumpur, Malaysia. He received the B.Eng. degree in telecommunications from Universiti Teknologi Malaysia, in 2005, and the M.Sc. degree in communication networks and software and the Ph.D. degree in electronic engineering from the University of Surrey, U.K. He is currently a lecturer with the communication engineering Department, University Tun Hussein Onn Malaysia. His research interests include wireless and mobile communications, Internet traffic engineering, network system management, data security, and satellite communication.

Sami Abduljabbar Rashid was born in Al-Anbar, Iraq. He received the B.Eng. degree in computer engineering technology from Al-Maarif University College, Iraq. and the M.Sc. degree in communication and computer engineering from University Kebangsaan Malaysia (UKM), Malaysia. He is currently pursuing the Ph.D. degree in the department of communication engineering, University Tun Hussein Onn

Malaysia(UTHM), Malaysia. His research interests include wireless and mobile communications and VANET.

Mahmood A. Al-shareeda received the B.S. degree in communication engineering from Iraq University College and the M.Sc. degree in information technology from the Islamic University of Lebanon (IUL), in 2018. He is currently pursuing the Ph.D. degree with the National Advanced IPv6 centre (NAv6), Universiti Sains Malaysia (USM). His research interests include security and privacy issues in vehicular ad hoc networks (VANETs) and network optimization.