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RESOURCE MANAGEMENT SCHEME FOR VEHICULAR CLOUD NETWORKING

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Master`s Thesis

Supervisor

Prof. Dr. Osman Nuri UÇAN

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The thesis titled RESOURCE MANAGEMENT SCHEME FOR VEHICULAR CLOUD NETWORKING prepared BY GHAIDAA SALIH FAYYADH ALMASHHADANI and submitted on 05/04/2023 has been **accepted unanimously** for the degree of Master of Science in Information Technologies.

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Ghaidaa Salih Fayyadh ALMASHHADANI

Signature

DEDICATION

I dedicate the work for my supervisor, who has been instrumental in helping me through the whole thesis process, and also to my parents, who has always been there for me during difficult times.

ABSTRACT

RESOURCE MANAGEMENT SCHEME FOR VEHICULAR CLOUD NETWORKING

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A communications network, in the conventional sense, is a collection of devices that enables users on the outside to interact with one another. This keeps the range of variables that must be considered for its design, operation, and attainment of the necessary quality levels within the confines of the same and reduces the role of users to merely gaining access to the network within the constraints set. The user, however, does not accept being relegated to the background in modern conversation. The main objective of this study is to create a model for V2V and V2I communication in VANETs that makes use of "machine learning optimization," IEEE 802.11p AODV, and other protocols to enhance the transmission and dependability of shared messages. We will assess this plan considering how a VANET network typically functions and other optimization techniques.

Keywords: AODV, VANET, V2V, V2I, Network.

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ABBREVIATIONS

AODV	:	Ad hoc On-Demand Distance Vector Routing
PSO	:	Particle swarm optimization
V2V	:	Vehicle-to-vehicle (V2V) communication’s
VANET	:	Vehicular ad hoc networks

1. INTRODUCTION

1.1 BACKGROUND

A communications network, in the conventional sense, is a collection of devices that enables users on the outside to interact with one another. This keeps the range of variables that must be considered for its design, operation, and attainment of the necessary quality levels within the confines of the same and reduces the role of users to merely gaining access to the network within the constraints set. However, in modern times, the user does not accept a supporting position in conversations. The need for portability, then a wide variety of media and content, and lastly the independence to create one's own networks tailored to one's requirements in time and space, were all essential requirements. To meet this need, we need novel, low-cost, and easy-to-deploy schemes in which the network is composed entirely of endpoint devices (which function as nodes) that require no external or permanent infrastructure. All this calls for a technological response that moves command of those messages to the network's edges. Each node in a wireless ad hoc network acts as both a station and a gateway, making it very different from traditional wired networks. To exchange data with other nodes in a network, a node must maintain its own locational knowledge and apply an algorithm for controlling the transmission and reception of packets. The routing protocol is a collection of data that contains both the routing algorithm and information about the current state of the network. Ad hoc networking protocols must be designed to use as few resources as possible to accommodate accurate and rapid changes in network topology. Routing protocols play an important role in achieving this goal [2].

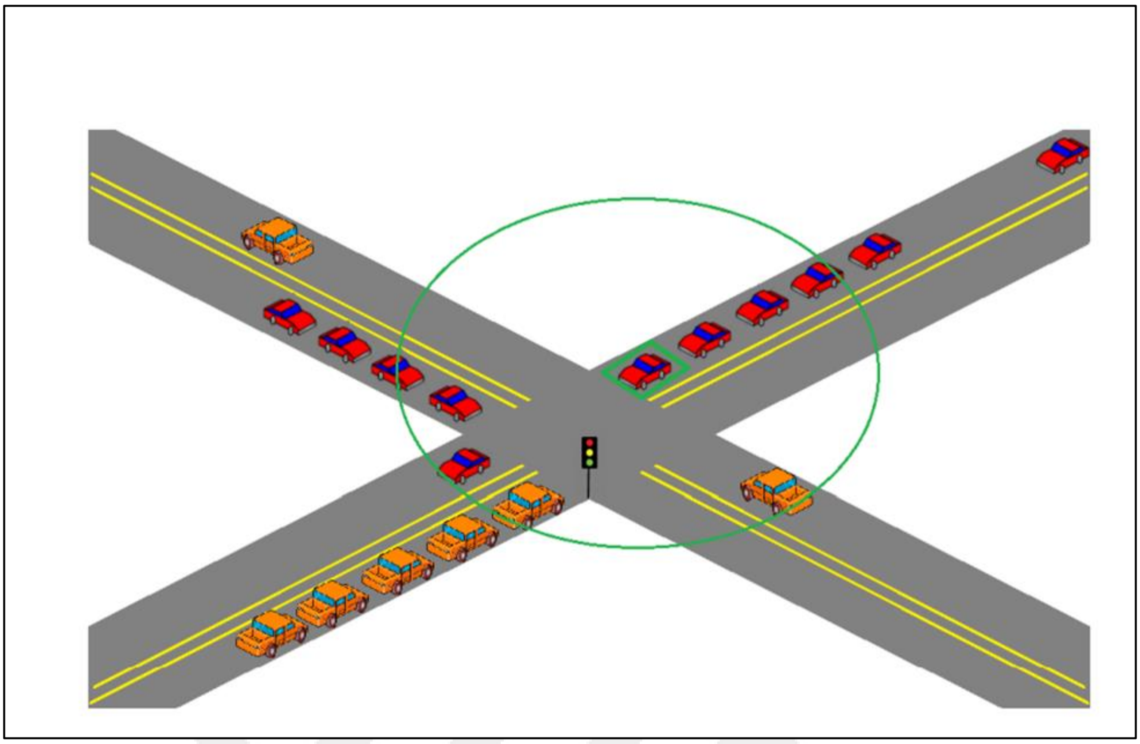

Figure 1.1 General Scheme for VANET Networks [4].

1.2 MOTIVATION

The routing process is responsible for the end-to-end transmission of data from a source or origin to a destination. The routing process of a network is the determination of the most efficient path from one point to another within the network. Establishing a route between two nodes, which is the primary objective of a routing protocol for ad hoc networks, enables the network to organize itself. The primary objective of the routing protocol is to ensure the timely and reliable delivery of messages. During the construction of a route, it is crucial to minimize the overhead on control packet headers and bandwidth consumption. Considerations to be taken into account in the design and study of new routing protocols include:

a. Efficiency and simplicity of use
b. Rapid, loop-free, and optimal path convergence. In order to make the network more stable, it may be feasible to set up multiple paths between the same set of origin and destination nodes.

c. protocol with a distributed and lightweight character, whose response to variations in topology and traffic patterns requires only a minimal increase in header sizes.
d. Effectiveness in terms of data transfer rate, electricity consumption, and processing power while requiring a small amount of processing power at the headend.
e. To be scalable, a network must be able to handle a large rise in nodes without experiencing a noticeable slowdown in performance.
f. Protection against unauthorized disclosure of information, unauthorized access, and malicious node-caused denial-of-service assaults.
g. In a position to back up service quality needs. Timely transmission of multimedia traffic relies heavily on quality-of-service guarantees.

1.3 PROBLEM STATEMENT

This thesis is mainly interested in bio-inspired approaches to optimize data collection in a heterogeneous Wireless Sensor Network (WSN) using a mobile data collector. We are targeting monitoring applications in the field of E-health, where data is collected periodically or on an event basis. In this type of application, in the event of an emergency, the loss of data and the routing time of this data are intolerable to avoid disasters. We address the problem of data loss due to buffer overflow of heterogeneous sensors. More specifically, we are interested in two aspects: the movement of the data collector which plays a very important role in data collection.

1.4 AIMS AND CONTRIBUTIONS

The main goal of this study is to create a model for V2V and V2I communication in VANETs that makes use of "machine learning optimization," IEEE 802.11p AODV, and other protocols to enhance the transmission and dependability of shared messages. After considering how a VANET network usually functions and other optimization measures, this plan will be ranked.

1.5 THESIS ORGANIZATION

This is the outline of the thesis: In Section 2, we will examine the development and application of smart networks thus far. Background information on each part is provided in Section 3. Our model and its application are described in depth in Section 4. In Section 5, we run our model simulation and keep track of the data we collect. In Section 6 we summarize our findings and discuss their potential implications moving forward.

2. LITERATURE REVIEW

More researchers are interested in developing VANET clustering protocols based on MANET clustering methods. However, the highway ID is ignored by every single proposed clustering algorithm for VANETs. This has directly led to instability in the clustering's building. More information about these prospective procedure ideas will be provided below. It has been suggested that lane-based clustering can be used to extend the life of clusters while decreasing transmission costs. The cluster leader is always stationed in the busiest thoroughfare. The authors assert that modern automobiles are equipped with sophisticated lane detection equipment and digital city maps that show drivers where they are in relation to traffic lanes. The traffic flow on a network with the most consistent cluster head is identified using a measure called lane weight (LW). The clustering algorithm does not account for the time it takes for vehicles to change lanes or head in a different direction, assuming they are all traveling in a straight path. This is because it is assumed that all vehicles are moving in a straight path. Here, in [9], we see how the Multi-Head Clustering Algorithm is put into practice. In addition to decreasing the frequency with which re-clustering must be performed, this algorithm also facilitates the formation of more robust clusters. This is because it can function with either one or many cluster centres. The Master Cluster Head is determined by picking a vehicle from each cluster that is within range of the other clusters' communications and voting on which vehicle will serve as the Master Cluster Head. (MCH). After that, a cluster's members hold elections to choose their Slave Cluster Leaders. (SCHs). For a cluster to be stable, all of its components must be heading in the same general path, as stated by the authors. Among the necessary criteria, this is one of the most important ones. To improve network stability while decreasing the naturally high degree of dynamic activity in VANETs, it was proposed in [5] that a multi-metric method be used for cluster head elections. Additionally, this algorithm adds a speed differential measure as a new parameter to its operations to improve the cluster's longevity. Cars moving quickly form one group, while those moving more slowly form another. It is common procedure to compare the performance of various VANET clustering protocols to that of various MANET clustering algorithms. The point is to find out which one is best. To maximize efficiency, Lowest ID clustering is an example of a clustering algorithm that selects a cluster head whose ID is smaller than the IDs of the other cluster members. The

