Republic of Iraq
Ministry of Higher Education and Scientific Research
University of Anbar
College of Computer Sciences and Information Technology
Department of Computer Science

Multi-Hop Broadcasting for Gaming over Vehicular Ad Hoc Networks

A Thesis

Submitted to the Department of Computer Science - College of Computer Science and Information Technology, University of Anbar as a Partial Fulfillment of the Requirements for Master Degree of Science in Computer Science

By

Salah Noori Mjeat

Bachelor of Computer Science

Supervised By

Assist. Prof. Dr.Foad Salem Mubarek

1443 A.H. *2022 A*

اسم الطالب: **صلاح نوري مجيت**

كلية علوم الحاسوب وتكنولوجيا المعلومات - قسم علوم الحاسبات

عنوان الرسالة: **البث متعدد المراحل للالعاب عبر شبكات المركبات المخصصة .**

كلية علوم الحاسوب وتكنولوجيا المعلومات

جامعة الأنبار

عنوان البحث			
Survey of Multiplayer Games over VANETs Environment			
جهة النشر	**AIP Conference Proceedings The First Virtual International Conference of Sciences (VICS2021)**	نوع المجلة	**Scopus**
حالة النشر	**Accepted**	رقم المجلة	
رابط البحث			

أسم وتوقيع المشرف
أ.م.د. فؤاد سليم مبارك

أسم وتوقيع رئيس القسم
أ.م.د. وسام محمد جاسم

Dedicate

- ✓ To my father (may God have mercy on him), who wished to see me in the advanced stages of my scientific career.
- ✓ To my dear mother.
- ✓ To my supervisor and my teachers.
- ✓ To my wife and children.
- ✓ To my brothers and sisters.
- ✓ To my relatives and friends.
- ✓ To my dear country.

Salah Noori Mjeat

2022

Acknowledgments

All praises to Allah Almighty, who enabled me to complete this work successfully. I would like to express my sincere gratitude to my supervisor ***"Dr. Foad Salem mubarek"*** for the continuous support of my research, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis.

I would also like to extend my thanks and gratitude to ***all my teachers*** in the College of Computer Science and Information Technology for everything.

Special thanks to ***my wife*** and ***all my family members*** for their tolerance and support and encouragement throughout the period of my studies.

Finally, I would like to thank ***all my friends*** for their support.

My thanks for all...

Supervisor's Certification

I certify that I read this thesis entitled **" Multi-Hop Broadcasting for Gaming over Vehicular Ad Hoc Networks"** *that was done under my supervision at the Department of Computer Science of the University of Anbar, by the student "**Salah Noori Mjeat** " and that in my opinion it meets the standard of a thesis for the degree of Master of Science in Computer Science.*

Signature:

Name: Assist. Prof. Dr. Foad Salem Mubarek

Date: / /2022

Linguist Certificate

*I certify that, I read this thesis entitled (**Multi-Hop Broadcasting for Gaming over Vehicular Ad Hoc Networks**) and I found it linguistically adequate.*

Signature:

Name: Dr. Omar Munthir Al Okashi

Date: /   / 2022

Certification of the Examination Committee

We the examination committee certify that we have read this thesis entitled " **Multi-Hop Broadcasting for Gaming over Vehicular Ad Hoc Networks***" and have examined the student "* ***Salah Noori Mjeat*** *", in its contents and what is related to it, and that in our opinion, it is adequate to fulfill the requirements for the degree of* ***Master of Computer Science****.*

Signature:
Name: ***Prof. Dr. Sufyan T. Faraj Al-janabi*** *(Chairman)*
Date: / / 2022

Signature:
*Name****: Assist. Prof. Dr. Khattab M.Ali Alheeti*** *(Member)*
Date: / / 2022

Signature:
Name: ***Assist.Prof.Dr. Abbas Abdulazeez Abdulhameed*** *(Member)*
Date: / / 2022

Signature:
Name: ***Assist. Prof. Dr. Foad Salem Mubarek*** *(Supervisor)*
Date: / / 2022

Approved by the Dean of the College of Computer Science and Information Technology, University of Anbar.

Signature:

Name: ***Prof. Dr. Salah Awad Salman***

Title: Dean of the College

Date: / / 2022

Student name: ***Salah Noori Mjeat***

Thesis title: Multi-Hop Broadcasting for Gaming over Vehicular Ad Hoc Networks

Abstract

With the advancement of car technology, a wide range of applications, ranging from safety (i.e. alert messages) to entertainment (i.e. games), are becoming more readily available to passengers. Many of these applications use a one-to-many transmission model, in which every car within the Region of Interest (ROI) can broadcast a message to all other cars within a few kilometers of the source. In order to perform a certain game between a group of passengers (players) over VANETs, a game message must be sent to the other players in the car platoon following each game event made by a player in the considered gaming car platoon within the ROI. This requires fast delivery of these messages since we need a mechanism to ensure quick delivery of these messages. Therefore, fast multi-hop message propagation was adopted over VANETs in a highway scenario in which there can be reduced delay of propagation messages by reducing the number of hops by selecting a specific node as a forwarder and based on having different contention windows among vehicles. The proposed algorithm is called Smart Inter-Vehicle Communication Schema (S_IVCS) and three approaches have been suggested: FIXED_300, FIXED_1000, and RANDOMALY approaches are evaluated with the S_IVCS approach in swiftly forwarding the messages to each vehicle expressing interest for infotainment to evaluate the ability of the proposed system while increasing the coverage radius. In addition, S_IVCS proves good performance compared to other approaches with respect to transmission time and number of hops. Also, the impact on the performance of S_IVCS with respect to the duration of time slots. The simulation has been performed using the Network Simulator (NS-2).

Keywords**:** Entertainment, game message, Fast multi-hop, contention window, Smart inter-vehicle communication, NS-2.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVEATION

Abbreviation	Description
ACK	Acknowledgments
AID	Adaptive approach for Information Dissemination
BPD	Broadcast Prediction of Dynamics
BSP	Broadcasting storm problem
BSSAs	Broadcast Storm Suppression Algorithms
CCA	Clear Channel Assessment
CDS	Connected Dominating Set
COW	Contention Window
COWB	Contention Windows for Backward
COWF	Contention Windows for Frontward
CP	Current position
Dist	Distance
DSQR	Distance and Signal Quality aware Routing
DSRC	Dedicated Short-Range Communication
ESM	Emergency Safety Message
ETR	Estimator Transmission Range
EWM	Emergency Warning Message
GPS	Global positioning system
HBD	Highest Backward Distance
HBR	Highest Backward Range
HFD	Highest Frontward Distance
HFR	Highest Frontward Range
IEEE	Institute of Electrical and Electronics Engineers
IFP	Intelligent Forwarding Protocol
ITS	Intelligent Transportation Systems
IVC	Inter vehicle communication
LDB	link dynamic behavior
LSAs	Locations based Suppression Algorithms
MAC	Medium Access Control

MANET	Mobile ad-hoc network
M-HRB	Multi-Hop Reliable Broadcasting
MPR	Multi-point Relay
NFV	Next Forwarder Vehicle
NS2	Network Simulator version 2
OSI	Open System Interconnection
P2P	Peer – to – Peer
PDR	Packet Delivery Ratio
PSAs	Probabilistic Suppression Algorithms
QoS	Quality of Services
ROI	Region Of Interest
RSU	Road Side Unit
RTB/CTB	Request To Broadcast/Clear-To-Broadcast
S_IVCS	Smarted_ Inter Vehicle Communication Schema
SP	Source position
TCP	Transmission control Protocol
TSAs	Timer based Suppression Algorithms
UDP	User Datagram Protocol
V2I	Vehicle-to infrastructure
V2V	Vehicle-to-Vehicle
VANET	Vehicular ad-hoc network
WPB	Weighted p-Persistence Broadcasting Algorithm
WSMP	Wave short message protocol

Chapter One
Introduction

1.1.Overview

An Ad-hoc network is a network composed of individual devices communicating with each other directly or indirectly through Road Side Unit (RSU). Many Ad-hoc networks are local area networks where computers or other devices are enabled to send data directly to one another rather than going through a centralized access point [1]. Ad-hoc social networks are formed by groups of nodes, designating a similarity of interests. The network establishes a two-layer hierarchical structure that comprises communication within-group and joining with other groups[2]. Ad-hoc network types are divided into two types according to their novelty, which are Mobile Ad-hoc networks (MANET), and Vehicular Ad-Hoc Network (VANET)[1], [3].

Most things related to MANET are related to VANET somehow, but they differ in the details. Rather than moving randomly as in MANET, vehicles tend to move in an orderly fashion by following the rules of the road such as stopping, slowing, and changing direction. Finally, cars have limited mobility. In 2006 the term MANET was describing a field of academic research and the term VANET was a promising field of applications [3], [4].

The VANET networks are simply an application of MANET. Vehicular networks are a projection of Intelligent Transportation Systems (ITS) [5].

The main objective of VANET networks is to improve road safety as well as transportation efficiency through the use of wireless communications technologies and the emergence of low-cost embedded sensors. For the establishment of such a network, vehicles must be equipped with some embedded sensors such as radars, cameras, a Global Positioning System (GPS) tracking system, and of course a processing platform [5].

VANET provides a wide range of benefits to users, for example, a high-speed Internet connection to the car computer makes the car communicate with the world through the web. While such a network does not pose particular safety concerns (e.g., one cannot safely write an email while driving), this limits the VANET potential as a productivity tool. It allows time (such as waiting in a long queue) to get some tasks done. GPS technologies can take advantage of linking them to vehicle traffic reports in order to find the best route to the workplace.In addition to linking voice communication technologies and services over the

Internet to reduce communication costs between employees, wherefore vehicular networks are receiving more and more attention from researchers and practitioners [6], [7].

Recently, vehicular applications for traffic safety, traffic efficiency, and entertainment have put forward higher requirements to vehicular communication systems. A common feature shared by many of these services concerns message dissemination within a ROI through multi-hop, ad-hoc Inter-Vehicles Communication (IVC) among a group of cooperative vehicles(platoon cars) [8]. IVC provides a way to exchange the messages that traverse may be over multi-hops from source vehicle to destination node or to groups of node within ROI [9]. In addition, the IEEE 802.11p based Dedicated Short-Range Communication (DSRC) technology is proposed to form Vehicular Ad-hoc Networks (VANETs) [10].

There are two sorts of multiplayer games in the context of multiplayer games: Internet multiplayer games and mobile multiplayer games [11].Because the player base of Internet multiplayer games is substantially greater than that of mobile multiplayer games, they are under a high focus by the industry sector. Until date, the most common approach to mobile multiplayer game design has been to construct games for small devices (such as cell phones) that need players to travel in order to complete the game objective.This strategy did not result in a slew of successful mobile multiplayer games [12].

The envision of VANET multiplayer games as a significant departure from the approaches, providing players with the opportunity to participate in a location-aware, mixed reality multiplayer game that takes advantage of inherent vehicular mobility. These features are not available in Internet multiplayer games. VANET multiplayer games will not be confined to small user-devices with relatively low computation power. As players will be in vehicles, they will have significantly more computation power and battery life available than those currently used for mobile multiplayer games. Devices on which VANET games will be played could be much more elaborate than current mobile devices [13] , [14].

1.2. Related Works

In VANET topology, the message broadcasting is the simplest way for communication.This simplest way of communication will be used for transmission of messages from vehicle to all vehicles over multi -hops in the RIO. But the method of message transmission leads to the unwanted data flooding which causes many problems such as the broadcast storm problems ,networks fragmentation or partition (i.e.it happens when the number of vehicles in the ROI is not sufficient to effect the data dissemination among the group of vehicles next to each other) in which affects the overall reliability and performance of the VANET networks .In this contexts, there are many researchers who have addressed this topic such as :-

O. Alzamzami et al, in 2021 [15] introduced a scheme to select the next-hop forwarder based on its mobility relative to the destination and the dynamic behavior of its link with the current forwarder. A cross-layer model of link dynamic behavior (LDB) is presented, which considers the loss ratio, physical interference, and medium access control (MAC) overhead.

H. I. Abbasi et a1, in 2019 suggested in [16] to use the Intelligent Forwarding Protocol (IFP) in VANET as a quick and reliable multi hop routing protocol for spreading safety messages (overall safety messages) between vehicles. IFP protocol exploits handshake-less communication with acknowledgments (ACK) decoupling for efficient collision resolution.IFP protocol reduces the channel access time by removing the handshaking mechanisms (i.e. RTB/CTB (Request To Broadcast/ Clear-To-Broadcast)) preceding the safety message transmission to minimize the message propagation delay by either eliminating the ACK-ing process or at least decoupling the message propagation process from ACKs to the sender. The message propagation delay is reduced and thus improves the Packet Delivery Ratio (PDR) of the proposed protocol. It should be mentionted that if the ACK packet is not received within a certain amount of time, the whole process (RTB-CTB-DATA -ACK) starts over again and this causes overhead on the system performance.

K. N. Qureshi et a1, in 2019 addressed vehicular networks [17] by presenting a Distance and Signal Quality aware Routing (DSQR) protocol.The proposed protocol begins its forwarding decision based on Mid-Area node selection by evaluating the direction and distance between neighboring nodes as well as link quality, and then chooses the best next forwarder node towards the destination node.In a realistic environment, the performance of DSQR is assessed using vehicle speed and traffic density. Evaluation of performance comparisons revealed that the proposed protocol outperforms existing protocols and reduces packet dropping and link failure issues.

X. M. Zhang et a1, in 2019 In [18], examined the impact of link quality and vehicular mobility on broadcast relaying on selection to minimize broadcast delay and maximize broadcast efficiency. They first proposed a novel multi-hop broadcast scheme based on a prediction of dynamics (BPD), which combines sender-based and receiver-based relay selection schemes and utilizes dynamic information to achieve model-based prediction. Then, for minimizing broadcast delay, they proposed a novel metric called expected remaining delay (D) and implemented it in BDP (BPD-D). And for maximizing broadcast efficiency, a new metric called expected rebroadcast efficiency (E) has been proposed and implemented in BDP (BPD-E). The suggested BPD-D and BPD-E broadcast protocols outperform existing broadcast protocols, with BPD-D having the least latency and BPD-E having the maximum dissemination efficiency, according to simulation findings.

Kim et al., in 2018 [19] introduced the notion of information flow propagation wave to characterize information flow propagation at a macroscopic level (IFPW).Using the idea that when information travels through multi-hop broadcasting communications, a moving boundary separates traffic flow into informed and ignorant regions from a macroscopic perspective, and advances towards the uninformed zone like a wave.

S. Latif et al, in 2017 [20] presented an approach to disseminate the data in VANET to minimize transmission storms and make optimal use of network resources, the Next Forwarder Vehicle (NFV) was chosen in their article to be passed to neighboring cars. The choice of NFV is influenced by a number of VANET characteristics. They chose the suitable vehicle as the NFV using the analytical network technique. The broadcast storm problem was significantly decreased in their technique using broadcast suppression technology in highway VANET, as well as sending data packets to all intended cars in the relevant region of the network with acceptable latency and network overhead. They discovered that by reducing the amount of broadcast data packets, they were able to successfully limit broadcast storms.When compared to the flood protocol, this technique has a 55 % overhead.

W. Benrhaiem et al, in 2016 Multi-Hop Reliable Broadcasting (M-HRB) [21] is the proposal for a wide range of VANET applications in the metropolitan region.The protocol is based on local state data that divides the streets into various units.These many cells are arranged in a grid-like pattern.To take use of the properties of periodic beacons, a proactive local state processing is proposed.As a result, the neighbor's quality is estimated, and appropriate forwarders are located, resulting in acceptable dependability in each hop in multi-hop broadcasting. Furthermore, the network lifetime is extended by reducing bandwidth use.In terms of dependability and bandwidth utilization, M-HRB outperforms previous methods.Even while it achieves higher performance in terms of dependability and forwarder selection in MANET, where forwarder selection must be maintained and selected for each transmission, the performance in a network with a large number of cars is hampered.

A. Bujari et a1, in 2016 [22] proposed a generalization of a prior message propagation scheme.They showed that network coverage via Fast-Broadcast is unintentional rather than deliberate.The proposal achieves network coverage while benefiting from the optimality results provided by the contention mechanism proposed by Fast-Broadcast by relying on a bloom filter embedded in the message header.

S. Ferretti et al, in 2016 [23] the need of focusing on effective and inexpensive communication solutions for the deployment of smart services in rural areas is discussed in this study. The primary wireless technologies, software structures, and protocols that must be exploited include multi-hop and multi-path communication. This paper introduces Always Best Packet Switching (ABPS), an operation mode that allows for seamless network handover without requiring changes to the current network hardware and configuration. This is in line with SIVCS demand for low-cost solutions that may function in a smart shire scenario. The effectiveness of our technique has been confirmed by simulated testing.

M. Chaqfeh et a1, in 2015 [24] focused on to developing a scalable data dissemination solution for VANET communication. They proposed various speed adaptive broadcast variations that can accurately estimate traffic regimes using simple speed data.Their method could achieve a high delivery ratio with low dissemination overhead, according to simulation results. As a result, in addition to the improvements it made over previous approaches, the approach's merit lies in the fact that it is free of any neighborhood management overhead.

All above references are based on deliver the generate message from source to other passengers on broadcast the message in one direction while the proposed system depends on deliver the generate message on two directions (backward and frwantward).

1.3. Problem Statement

The rapid, epidemic, and scalable delivery of data among all participants in the same application is one of the most pressing issues in vehicular networks. This thesis concentrates on broadcasting game events to all players in vehicular networks by using multi-hop broadcasting of game messages. It is common knowledge that a high degree of interactivity is a vital element for games between players over vehicular ad hoc networks. Furthermore, the importance of interactivity also resides in the fact that another fundamental gaming property can be guaranteed through it: networking delay fairness among players. Therefore, to provide high interaction among players and reduce delay, we need an intelligent procedure by selecting one of neighbor nodes to be forwarder to next hop and the rest of nodes stops of broadcasting according to waiting time that is randomaly based on the distance between source node and forwarding node within single hop. If no intelligence is applied to the multi- hop broadcasting scheme, any node in the network would simply relay every received message and may be cause what is known the broadcast storm problem.

