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Resource Allocation and Edge Computing for Dual Hop Communication in Satellite Assisted UAVs enabled VANETs

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ABSTRACT: VANETs are highly attractive and is used in maximum of the applications of cross-regional communication. To increase the coverage of the vehicular network, Unmanned Arial Vehicles (UAVs) are introduced, and they get connected with the satellite networks to perform heterogeneous communication. With the help of this connectivity, the communication quality of ground level to air medium is increased. Currently the vehicle usage is highly increased and as a results of communication link failure, improper resource allocation are arises whither abruptly assumes a stability about a network with that increases an energy consumption and communication delay in the heterogeneous networks. In these conditions, thus study is idea of Resource Allocation and Edge Computing for Dual Hop Communication (RAEDH) in introduced in satellite assisted UAVs enabled VANETs. The major sections of the approach are UAV assisted mobile computing, resource allocation among the vehicles and the UAVs, and dual communication among the vehicles and the UAVs.Through these methods the input resources are properly allocated and that reduces the power utility and communication delay. Initially, the vehicular network is established, incorporating trusted components like TA, RSU, and CRS. Subsequently, mobile edge computing reduces energy consumption through computation offloading and optimized UAV trajectory selection. Resource allocation, facilitated by whale optimization, ensures effective utilization across vehicles. The implementation of this method is done in NS3, and the scenario is analyzed using two parameters like number of vehicles and its speed. The output parameters that remain thought-out over a performance examination stay throughput, end-to-end delay, energy efficiency, packet loss, packet delivery ratio, and routing overhead, and as well those results are compared with the earlier methods. Finally, dual-hop transmission between vehicles and UAVs enhances delivery ratio and throughput. From the results and discussion, it has been proven that the proposed RAEDH-SAVs attained maximum results in terms of energy efficiency, delivery ratio, and throughput.

Index Terms: Vehicular ad hoc networks (VANETs), Resource Allocation, Edge Computing, Dual Hop Communication, Satellite Assisted UAVs enabled VANETs.

1. INTRODUCTION

High mobility, speed, frequently varying topology, and irregular node distribution in an ever-changing environment have made Vehicular Ad-hoc Networks (VANETs) increasingly popular, and they now account for the vast majority of ITS deployments [1]. In order to organize the VANETs environment a special standard is developed which is IEEE 802.11p. The primary goal of this protocol's development is to improve wireless communication efficiency in a constantly changing environment [2], [3]. This protocol is mainly developed to enhance the efficiency of the wireless communication in the frequently varying environment [4],[5],[6].

The automobile industry has seen a qualitative transformation in recent years, with the increase in the number of cars connected to the network being mostly attributable to technological and digital advancements [7],[8],[9]. Higher network quality becomes essential to achieve safe driving for the vehicle users so that VANETs concentrates on safety and infotainment [10],[11]. To achieve effective communication among the vehicles producing low latency and faultless connections among the vehicles are needed and that is the only way to increase the Quality of Service (QoS) levels. Since many vehicles are employed in the network in 5G (and beyond) technologies at the moment, it is necessary to improve the vehicles' intelligence in order to overcome barriers on the ground. For that purpose, Unmanned Arial Vehicles (UAVs) are developed which are more flexible to communicate with each other in the VANET infrastructure. It is highly suitable for the infrastructure less environment where it can achieve high road safety and content delivery. The network becomes so wider with the usage of the UAVs so that there is no necessary for the use of Base Stations (BS) and Roadside Units (RSU) in it to monitor the fast moving vehicles. To establish the effective

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connectivity , the UAV can plan its own trajectory so that it can get closer to those vehicles which are present in the dense areas [12]. An architecture of UAVs hanged vehicular communication as explained in Figure 1.