Weighted Clustering Algorithm (WCA) selects cluster heads based on a weighted combination of the node's average speed, battery life, number of neighbours, and neighbours’ average speeds. The behaviour of these protocols can be significantly altered by small modifications to their parameters (such as the size of the cluster or the interval between hellos, election intervals, and timeout intervals, among other things). Nobody, including the authors, has provided instructions on how to tune and optimize the devices for various mobility scenarios. In light of this, it is crucial to determine the optimal set of configuration parameters for these networks. As a result of the proliferation of VANETs and MANETs, a multitude of optimization algorithm-based approaches for optimally configuring communication protocols have emerged. Various meta-heuristic algorithms have been used to enhance the quality of service (QoS) of the AODV protocol [13] and a file transfer protocol [16] in realistic VANET scenarios, for instance. Detailed descriptions of a variety of multi-objective optimization algorithms for broadcasting methods in MANETs are provided in [14] and [15]. Recent publications describe the development of a novel parallel multi-objective local search algorithm for optimizing the energy efficient broadcasting algorithm, with the aim of maximizing coverage while minimizing time, power, and network resources. [17] Ituraea AWCP is a cluster protocol designed specifically for VANETs that takes mobility information into account to provide stable, long-lasting clusters. Consequently, we define a multi-objective optimization problem in which we employ the non-dominated sorted genetic algorithm NSGA-II to determine the optimal values for the AWCP protocol parameters, and we obtain the optimal values for the AWCP protocol parameters.

It is best to understand what "vehicular ad hoc networks" (VANETs) are by deconstructing the term into its component parts. In this context, "vehicular" refers to the networks' intended use by motorized vehicles. This type of network is referred to as ad-hoc networking because it lacks a centralized point of entry. Due to the temporary nature of the connections, the only information that can be obtained about a specific node is its neighbours. If two or more nodes are interconnected, it is said that the network contains nodes. To accommodate the ever-changing nature of vehicular traffic, VANETs are highly dynamic networks with frequent disconnections and topological alterations. Depending on the location, the vehicle density in VANETs can range from low on rural roads to high in urban areas during rush hour. Because radio communication is possible, there is no requirement for infrastructure along roads in the case of VANETs. VANETs can communicate with Road Side Units without requiring additional infrastructure, allowing for more efficient traffic flow. [7] The four primary types of traffic communication are vehicle-to-vehicle (V2V) communication, infrastructure communication, vehicle-to-broadband communication, and in-vehicle communication (V2B). V2V is an acronym for vehicle-to-vehicle (V2V) communication, which focuses primarily on safety. The importance of these lies in the fact that they must be completed quickly. Communication between vehicles and infrastructure (V2I) reduces the need for human intervention by allowing vehicles to receive real-time traffic and road condition updates over a wide area network. Two applications that benefit from this technology are vehicle tracking and active driver assistance. V2B communication enables the use of wireless broadband mechanisms such as 4G, which enables the transmission of more traffic data and multimedia content at a faster rate. V2X, also known as "vehicle-to-everything," refers to the various V2 components that are used together. In the context of a vehicle's communication system, "in-vehicle communication" refers to any device or system that can detect whether a driver is impaired or fatigued. [9] VANETs can be utilized to collect and process data for both safety-related and non-safety-related purposes. Due to the rapid movement of vehicles on the network, safety-related VANET applications require messages to be delivered with minimal delay, high reliability, and robust security. When sending messages, it is common for vehicles to include their location, speed, and other pertinent information. It is used to prevent intersection collisions, alert people after an accident, extend signs, and for a number of other purposes. GPS systems are frequently combined with non-safety-related applications to improve traffic flow and passenger comfort, as well as to locate points of interest and other vital information. To prevent interference and distraction, the physical network channels are separated from the more vital safety-related applications [6]..

3. MATERIALS AND METHODS

In this chapter, we'll go over some of the key pieces that made up the framework upon which our model was built.

3.1 VANET NETWORK

Vanets are a subset of MANETs designed specifically for use in moving vehicles. It consists of a group of devices that can exchange data via wireless connections without a central server. Every node can forward messages to where they need to go, functioning as a router. [24].

3.1.1 Vanet Characteristics

Here is a list of what we know about these networks: Free will. Any given node in a network can act independently to handle data it receives and sends over the network. Network breakdowns are tolerated better because authority over the network is not centralized but rather resides in each individual node.

a. Distributed routing (A). Similar to their independence, the nodes' ability to transport data is essential. As a result, we need to specify new routing methods able to accommodate this feature.

b. Instead, the structure of the network can change. The location of individual nodes in a MANET is completely fluid. Since vehicles on VANETs tend to travel in a predictable pattern—say, along the curves of a street circuit—it is necessary to qualify this feature. And yet, the cars are much swifter than a terminal in a traditional mobile network. As a result of this angular dispersion, significant packet losses may arise. There will need to be detection and mitigation mechanisms in place for such events.

c. Links' carrying capability can fluctuate, so C. This trait is inherent to the wireless transmission medium and thus plays a role in all wireless communications; however, its impacts are magnified in VANETs. This occurs due to the fact that each node serves as a router, and data travels across numerous wifi connections.

d. Inadequate access to computers. The nodes of this type of network are typically lightweight terminals on board vehicles, which means that computing power, bandwidth, and battery life must all be carefully optimized by the algorithms used.

Table 3.1 VANET Network Characteristic [24].

Content	The traditional cellular wireless network	VANET
Topology	Fixed	Dynamic, flexible
Infrastructure	Yes	Little
Safety and quality of service	Better	Poor
Configuration speed	Slowly	Quickly
Cost	High	Low
Survival time	Long	Short
Route selection and maintenance	Easy	Difficult
Network robustness	Low	High
Relay equipment	Basic station and wired backbone network	Wireless nodes and wireless backbone network
Backbone network characteristics	High speed, reliable	Low capacity, high error

3.1.2 Challenges

The unique features of a VANET network are balanced by the difficulties inherent in making the network operate as intended. Below, we'll list a few of them: Administration of networks: Because of this high mobility, both the topology of the network and the circumstances of the communication channels are constantly evolving. Due to their inability to adapt to rapid change, well-established architectural patterns like trees are out of the question. Managing Traffic and Preventing Crashes: The vastness of the potential network presents a significant obstacle. During rush hour and in more remote regions, traffic densities can rise to unacceptable levels. Since the network may go down during rush hour, traffic and mishaps cannot be managed effectively. Since VANETs typically use a common medium for communication, the MAC design is crucial to the network's functioning. The security of VANET is complicated by the fact that its many uses make its data particularly susceptible to compromise. The implementation of a VANET network faces not only technological hurdles, but also social and economic ones. A system's high vulnerability makes it challenging to persuade manufacturers to engage in it. A significant attack on this kind of network could compromise sensitive information [4].

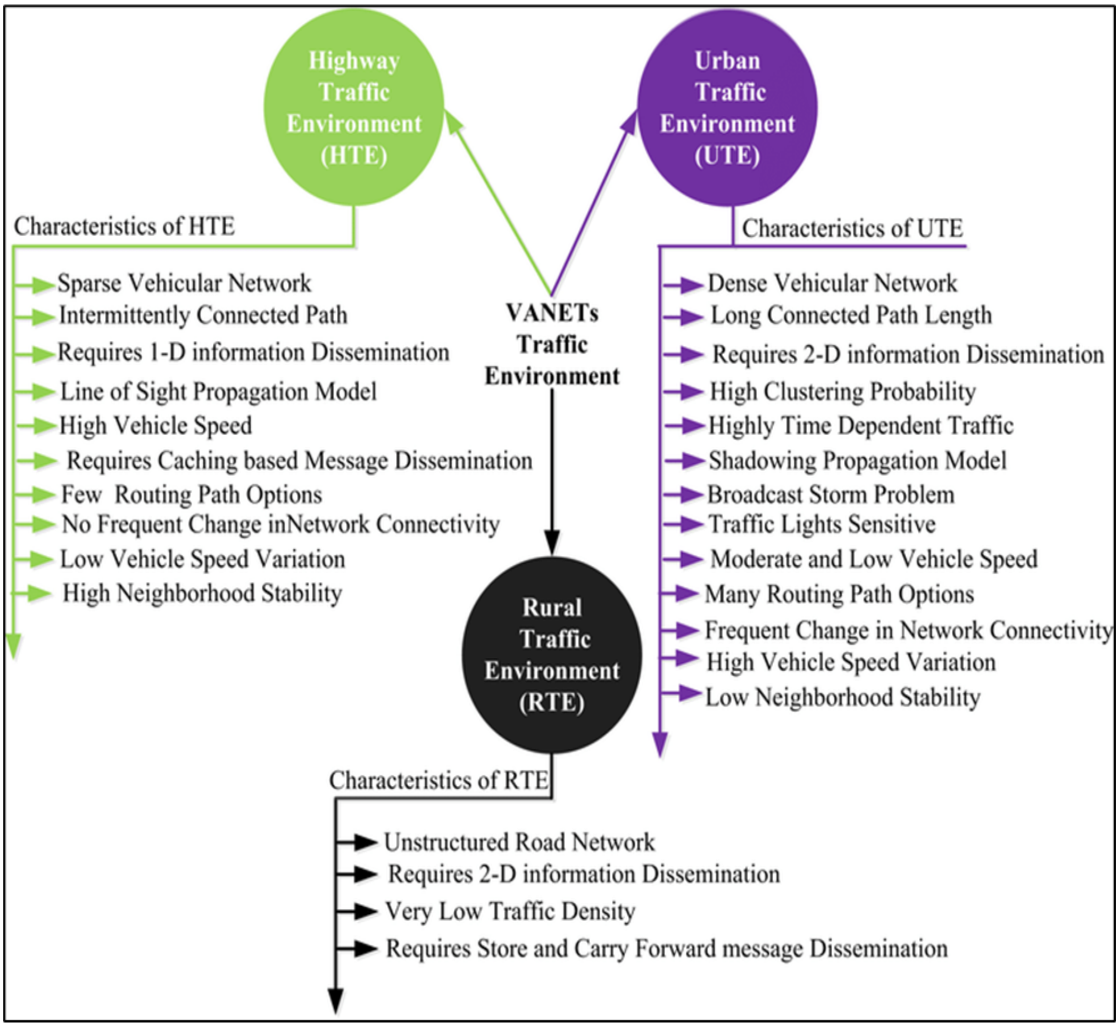

Figure 3.1: VANET Network Traffic Classification [6].