1.4. Research Aim

The aim of this thesis represented by Enhancing the performance of vehicular networks for message‘s game over platoon car by reducing the number of hops through apply S_*IVCS*. Also, to remove or reduce the broadcast storm problem (BSP) which is appearing in case of each receiving node try to rebroadcast its receiving message. The study is an attempt to reduce the redundant transmissions by choosing the next -hop forwarder of a broadcast game message. This is done based on the distance from the previous sender and on expected transmission range which represented an efficient priority scheme and reduces the selective waiting time to select next hop. .

1.5. Contributions

The contributions of this thesis are:

1. Provide an intelligent way to generate estimator for each node. This lead to elect the farthest node to be next forwarder.
2. Reducing the redundant transmission by choosing the next–hop forwarder.
3. Ensure that any game event generated by a player reaches the group of players within the ROI.
4. Implement a new *S_ IVCS* session layer between the application layer and lower tiers to optimize application message broadcast across the car platoon.
5. Define contention windows for backward and frontward (COW_B, COW_F) for broadcast messages to identify which vehicle will send the broadcast message on the next hop to ensure reliable timely transmission of gaming messages and increase system throughput.

1.6. Thesis Outline

The next chapters of this thesis can be outlined in the following abbreviated expressions:

- ✓ **Chapter Two:** Gives the theoretical background of the intelligent transportation system. A Vehicular Ad-Hoc Network VANET and its architectures.
- ✓ **Chapter Three:** This chapter contains a complete description of the proposed system design in terms of the study case, methodology and algorithms.
- ✓ **Chapter Four:** Introduces results and evaluation of the proposed system design and the dissection of the obtained results.
- ✓ **Chapter Five:** Displays the main conclusions of this research, give suggestions for future works .

Chapter Two

Theoretical Background

2.1.Introduction

This chapter includes the theoretical background of the proposed system, through which we discussed an explanation of the ad hoc networks in general. Then we touched on its types, namely, a network dedicated to mobile ad hoc network and a vehicular ad hoc network, where the narrative was in particular about the last, which is the network of our proposed system. The dive into our research topic (Multiplayer games over Vehicular Ad Hoc Networks) was more in-depth.

2.2.Ad-hoc Networks Concepts

Ad-hoc networks, which are also called mesh networks, are defined by the manner in which the network nodes are organized to provide pathways for data to be routed from the user to and from the desired destination. Actually, the two names ascribed to these networks provide considerable insight. Ad-hoc has two definitions: the first can be either “impromptu” or “using what is on hand”, while the other is “for one specific purpose” [25].

Ad-hoc networks follow both definitions: first, they are formed as they are needed (impromptu), using resources on hand, and second are configured to handle exactly what is needed by each user a series of “one specific purpose” tasks. The term mesh network accurately describes the structure of the network: All available nodes are aware of all other nodes within range. The entire collection of nodes is interconnected in many different ways, just as a physical mesh is made of many small connections to create a larger fabric. Figure 2.1 provides a simple diagram illustrating these concepts. This diagram is modeled after a wireless “hot spot,” where an ad-hoc network links users to a router with access to the Internet. In this example, two users are highlighted, showing two paths through several nodes to the router [25], [26].

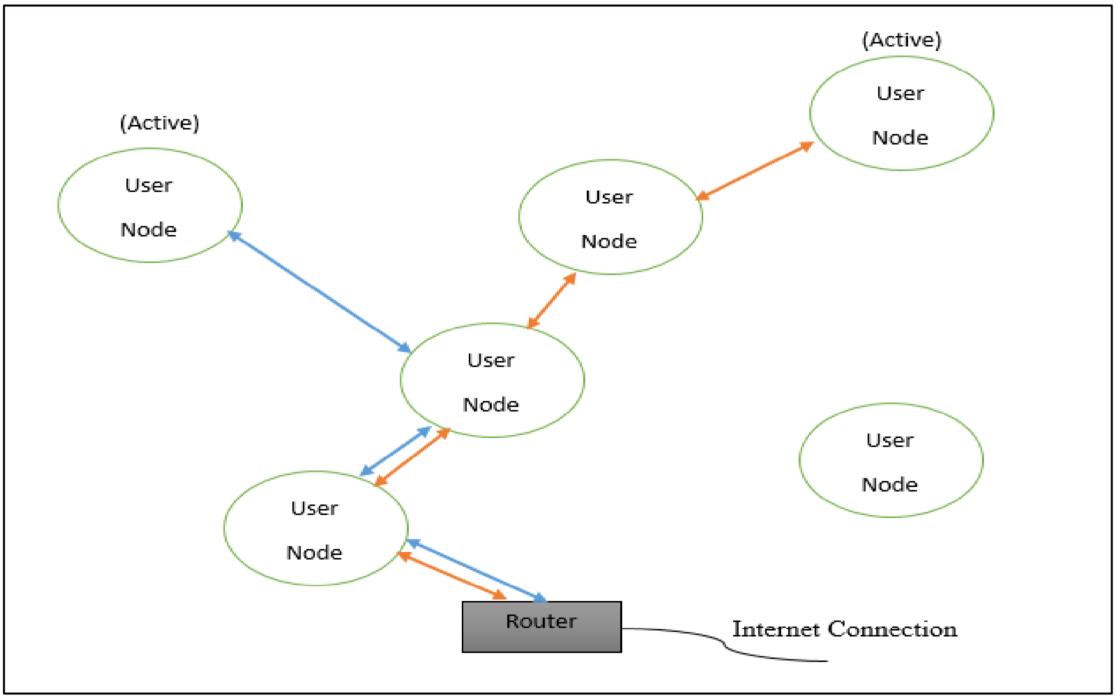

Figure 2.1 Basic structure of an ad hoc, mesh, network.The path from the users node to the destination node is provided by other users' devices acting as routers [25].

2.2.1. Advantages and disadvantages of Ad-Hoc Networks

The principal advantages of an ad hoc network include the following [27]:

- Independence from central network administration.
- Self-configuring, nodes are also routers.
- Self-healing through continuous re-configuration.
- Scalable: accommodates the addition of more nodes.
- Flexible: similar to being able to access the internet from many different locations.

While ad hoc networks are typically used where they have the greatest emphasis on their advantages, there are also some disadvantages:

- Each node must have full performance.
- Throughput is affected by system loading.
- Reliability requires a sufficient number of available nodes. In addition, sparse networks can have problems.
- Large networks can have excessive latency (time-delay), which affects some applications.

2.3.VANETs Characteristics

The VANETs are highly dynamic ad hoc networks with high reliability, offering multiple services, but have limited access to the network infrastructure. VANETs have characteristics of high mobility and frequent change in topology as compared to the MANETs, [28], [29] and can be further categorized into the network topology and communication mode as well as the vehicle and driver mode. The characteristics of the VANETs are as follows:

- **High mobility:** The high versatility of VANET hubs is the imperative feature. In the essential procedure of hubs communication, hubs move in various directions at different speeds. The high versatility of hubs gives the complex topology to the system. VANET mobility range is high when contrasted with MANET.
- **Dynamic topology:**VANET topology changes quickly, it is dynamic and unpredictable.The association time is limited particularly between hubs moving in inverse directions.This topology helps the attack of the whole system and complicates the discovery of malfunction.
- **Frequent extractions:** the dynamic topology and the high mobility of hubs and also different conditions, for example, atmosphere, because of movement density frequent disconnections of vehicles happened from the system.
- **Transmission medium Accessibility**:In the VANE system, the transmission medium is air. Regardless of the way that the across the board openness of this remote transmission medium which is one of the huge points of interest in IVC, transforms into the wellspring of some security issues.
- **Limited bandwidth**:The institutionalized DSRC band for VANET can be considered constrained.Where the whole transmission capacity range is 75 MHz. Impediment of utilization in a few nations proposes that these 75 MHz ranges are not all permitted. The greatest hypothetical throughput is 27 Mbps.
- **Attenuations**:DSRC band has also transmission issues to computerized transmission with such frequencies, for example, diffraction, reflection,

scattering, diverse sorts of blurring Doppler Impact, misfortunes, and spread deferrals because of multipath reflections.

- **Restricted transmission control:**The transmission power is bound in the WAVE system, which requirements the space that information can reach. This distance and space is up to 1000 m. Also, in certain particular cases for example public safety and emergency it is permitted to transmit with a higher power.

2.4. Broadcasting in VANETs

In the last two decades, mobile communications have significantly changed human lifestyle, by allowing them to exchange information of any type at anytime from anywhere. In vehicular ad hoc networks (VANETs) , mobile communication system consider important element for sharing information among vehicles and infrastructures that offering a large set of applications, in terms of safety, convenience, comfort, environment protection, entertainment and automated roadways.Vehicles in VANETs equipped with wireless communication system, on board computing or processing devices, in-car sensors, and navigation capabilities will create a spontaneous network while moving along road.Direct wireless communication among vehicles enables the VANETs to exchange information among all participants, without any fixed communication infrastructure access points of wireless networks and base stations of mobile phones.Although different communications paradigms such as unicast [30] geocast or multicast [31] , [32] can be used in VANETs but most suitable form is broadcast [33] , [34] because it is simple and easy to implement.

2.5. Broadcast protocols

The main goal of routing protocols is to achieve the shortest possible communication time while using the fewest possible network resources. Most VANET applications are built upon the data push communication model, where information is disseminated to a set of vehicles.

2.5.1. Classifications of broadcast protocols

The broadcast protocols can be classified in several way such as Single-hop vs. Multi-hop[35] , Deterministic vs. Probabilistic[36], Vehicle-to-Vehicle (V2V) vs. Vehicle-to infrastructure (V2I)[37]:-

A. Single-hop vs. multi-hop

The major difference between the single-hop and multi-hop protocols is the mode of transmission of data packets in VANETs, as shown in Figure 2.2 and Figure 2.3 respectively. Flooding is used in multi-hop broadcast protocols to send information packets across the network. Generally, whenever a source vehicle (node) broadcasts an information packet in a particular area, some of the receiving nodes become forwarders to perform rebroadcast. Consequently, the information packet propagates from source vehicle to all vehicles in VANETs.

In single-hop routing protocol, the source node broadcasts the data packet to its neighbor nodes only, and these receiving neighbor nodes store the information and do not broadcast it further.

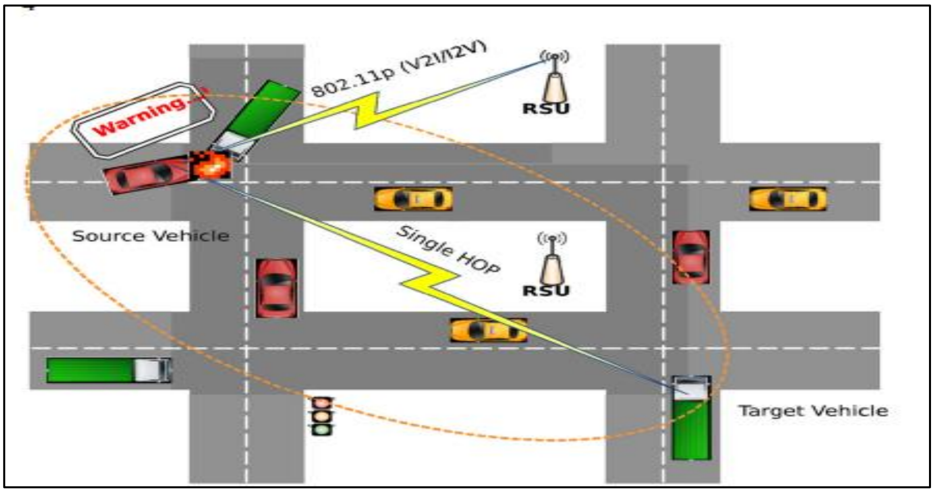

Figure 2.2. Single-hop communication in VANETs[35].

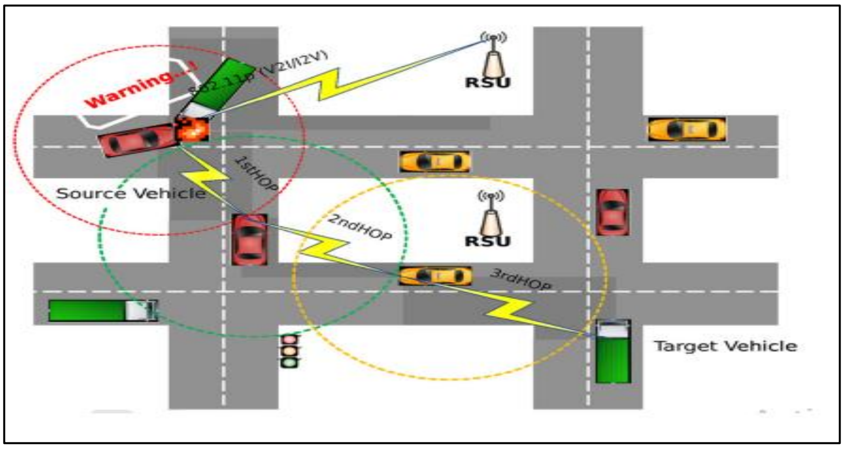

Figure 2.3.. Multi-hop communication in VANETs[35].

B. Deterministic vs. probabilistic

Deterministic protocols permit a subset of vehicle nodes to participate in the broadcast procedure. Multi-point Relay (MPR) and Connected Dominating Set (CDS) algorithms are two examples. Moreover, in case of mobility scenarios, the permitted nodes will change very frequently in accordance with topological changes.

Whereas, probabilistic broadcast protocols select well-balanced routes for packet propagation throughout the network by balancing the power usage among all participating nodes in VANETs. In these protocols, each node is permitted to forward data packet, if it attained the required probability value. Furthermore, these protocols are very resistible against attacks or failures and also unlike the deterministic protocols, mobility conditions of nodes does not affect these protocols.

C. V2V vs. V2I

V2V data distribution relies entirely on ad hoc communication between vehicle nodes and does not require any infrastructure support. For data broadcast over the network, V2V protocols use either a flooding or a relaying technique.

The sender vehicle broadcasts the data packet to all of its neighbors in the flooding procedure. Flooding causes the broadcast storm problem (BSP) in dense networks when a large number of vehicles communicate enormous amounts of data, inefficiently utilizing the limited resources available [38].

In the relaying strategy, the sender vehicle transmits a data packet to all of its neighbors, who store it. Following that, the next forwarder vehicle is chosen to broadcast data packets to its neighbors based on any criterion. Relaying is a stable, scalable, and well-suited strategy for dense networks, but it comes with a large delay and overhead.

In V2I data broadcast, infrastructure is required to perform vehicle-to-infrastructure communication. Push-based or pull-based approaches are used in V2I protocols. The push-based approach is particularly suited to public-interest data. Roadside infrastructure transmits an Emergency Warning Message (EWM) to all vehicles within its specified vicinity [39].

The pull-based approach is more appropriate to get particular data, such as, traffic or environmental condition.In this approach,Vehicles can ask the authorities for any kind of information regarding a certain piece of data. Because of the increased data traffic, this strategy may generate packet collisions, contention, and interference [40].

In VANETs, a multi-hop relaying technique is utilized whenever data must be transmitted outside of a vehicle transmission range. In other words, flooding is a network with data packets that can be used to conduct multi-hop relaying. The retransmission of the same data packet will increase as the density of vehicles in a network grows. This increment in retransmission in a specific area will use the limited bandwidth, demonstrating that pure flooding is not scalable and causing major packet collisions (referred as broadcast storm problem). A Nnmber of retransmissions of the same data packet is an effective and typical technique to tackle these two concerns of scalability and packet collision. This can be accomplished by designating a few vehicles as the next forwarders of received data packet. Here, multi-hop broadcasting is good for safety alerts and gaming message applications. In multi-hop approaches, data packets are swiftly distributed, and such techniques do not necessitate a huge amount of storage space to hold non-broadcast packets [41].

Table 2.1 presents a brief comparison of these two main categories.

Table 2.1 Data dissemination approaches

Approaches	Typical scenario	Drawback
V2I dissemination Push based	Public-interest data	Not suitable for non-public data
Pull based	User-specific data	High data traffic, interference, collisions
V2V dissemination Flooding	Sparse networks	Not scalable, high data traffic
Relaying	Dense networks	Requires an efficient relay selection in order to ensure reliability
Opportunistic	Network partitions	Possible high overhead and delay

2.6. Broadcasting Storm Problem (BSP)

The network environment , whether it is a static or dynamic network are the most important design considerations for routing protocols. Multiple restrictions, including high reliability, efficiency, and scalability performance measures, challenge design of the underlying communication system. A (VANET) is a specific type of (MANET) where dynamic routing protocols are essential. A VANET is a self-organized network that functions without fixed infrastructure and, like a MANET, has serious routing challenges such as the BSP. The BSP takes place when numerous vehicles in the same transmission range seek to rebroadcast messages at the same time, thereby causing high data traffic, network congestion, packet collisions, and extra delay at the Medium Access Control (MAC) layer [42]. It It is more common with data transmission techniques that rely on flooding. The Figure 2.4. reflects the storm of rebroadcast messages that have been replayed. Each node in this diagram starts the rebroadcasting procedure at random.All of the vehicles will try to get into the channel, which will cause a lot of traffic jams and accidents. In the following section, we will show the forms caused by BSP.