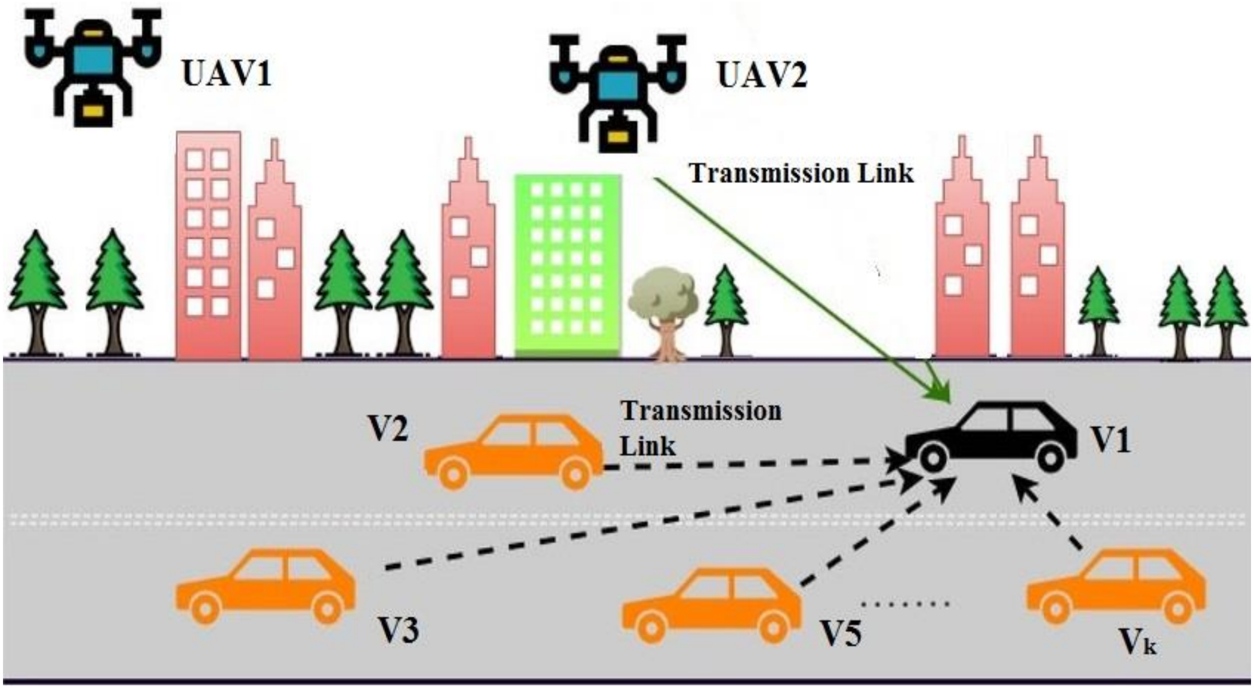

Figure 1 – UAVs hanged Vehicular Communication

The capability of UAVs is that it can fly wider so that it can be used in several applications such as agricultural, public, and military domains. In the agricultural field, the UAV is used to monitor the atmospheric parameters which help to effective farming. In the public sector, the organizations like police, intelligent transportation and safety-based application were UAVs are highly used. With the intervention of UAVs, the critical rescue operation, momentary connectivity to analysis the climatic disasters can be easily identified. Furthermore, to create a wider network area either single or multi-UAVs are created in the network. To achieve effective communication compared with single UAV, the concept of multi-UAV produced more scalability, high efficiency, and lifetime. The construction of multi-UAVs systems is not so easy because of its unique characteristic of most high mobility. The complication is so high when compared to the VANETs constructions. In general, dynamic topology construction consumes more power and that leads to frequent link failure and that results in the creation of incontinence in the cooperative communication. To construct wider network coverage, both single hop and multi-hop-based routing model is essential for the UAVs. Through single hop communication model, the source can send the information directly to the destination without the presence of UAVs. If the base station and the unmanned aerial vehicle (UAV) are within direct communication range, the vehicles will send the data to them immediately. In the multi hop model the UAVs communicate with the vehicles to receive or transmit the data through BS or hop by hop manner. So that best neighbor selection is very essential to achieve effective communication [13],[14],[15].

To improve the communication standard of the vehicular network numerous schemes are developed recently and that helps to enhance the network performance effectively. UAVs constructions are promising alternatives to the RSUs, and the UAVs are more flexible, automatic, and mobile when compared with the RSUs so that it can solve maximum of the vehicles problems simultaneously. In addition, a transmittal connection between UAVs is very stable, allowing vehicles within line-of-sight to the UAVs to accomplish a higher delivery rate than they could with RSUs [16]. Later on the current challenges which are present in the UAVs-assisted VANETs networks are improper resource allocation among the vehicles and the UAVs and as well ineffective edge detection process. Additionally, irregular UAVs mobility creates certain design challenges at the time of communication. With the aim of Resource Allocation and Edge Computing towards Dual Hop Communication is concentrated and the main commit-research study.