3.2 VANET ROUTING PROTOCOLS

A vehicle is typically thought of as a locomotion device that responds to the driver's input. This paradigm has evolved because of recent advancements in communication and control systems, which have enabled autonomous and intelligent vehicle behavior and laid the groundwork for an intelligent vehicle network. To set the scene for the next generation of wireless communications, VANET operates similarly to a wireless network (WLAN), except that instead of linking mobile devices and computers, it links vehicles. The vehicles must analyze data before sending it out into the world. (that is, the measurements of one or more local parameters). It is on this mechanism that broadcast protocols and apps rely heavily when developing a unified framework. Figure below illustrates this plan. This scheme is modified in some works, such as [5], because vehicles equipped with a Learning Automata (LA) mechanism handle more data. However, it does present a novel method due to the benefits it will bring to VANET applications. Direct vehicle-to-vehicle and vehicle-to-infrastructure communication can usher in a new era of highway and road safety uses. In the event of a mishap, for instance, vehicles in the area can relay the news to others and prompt them to reevaluate their path in light of the new information. This will significantly reduce congestion, leading to a more effective and convenient transit network. In the plan depicted in the figure below, vehicles work together to send a traffic alert message to one another.

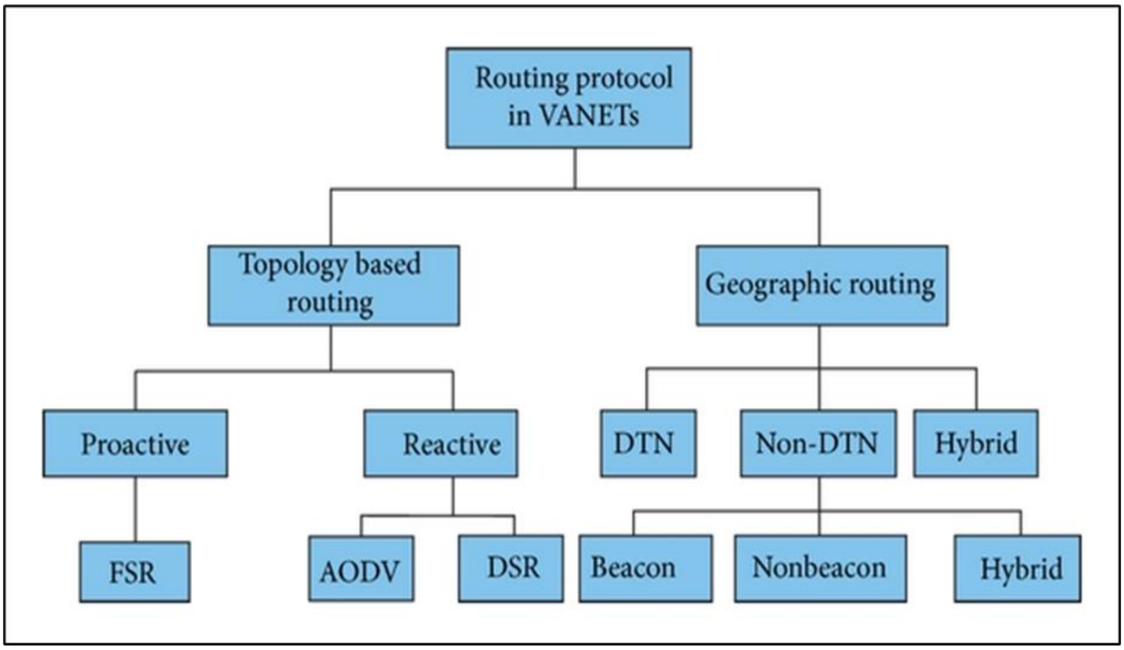

Figure 3.2: Routing Protocols in VANET [10].

Although a VANET network can serve a wide variety of applications, network connectivity is crucial. In MANET networks, "flooding" is a prevalent method of information dissemination. Each component in this network shares data with its nearest peers. Each server only sends out a maximum of one packet per round of transmissions. TTL (time to live) is also employed to restrict the range over which a message can travel. As is standard practice, if one car spots an accident or hazardous scenario on the road, it must alert the others. To deal with the congestion in a network, new protocols can be implemented to determine which nodes and transports are responsible for sending packets to their destinations. Mobile nodes in a MANET network rely on mutual aid to perform distributed routing between moving cars. Due to the decentralized nature of VANET networks, routing poses a significant problem due to the unpredictable topological shifts that occur within them [19]. Contextually, designing optimization methods that can adjust to the needs of a VANET network is essential to the network's proper functioning beyond simply relying on the retransmission of messages within the network. The vehicle will send out a request communication to the network in order to get the data it needs. If a user asks, for instance, about the gas rates at gas stations near him, or about parking spots in the area, the request's recipient will be able to access that information. Depending on the level of cooperation between the vehicles, there are various options for sending such a communication. It's been noted [30] that information transmission from vehicles traveling in the opposite way can be particularly effective.

Table 3.2: VANET vs MANET Parameters.

S. No.	Parameter	MANETs	VANETs
1.	Cost of production	Cheap	Expensive
2.	Change in n/w topology	Slow	Frequent and very fast
3.	Mobility	Low	High
4.	Node Density	Sparse	Dense and frequently variable
5.	Bandwidth	Hundred Kps	Thousand Kps
6.	Range	Upto 100m	Upto 500m
7.	Node Lifetime	Depends on power resource	Depend on lifetime of vehicle
8.	Multi-hop Routing	Available	Weakly available
9.	Reliability	Medium	High
10.	Moving pattern of nodes	Random	Regular
11.	Addressing scheme	Attribute Based	Location based
12.	Position Acquisition	Using Ultrasonic	Using GPS,RADAR

3.2.1 IEEE 802.11p

Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), and Code Division Multiple Access (CDMA) are the three most popular methods for medium access control. (from the English: code-division multiple access; multiple access by code division). In VANET networks, synchronization is difficult to accomplish due to the high mobility of the nodes, making it challenging to manage communication through time slots using various channels and coding for any of these protocols. For cars to be able to talk to one another, there needs to be a set protocol for how that should work. To this point, IEEE 802.11p has won out as the most widely adopted protocol for in-car networks. This protocol uses Carrier Sense Multiple Access and Channel Access to obtain a communication channel slot in real time. (short for Carrier Sense Multiple Access with Collision Avoidance, or multiple access with carrier listening and collision avoidance in English). To better serve the needs of vehicle-to-X communication, IEEE 802.11p is adapted. This is an update to the IEEE 802.11 specifications, the benchmark for wireless LAN hardware and software. (WLANs). Most IEEE 802.11 protocols are designed with the assumption that nodes (end devices) in a network will interact with one another through access points. (APs). (Access points). The dynamic structure of a VANET allows for a reduction in the number of APs required [4]. As an alternative, peer-to-peer transmission is frequently used, in which the servers perform the role of infrastructure. However, a VANET network spreads data using.

3.2.2 Bluetooth

Similarly labeled as 802.15.1. In terms of one-on-one wireless contact, it is the most pervasive system at present. (wPAN). Rates can go up to 2Mbps, and ranges can go up to 100 meters, with different classes based on electricity requirements. It uses an unlicensed frequency range and has reliable security protocols.

3.2.3 UWB

The Ultra-Wide Band standard, which is built on the IEEE 802.15.3 protocol, achieves its results by emitting weak signals over a broad frequency range. While its range is extremely short at only 10 meters, the 480 Mbps it offers more than makes up for its shortcoming. It has a minimal need for electricity, making it ideal for use in remote areas.

3.2.4 ZigBee

The 802.15.3-based Ultra-Wide Band standard operates by dispersing a small amount of energy over a broad frequency range. It has a short range (only 10 meters), but its 480 Mbps transmission speed makes up for it. It has a minimal need for electricity, making it ideal for use in remote areas.

3.2.5 AODV Protocols

Another example of a scenario where route tables are useful is in wireless ad hoc network routing algorithms. Sending data from one node to another requires consulting the node's routing table, which contains the paths that must be taken. When it comes to routing, proactive protocols and reactionary protocols are very different from one another. Proactive protocols, such as OLSR, encourage frequent control message exchanges, which allows nodes to accurately model the network structure. (Optimized Link State Routing). On a regular basis, a node checks to see if its peers are still online. Every day, and whenever the connectivity detection algorithm is updated, the servers send each other status updates on their connections. It is common procedure to send an abundance of control messages or hello messages to the network to accomplish this. Ad hoc On-Demand Distance-Vector (AODV) is an algorithm designed specifically for use in mobile ad hoc networks. (Also known as "ad hoc wireless networks"). Time and again, each node broadcasts the message "hello" so that every other node can pick it up. An RREQUEST transmission is broadcast by a node when it needs to communicate with another node that is not in its near neighborhood. (From the English: Route Request, or route request message). The RREQ message stores data such as the message's sequence number, sender, and time of expiry. Some have called it the "next generation" of AODV. (From the English: Dynamic Manet on Demand, MANET dynamic on demand). The principles behind DYMO are comparable to AODV.