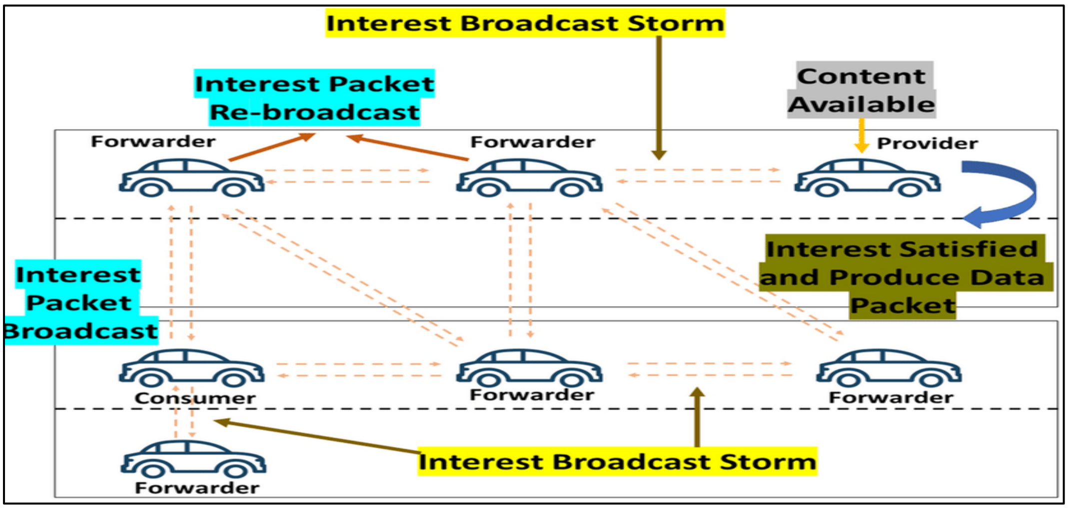

Figure 2.4. The broadcast storm problem on the vehicular network

2. 6.1. The forms causes of BSP over vehicular Networks

The Data Dissemination (communication among participant vehicles) in VANET within ROI is mostly accomplished through "Broadcasting" technique which could be as follows[43]:

A. BSP in Simple Flooding: All of the vehicles in the network are simply broadcasted the messages. It is also named as blind flooding [44].

B. Probabilistic and Delay based Broadcasting: The messages are propagate in a probabilistic manner based on a given probability value. The probability value is determined as a ratio between sending vehicle distance and receiving vehicle and the average transmission range [45].

C. Area based Broadcasting: The messages are broadcasted based on the ROI of the transmitting and receiving vehicle locations. In this method, distance information is used to decide which nodes should rebroadcast [46].

D.Neighbor Knowledge based Broadcasting: The messages are transmitted based on the adjacent node knowledge. The vehicle must share 1-hop or 2-hop neighborhood information with other nodes via periodic hello messages in order to determine the next forwarding node in this technique. However, this technique is not appropriate for vehicular environments since messages become outdated due to the high mobility of vehicles [47].

2.6.2. Broadcast Storm Suppression Algorithms (BSSAs)

BSSAs are described as methodologies aimed at reducing the number of rebroadcasting nodes so as to decrease redundant packets and mitigate BSP [48]. The ultimate aim is to rebroadcast and spread a message to the ROI using only the set with the smallest number of vehicles [49]. BSSAs can be divided into several categories depending on the various types of broadcasting strategies as described in Figure 2.5 [50].

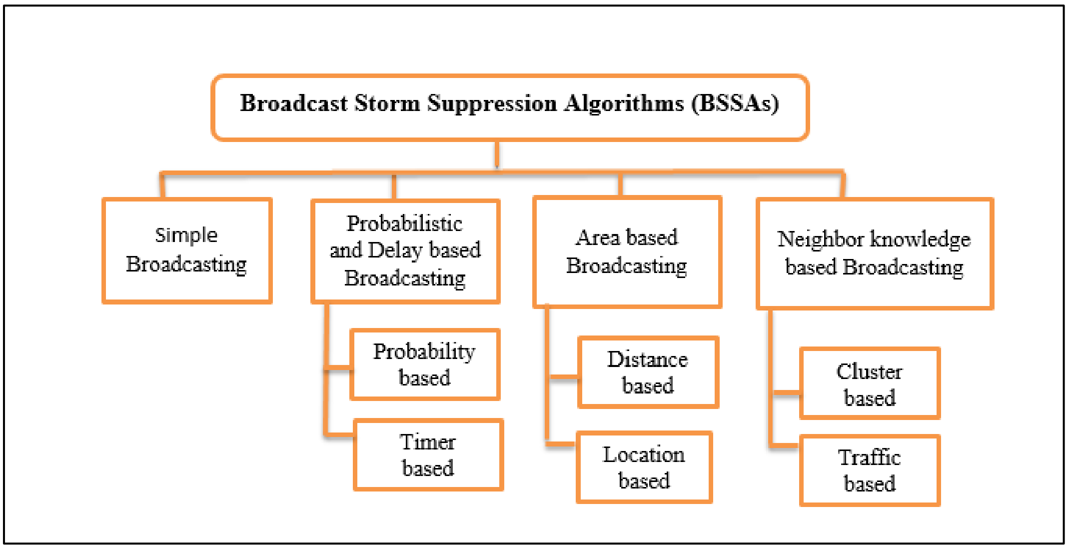

Figure 2.5. Taxonomy of Broadcast Storm Suppression Algorithms[50]

We selected some portions in the given classification that represent prominent BSSAs that are majorly applied in many VANETs to suppress BSP as follows:-

A. Probabilistic Suppression Algorithms (PSAs)

PSAs attempt to suppress BSP by only broadcasting the Emergency Safety Message (ESM) to selected nodes depending on a “value of probability”. The “value of probability” identifies rebroadcasting nodes in a ROI based on their availability at the ROI boundary locations.The nodes that are the farthest position from the sender node have the highest probability [45]. For example (Weighted p-Persistence Broadcasting Algorithm (WPB)).

B. Timer based Suppression Algorithms (TSAs)

TSA algorithms send Emergency Safety Messages (ESM) to certain nodes that are available inside a ROI’s slot.Based on the geographical area, ROI is separated into numerous slots. Through the division of the slots, the vehicle density problem that exists in PSAs can be reduced.The slots closest to ROI have the highest priority for receiving ESM for rebroadcasting. For example, (Slotted 1-Persistence Algorithm (SOB)) [51].

C. Locations based Suppression Algorithms (LSAs)

LSAs are designed to mitigate the impact of BSP in the accident zone.Without the need for a central controller, choose a suitable action (re-broadcast or discard). For example, Adaptive approach for Information Dissemination (AID) [52].

2.7. VANET Applications

usage models for the VANET form of communication.As more people spend time on the road, there is a greater need for internet access to communicate with one another, as well as to obtain real-time news, traffic updates, and weather reports, among other things.Furthermore, some of the most recent VANET-related applications include online file sharing, real-time video updates, and entertainment via internet connections via RSUs or V2V connections. Furthermore, VANET applications are divided in two categories: :At home, safety and comfort are of the utmost importance [53].

Several methodologies have previously classified VANET applications into two categories: safety and comfort applications.The authors classified VANETs applications into three categories: traffic efficiency, road safety, and entertainment. However, other authors expanded the classification of VANETs to include driver and vehicle applications, as illustrate in Figure 2.6 [54].

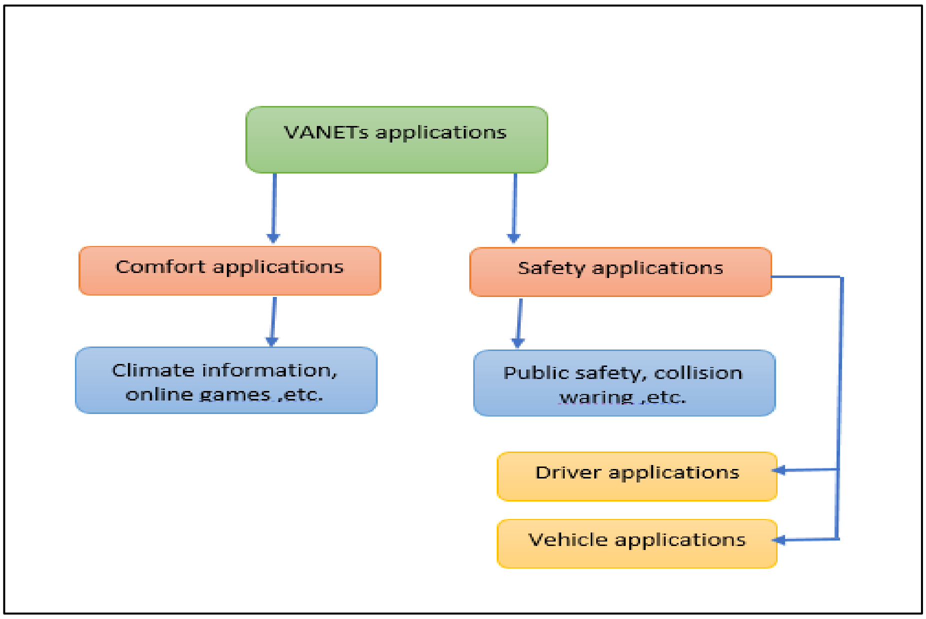

Figure 2.6. The VANET applications [54].

2.7.1. Safety Applications

These applications aim to save human lives on the road. The aim of these applications is to deliver the safety-related information to the required receiver in time to avoid any accident and are as the following are described :

- **Information Message**: It includes work zone messages on the highway, toll collecting stations, and speed limit messages, among other things.
- **Assistance Messages** :This is the type of information that will help the driver along the way. Messages about lane switching, cooperative collision avoidance, and navigation are included. The most important message in terms of assisting the driver by advising him or her to reduce speed in order to avoid any uncertain conditions is the message.
- **Warning Messages** :It contains information such as upcoming traffic signals, toll points, and any road condition advisories.

2.7.2. Comfort Applications

The main goal of these applications is to provide passenger\ driver comfort as well as traffic efficiency. Furthermore, the aforementioned applications can be named as value-added services. Automatic toll collection, site-based services such as the location of shopping malls, restaurants, and other facilities, as well as internet connectivity, are among these applications.

2.8. VANET Mmultiplayer Games

As a significant departure from the aforementioned approaches, we believe that VANET multiplayer games will provide players with the option to participate in a location-aware, mixed reality multiplayer game that takes advantage of inherent vehicle mobility. These are features that are not present in Internet multiplayer games. Compared to mobile multiplayer games, VANET multiplayer games will not suffer from limited battery lifetime and they will also not be limited to small user-devices with limited computing capability.Because the participants would be in vehicles, they will have access to substantially greater computing power and battery life, and it is simple to envisage that the devices used to play VANET games will be far more elaborate than those currently utilized for mobile multiplayer games.

Multiplayer games are real-time applications that require a certain level of quality of services QoS in order to be playable.The most important QoS metrics for games are[55]: end-to-end delay, jitter, and packet loss. The required data rates for most games are quite modest when compared to the DSRC data rates (from 6 Mb/s to 54 Mb/s), with majority of games generating under 100 Kb/s per player[56] ,[57].

2.9. Rrequirements Of Games Over VANET

VANET games are characterized by five interrelated parameters from the viewpoint of networking[11] :

- **Interactivity**: (or responsiveness), it represents the time between when a node generates a game event and when other nodes are informed by that event.To ensure a satisfactory game for the final users, the time between the generating a game event on one node and its processing on any of the other nodes participating in the same game session should remain under a determined interactivity threshold.

- **Consistency**: refers to the simultaneous uniformity of the view of the game state in all system nodes. A realistic example of how network delays influence consistency in all nodes. If Player A drinks half a bottle of water, all players in the game at that moment will see half a bottle of water.
- **Fairness:** (or networking fairness) it is correlated with giving each player an equal chance of winning the game session.
- **Scalability:** regards the system ability to provide successful service to a broad player group. In fact, having revenue generated by a very high number of players is of major importance to game companies. In addition, human beings are social beings who value the company and rivalry of others against actual adversaries. In fast-paced games, however, as more players cause the interactivity threshold to be breached, scalability is often compromised by denying access to some users based on their delays. As a result, we can achieve greater scalability in terms of both the geographic distribution and number of players permitted to participate while maintaining interactivity.
- **Continuity**: is about ensuring that no handoffs, disconnections, or any other mobility\ wireless issues will interrupt the game sessions. Indeed, by getting their game session constantly disrupted and restarted (usually after a while) with new players, players will be very irritated.

2.10. The Concept of Platoon Cars

A platoon can be defined as a collection of vehicles that travel in a close proximity and safely together and are interconnected via VANETs. Each vehicle can interact with one another by using V2V communication and one of the platoon's vehicles acts as the leader, managing the platoon's speed and direction [58]. Vehicles can join or depart the platoon dynamically (for example, a vehicle can leave the platoon when it reaches its goal).

The purpose of a platoon is to create a cooperative system consisting of sub-systems that are all aligned with participant vehicles. Platoon formation of linked vehicles can aid in traffic flow efficiency, safer driving, enhanced roadway utility, and fuel efficiency, among other things.

One of the most essential factors for a platoon's performance is its reliability and efficiency, which are dependent on underlying control systems and aspects such as constant spacing, variable spacing, and dynamic headway.

When forming a platoon, the following factors should be considered: (1) platoons must be of a reasonable length to occupy minimum lane capacity and use less fuel; and (2) newly formed platoons must remain intact for a reasonable period of time, because if vehicles leave and rejoin them too frequently, they may drive further apart, reducing the overall safety of the platoon cars.

2.10.1. The Structure of a Platoon

The platoon can be structured as a follows (illustrated in Figure 2.7)[59]

1. **Platoon leader**: the platoon leader represents the platoon's first vehicle. It is accomplished by sending an identifier to other vehicles in the platoon, which is then used to link the leader and follower vehicles. This leader is also in charge of broadcasting traffic information, such as speed, velocity, and acceleration, to other vehicles in the platoon, as well as managing and controlling platoon driving performance.
2. **The member vehicle**: the identification is used by a group of follower vehicles in a platoon to transmit information about direction, position, speed, and acceleration to the leader and neighboring vehicles.
3. **The tail vehicle**: is the platoon's last vehicle and is responsible for connecting to the following platoon.
4. **Free vehicle**: a free vehicle is any vehicle on the road that is not a member of our platoon, but it can request to join the platoon by sending a request to the platoon leader.

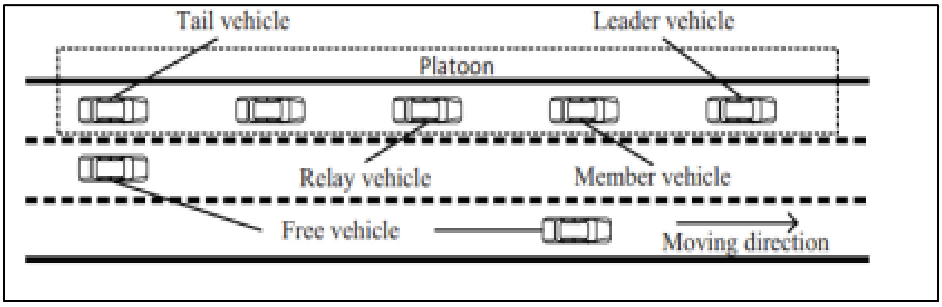

Figure 2.7. The structure of platoon car [59]

2.10.2. The Platoon Management

The key feature of platoon formation is the coupling between the communication and control systems.

A general platoon-based VCPS architecture can be illustrated in Figure (2.8) [61]. The platoon-based mobility/control model, which regulates vehicle dynamics under a platoon-based driving pattern, and the networking/communication model, which generalizes the networking requests of VANET applications of a vehicle, such as communication topology, networking layer specification, and so on, make up the vehicle's unity. The networking/communication process and the platoon mobility process are the system's two essential processes.The platoon mobility process can be described as a series of platoon driving operations governed by a mobility/control model and aided by vehicular communication. Platoon formation, maintenance, merging, and separation are all common actions. DSRC, which has been defined in IEEE802.11p, is used for V2V wireless communication. It supports high data rates and has a transmission range of 100 to 1000 meters, making it ideal for broadcasting information between platoon vehicles. There are numerous essential concerns in platoon administration, such as joining and splitting platoons.

1. **Joining a platoon**: A vehicle outside the platoon can submit a request to the platoon leader to join. The leader then chooses whether or not this vehicle may join. If the leader accepts the request to join, it sends an acceptance message and assigns the new vehicle to a platoon location.
2. **Split platoon**: any vehicle in the platoon can request permission from the leader to split and leave the platoon by sending a departing request to the leader and waiting for acceptance; then, the vehicle takes up more space than the vehicle ahead of it.

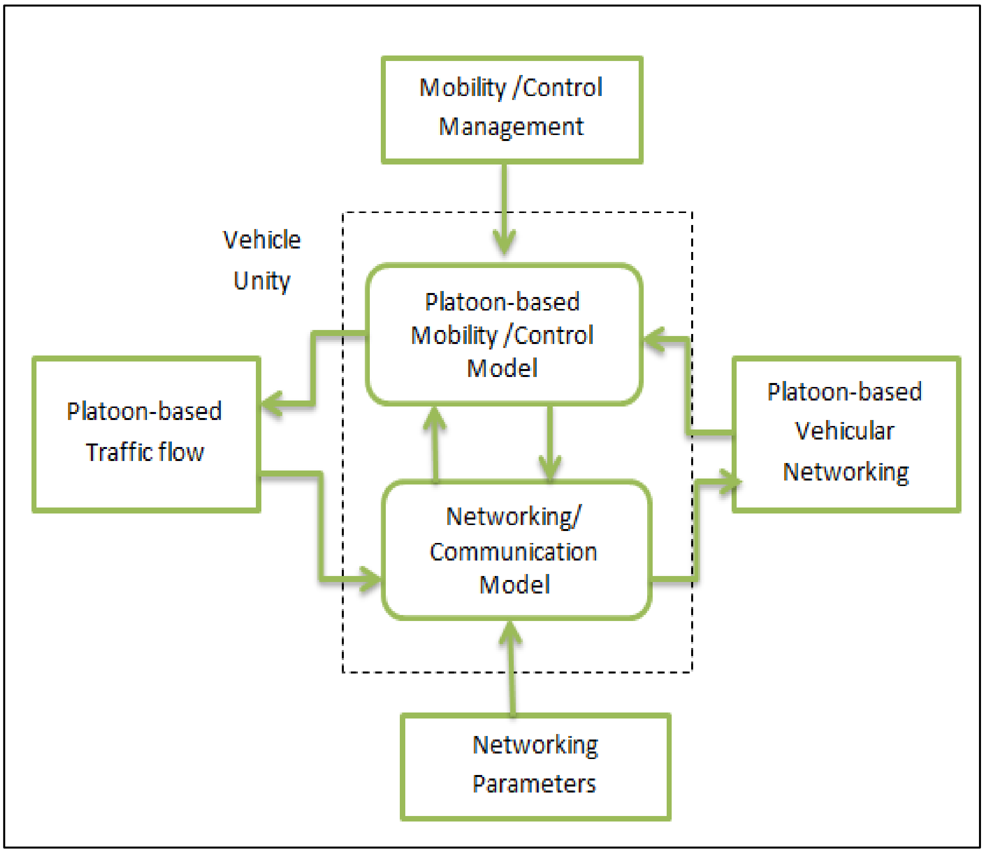

Figure 2.8.The architecture of platoon[60]

2.11. The Discussion

The considered scenario proposed a dynamic technique that takes traffic density into consideration when determining the optimum contention window (min & max) parameters in order to decrease the transmission time.Vehicles can use the information sent along with the hello message to estimate the number of vehicles in a transmission-size area.