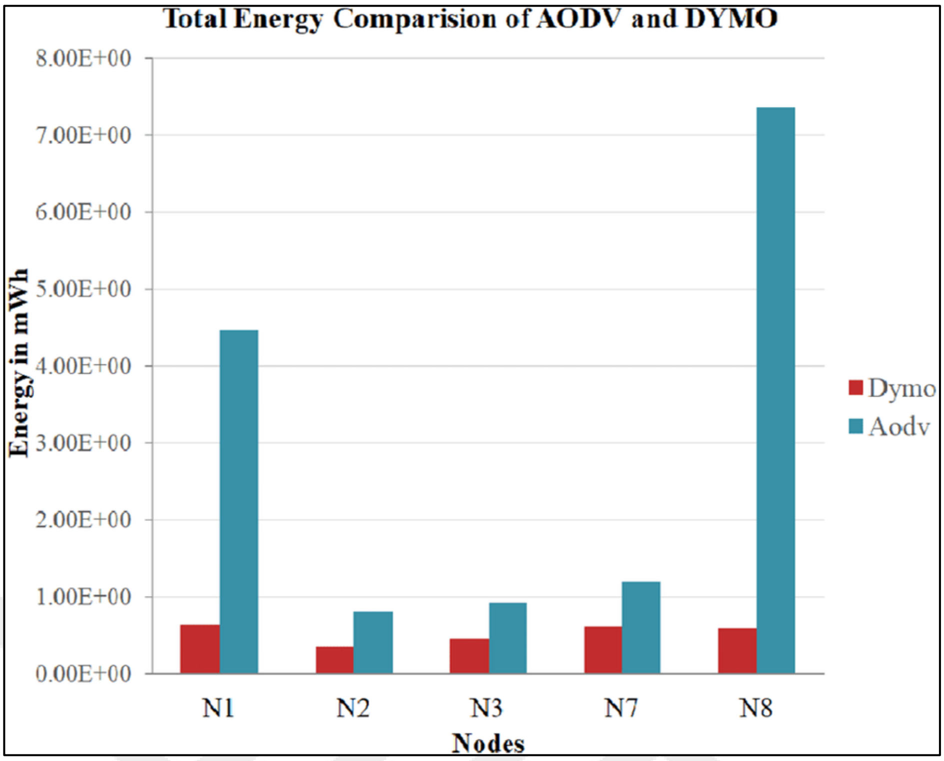

Figure 3.3: DYMO vs AODV Energy Consumption [19].

Because it is a purely reactive protocol, routing calculations are performed only when required. In contrast to the AODV protocol, the DYMO protocol does not broadcast HELLO messages. Instead, it relies solely on the sequence numbers assigned to all packets, thereby eliminating the need to broadcast any unnecessary messages. Using sequence numbers, this protocol ensures that packets reach their destinations successfully. Multi-hop is a feature of Dymo that can be utilized as necessary and on demand. In an ad hoc mobile network, a route between two nodes is only discovered if the routing table does not already contain information about it, and the routes are periodically updated to remove any non-existent routes from the routing table and decrease the likelihood of packet loss [22]. Each node in the network can calculate and updating the local topology in order to evaluate the messages passed between vehicles. According to this topology, adjustments are made to routing databases and alternate paths. As a result, dynamic routing protocols are only used when data packets from the source are transmitted frequently over the network, necessitating the constant updating of routing tables via centralized control design. Conversely, mobile ad-hoc networks, also known as MANETs, reduce the efficiency of proactive protocols' communication channels significantly. Due to the frequent topology changes in MANETs, the transmission of control messages informing nodes of the changes is necessary. When intermittent source data traffic must be transmitted on the fly, reactive protocols are preferred over proactive protocols. Message-forwarding is the process used when using location-based protocols, also referred to as GeoRouting, to forward communications to their intended recipients. In this instance, the nodes are chosen according to their ability to move transmitted data packets closer to the final location. Location-based geographic protocols like GPSR (from Greedy Perimeter Stateless Routing, Greedy Routing by Perimeter) and CBF make use of this technique. (from English, Contention-Based Forwarding) Both methods are commonly used to distribute packets in conventional Ad-hoc or MANET mobile networks. The target node searches its location table in the GPSR method to find the closest neighbor. The data packet is then retransmitted in a unicast fashion after being used to determine the neighbor. CBF, on the other hand, disperses data packets through broadcast interactions. Additionally, the packet includes location data for the originating node. Based on the information given, each recipient will be able to locate their destination. The timers on the receiver are set when a packet is received, and when the timers run out, fresh packets are sent to take the place of the expired ones. The receiver that is nearest to the destination retransmits the packet because the duration of the timer is inversely proportional to the amount of progress made.

Routers can be based on location, path, network topology, or routing [37]. This protocol uses medium information in a domain to help routing choices. Global context calculates the sending path, avoiding source node topology issues. Therefore, intermediate nodes use local context information to quickly forward packets along the path instead of unicast packet forwarding whenever feasible. They can be used for new path discovery, resilience, broadcasting, and multicasting. Vehicle position can be predicted, like network protocols. Road traffic factors predict this. Due to bidirectional traffic flow and fixed roads, a car's speed follows traffic patterns that can be applied to a line of cars. Thus, cars going in opposite directions are linked briefly, while those going in the same route are linked longer,This pair selection method may reduce topology change rates, route change frequency, and routing efficiency [33]..

3.3 OPTIMIZATION ALGORITHMS

In the early 1990s, Kennedy and Eberhart developed an optimization technique for nonlinear functions in continuous and discrete spaces based on the simulation of a simple social model describing the migration of schools and flocks developed a formalized. Using a population of particles that correspond to the individuals and each of which represents a potential solution to the problem, it is possible to search for solutions in PSO systems Particles "fly" through the search space until they reach a stable state, which is accomplished by restricting the search space. A presumption of the PSO system is that individuals disregard their own experiences and instead adopt the beliefs of their successful peers. Both "social only" and "cognitive only" models support this supposition. The location of a particle can be altered using either of these two models A point in N-dimensional space is used to represent the I-th particle in particle swarm optimization (iN). Pi = pi1, pi2 (),, piN represents the particle's previous best position, i.e., the position where the best value of the cost function was obtained in the previous iteration. g represents the best estimate of where things should be based on the opinion of the general public. When the velocity of a particle I is calculated as vi = vi1, vi2,, v, the result is expressed as vi = vi1, vi2,..., v. (iN). Using the following equations and formulas (one and two), it is possible to manipulate particles: R1 and R2 are two random numbers between 0.01 and 1 within the range [29]. 0.01 to 1. The new velocity of the particle is calculated using equation (1), which considers the particle's previous velocity as well as the distances between its current position and the best position and the best position within the group. According to equation 2, the particle then moves to a new location. Inertia represents the mass of the world. Here is an example of a formal formulation of the problem of multi-objective evolutionary optimization: Determine where the vexillum is located.

$$X = [x_1 x_2, \dots \dots . . x_n] \tag{3.1}$$

That satisfies the m inequality constraints

$$g_i(x) \leq 0 \qquad i = 1,2,3, \dots \dots \dots m \tag{3.2}$$

And optimize the vector function

$$F(X) = [f_1(x), f_2(x), \dots \dots . , f_k]^T \tag{3.3}$$

A set of evaluation criteria is required to determine a solution's "goodness" in terms of overall quality. These criteria are expressed as objective functions and can be computed by taking into account the decision variables. The possible outcomes of a multi-objective problem are as follows:

Enhance the functionality of all target functions. Increase the value of every objective function. "Reduce some functions while enhancing the efficacy of others." Typically, maximization and minimization problems are employed to simplify a problem. By applying the following identity, all functions that should be maximized can be transformed into problems that should be minimized:

$$\max\ f_i(x) = \min(-f_i(x)) \tag{3.4}$$

It is possible to control the particle's ability to switch between local and global (short-range and long-range) exploration by employing the Shi and Eberhart (1998) method, which controls the influence of previous speeds on the current speed. As a result, a heavier inertial mass is more conducive to global scanning, whereas a lighter mass is more conducive to local scanning, which helps to narrow the search area. When the inertial weight is properly chosen to provide a balance between local and global search capabilities, the number of iterations required to find the optimal point is reduced. Despite the conceptual simplicity of the PSO algorithm, there is a desire to enhance its performance through a variety of means. Eberhart and Kennedy (1995) modified the neighborhood concept starting with the best global position pg., the best position of the m closest particles pl, and the best position of the m nearest particles pg. (1995). Clerc (1999) uses a constriction factor K to keep PSO particles moving continuously, which aids in the algorithm's completion. Lvbjerg and Kink (2001, 2002) merged PSO with the reproduction seen in Genetic Algorithms, subpopulations, and critical self-organization in order to increase the population's diversity. (SOC). As the work proceeds, the inertia (w), as well as the individual (c1) and social (c2) parameters, change because EPSO generates its self-adaptation using a Gaussian distribution.