Vehicles can use the information that sent along with the hello message to estimate the number of vehicles in a transmission-size area at every 200 ms. Based on distances , the elect nodeis selected to be forwarder to next hop and thus message can be reached to all players in the ROI [61], [62]. All details of this scenario will be discussed in the next chapter.

Chapter Three

The Design of the Proposed System

3.1 Introduction

Gaming is one of the entertainment application that is available to the passengers that exploiot the vehicular networks. When any passenger (player) generates event games, these event games should be reached to most passengers (players) within the ROI. The main problem of this transmission represents by fast delivey of these event games esspecially with nature of topology of VANETs. In this chapter will focus on the need for minimizing the number of transmission hops required to cover a given car platoon on highway environments. The minimization of the number of hops is achieved by individuating the farthest car within the source's transmission range, which has to forward the message to the next hop. Also in this chapter includes optimization of broadcasting message within the session layer of Open System Interconnection Model (OSI) Model and show the effect the other layers in optimization of this broadcasting.

3.2 Background of our Scenario

The scenario that was applied is a game played among passengers in a vehicles platoon travelling along the same road requires using broadcasting protocols of vehicular networks. These protocol serve the one too many broadcast of messages so that any player (passenger) when generates any action\ events of game message should be reached to all players (passengers) within the ROI. The communication between players either directly (V2V) or indirectly by using multi-hop communication. However, if no intelligence is added to the multi-hop broadcasting technique, each node in the network will simply try to relay every game message it receives. The resulting rise in the quantity of gaming messages sent would cause traffic congestion, collisions, delays, and possibly transmission paralysis in the vehicle networks. The BSP is a term used to describe this occurrence in mobile ad hoc networks. The intelligence scheme includes elect the farthest node which is being the next forwarder and the rest neighbor nodes will not rebroadcasted. By this way, for each sender in its transmission range there is only one rebroadcast. According to (COW), each node will share in rebroadcasting task, node with small COW vastly forward the game message and each node receive the duplicated game message, will not forward again.

3. ٣ Assumptions

For an effective multi-hop broadcasting system, having the furthest vehicle in the sender's transmission range is evident.

However, in order to put this idea into action, the following assumptions must be true:-

Assumption 1: Our scenario supporting GPS for getting information location.

Assumption 2: Our scenario will depend primly on V2V communication.

Assumption 3: Each receipting vehicle must be aware of its position within the sender’s transmission range.Therefore, the distance between two vehicles can be copmputed based on the equation of the distance between two points.

Assumption 4 .Uses Timers to determine whether enough time has elapsed and it is time to send a greeting message to surrounding cars' transmission range estimators.

Assumption 5 .Each receiving vehicle continuously computes and updates its transmission range estimation by utilizing data (for example, position and hearing capacity) from other vehicles in the surrounding.

Assumption 6 .All the vehicles that participate in our scenario have VANETs techniques so, penetrations rate is available for all members of vehicle.

3.٤ Proposed System

Generally, our system can be summarized into two phases:-

Phase 1: Estimation Phase

This phase start when source node begins generate hello messages and broadcasting it to all neighbor nodes (Backward or Frontward). Most neighbor nodes get these messages, and each will extract its information to computes its relative position to the source node within the source’s transmission rang. Each vehicle tries to estimate its transition range and enable estimator by exploiting the information that regarding the maximum distance (backward or frontward) within the ROI. An efficient priority scheme to choose the next –hop forwarder of a broadcast message based on the distance from the previous sender and on the expected the transmission range. This phase is illustrated in an algorithm 3.1, which reduces redundant transmissions (and message propagation delay). In a highly dynamic network like vehicle networks, a dynamic prediction of the transmission range that is needed to accurately determine the priority is a key element.

Phase 2: Forwarder Phase

In order to rebroadcast the message to the next hop, selection each node calculates its COW which its value varying from low contention window($COW_{min)}$ to high contention window(COW_{max}) and based on highest node distance. The longest node distance will be elected to be the farthest node and according to COW value, the node participates in rebroadcasting the gaming message to the next hope. Only a minor overhead is incurred due to the exchange of a few data between cars in order to properly feed the transmission range estimator.

3.٥ Methodology

The proposed system consists of groups of vehicles (car platoon) moving in highway environment and aimed to fast multi-hop propagation of entertainment message in vehicular networking. Assumption 1 is true due to each of vehicle have knowledge about its position according to its GPS. According to assumption 2, the investigated scenario consists of vehicles having V2V communication capabilities that use inter-vehicle communication characteristics to facilitate message broadcasting over a specific ROI. Hello messages allow vehicles to exchange information (backward or forward) about their location and compute and estimate of their transmission range. This information is then used to evaluate message forwarding criteria, allowing vehicles with the greatest distance from the source to be prioritized as the next forwarders. To clarify, consider the example depicted in Figure 3.1, where vehicle A is a source vehicle. The farthest vehicle from the current sending vehicle will have a higher chance of becoming the next forwarder, thanks **to** the algorithm smaller COW assigned to the transmission range's farthest vehicles. As a result, messages are delivered quickly in the ROI with the fewest possible hops. Vehicles B and C (if the message is being sent forward) and D make up the best candidate for forwarding path in this scenario (if direction is backward).

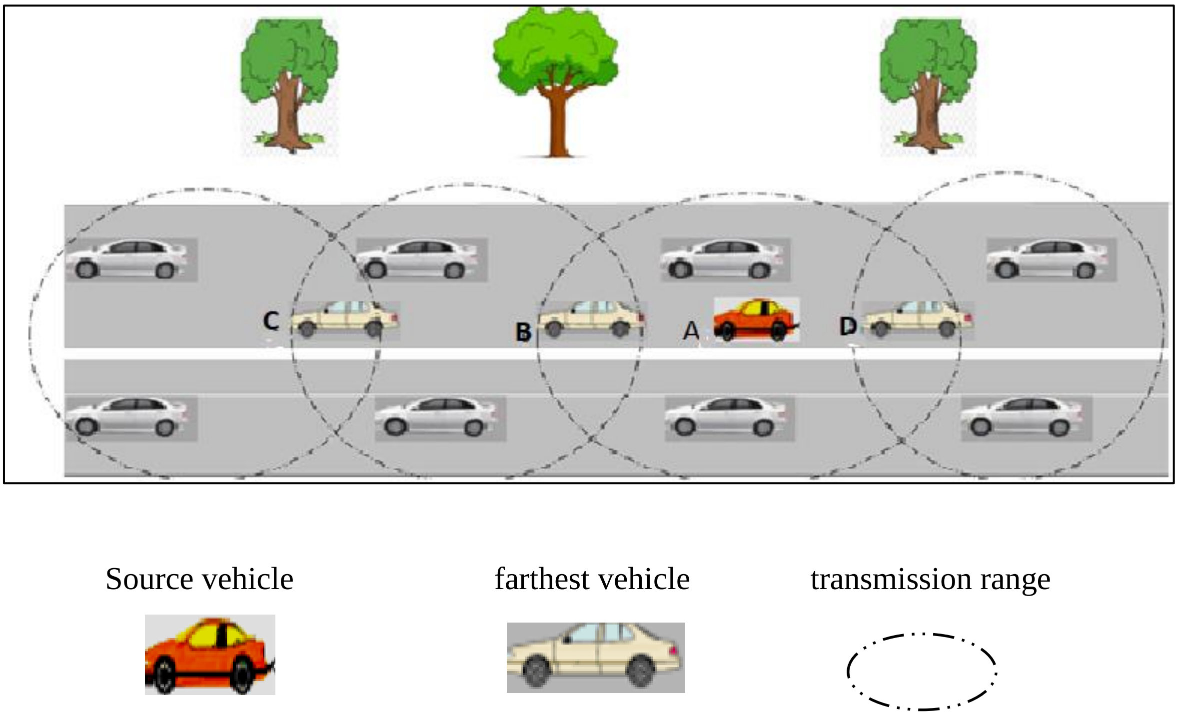

Figure 3.1. Represent Scenario of determine of farthest vehicle

3.٦ Proposed System through OSI Model

The addition of a suggested IVC session layer between the application layer and lower layers, as indicated in Figure 3.2, is the fundamental uniqueness of the proposed design. This new layer is in charge of improving the broadcast of each application message across the car platoon, and it is made up of three primary components: a Hello message generator, a timer generator, and a parameters handler that includes Estimator Transmission Range. This new architecture named with Smarted Inter Vehicle Communication Schema (*S_IVCS*) which involved the previous three primary components.

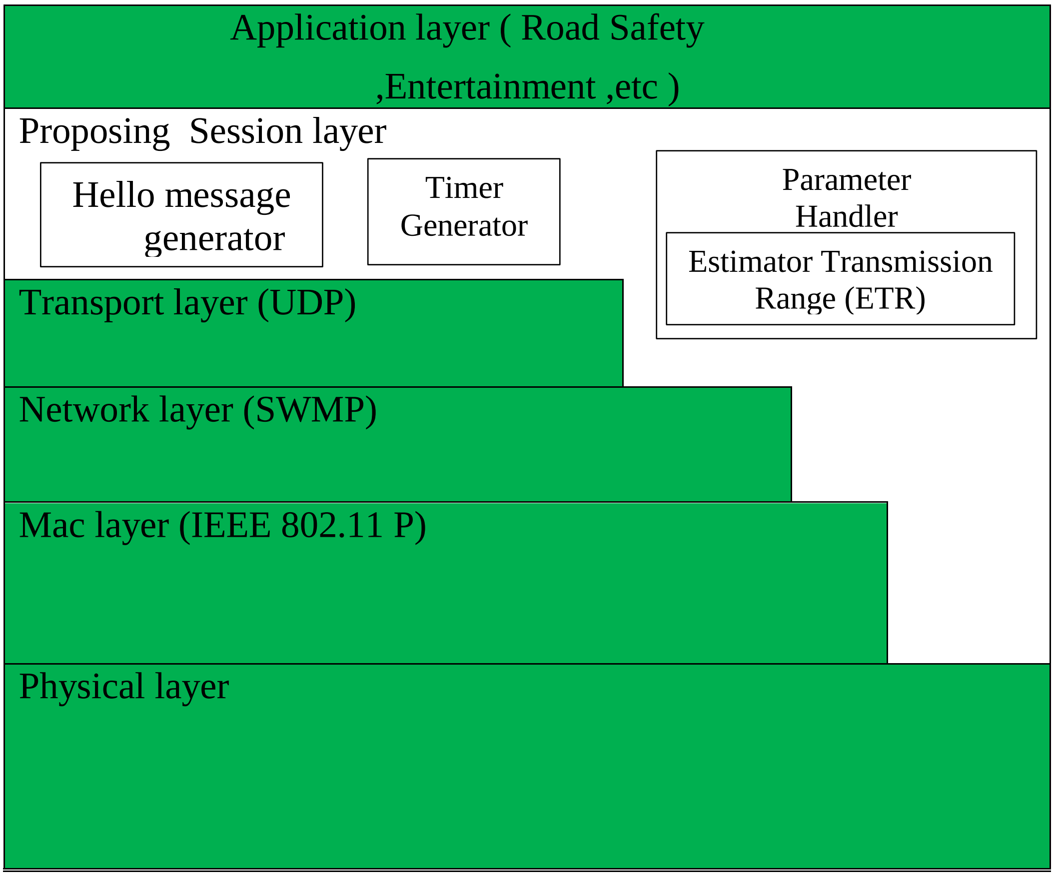

Figure 3.2 the proposed system through OSI model

3.٦.1 Application layer

Any application message (safety or entertainment application) that generates at application layer of a node has to pass the session layer. To successfully service apps, such as entertainment, in promptly propagating their messages via a vehicular network, an architecture can handle a wide range of application classes and capabilities.

3.٦.2 Proposed Session layer

When a message arrives at the session layer, it is encapsulated with a new header with some parameters, such as the Hello message generator, the Timer generator, and the parameters handler. These three parameters are responsible for optimizing the broadcasting of message applications in which the receiving node will extract the information and update their own parameters. The transmission range is computed by the Estimator Transmission Range (ETR) estimator that is included within the parameters handler and sent along with the application message. It allows receiving vehicles to determine how far away from the sender a message can still be understood and their relative location within that distance.As a result, assumption 3 holds true, and cars can select their own priority in becoming the next forwarder (i.e., the vehicle that is farthest from the sender's transmission range will be the next forwarder).

It requires some information (i.e., parameter values) from other cars with a specific regularity to compute an accurate ETR. It can only hear one message every 200 milliseconds (this value was taken from a reference in chapter two section 2.11) but this is enough to produce a fair calculation of transmission range. As a result, if no messages are exchanged in the network for a certain period of time, the hello message generator will generate a hello message solely for the purpose of broadcasting parameters and keeping the ETRs of vehicles in the vicinity running. As assumed in assumption 4, the Time Generator oversees creating timers in order to apply the distributed system for favoring distant cars in becoming the next message forwarder.The goal behind the ETR is to have a small number of greeting messages transmitted across cars in order to learn about other vehicles' hearing capabilities.

More in detail, when source node begins by generating hello message and broadcasting to all neighbor nodes,the Parameters Handler of the sender inserts the following data:-

- ❖ Sender’s position, driving direction of vehicles, and identifier of each vehicle.
- ❖ Message’s direction of propagation and identifier of hello message.
- ❖ Highest backward distance (HBD) parameters of the sender.
- ❖ Highest Frontward distance (HFD) parameter of the sender.
- ❖ Highest Frontward Range (HFR) estimation of the sender.
- ❖ Highest Backward Range (HBR) estimation of the sender.

Parameters HBD and HFD represent the highest distance from which another vehicle, backward or frontward respectively, has been heard by considered one.

In fact, the high mobility of vehicles and surrounding vehicles make it is not possible for transmission range to remain static.Therefore, assumption 5 is true at this point in which every receiving vehicle continuously computes and updates its transmission range estimation. Therefore, the parameter Handler of receiving vehicles exploit these information to estimate their highest range estimation of the receiver (backward HBR and frontward HFR) based on the received information about the position, HBD and HFD values .HBR and HFR represent how far a transmission is expected to go before the signal become too weak.

HBR obtained only messages coming from following vehicles and its value is computed as the maximum among:

- ❖ The longest distance from vehicles that generated these messages.
- ❖ The highest among their HFD values in these messages.

HFR utilizes only messages that sent by preceding vehicles; its value corresponds to the maximum among:

- ❖ The longest distance from which a message has been received from a preceding vehicle.
- ❖ The highest HBD advertised within these messages.

Algorithm (3.1) describes Estimator Transmission Range

Algorithm (1) : Generate Estimator Transmission Range
Input: Hello message
Output: generates maximum range(Backward or Forward)

Begin
Step1 - Sp = msg.sender-position // Sender node position
Step2 - Cp= current position // current position of each node
Step3 - Dist=distance (Sp, Cp) // differences between sender position & current node position.
Step4 - If(received from front(msg))
Step5 - HFD = Max(Current _HFD , Dist)
Step6 - update HBR=(HFD ,msg.HFD)
*Step*7 - Else (received from back(msg))
Step8 - HBD=Max(Current_HBD ,Dist)
Step9 - update HFR=(HBD , msg.HBD)
Step10 - End if
END

This value is calculated as the largest among all received HBDs and all distance from vehicles that generated them. With the same steps can be made HBR for messages coming from vehicles front and based on largest distances for HFD.In other words, the two transmission range estimators are updated as follow equ 3.1 in [63] (step 6, step 9 of the code in Algorithm 3.1).

$$H_xR = MAX\ (HxR_{current},\ Dist,\ msg.\ HxD) \qquad \ldots (3.1)$$

Where HxR represent HFR or HBR , $HxR_{current}$ is the current value to be update, Dist is the difference distance of vehicle that broadcast the message and current position of the vehicle, and msg. HxD the data contained in the received message, related to the highest hearing distance.

When messages are transmitted along the car platoon, vehicles on the message's route employ transmission range estimate (HBR or HFR depending on the direction of the message) to identify which of them will have to take on the responsibility of becoming the next forwarder. We want the farthest car within the sender's transmission range to complete this duty since our goal is to decrease propagation latency by decreasing the number of hops. As a result, the greater the distance between the sender and the receiving vehicle, the higher the priority of that vehicle in becoming the next forwarder. All previous activities represent the first phase of the proposed system while the next activities represent the second phase of the proposed system.

Vehicles priority for forwarding messages are defined, consequently, by assigning varying waiting durations from the moment the message is received to the time they will attempt to transfer it.This waiting period is calculated at random depending on a contention window value, like in the IEEE802.11MAC protocol's traditional back off techniques.