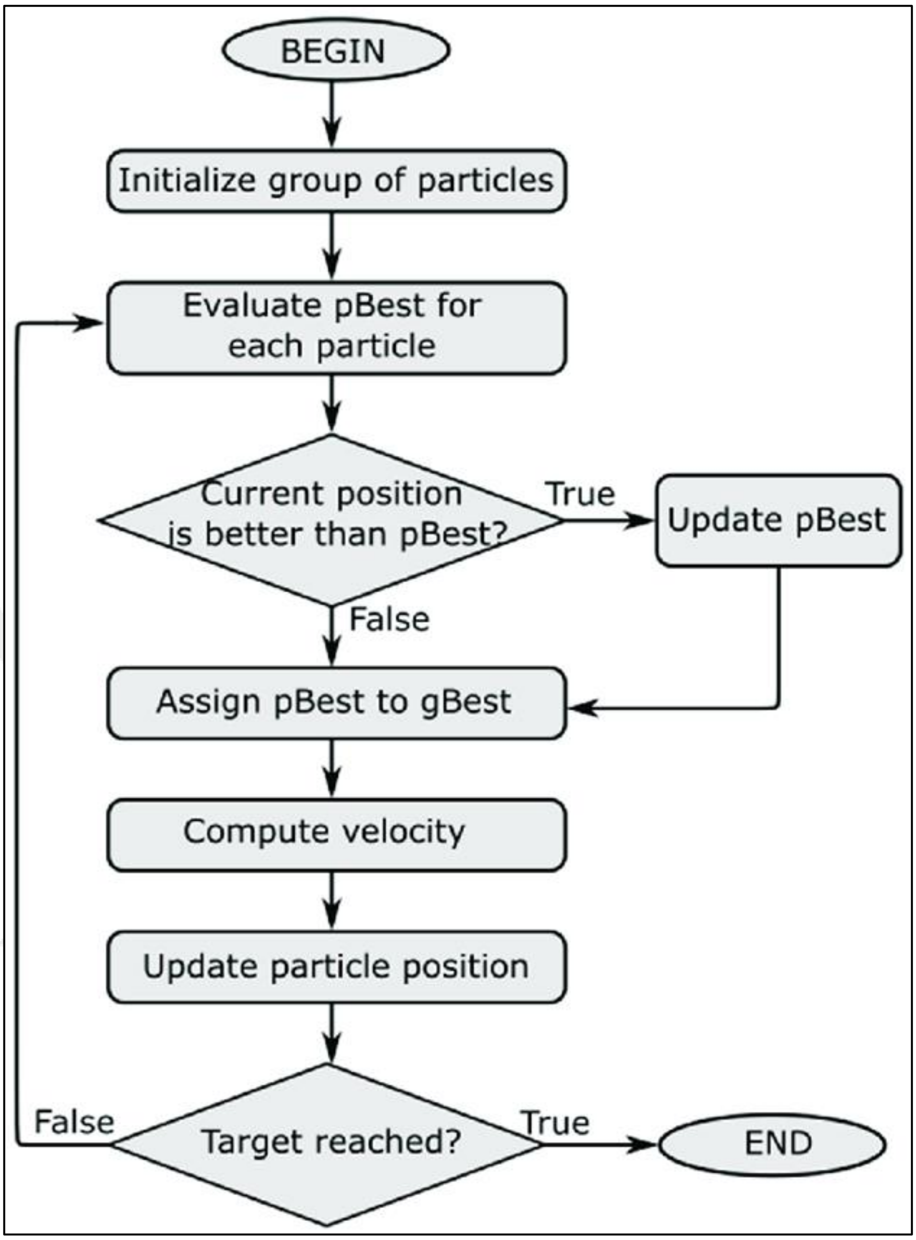

Figure 3.5: PSO Diagram.

According to Zhang and Xie (2003), the inclusion of a differential evolution operator results in a Gaussian-type mutation on the pin and the DEPSO variant. In the previous section, the differential evolution operator was discussed. Monson and Seppi (2004) created their own version of the KSwarm algorithm by incorporating a Kalman filter (Kalman Swarm, 2004). Genetic programming, according to Poli et al., can be used to evolve the most optimal force-generating equations for controlling particles (2005). In contrast to the previous definition of "neighborhood," the variation with independent neighborhoods (INPSO) presented by

Grosan et al. (2005) is distinguished by the formation of independent sub-swarms. Tillett and colleagues (2005) introduce the concept of natural selection in DPSO variation by stating that subswarms are either reproduced or eliminated based on their performance as a whole. As demonstrated by Liu and Abraham (2005) in their research on turbulence (TPSO) and diffusely adapted turbulence, a significant decrease in particle velocity results in a penalty that prevents rapid convergence (FATPSO). When evaluating repellency in their study, Leontitsis et al. (2006) take into consideration the concept of worst point repellency. Yisu et al. (2007) introduced three variants: distribution vector (DVPSO), crossing ability (COPSO), and environmental adaptation (Yisu et al., 2007). (2007). (LAPSO). In order to gain a deeper comprehension of the behavior of the PSO algorithm, additional areas of research include mathematical and statistical analysis (e.g. Ozca and Mohan, 1999; Clerc and Kennedy, 2002; Bartz-Beielstein et al., 2004). This algorithm can also be used to obtain results that are superior to those obtained through other optimization techniques, as well as to develop new applications. Backpropagation-free training of neural networks (Easter Selvan et al., 2003), tuning of PID controllers (Krohling and colleagues, 2002), tuning of neuronal controllers (E. Conradie et al., 2002), and tuning of predictive controllers (E. Conradie et al., 2002) are among the many applications (Krohling et al., 2002). 2003 (Yuan et al.).

4. PROPOSED METHOD

4.1 MAODV

MAODV, also known as Multicast AODV, is the protocol's multicast extension. Each multicast group will have multiple sources and destinations, all of which will be connected to a shared bidirectional multicast tree. As long as a group member is connected to a specific branch, the tree will continue to exist. A node that keeps track of the group's sequence number leads multicast groups. This sequence number ensures that the multicast group always has access to the most up-to-date routes by ensuring that they are always the most up-to-date routes. The leader node is the node that acts as the multicast tree's root. Due to the fact that MAODV and AODV unicast share the Route Request (RREQ) and Route Reply (RREP) packets, the operation and design of these two protocols are extremely similar. There are also group-specific messages known as Multicast Activation (MACT) and Group Hello (GRPH). The TTL field in the header indicates the spread range of the RREQs. The network is flooded with group leader nodes, each of which broadcasts its address, group leader status, and the sequence number of the relevant group. In order for a node to send messages to a multicast group, it must first attempt to become the group's leader. If no response is received, he assumes command and begins transmitting his message. If the group leader had received an announcement message, data messages were sent directly to him for distribution over the multicast tree; otherwise, they were sent to the entire group. Sending a request to the network when a node wants to join a group as a receiver causes the network to be flooded with requests. These requests may receive responses from any member of the multicast group. Nodes that receive responses during their journey through the network are automatically added to the multicast tree.

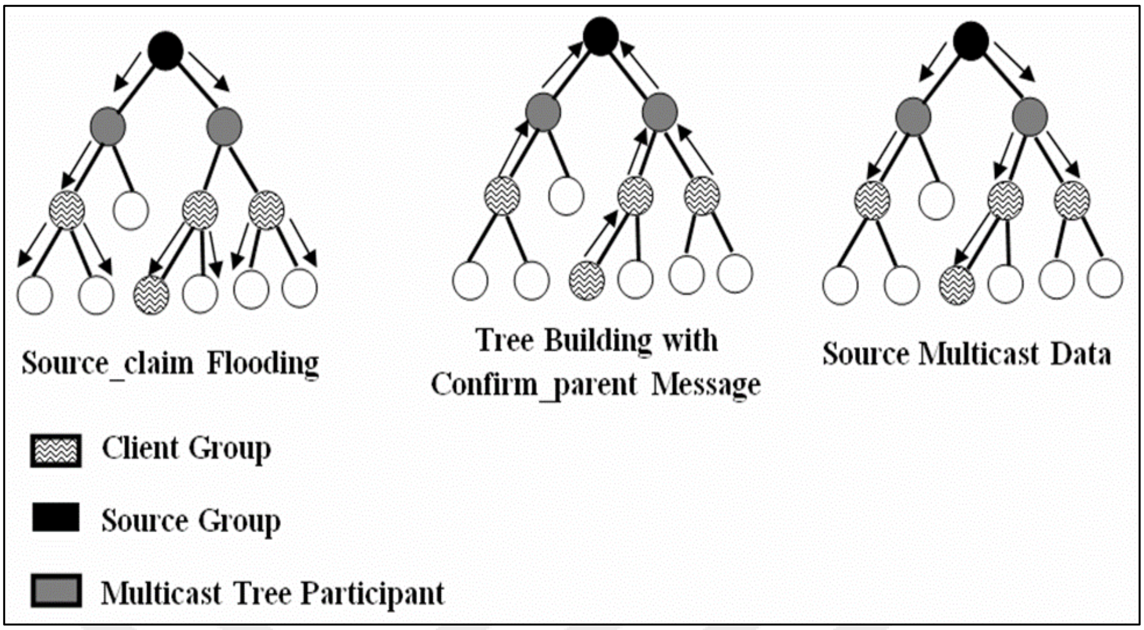

Figure 4.1: Multicast Tree Flooding in PSO.

A mechanism for controlling access to the network and the services it provides is required in VANETs, just as it is in conventional networks. Nodes are responsible for management and routing in a VANET because there is no centralized management or routing unit. If an intruder gains access to network services, the results could be catastrophic. Intruders may have the ability to sabotage traffic routing or gain access to user IDs. The network layer is responsible for ensuring that no unauthorized nodes receive or route data by joining the network. It is also essential to prevent unauthorized access to application-layer services, such as key management. Authentication of network users is currently the most prevalent form of access control in the industry. Example: A user must identify himself to the network prior to the network authenticating him as an authorized user. Depending on the type of ad hoc network and whether or not the services are centralized or distributed, a variety of access control mechanisms must be implemented. To utilize a distributed network access control mechanism, we will need digital certificates and certification authorities. In other authentication schemes involving centralized services, the user and password are required. Prior to configuring the network's access control mechanisms, it is highly advantageous to conduct preliminary research on the network's security requirements.

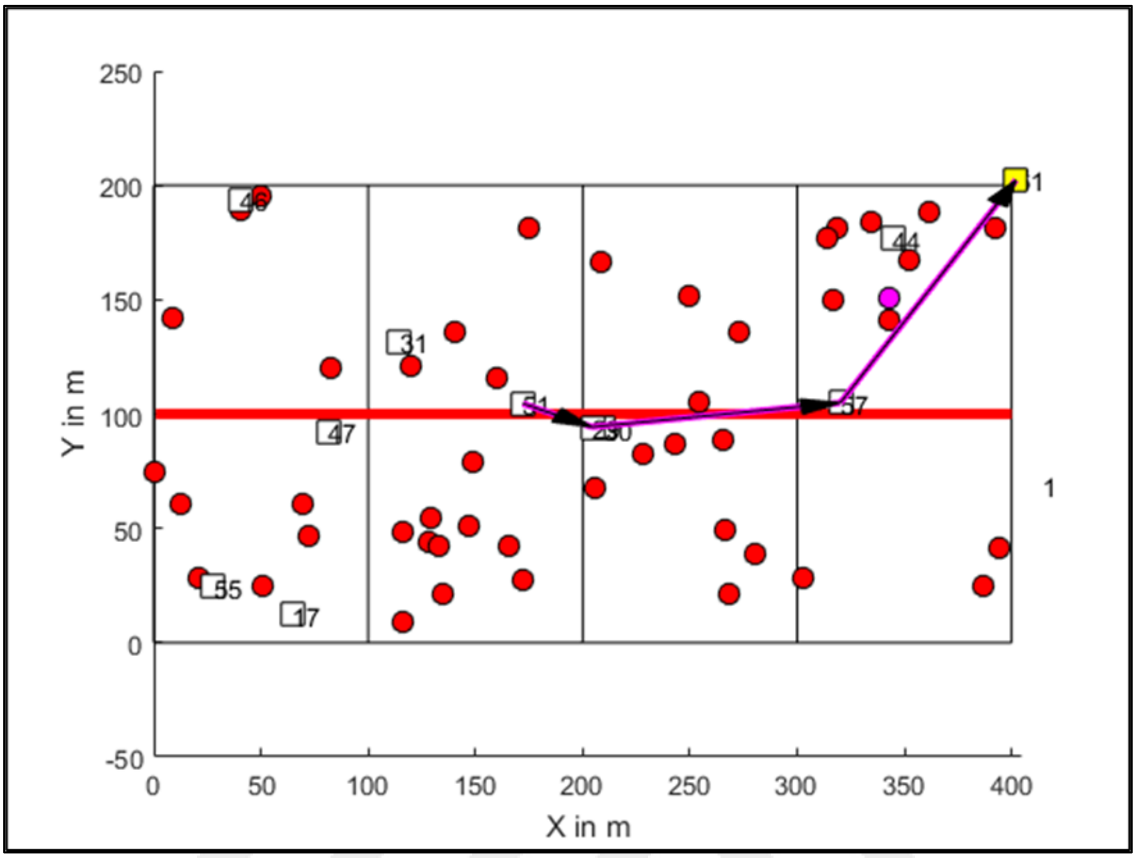

Figure 4.2: Simulation of VANET AODV in MATLAB R2021a.

4.2 MOADV PSO WORKFLOW

[23] When we speak of staggery, we are referring to the capacity of agents to alter their environment and respond to those modifications. Using this method, individual particles communicate with one another to determine the optimal solution. Using circuit switching, circuit switching networks are a type of communication network. In packet-switched networks, each data packet may take a different path through a fixed virtual circuit than the one preceding it (also referred to as data networks). Personal computer networks and the Internet are typical examples of what is meant by "big data" in this context. The most important function of a data network is to ensure that its users always have access to the necessary information. This is possible through the use of a suitable network control system. ParticleNet investigations have utilized PSO-based algorithms to help solve the routing problem in telecommunication networks. Routing in a network refers to the procedures required to transmit data from one node to another. Regardless of its significance, its

widespread impact on network performance, as well as the randomness and instability it can exhibit over time, make it a difficult problem to solve. Along with the problem's physical distribution across a real network, this is one of the characteristics of PSO algorithms that makes them a particularly promising method for solving it.

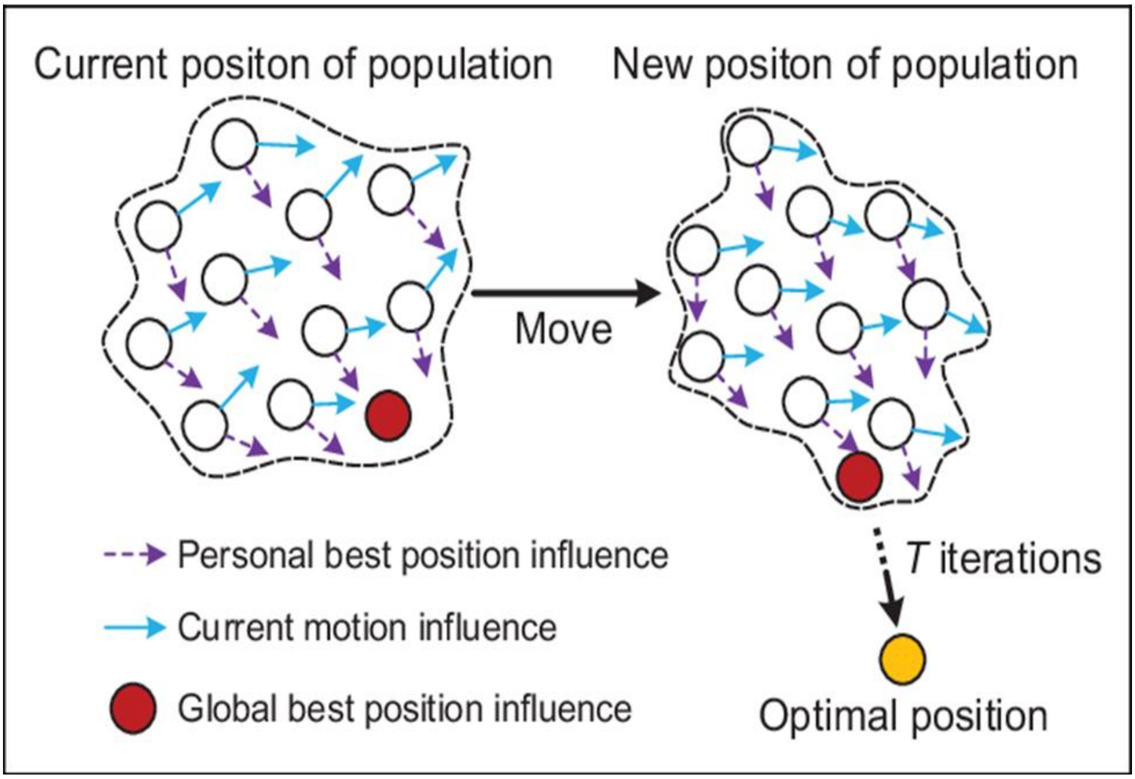

Figure 4.3: PSO Particle Net Optimization.

The PSO processing paradigm is an excellent choice for distributed mechanisms that require high levels of redundancy and fault tolerance, as well as the flexibility to accommodate a wide range of objectives and constraints. In terms of routing problems, PSO is the only algorithm that has produced experimentally and numerically satisfactory results [27], despite the fact that ParticleNet has developed a variety of algorithms. The primary objective of PSO is to enhance the efficiency and performance of a heuristic. Particle Colony Optimization (PCO) routing algorithms are frequently employed in order to determine the most efficient routes. The idea that the principles of particle self-organization, which allow natural particles to behave in highly coordinated ways, can be applied to groups of artificial agents collaborating to solve computational problems, is central to this method. Computer scientists have utilized particle collective intelligence models to optimize and control practical algorithms [27] in recent years. [28]. PSO has been applied to numerous problems, such as the traveler problem [22] and the quadratic assignment problem [23]. These are only two examples of issues where PSO has been utilized. According to the results of the experiments [29], particle colonies can find the shortest path between two points in their environment by employing probabilistic rules based on local information. This meta-heuristic has a vast array of potential applications, and theoretical understanding has significantly enhanced the performance of algorithms that employ it in their design. However, there are still numerous areas where multiple contributions can be made, as listed below. The application of PSO algorithms to more complex optimization problems, such as those involving dynamic data, function objective values, and parameter values, is one of these research areas. Constraints and decision-making are both dynamic and subject to change. Due to uncertainty or other factors such as approximation or approximation, when we only have probabilistic information about objective function values, decision variable values, or restriction limits; multi-objective tasks that evaluate the quality of solutions based on objective functions; when we only have probabilistic information about objective function values, decision variable values, or restriction limits; [29].

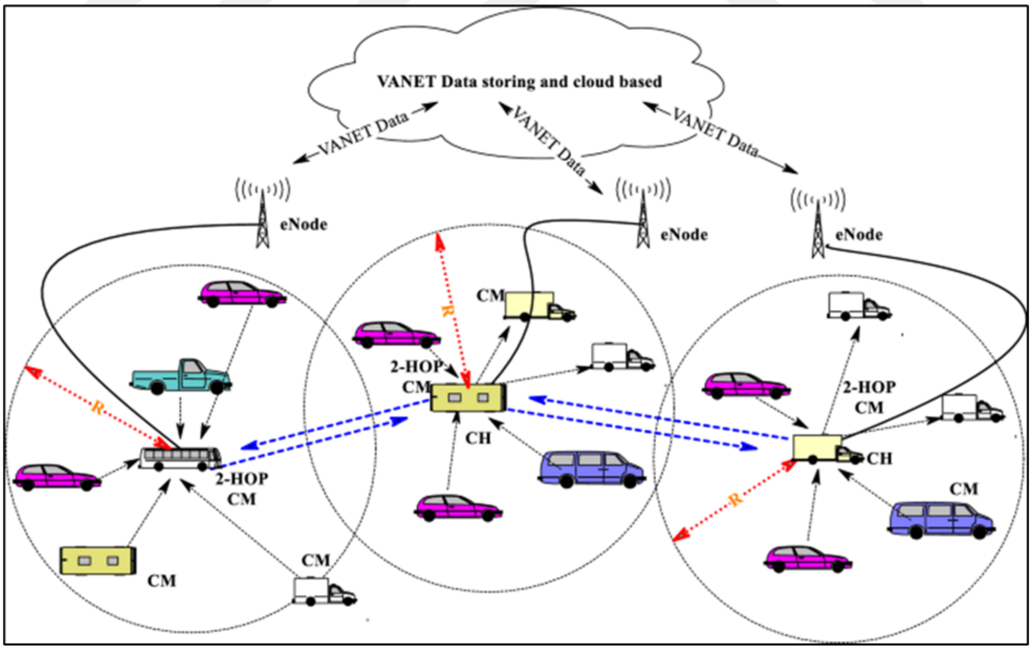

Figure 4.4: PSO MOADV Workflow.