To increase the system robustness ,if one of these vehicles becomes disconnected before receiving or passing the message, the task will be completed by the vehicle that is the furthest away. When a node forwards a message, vehicles between the previous and current forwarders will halt forwarded messages at a greater distance from the source and reset their channel contention mechanism on the following hop.

At each hop, the self-selected forwarder changes the message's HBR and HFR fields with its computed values, making correct parameters accessible for the next section of road.

Each vehicle contention window (COW) is measured in slots and varies between a minimum (COW_{Min}) and a maximum (COW_{Max}) based on the distance from the sending/forwarding vehicle. The transmission range corresponds to HBR if the message is directed backward, or to HFR if the message is directed frontward. The two cases,denoted by COW_B and COW_F are shown in (3.2) and (3.3) [64], respectively.

$$COW_B = [(\frac{HBR - Dist}{HBR} * (COW_{Max} - COW_{Min})) + COW_{Min}] \quad \ldots(3.2)$$

$$COW_F = [(\frac{HFR - Dist}{HFR} * (COW_{Max} - COW_{Min})) + COW_{Min}] \quad \ldots(3.3)$$

where COW_B, COW_F refer to contention window for backward and frontward broadcast messages respectively and HBR, HFR refer to maximum range backward and frontward respectively. In our method, we use (3.2) or (3.3) to identify which vehicle will transmit the broadcast message on the following hop. When the considered vehicle receives the message, it detects the message's propagation direction and extracts the parameters it needs to enter them into (either eq. (3.2) or eq. (3.3)). If receiving the message from front, the considered car extracts HBR and utilizes (3.2) to determine its COW_B as explain by algorithm 3.2. Otherwise, if receiving from back , extracts HFR an utilizes (3.3) to compute its COW_F. Then computes a random waiting time.

To illustrate the cases of how select random waiting time, let us suppose the message received from the front (algorithm 3.2):

1. If the identical message is heard from behind (step4) while waiting, the message has already spread across the considered vehicle, and it is no longer necessary to try to forward it .
2. If the same message is heard from the front (step5), it signifies that it has already been transmitted by a previous vehicle; the application message forwarding operation must therefore be resumed with the updated parameters contained in the message by the last forwarder .

3. If the waiting time expires without any other car forwarding the same message, the considered car puts its own current parameters in the message, including HBR (step6), and broadcasts it (step7).

(Obviously, the same, even if specular, procedure applies to the HFR parameter).

Algorithm (3.2) describes Forwarder selection Algorithm

Algorithm (2): Calculate the Forwarder's Waiting Time
INPUT: A broadcast message was received from the front.
OUTPUT: Forwarder's waiting time can be selected.

BEGIN
Step1 - COW = COW_calculated_with_Equation (2)
Step2 - RCOW=Random(COW)
Step3 -Wait (RCOW)
Step4 -If (same-broadcast –msg-heard-back)
Exit
Step5 -Else if(same –broadcast –msg-heard- front)
Restart –broadcast-msg-procedure
Else
Step6 - Max.msg .HBR
Step7- Transmit (Max.msg.HBR)
END

3.٦.3 Transport Layer

In Internet gaming, Transmission control Protocol TCP and/or User Datagram Protocol UDP are utilized based on the kind of communication required. However, TCP is favored when reliability is necessary. When data must be sent swiftly, UDP is the most widely utilized protocol (for example, player coordinates in a fast-paced game). Connection-oriented transport protocols like TCP, on the other hand, have been demonstrated in several experiments to function badly in wireless ad hoc networks, particularly when the nodes are mobile.

3.٦.4 Network Layer

In order to provide faster delivery of message, it is preferred use a multi-hop routing protocol due to games would benefit from quality of service –aware, position- based routing protocol that provide accurate information .Based on assumption 3 each vehicle can get its position from its GPS device that equipped with each vehicle according to the (ITS).

Wave Short Message Protocol (WSMP) instead of IP might be an attractive choice for entertainment applications such as games since a single WSMP can be transmitted to several nodes. WSMP, on the other hand, leaves it up to the application to discern between messages. In addition, the WSMP's goal is to provide datagrams quickly and reliably with minimal overhead.

3.٦.5 MAC Layer

In the implementation of ad hoc networks, IEEE 802.11 wireless network is used. Its maturity has led us to adopt IEEE 802.11p as our network protocol. The IEEE 802.11p is also taken into consideration because to its vehicular features. While in ad-hoc mode, WiFi Direct or WiFi P2P can be used to create a wireless network.

VANETs are characterized by their lack of centralized control, which necessitates the dynamic allocation of slots, codes, and channels. So that medium access may be used efficiently, VANET MAC protocols should coordinate channel access among these multiple nodes.Shared medium access causes signals from two or more nodes in a specific range to collide and interfere with each other due to simultaneous transmission. Other factors, like the terrain and the movement of mobile nodes, can alter the strength of the signal available to the receiver. Because there will be more hidden nodes, more retransmissions and reservation packets will interfere with other existing transmissions and cause collisions.

The IEEE 802.11 DCF (Distributed Coordination Function) is a contention-based MAC technology.According to the protocol, a frame arriving at the terminal medium access channel must be evaluated to determine if the medium access is active or not. If the channel is idle at the time, or during a DIFS (DCF Inter frame Space) time period, the frame can be transmitted. Other than that, if the medium becomes idle again, the back off procedure will be used to reduce the likelihood of colliding with another waiting station. BEB stands for binary exponential back off Among the most versatile wireless technologies, IEEE 802.11 (WiFi) is widely utilized in this context, along with other technologies like Bluetooth, Zibgee and Near Field Communication (NFC) .Moreover, as it connects two or more wifi devices and allows them to send and receive data without using extra devices like an access point, ad hoc networking is helpful (WiFi router).

3.٦.6 Physical Layer

The lowest tier of the network stack, the Physical layer (Physical Protocol) is essential. All channels in nature are confined by two basic boundaries, which govern the bandwidth of the channel. These constraints include the Nyquist limit, which applies to noiseless channels, and the Shannon limit, which applies to noisy channels. Carrier sensing, Clear Channel Assessment (CCA), sending and receiving packets, received energy detection on received packets, changing channels on physical layers that allow multiple channels, and altering the state of the transceive are all services supplied by the physical layer .

Chapter Four
Implementation Results and Discussion

4.1. Introduction

This chapter presents all details about the execution, performance and evaluation of the proposed system .We have considered a scenario which is contains a platoon of vehicles approaching a highway strip shaped road.

4.2. NS-2 Simulation Environment

The implementation of proposed system schema in the simulation environment that used computer with Linux Ubuntu (16.4) operating system. The simulator tool NS2, version (2.35) is used as shown in Figure (4.1).

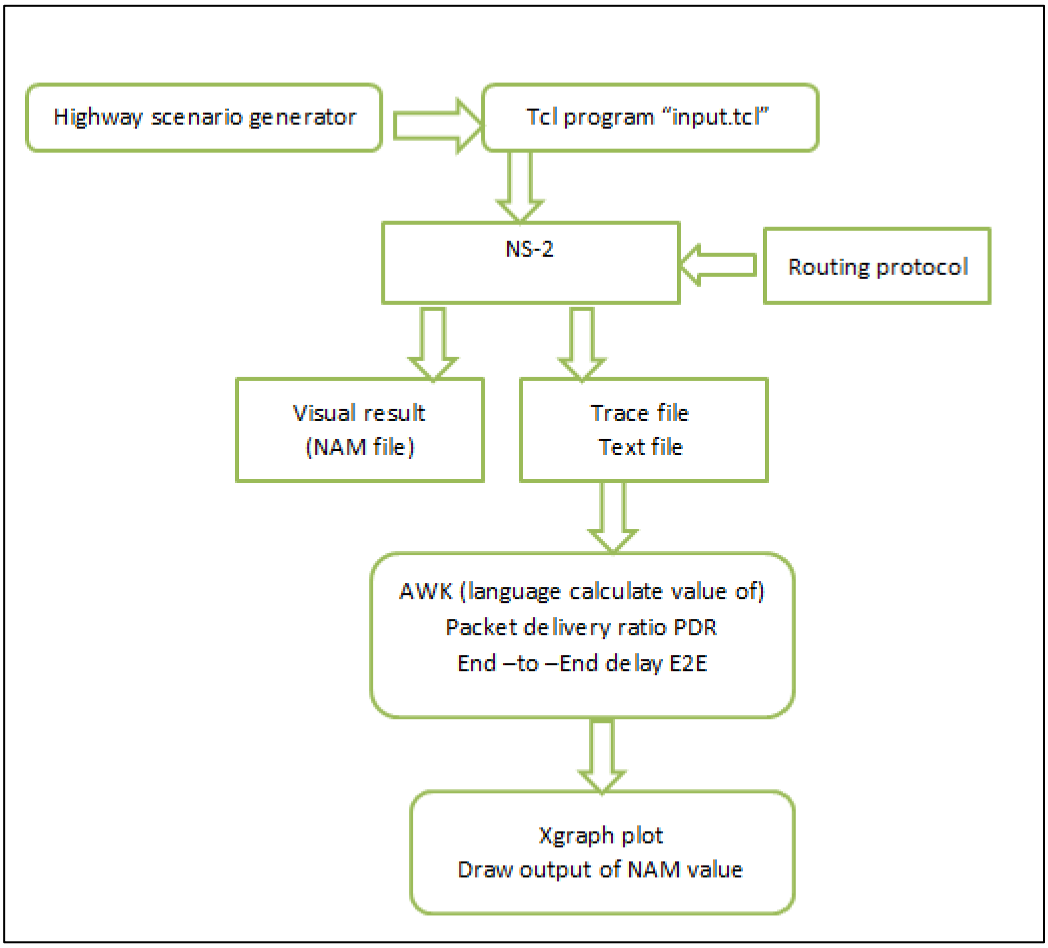

Figure 4.1. Work of simulation

4.3. Experimental Evaluation

The proposed S_IVCS approach has been brought into several experimental studies to test the effectiveness of the approach. A set of simulations was conducted where every instance undergoes 500 runs. The same has been compared with significant existing approaches discussed in the literature. The proposed S_IVCS approach was simulated using Network Simulator NS-2 (Version: NS-2.35). As an enhancement, the parameters in the MAC layer were changed to prepare it to operate similar to that of the IEEE802.11p, and software was added to it to compare the proposed S_IVCS with existing approaches. The simulation parameters are discussed in the following table 4.1. This section presents the simulation environment, performance metrics, and simulation results. A comparative study was presented based on the performance metrics with the protocols FIXED_300, FIXED_1000, and RANDOMLY with the proposed S_IVCS. The simulation has been carried out for the generating interval that can be varied to 100, 300, and 500 ms. Table 4.1 describes the simulation parameters.

TABLE 4.1

SIMULATION PARAMETERS

PARAMETER	DESCRIPTION
Simulator	NS-2.35
Topology	Highway for groups of vehicles (platoon car)
Number of nodes	50 and 100 nodes (players)
Coverage radius	300m &1000 m
Speed of vehicles	70-140 km/h
Mac layer	DSRC (Dedicated Short Rang Communcation) IEEE802.11P.
Propagation Model	Two- Ray Ground
Physical Model	Wireless phy
Antenna Model	Omni-Antenna
Contention Window minimum and maximum(COW_{min} ,COW_{max})	32, 1024 according to eq .2&3 in chapter 3.
Interval of Hello Messages	200 ms
Size of Hello Messages	50 bytes
Application size of the messges	200 bytes
Simulation Time	200 sec

Once the “hello message” is generated, a hello message has is seted as 200 ms the stand –by threshold. This denotes it forwards 5 number of “hello messages” carrying 50B payload that are generated every second in the bounds of the coverage radius only if no transmission of the application message takes place. The proposed S_IVCS approach was compared with three existing approaches, two of which are inspired by the approaches proposed in chapter three. The proposed S_IVCS consider a parameter for coverage radius which is constantly equal to that of a fixed known value instead of calculating it dynamically based on real-time channel conditions. It thus carries a deficiency in its handler for parameters with the estimator for coverage radius. This approach has been termed as FIXED_1000 if it uses 1000m as the parameter for coverage radius and FIXED_300 if it uses 300m. Both these approaches assure best performance in the coverage radius of 1000m and 300m, respectively. This coverage radius was selected as 1000m and 300m from the IEEE802.11p report, which denotes that these two values are the boundaries in the scenario of highway road.

A RANDOMLY approach was also evaluated, which do not use distance priority to denote a framework that utilizes a traditional multi-hop transmission approach. The contention window used has been fixed as COW_{Min} in the beginning and it adopts a conventional back-off method where its value gets doubled each time a transmission takes place which ends up in collision thus linearly decreasing with each successful broadcast.

4.4. Results and Discussions

Based on algorithms 3.1 and 3.2 in chapter three, the performance was analysed of the proposed S_IVCS approach by comparing the scheme with notable existing schemes in the literature. Initially, the potential of the proposed approach was evaluated in swiftly forwarding the messages to each vehicle which express interest for infotainment. In this section, vehicles would be considered that are interested in game events.Further,the same experiments was demonstrated to evaluate the ability of the proposed system while increasing the coverage radius. Also, the reliability of the proposed system was evaluated by verifying the percentage of messages that are accurately received by all the participating vehicles. Conclusively, the impact on the performance of S_IVCS with respect to the duration of time slots was evaluated. Only consider the messages that belong to the worst case, i.e., the messages forwarded by the car approaching the car platoon for covering the entire vehicular network.

4.4.1. Infotainment – message Gaming: Time of Delivery with minimum coverage radius

The application “message gaming" was considered and compared the proposed S_IVCS with FIXED_300, FIXED_1000 and RANDOMLY approaches over a vehicular network of length 8 km, simultaneous players of 50 and 100 with 300m and 1000m coverage radius. The performance of the system has been evaluated with various generation rates for the message gaming events at individual player. In each vehicle, the game events generated every 100, 300 and 500ms.

The results shown in the Figure 4.2 and Figure 4.3 proved that S_IVCS had shown significantly better outcome compared to the other three approaches and specifically much better compared to FIXED_300 which was the best approach with 50 simultaneous players. The achieved results show a possiblty of the capability of the proposed S_IVCS in adapting to even negligible variations in the coverage radius that has been generated by the wireless network.

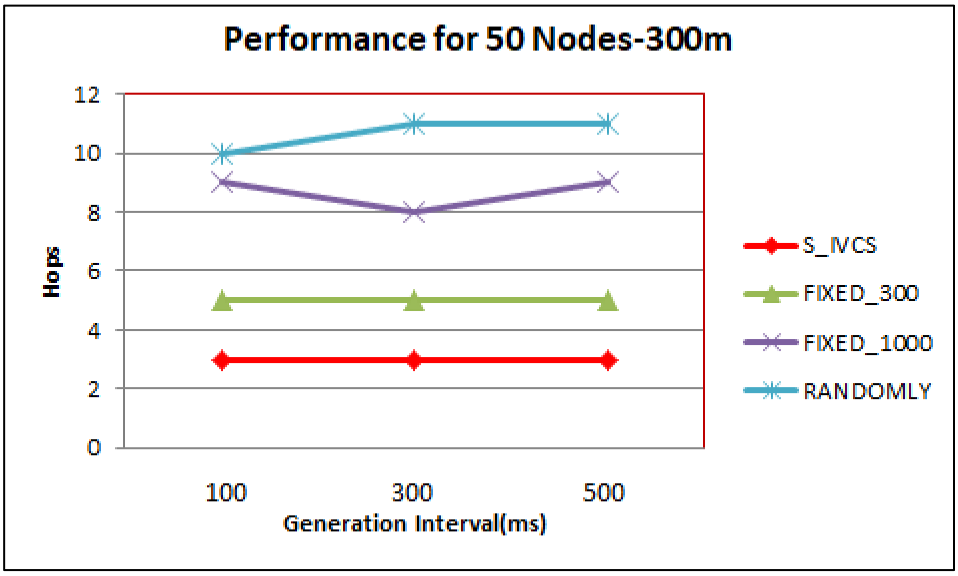

Figure 4.2 Generation Interval vs. hops for 50 players -300m

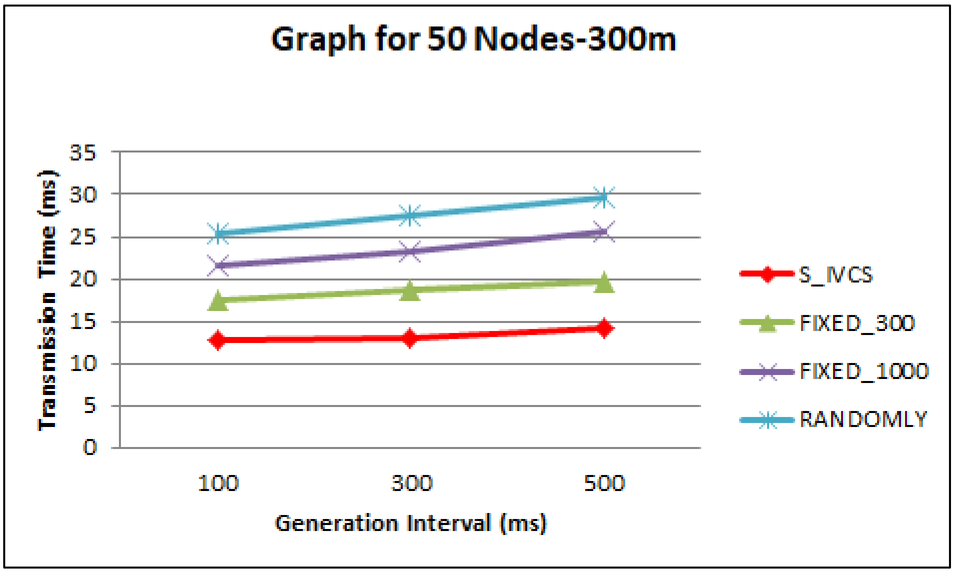

Figure 4.3 Transmission Time vs. Generation Interval for 50 players -300m

Figure 4.3 clearly depicts that all the four approaches look completely self-determined from the utilized message transmission rate. It is also noted that the FIXED_300 had shown performance degradation while network congestion has increased with the maximum message transmission ratio of 500 ms inter-delivery time whereas S_IVCS achieved superior results even with increased network congestion.

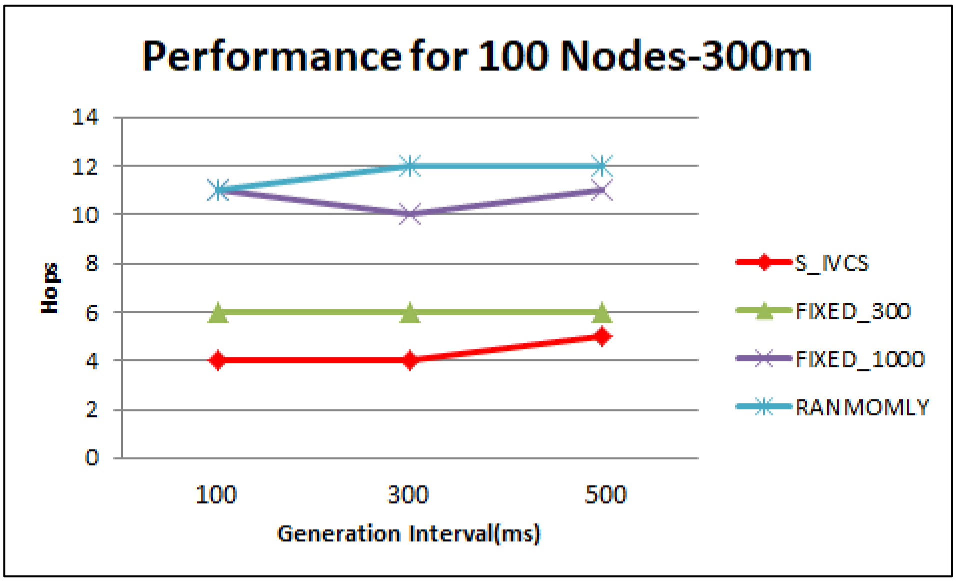

Figure 4.4 Generation Interval vs. Hops for 100 players-300m

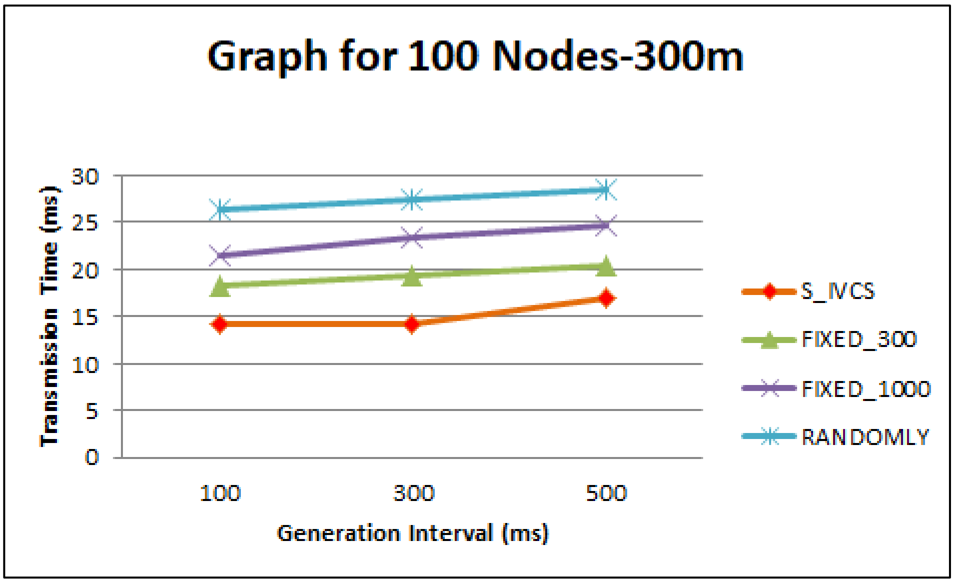

Figure.4.5 Generation Interval vs. Transmission Time for 100 players -300m

Results in Figure 4.4 prove that S_IVCS had shown significantly better results while compared to the other three approaches while considering 300m coverage radius with 100 simultaneous players. It is also noted that FIXED_300 in Figure 4.5 had shown performance degradation while network congestion has increased with the maximum message transmission ratio of 500ms inter-delivery time whereas S_IVCS achieved superior results even with increased network congestion considering 100 simultaneous players as well.

It is noted that increasing the number of players increases the number of hop-count, resulting in reduced transmission time. Even with this case, the proposed scheme is capable of achieving better results since the vehicle density parameter was considered in the estimation protects the system from increased hops, reduced transmission time, message collisions, retransmissions, and message reliability.

4.4.2. Time of Delivery with extended coverage radius:

In order to complete the evaluation of the performance of S_IVCS, coverage radius 1000 m was also considered. While comparing with the scenario of 300 m coverage radius, it was anticipated that the system experiences increased transmission interferences since a single broadcasting range area manages several number of communicating vehicles. Because, in gaming application, they achieve increased message generating rate and host of sources,hence, we have considered the application results alone in this study.

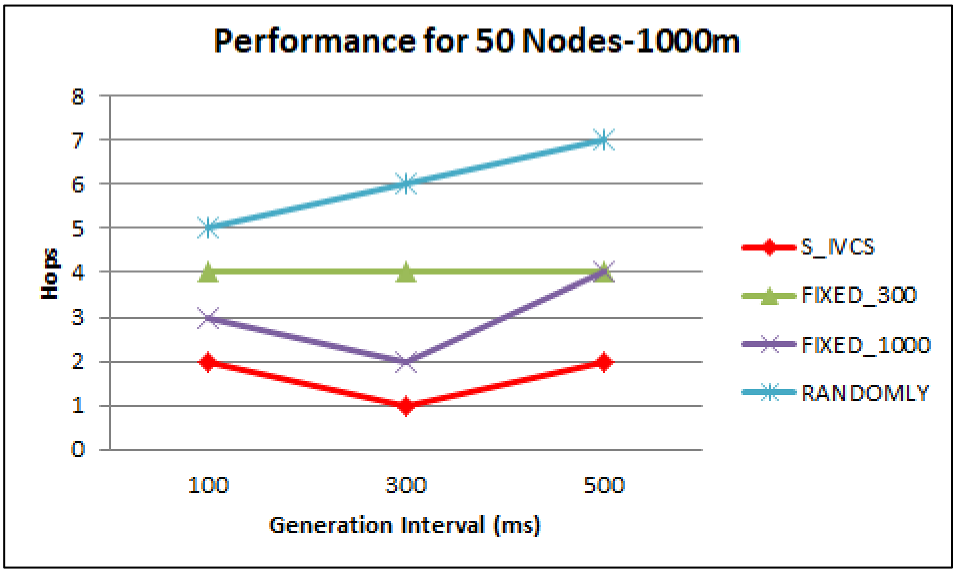

Figure 4.6 Generation Interval vs. Hops for 50 player-1000m.

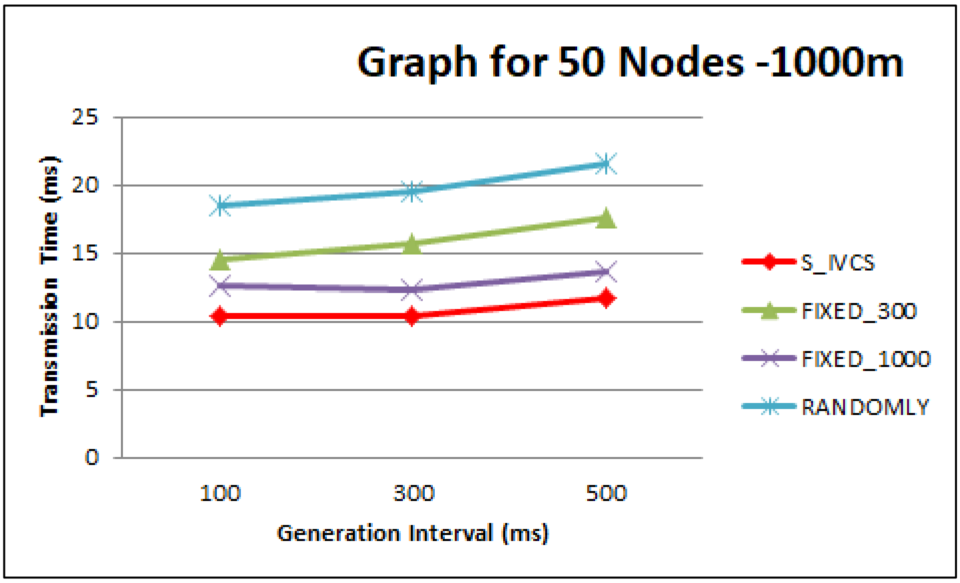

Figure 4.7 Generation Interval vs. Transmission Time for 50 players-1000m

Figure 4.6 shows the number of hops needed towards covering the car platoon. The FIXED_1000 showed superior results while compared to FIXED_300 as expected and S_IVCS shown far more superior results while compared to the other three approaches. Thus, the S_IVCS achieves accurate coverage radius estimation for every vehicle even without any kind of knowledge. While evaluating the final broadcasting time that is required for message propagation over the entire car platoon, it was found that whenever the gaming application does message generation on any individual vehicle for every 200 ms, the overall broadcasting time is significantly larger compared to the FIXED_300 and FIXED_1000. This leads to message collisions, which in turn enable retransmission of messages which are more time consuming as per the results shown in Figure 4.7. In this case, the proposed S_IVCS had produced extremely better results compared to the best suitable scheme FIXED_1000 and other schemes FIXED_300 and RANDOMLY.

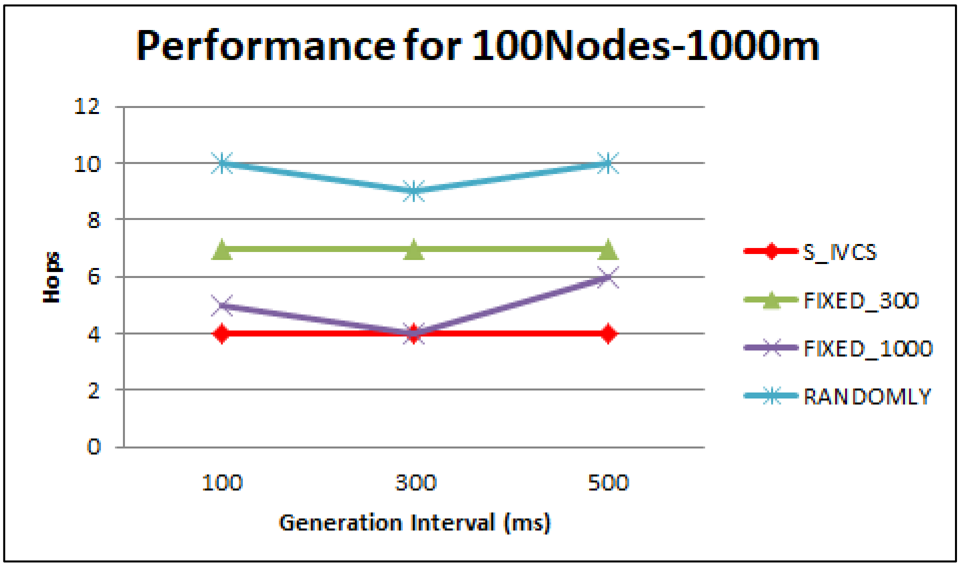

Figure 4.8. Generation Interval vs. Hops for 100 players-1000m

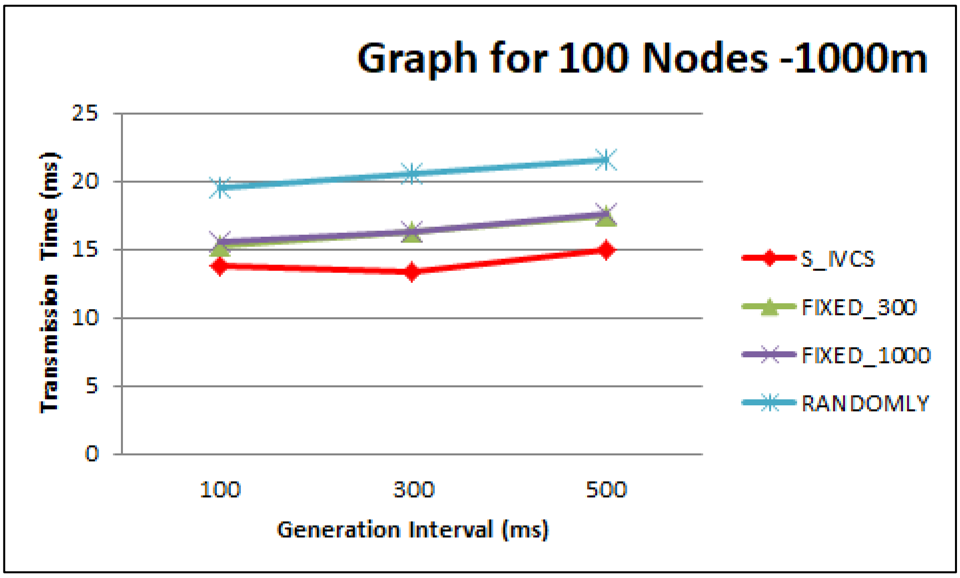

Figure 4.9. Generation Interval vs. Transmission Time for 100 nodes-1000 m

Similarly, Figure 4.8 with 100 simultaneous players along with a 1000 m coverage radius shows the generation interval against the number of hops, and

Figure 4.9 shows the results of the generation interval against transmission time for the coverage radius of 1000 m with 100 simultaneous players. It is also noted for the coverage radius 1000 m. While the number of nodes increases, the hop count in turn reduces the transmission time. Yet, the proposed S_IVCS still manages to achieve superior results since vehicle density parameters have been considered during computation that protect the system from increased hops, reduced transmission time, message collisions, retransmissions, and message reliability.

4.4.3. Reliability in Delivering The Messages:

Though the proposed solution did not aspire to achieve reliability, the evaluation of the solution proved the capacity of the S_IVCS approach in message delivery to all the vehicles that are involved in the same application. The results achieved are for the gaming application where the dense network traffic provides a robust challenge to deliver the message events with reliability.

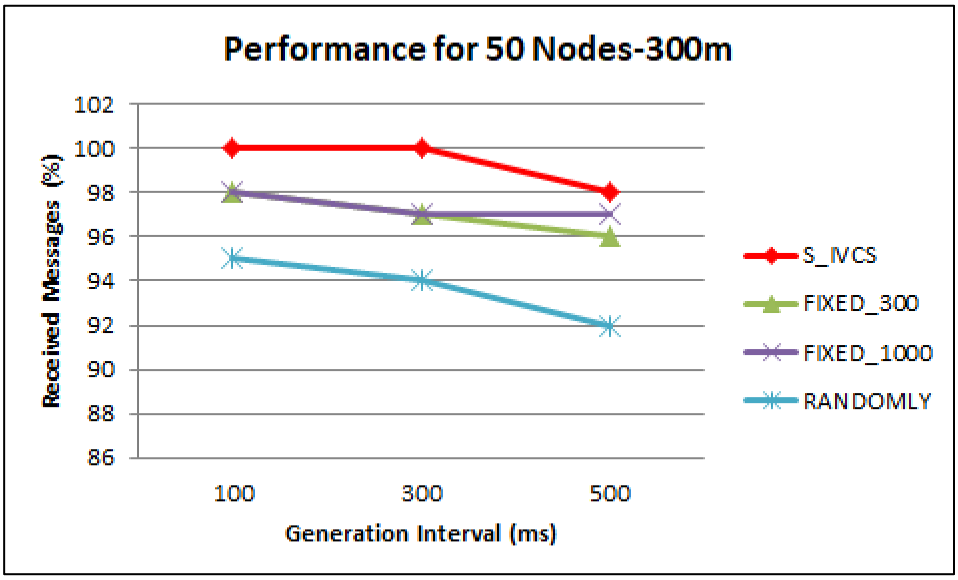

Figure 4.10.generation Interval vs. Received Messages for 50 players-300m

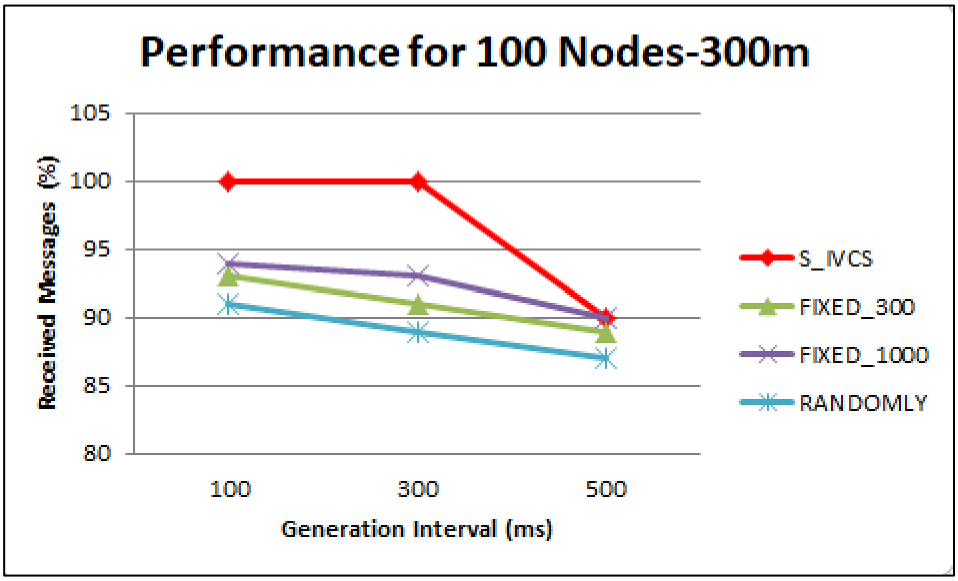

Figure 4.11. Generation Interval vs. Received Messages for 100 players -300m

The results were presented for two cases: 300 m and 1000 m of practical coverage radiuses, with 50, 100 players respectively as shown in the Figures 4.10 and 4.11. All these approaches assure same performance outcomes, specifically, it guarantees higher reliability till it considers the case where every individual player produces a game event within every 200 ms. In such a case, the percentage of the application messages received by overall number of vehicles slashes to about 90% with a coverage range 300m and to lesser than 65% with a coverage range 1000 m.