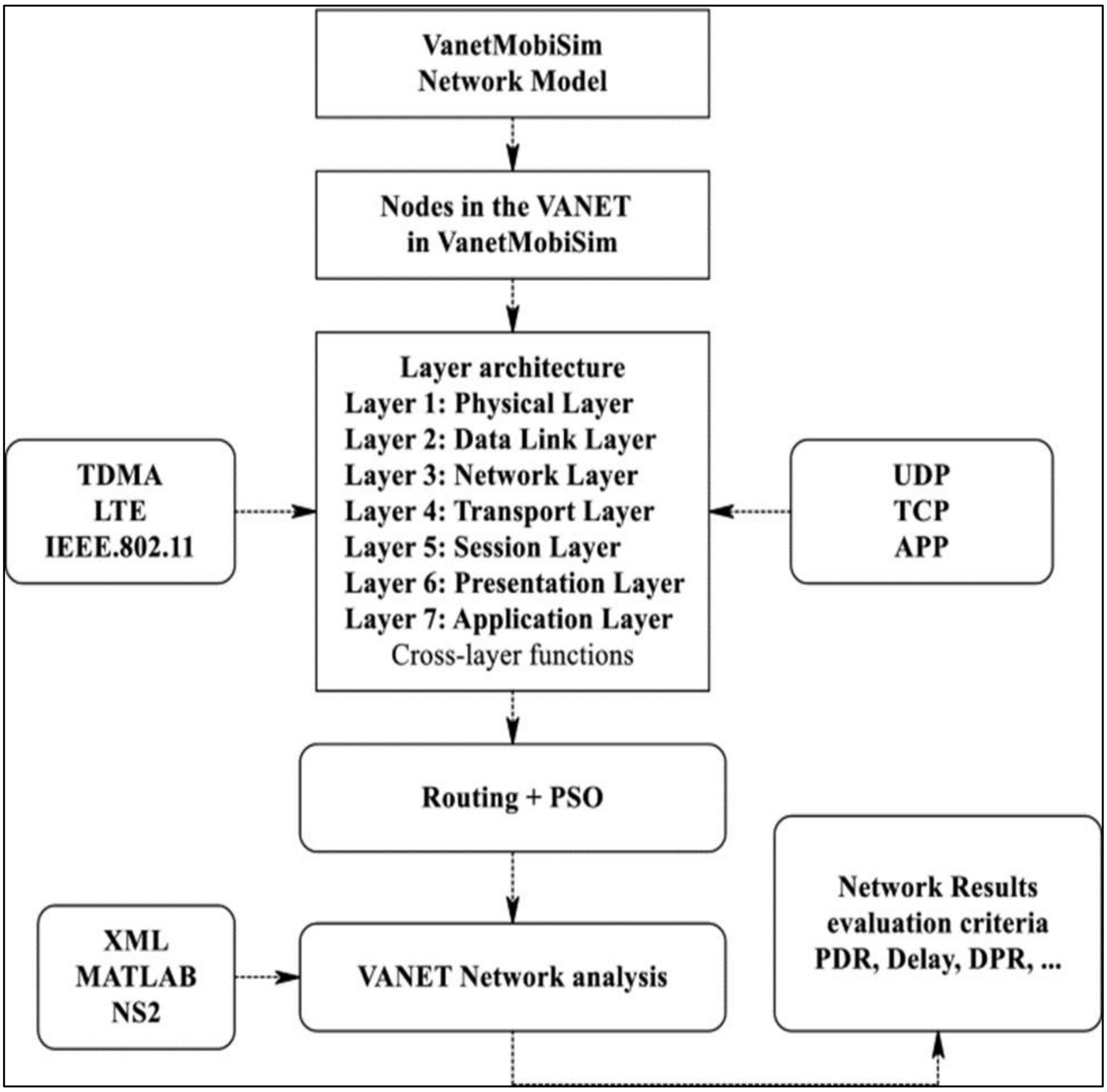

Figure 4.5: PSO VANET Scheme.

This section introduces an Ant Colony Optimization model that can be used to enable users to access various system resources from any location when working in an Internet of Vehicles (IoV) environment. Figure 7-2 depicts the interaction between various IOVs for the purpose of gaining access to various resources. VANET networks are designed to provide quick and easy access to a variety of resources for vehicles, regardless of their location. For the exchange of resources with other vehicles in the network, each vehicle in the network must be willing to collaborate with its neighbors. This can be achieved by employing intermediate nodes that serve as repeaters between vehicles. Using cooperative models between nodes in a P2P system, vehicles in an IOV environment can perform a variety of tasks [11], which are described in greater detail below. The closest RSUs deployed along the highway can also share resources such as bandwidth, processing power, and storage space. When traffic data is high, RSUs provide services to moving vehicles in order to reduce access delay and increase infrastructure reliability, thereby reducing congestion. Utilizing the IEEE 802.11 protocol family, which includes Zigbee, Bluetooth, and WiFi, it is possible for vehicles to communicate over both short and long distances. Due to the high mobility of nodes in an IOV environment, a standard must be implemented; however, vehicles can share their resources with other vehicles that also share an access channel. The infrastructure of a distributed model is provided by decentralized nodes responsible for programming and switching. There are multiple services operating concurrently. Peer-to-peer and remote server units (RSUs) may be utilized to develop both local and global resource sharing (centralized server). Accessing resources from any location necessitates a trade-off between the time required and the amount of administrative burden incurred. In order for packet switching to be effective, an optimal system must be in place, which necessitates the assignment of different resources to distinct resources based on their data is collected in a spatial-temporal environment.

5. SIMULATION AND RESULTS

The first possible results are tested using these algorithms. These outcomes are direct communications over a VANET and indirect communications over a VANET via intermediate nodes. During this study, the following distinct ad hoc unicast algorithms will be simulated: - MAODV - DSDV - DSR - FSR - OLSR In chapter 2 of the state of the art, the characteristics of each protocol are explained; however, at this point, it is important to remember to which group each of them belongs. The MAODV and DSR protocols are both reactionary, while the other protocols are proactive. Two nodes are selected at random from the pool of available nodes for each configuration, and a connection is established between those two nodes using first the UDP protocol and then the TCP protocol.

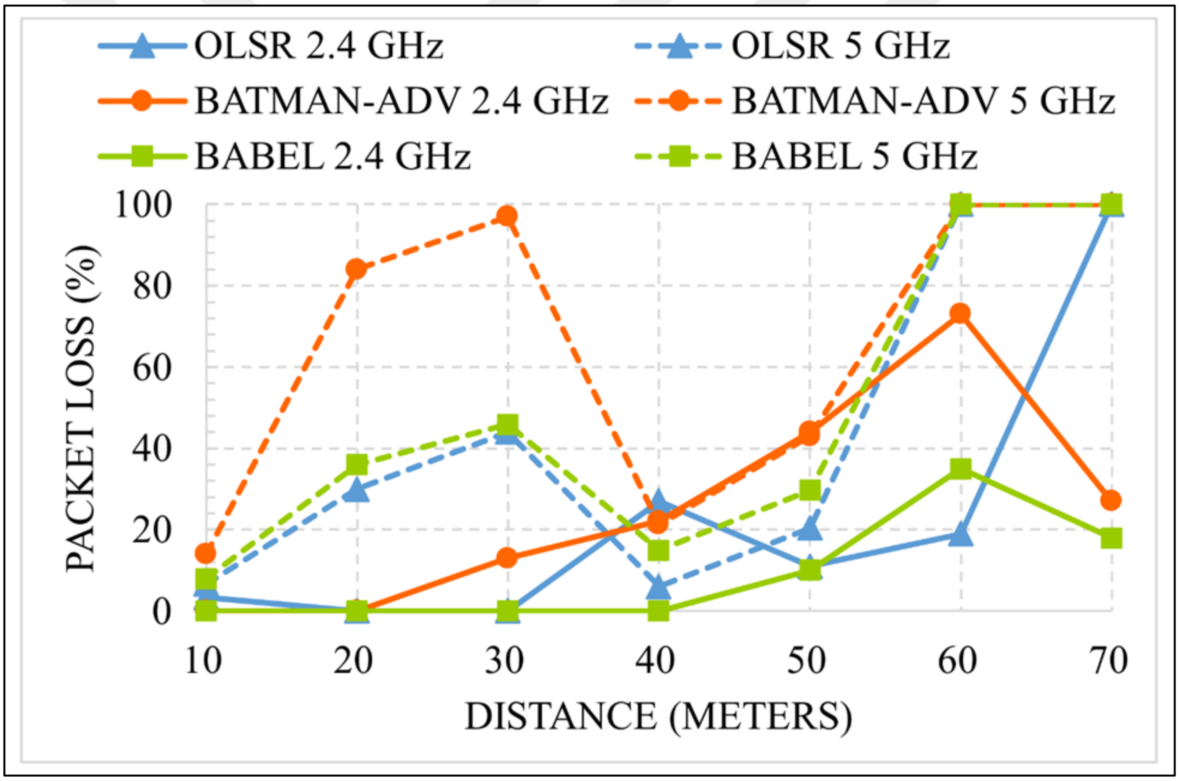

Figure 5.1: Packet Delivery Success Rate Over Distance.

As it is similar to UDP applications in that it sends data at a constant rate and doesn't care if the packets have been delivered, a UDP CBR (Constant Bit Rate) application has been selected. In order to mimic a TCP link, FTP software was selected. Connections must have the following characteristics, all of which will be specified in the tcl file: When using TCP for file transfer via FTP, frames of 1000 bytes are typically transmitted. Congestion is managed by the TCP TAHOE method with a 20-packet window size. The data packet size for CBR over UDP is 210 bytes, and it is transmitted at 448 kbps at a time period of 3.75 milliseconds. Postal service limits the number of parcels sent per day to 2684353456. All of the protocols are used to simulate these links and their results are compared in terms of packet delivery success rate (pdfr), latency from beginning to finish, and the amount of extra communication required by each protocol. To provide a visual representation of the performance of each protocol, we will show three-dimensional graphs of the results obtained. While additional comparisons could be made—by, say, changing the speed of the vehicles or gradually adding more connections to the VANET—we believe that the ones we've already considered are adequately representative for our case study. Prior to beginning the task at hand, it is vital to investigate the surrounding area thoroughly. To that end, we need to double-check that our two-node setup maintains the same relative positions across all situations, despite variations in traffic flows and protocols. The viability of the simulation findings depends on meeting this requirement. Choosing the nodes at random would produce an unpredictable outcome, such as a situation in which no packets could possibly reach the cars because they were too far away to be seen, or vice versa. Because of how near they are to one another, the pdfr is always one hundred percent, and the connection is always direct. The components that will be taken into account in the simulation are selected through a series of pre-tests. As a result of nam's animation, we are able to see how various transportation options work. Observations show that nodes 0 and 1 always appear first in their respective lanes, and that by keeping the same speed scheme across all scanners, their relative positions remain unchanged; the distance between them only changes as a function of the total number of vehicles.