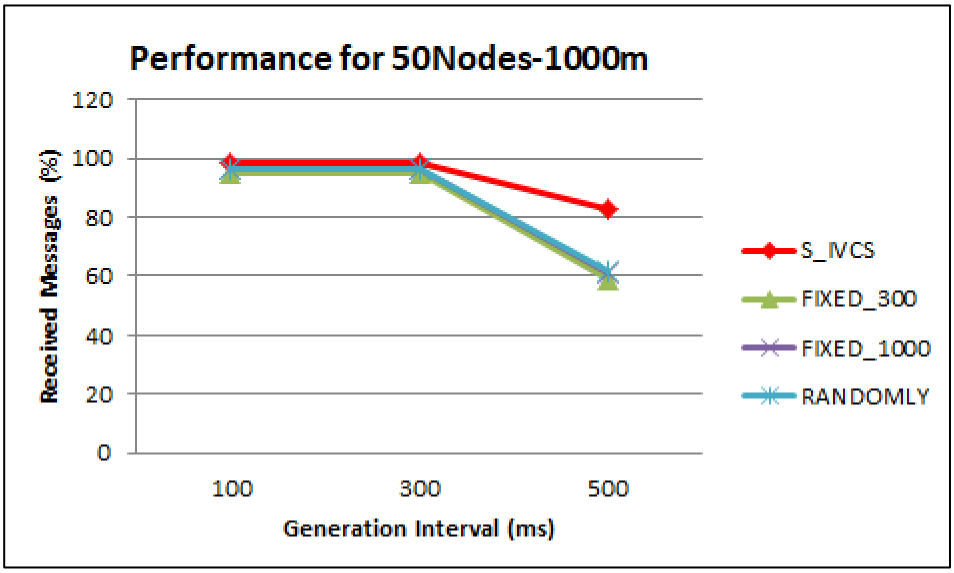

Figure 4.12. Generation Interval vs. Received Messages for 50 players -1000m

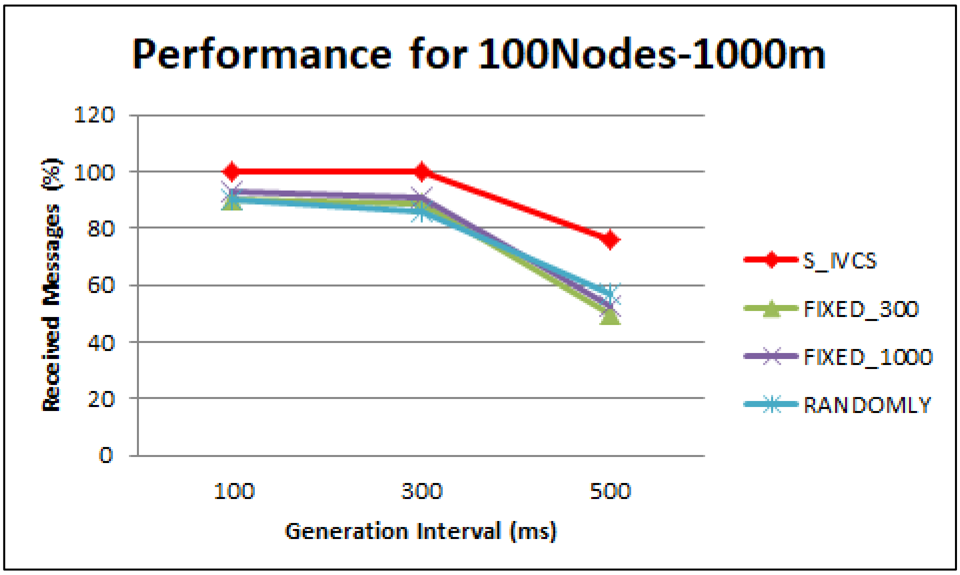

Figure 4.13 Generation Interval vs. Received Messages for 100 players -1000m

Secondly, the coverage radius of 1000 m is highly critical since it has around three times the number of individual players and broadcast messages when compared to a 300 m coverage radius. As expected, the integration of a longer coverage radius with a dense message generating rate results in retransmissions, message collisions, delays, and unreliable message delivery.

4.4.4. Impact over Time Slot Duration on S_IVCS

Real-time coverage radiuses of 300 m and 1000 m have been considered, along with 50 and 100 players in the current scenario. The results of the considered scenario are shown in the following Figures.

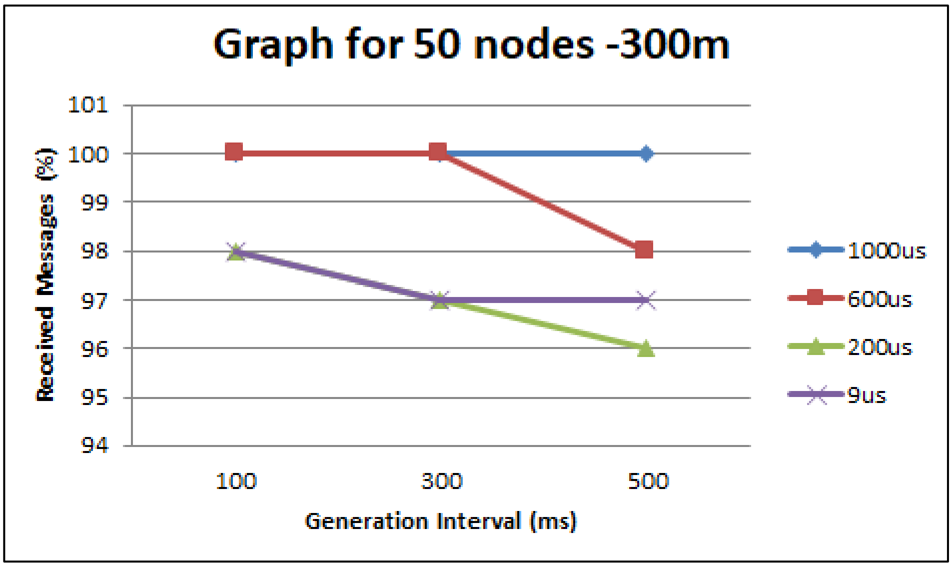

Figure 4.14 Generation Interval vs. Received Messages for 50 players-300m

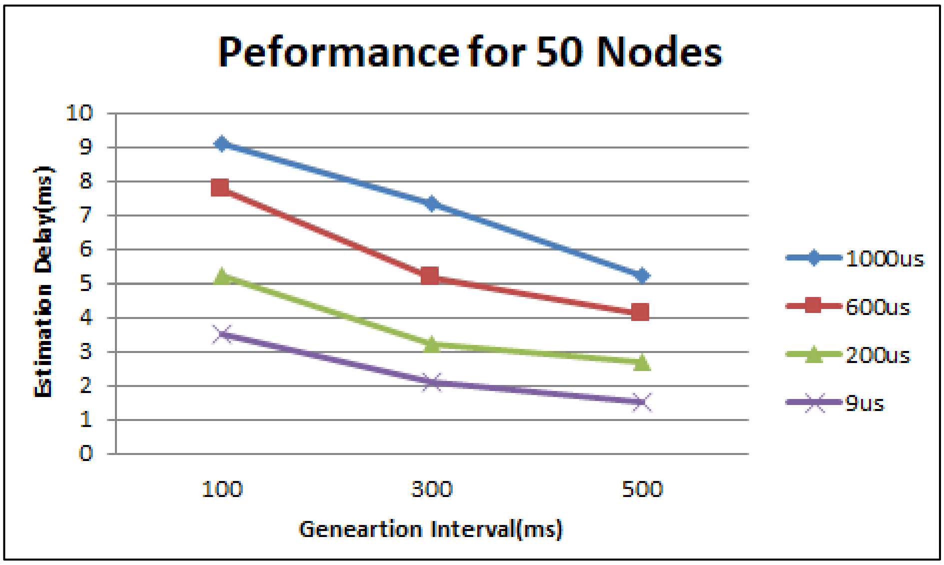

Figure 4.15 Generation Interval vs. Estimation Delay for 50 player

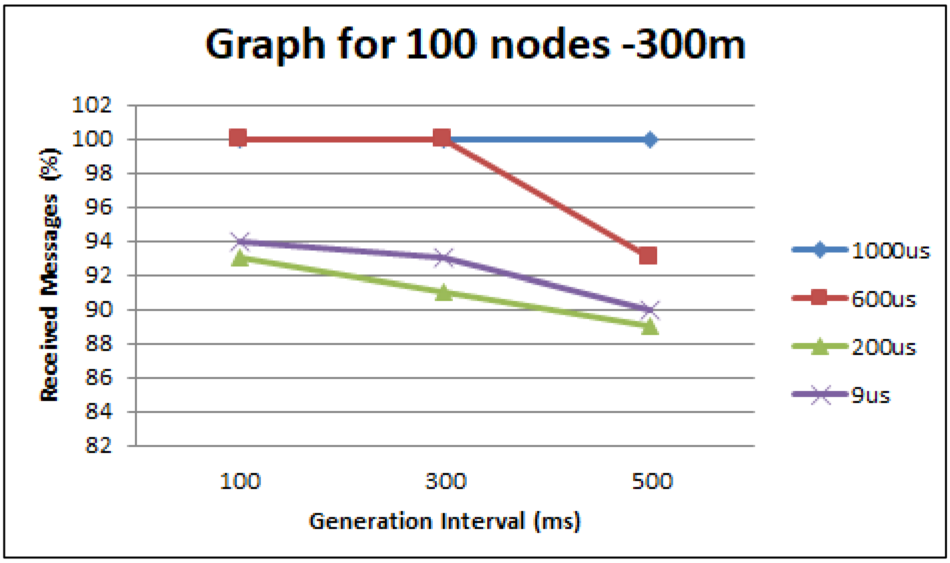

Figure 4.16 Generation Interval vs. Received Messages for 100 players -300m

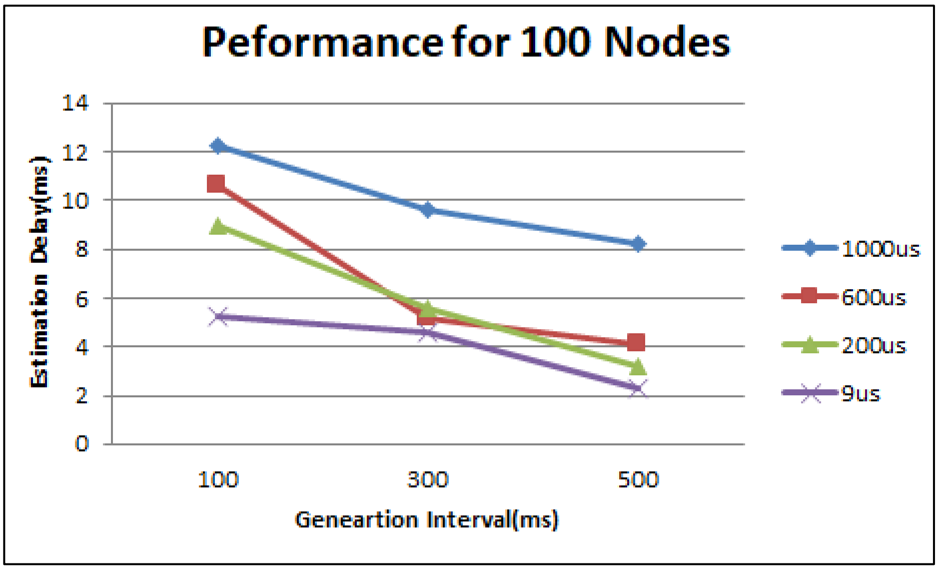

Figure 4.17 Generation Interval vs. Estimation Delay for 100 players

Results in Figures 4.14 and 4.16 denote the immediate variation of the time of delivery of any message of gaming event to the most distant player present in the car platoon with 300 m coverage radius and with 50, 100 simultaneous players. The Figures show that increasing the overall time of delivery relates to extended duration of time slot. While considering the high speed gaming, it is possible to accept only minimum delays. Hence, the time slots that are higher than 200μs cannot be considered as a practicable configuration. But, very smaller values of time slot may end up in increased collisions, loss of reliability towards delivering all the messages to each other vehicle and interferences. Considering Figures 4.15 and 4.17, they depict the percentage of message of gaming events which were delivered successfully to the entire players. While utilizing the time slots of 9 µs, the delivery speed clearly increases as seen in Figures 4.14 and 4.16. To sum up, it is evident that 200µs achieved for both reliable and swift messages delivery among other tested ones.

It is also noted that while increasing the rates of message generation, S_IVCS requires a minimum time for calculation to be accurate. Furthermore, it is also a real-time fact that the computation depends on the position of the vehicles and the distance between them when sharing the hello messages and application messages. As a result, the higher the messages, the more information that can be received, and the more swift and accurate computation has been built. But, all the configurations that are computed experience minimum delays, with the maximum delay being 20 ms. Thus, the proposed approach shows its ability to easily and rapidly adapt itself, which has been noticed as the best characteristic in a vehicular network over a largely dynamic scenario.

Chapter Five

Conclusions and Future Works

5.1 Conclusions

As the deployment of smart vehicles becomes more widespread, the application of system evaluation methodologies to network and in-vehicle computing systems becomes increasingly more important. This work focuses on VANET high mobility environment effects and also reflects how to send a message from a player to a group of players in vehicular networks. The proposed system depends on multi-hop broadcasting to deliver the message from the source node to another player in the ROI, to provide fast delivery and establish a session among multiplayer. The results were validated using simulators (NS-2) for the different stages of work. The performance of the resulting schemes meets the requirements to a high degree.

The most important points of a conclusion from this work can be summarized as follows:

1) Vehicles having V2V communication capabilities exchange Hello messages information (backward or forward) to compute and estimate their transmission range.
2) S_IVCS improves the application message broadcast across the car platoon by adding IVC session layer between the application layer and lower layers. This new additive session layer involved three primary components; Hello message generator, timer generator, and parameters handler.
3) Cars can select their own priority in becoming the next forwarder. Since receiving vehicles can determine how far away from the sender vehicle thus message could be understood with their relative distance.
4) Experiments showed that the suggested system S_IVCS may expand its coverage radius while maintaining its functionality.The suggested system's reliability has also been confirmed by the percentage of messages received correctly by all participating cars.
5) Because of the proposed S_IVCS capacity to adapt to even minor alterations in the coverage radius provided by the wireless network, it outperforms all other techniques.

6) Defining COWB and COWF for broadcast messages guarantees that gaming messages are delivered reliably and on time, as well as increasing message system throughput.

5.2 Future Works

Computing and wireless communication technologies have gone through accelerating advancements in the recent past, enabling emerging applications that are contributing to life quality. Among other technologies, vehicles and ad-hoc networks have played a pivotal role in providing various kinds of applications. There are still many challenges to cope with in VANET field, which expand several new research directions to extend some proposals or consider further complementary developments. Based on profound investigations and considerations, the possible directionsfor future are as follow:

1- The concept SIVCS can be extended to a number of research directions. For example, it could be used to support the transmission of the message applications, or coupled with routing protocols in ad hoc and sensor networks to reduce nodes and energy consumption.
2- Analysis the impact of penetration rate on the communication of platoon cars.
3- There are other parameters of interest as well, such as, link duration; number of connected period .There is a need to test our proposed system with these parameters.
4- Analyze how one vehicle seeks to interact with the platoon car and how communication is established with other vehicles.
5- Investigate how to integrate security function into the mechanisms of the routing protocol for VANETs.

References

References

[1] W. J. Tsaur and H. T. Pai, "A new security scheme for on-demand source routing in mobile ad hoc networks," *IWCMC 2007 Proc. 2007 Int. Wirel. Commun. Mob. Comput. Conf.*, pp. 577–582, 2007, doi: 10.1145/1280940.1281063.

[2] N. Aneja and S. Gambhir, "Recent Advances in Ad-Hoc Social Networking: Key Techniques and Future Research Directions," *Wirel. Pers. Commun.*, vol. 117, no. 3, pp. 1735–1753, 2021, doi: 10.1007/s11277-020-07942-7.

[3] I. Chlamtac, M. Conti, and J. J. N. Liu, "Mobile ad hoc networking: Imperatives and challenges," *Ad Hoc Networks*, vol. 1, no. 1, pp. 13–64, 2003, doi: 10.1016/S1570-8705(03)00013-1.

[4] C. B. Sources *et al.*, "An Overview of Routing Protocols in Mobile Ad- Hoc Network 1 2 International Journal of Advanced Research in An Overview of Routing Protocols in Mobile Ad-Hoc Network," no. August, 2015.

[5] S. Allani, T. Yeferny, R. Chbeir, and S. Ben Yahia, "A Novel VANET Data Dissemination Approach Based on Geospatial Data," *Procedia Comput. Sci.*, vol. 58, pp. 572–577, 2016, doi: 10.1016/j.procs.2016.09.089.

[6] P. I. Offor, "Vehicle Ad Hoc Network (VANET): Safety Benefits and Security Challenges," *SSRN Electron. J.*, 2013, doi: 10.2139/ssrn.2206077.

[7] P. I. Offor, "Vehicle Ad Hoc Network (VANET): Safety Benefits and Security Challenges," *SSRN Electron. J.*, no. 2009, 2013, doi: 10.2139/ssrn.2206077.

[8] G. Marfia, M. Roccetti, A. Amoroso, and M. Gerla, "Behind the scenes: Lessons learned from the greatest intervehicular accident detection test ever," *2013 10th Annu. Conf. Wirel. On-Demand Netw. Syst. Serv. WONS 2013*, pp. 74–78, 2013, doi: 10.1109/WONS.2013.6578324.