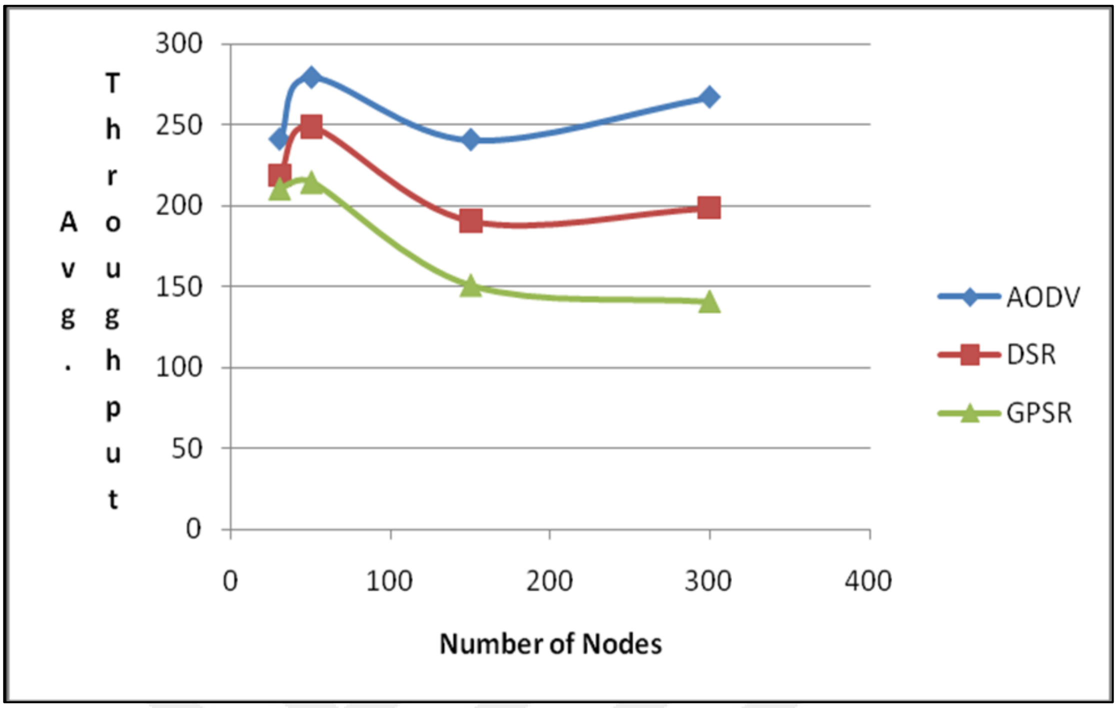

Figure 5.2 Throughput Over the Number of Nodes.

5.1 COMPARISON BETWEEN PROTOCOLS

The mean profile exhibits optimal behavior for the situation under consideration. Indeed, it is within this situation where we find the highest delivery percentage across all protocols. The success rate, delay, and overhead of reactive procedures are all better than those of non-reactive ones. This is to be expected given the high rate of topology change in VANETs, rendering proactive protocols outdated in a short amount of time. Let's examine the findings of each image in greater detail: Formula for Success Percentage: Proactive procedures are vastly different from their reactive counterparts (DSR and MAODV, in that order). The success percentages of packet delivery are higher in reactive protocols. For the FSR procedure, we can see that the delivery rates are relatively stable and do not scale linearly with the number of cars on the road. Therefore, FSR is not responsive to topology changes and cannot optimize routes when new nodes are added between the sender and the recipient. When traffic is light, however, pdfr drops. This is because there is no contact between the sender and receiver when there are too few nodes in between them. A primary finding from a comparison of delays is that, across the board, latency decreases dramatically when traffic levels are minimal.

Table 5.1: AODV vs DSR Comparison in Terms of Simulation Parameters.

Parameters	AODV	DSR
Source Routing	No	Yes
Time Relay	Does relay	Doesn't relay
Path Discovered	Single route	Multiple routes
Periodic Broadcast	Yes(HELLO message)	No
Routing Overhead	Less	More
Route Storage Structure	Routing Table	Route Cache
Benefit	Adaptable to highly dynamic network topologies	Multiple Routes
Caching Overhead	Low	High

Even if it is the case that a lower number of packets make it to their destination, the ones that do experience shorter wait times because they travel through a smaller number of intermediate sites on their way there. Even though they have a superior pdfr, the reactive protocols have significantly longer delay times. This is because they have access to more recent and up-to-date routes, but the fact that the route discovery procedure is carried out each time a packet needs to be sent results in transmission delays. This can be explained by the fact that they receive updated and more recent routes. MAODV has fewer delays than DSR within the realm of reactive protocols, with the exception of the high traffic profile. - In the clouds: The OLSR behavior attracts attention in the overhead graph because it displays an overhead that is significantly higher than that of the other protocols. As a result, we are able to draw the conclusion that its utilization in those settings is not recommended. The network is subjected to less strain thanks to reactive procedures.

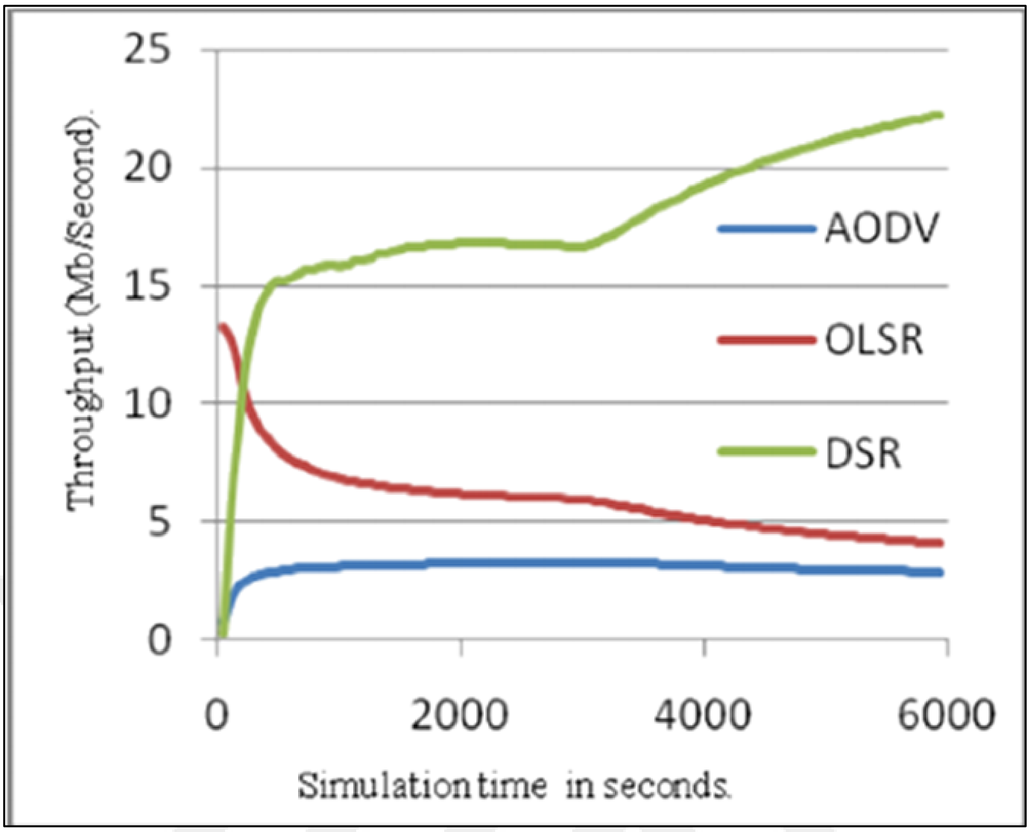

Figure 5.3: Average End to End Delay in AODV, OLSR and DSR.

6. CONCLUSION

IOV is the name of a new area of study that concentrates on the idea of vehicles as information-sharing devices with Internet connectivity. This research effort looked into the process of creating and implementing VANET networks. As a result, the main drawbacks and traits of this type of wireless communication network have been described, and their importance in the framework of an Internet of Things future has been illustrated. Nodes in an IOV environment have the potential to provide safety and entertainment for passengers on board, but due to continuous topological changes and the variable density of vehicles on the road, the diffusion of information to the destination requires a specialized approach, specifically in the IOV environment. In this work, we suggest an optimization-based method for improving the performance of 802.11p. By modifying information from this type of network, such as vehicle location, speed, and link information, this method makes it possible to predict neighboring vehicle mobility and connection. In this model, a hybrid routing approach that combines topology-based and location-based routing techniques is developed using car position and link information. ices. Based on link variables and message propagation randomness, the heuristic determined the best course of action. It is possible to increase the effectiveness and dependability of data dissemination and transfer by using optimization theory to program artificial ants to take the best course. A route-updating method was created to maintain traffic balancing. By storing pheromone information in their routing tables and using hello signals to find out the status of their near neighbors, nodes can maintain the efficiency of their paths. The pheromone level of the link determines how best to communicate between the source and destination nodes. The suggested method produces the best outcomes in packet loss and packet reception under a variety of conditions and vehicle densities.

The VANET simulation and the tools needed to simulate two urban scenarios and one freeway scenario were created using maps of Basra city and the i95 highway as a starting point. Fuzzy methods based on multiple criteria are suggested and evaluated on these maps for use in AODV routing decision making. The first of these fuzzy methods considers the number of relay nodes, distance relative to transmission range, and vehicle movement speed, which are all significant factors in the VANET environment, and the second of these fuzzy methods considers the number of relay nodes, distance relative to transmission range, and vehicle movement speed. Second, the proposed fuzzy system is compressed to reduce the computational complexity of taking into consideration many variables concurrently, and the vehicle direction factor is added to the first proposed system. Simulations confirmed the effectiveness and efficiency of the suggested schemes. It's conceivable that in the near or far future, researchers will investigate even more intelligent methods.

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