[9] F. Dressler, H. Hartenstein, O. Altintas, and O. K. Tonguz, "Inter-vehicle communication: Quo vadis," *IEEE Commun. Mag.*, vol. 52, no. 6, pp. 170–177, 2014, doi: 10.1109/MCOM.2014.6829960.

[10] X. M. Zhang, L. Yan, K. H. Chen, and D. K. Sung, "Fast, Efficient Broadcast Schemes Based on the Prediction of Dynamics in Vehicular Ad Hoc Networks," *IEEE Trans. Intell. Transp. Syst.*, vol. 21, no. 2, pp. 531–542, 2020, doi: 10.1109/TITS.2019.2896627.

[11] W. Xu, Wu, Daneshmand, Liu, "A data privacy protective

mechanism for WBAN," *Wirel. Commun. Mob. Comput.*, no. February 2015, pp. 421–430, 2015, doi: 10.1002/wcm.
[12] S. Xu, P. Guo, B. Xu, and H. Zhou, "QoS evaluation of VANET routing protocols," *J. Networks*, vol. 8, no. 1, pp. 132–139, 2013, doi: 10.4304/jnw.8.1.132-139.
[13] O. K. Tonguz and M. Boban, "Multiplayer games over Vehicular Ad Hoc Networks: A new application," *Ad Hoc Networks*, vol. 8, no. 5, pp. 531–543, 2010, doi: 10.1016/j.adhoc.2009.12.009.
[14] L. S, T. O, H. C. L, and S. V, "P roviding E ntertainment A pplications in VANET E nvironments," no. February, pp. 30–37, 2016.
[15] O. Alzamzami and I. Mahgoub, "Geographic routing enhancement for urban VANETs using link dynamic behavior: A cross layer approach," *Veh. Commun.*, vol. 31, p. 100354, 2021, doi: 10.1016/j.vehcom.2021.100354.
[16] H. I. Abbasi, R. C. Voicu, J. A. Copeland, and Y. Chang, "Towards Fast and Reliable Multihop Routing in VANETs," *IEEE Trans. Mob. Comput.*, vol. 19, no. 10, pp. 2461–2474, 2020, doi: 10.1109/TMC.2019.2923230.
[17] K. N. Qureshi, F. Bashir, and A. H. Abdullah, "Distance and signal quality aware next hop selection routing protocol for vehicular ad hoc networks," *Neural Comput. Appl.*, vol. 32, no. 7, pp. 2351–2364, 2020, doi: 10.1007/s00521-019-04320-8.
[18] M. Chaqfeh and A. Lakas, "A novel approach for scalable multi-hop data dissemination in vehicular ad hoc networks," *Ad Hoc Networks*, vol. 37, pp. 228–239, 2016, doi: 10.1016/j.adhoc.2015.08.021.
[19] Y. Kim, S. Peeta, and X. (Sean) He, "An Analytical Model to Characterize the Spatiotemporal Propagation of Information Under Vehicle-to-Vehicle Communications," *IEEE Trans. Intell. Transp. Syst.*, vol. 19, Jan. 2016, doi: 10.1109/TITS.2015.2512523.
[20] S. Latif *et al.*, "Multicriteria Based Next Forwarder Selection for Data Dissemination in Vehicular Ad Hoc Networks Using Analytical Network Process," vol. 2017, 2017.
[21] W. Benrhaiem, A. S. Hafid, and P. K. Sahu, "Multi-hop reliability for broadcast-based VANET in city environments," *2016 IEEE Int. Conf. Commun. ICC 2016*, 2016, doi: 10.1109/ICC.2016.7511084.
[22] A. Bujari, "A Network Coverage Algorithm for Message Broadcast in Vehicular Networks," *Mob. Networks Appl.*, vol. 21, no. 4, pp. 668–676, 2016, doi: 10.1007/s11036-016-0723-7.

[23] S. Ferretti, G. D'Angelo, and V. Ghini, "Smart Multihoming in Smart Shires: Mobility and Communication Management for Smart Services in Countrysides," Apr. 2016.
[24] M. Chaqfeh and A. Lakas, "Beacon-free scalable multi-hop data dissemination in Vehicular Ad hoc Networks," *IWCMC 2015 - 11th Int. Wirel. Commun. Mob. Comput. Conf.*, pp. 280–284, 2015, doi: 10.1109/IWCMC.2015.7289096.
[25] G. Breed, "Wireless ad hoc networks: basic concepts," *High Freq. Electron.*, no. March, 2007, [Online]. Available: http://highfreqelec.summittechmedia.com/Mar07/HFE0307_Tutorial.pdf
[26] S. R. Malwe and G. P. Biswas, "Location aware sector-based routing in wireless ad hoc networks," *Proc. 2015 Int. Conf. Green Comput. Internet Things, ICGCIoT 2015*, pp. 154–159, 2016, doi: 10.1109/ICGCIoT.2015.7380448.
[27] M. Dipobagio, "An overview on ad hoc networks," *Inf.Fu-Berlin.De*, pp. 1–9, 2009, [Online]. Available: https://www.inf.fu-berlin.de/groups/ag-tech/teaching/2008-09_WS/S_19565_Proseminar_Technische_Informatik/dipobagio09overview.pdf
[28] M. N. Mejri, J. Ben-Othman, and M. Hamdi, "Survey on VANET security challenges and possible cryptographic solutions," *Veh. Commun.*, vol. 1, no. 2, pp. 53–66, 2014, doi: 10.1016/j.vehcom.2014.05.001.
[29] G. Karagiannis *et al.*, "Vehicular networking: A survey and tutorial on requirements, architectures, challenges, standards and solutions," *IEEE Commun. Surv. Tutorials*, vol. 13, no. 4, pp. 584–616, 2011, doi: 10.1109/SURV.2011.061411.00019.
[30] R. O. B. Eraldi and R. O. B. Aldoni, "U Nicast R Outing T Echniques F or Mobile Ad - Hoc Networks," pp. 1–34.
[31] K. Akkaya and M. Younis, "A survey on routing protocols for wireless sensor networks," *Ad Hoc Networks*, vol. 3, no. 3, pp. 325–349, 2005, doi: 10.1016/j.adhoc.2003.09.010.
[32] A. Boukerche, B. Turgut, N. Aydin, M. Z. Ahmad, L. Bölöni, and D. Turgut, "Routing protocols in ad hoc networks: A survey," *Comput. Networks*, vol. 55, no. 13, pp. 3032–3080, 2011, doi: 10.1016/j.comnet.2011.05.010.
[33] Y. Toor, P. Mühlethaler, A. Laouiti, and A. De La Fortelle, "Vehicle ad hoc networks: Applications and related technical issues," *IEEE Commun. Surv. Tutorials*, vol. 10, no. 3, pp. 74–88, 2008, doi: 10.1109/COMST.2008.4625806.
[34] C. Wu, S. Ohzahata, and T. Kato, "A low latency path diversity mechanism for sender-oriented broadcast protocols in

VANETs," *Ad Hoc Networks*, vol. 11, no. 7, pp. 2059–2068, 2013, doi: 10.1016/j.adhoc.2012.02.007.
[35] S. Panichpapiboon and W. Pattara-Atikom, "A review of information dissemination protocols for vehicular ad hoc networks," *IEEE Commun. Surv. Tutorials*, vol. 14, no. 3, pp. 784–798, 2012, doi: 10.1109/SURV.2011.070711.00131.
[36] D. G. Reina, S. L. Toral, P. Johnson, and F. Barrero, "A survey on probabilistic broadcast schemes for wireless ad hoc networks," *Ad Hoc Networks*, vol. 25, no. PA, pp. 263–292, 2015, doi: 10.1016/j.adhoc.2014.10.001.
[37] L. A. Villas, A. Boukerche, G. Maia, R. W. Pazzi, and A. A. F. Loureiro, "DRIVE: An efficient and robust data dissemination protocol for highway and urban vehicular ad hoc networks," *Comput. Networks*, no. PartA, pp. 381–394, 2014, doi: 10.1016/j.comnet.2014.10.012.
[38] C. Technologies, "Data Dissemination Protocols for Vehicular Ad hoc Networks".
[39] G. K. Swathishree and I. Janani, "a Vehicular Collision Control for Emergency Warning Messages in Vanet," 2016.
[40] A. Mondal and S. Mitra, "Secure data dissemination in VANET - A pull based approach," *4th IEEE Conf. Commun. Networks Satell. COMNESTAT 2015 - Proc.*, pp. 60–67, 2016, doi: 10.1109/COMNETSAT.2015.7434293.
[41] W. Li, X. Cheng, T. Jing, and X. Xing, "Cooperative multi-hop relaying via network formation games in cognitive radio networks," *Proc. - IEEE INFOCOM*, pp. 971–979, 2013, doi: 10.1109/INFCOM.2013.6566886.
[42] A. D. Ghodrati, "Reduces Broadcast Storm Using Clustering in VANETs," vol. 7, no. 13, pp. 979–987, 2013.
[43] C. Hu, Y. Hong, and J. Hou, "On Mitigating the Broadcast Storm Problem," pp. 104–110, 2003.
[44] K. Suriyapaibonwattana and C. Pomavalai, "An effective safety alert broadcast algorithm for VANET," *2008 Int. Symp. Commun. Inf. Technol. Isc. 2008*, pp. 247–250, 2008, doi: 10.1109/ISCIT.2008.4700192.
[45] O. K. Tonguz, N. Wisitpongphan, J. S. Parikh, F. Bai, P. Mudalige, and V. K. Sadekar, "On the broadcast storm problem in ad hoc wireless networks," *2006 3rd Int. Conf. Broadband Commun. Networks Syst. BROADNETS 2006*, 2006, doi: 10.1109/BROADNETS.2006.4374403.
[46] A. G. Wadday and D. Mohammed, "Performance of Maximum Distance on-demand Routing Protocol based on Random Variable Velocity," *4th Sci. Int. Conf. Najaf, SICN 2019*, pp. 1–

4, 2019, doi: 10.1109/SICN47020.2019.9019381.
[47] N. Karthikeyan, V. Palanisamy, and K. Duraiswamy, "Performance Comparison of Broadcasting methods in Mobile Ad Hoc Network," *Int. J. Futur. Gener. Commun. Netw.*, vol. 2, no. 2, 2009.
[48] F. J. Martinez, M. Fogue, M. Coll, J. C. Cano, C. T. Calafate, and P. Manzoni, "Evaluating the impact of a novel warning message dissemination scheme for VANETs using real city maps," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 6091 LNCS, pp. 265–276, 2010, doi: 10.1007/978-3-642-12963-6_21.
[49] S. C. Lo, J. S. Gao, and C. C. Tseng, "A water-wave broadcast scheme for emergency messages in VANET," *Wirel. Pers. Commun.*, vol. 71, no. 1, pp. 217–241, 2013, doi: 10.1007/s11277-012-0812-2.
[50] M. C. and S. S. Sathya, "M Anagement I Ssues and C Hallenges in M Obile," *Int. J.*, vol. 5, no. 1, pp. 1–6, 2013.
[51] N. Wisitpongphan, O. K. Tonguz, J. S. Parikh, P. Mudalige, F. Bai, and V. Sadekar, "Broadcast storm mitigation techniques in vehicular ad hoc networks," *IEEE Wirel. Commun.*, vol. 14, no. 6, pp. 84–94, 2007, doi: 10.1109/MWC.2007.4407231.
[52] M. Bakhouya, J. Gaber, and P. Lorenz, "An adaptive approach for information dissemination in Vehicular Ad hoc Networks," *J. Netw. Comput. Appl.*, vol. 34, no. 6, pp. 1971–1978, 2011, doi: 10.1016/j.jnca.2011.06.010.
[53] S. Gillani, F. Shahzad, A. Qayyum, and R. Mehmood, "A survey on security in vehicular ad hoc networks," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 7865 LNCS, pp. 59–74, 2013, doi: 10.1007/978-3-642-37974-1_5.
[54] M. S. Sheikh, J. Liang, and W. Wang, "Security and Privacy in Vehicular Ad Hoc Network and Vehicle Cloud Computing: A Survey," *Wirel. Commun. Mob. Comput.*, vol. 2020, 2020, doi: 10.1155/2020/5129620.
[55] J. Färber, "Traffic modelling for fast action network games," *Multimed. Tools Appl.*, vol. 23, no. 1, pp. 31–46, 2004, doi: 10.1023/B:MTAP.0000026840.45588.64.
[56] J. Kim, J. Choi, D. Chang, T. Kwon, Y. Choi, and E. Yuk, "Traffic characteristics of a massively multi-player online role playing game," *Proc. 4th ACM SIGCOMM Work. Netw. Syst. Support Games, NetGames 2005*, pp. 1–8, 2005, doi: 10.1145/1103599.1103620.
[57] H. Kim, M. Parashar, D. J. Foran, and L. Yang, "Investigating

the use of autonomic cloudbursts for high-throughput medical image registration," *Proc. - IEEE/ACM Int. Work. Grid Comput.*, pp. 34–41, 2009, doi: 10.1109/GRID.2009.5353065.
[58] S. Zeadally, J. Guerrero, and J. Contreras, "A tutorial survey on vehicle-to-vehicle communications," *Telecommun. Syst.*, vol. 73, no. 3, pp. 469–489, 2020, doi: 10.1007/s11235-019-00639-8.
[59] Y. Chong, S. Si, H. Guo, and H. Zhao, "Modeling and performance of the IEEE 802.11p broadcasting for intra-platoon communication," *Sensors (Switzerland)*, vol. 18, no. 9, 2018, doi: 10.3390/s18092971.
[60] D. Jia, K. Lu, J. Wang, X. Zhang, and X. Shen, "A survey on platoon-based vehicular cyber-physical systems," *IEEE Commun. Surv. Tutorials*, vol. 18, no. 1, pp. 263–284, 2016, doi: 10.1109/COMST.2015.2410831.
[61] C. E. Palazzi, S. Ferretti, M. Roccetti, G. Pau, and M. Gerla, "How do you quickly choreograph inter-vehicular communications? A fast vehicle-to-vehicle multi-hop broadcast algorithm, explained," *2007 4th Annu. IEEE Consum. Commun. Netw. Conf. CCNC 2007*, no. 1, pp. 960–964, 2007, doi: 10.1109/CCNC.2007.194.
[62] A. Amoroso, M. Ciaschini, and M. Roccetti, "The farther relay and oracle for Vanet. Preliminary results," *ACM Int. Conf. Proceeding Ser.*, 2008, doi: 10.4108/ICST.WICON2008.4859.
[63] C. E. Palazzi, S. Ferretti, and M. Roccetti, "Communities on the road: Fast triggering of interactive multimedia services," *Multimed. Tools Appl.*, vol. 44, no. 2, pp. 229–247, 2009, doi: 10.1007/s11042-009-0292-x.
[64] C. De Francesco, C. E. Palazzi, and D. Ronzani, "Fast Message Broadcasting in Vehicular Networks: Model Analysis and Performance Evaluation," *IEEE Commun. Lett.*, vol. 24, no. 8, pp. 1669–1672, 2020, doi: 10.1109/LCOMM.2020.2993006.

الخلاصة

مع تقدم تكنولوجيا السيارة ، أصبحت مجموعة واسعة من التطبيقات ، بدءًا من الأمان (أي رسالة تنبيه) إلى الترفيه (أي لعبة) ، متاحة بسهولة أكبر للركاب. تستخدم العديد من هذه التطبيقات نموذج ناقل الحركة من مركبة إلى مجموعة مركبات ، بحيث يمكن لكل سيارة داخل منطقة الاهتمام أن تبث رسالة إلى جميع السيارات الأخرى في نطاق بضعة كيلومترات من المصدر. من أجل أداء لعبة معينة بين مجموعة من الركاب (لاعبين) عبر شبكات المركبات اللاسلكية ، يجب إرسال رسالة اللعبة إلى اللاعبين الآخرين في فصيلة السيارة بعد كل حدث لعبة يقوم به أحد اللاعبين في فصيلة سيارات الألعاب المعتبرة داخل منطقة الاهتمام و يتطلب ذلك تسليمًا سريعًا لهذه الرسائل ، نظرًا لأننا نحتاج إلى آلية لتسليم هذه الرسائل بسرعة ، لذلك ، تم اعتماد خوارزمية سريعة لنشر الرسائل متعددة المراحل عبر شبكات المركبات اللاسلكية في سيناريو الطريق السريع والتي يمكن من خلالها تقليل تأخير رسالة الانتشار عن طريق تقليل عدد القفزات من خلال تحديد عقدة محددة كمعهد توجيه واستنادًا إلى وجود نوافذ تنازع مختلفة بين المركبات. تم اقتراح خوارزمية جديدة تسمى خوارزمية الاتصال الذكي بين المركبات (S_IVCS) وثلاثة أساليب هي FIXED_300 و FIXED_1000 و RANDOMALY وتم تقييمها باستخدام أسلوب S_IVCS في إعادة التوجيه السريع الرسائل الموجهة لكل مركبة والتي تعبر عن الاهتمام بالمعلومات الترفيهية لتقييم قدرة النظام المقترح مع زيادة نصف قطر التغطية ، تم أيضًا تقييم التأثير على أداء S_IVCS فيما يتعلق بمدة الفواصل الزمنية من خلال المحاكي NS-2.

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة الأنبار
كلية علوم الحاسوب وتكنولوجيا المعلومات
قسم علوم الحاسبات

البث متعدد القفزات للالعاب عبر شبكة المركبات اللاسلكية

رسالة مقدمة الى

قسم علوم الحاسبات – كلية علوم الحاسوب وتكنلوجيا المعلومات جامعة الانبار،

وهي جزء من متطلبات نيل درجة الماجستير في علوم الحاسبات

قدمت من قبل

صلاح نوري مجيت

بإشراف

أ.م.د. فؤاد سليم مبارك

١٤٤٣ هـ ٢٠٢٢ م