Research Contribution:

- For better heterogeneous vehicular communication, a concept on UAV-enabled satellite networks are developed and to achieve high quality in communication RAEDH-SAV approach is developed which is mainly classified into three sections. They are UAV assisted mobile edge computing, resource allocation among the vehicles and the UAVs and dual communication among the vehicles and the UAVs.

- At the initial stage the vehicular network is constructed with the presence of certain devices like Trusted Authority (TA), Roadside Units (RSU), Vehicles (Nodes), Centralized Reputation Serve (CRS) and Pseudonym.
- Secondly, mobile edge computing is developed to reduce the energy utilization through of computation offloading and UAV trajectory selection.
- Then, resource allocation is performed among the vehicles and with the presence of whale optimization and its adaptive methods the resources are effectively allocation among vehicles by a network.
- Finally, dual hop transmittal is initiated among the vehicles and the UAVs and hat helps to increase the delivery ratio and throughput of the vehicles.

The organization of the paper is listed here. In section 2 the earlier researches which are involved in satellite based UAVs assisted VANETs networks remains assessed also its deficiency identified. Inside division 3 a proposed RAEDH-SAV method is discussed, and it includes the ideas of edge computing, resource allocation and dual hop communication. Inside division 4 a performance analysis is performance which considers the number of vehicles and speed. In section the paper conclusion and its future direction are given

2. Related work

This In [17] the author Honghao Gao et.al outlines a dependable VANET routing choice technique based on the Manhattan mobility model that takes roadside units (RSUs) into account for data transfer in both wireless and wired modes. Additionally, for network optimization, a more advanced greedy algorithm for vehicular wireless communication is applied. This method increases the performance of package delivery ratio, time delay, but it consumed high energy for the communication process and that affects the network performance. In [18] the author Yixin He et.al suggested a relay selection algorithm to resolve a multi-objective optimization issue by taking both the Shortest Transmission Protocol (STP) and Transmission Cost (TC) account for the Air-to-Ground into account for the Air-to-Ground (A2G) VANETs. This reduces network complexity it has minimum network density so that only it supports lower number of vehicles and UAVs. In [19] in order to effectively notify the rescue services, Authors Omar Sami et al. provided a trustworthy routing approach to keep communication stability at a high level based on an efficient backbone, taking into account the UAVs' rapid mobility and limited battery capacity. This technique reduces energy consumption, but it affects the throughput and as well this communication process increases the latency by the time contrast data communication among devices. A low-cost roads surveillance Application developed by Fatima Zahra Rabahi.et.al employing drones to aid police officers and drivers on Flying Ad-Hoc Network (FANET) is described in [20]. While the proposed method for UAV-assisted vehicles has a high packet transfer rate, low transmittal delay, and low UAV battery energy consumption, but its communication cost is not effective to perform, and it is not designed in the considerable manner.

In [21] In order to improve the communication between remote places the author Adwitiya et.al, proposed an ad-hoc network based on flying UAVs. This method provides better performance of packet delivery ratio, throughput, and delay but the density of the vehicles are limited in this model and that to attain maximum stability becomes questionable with this method. In [22] the author Jun Xiong et.al, developed a new framework with Global Navigation Satellite System (GNSS), Inertial Measurement Unit (IMU) and vehicles observations which significantly improves the stability and precision of relative state estimation. The drawback of this method is high energy consumption at the time data transmittal among the vehicles. In [23] the author Xianbo Jiang et.al suggested localize based on generalized approximate message passing (GAMP) to determine the positioning of Vehicles. Additionally, Euler angles are employed to classify the Angle of Arrival - Classification (AOA-CL) problem. This gives accurate position of the vehicles, but the process is high complexity at the time of vehicles localization and resource allocation. In [24] the author, Hui Xue et.al, provided a designing method depends on the Wave protocol to implement the hardware and software necessary for the VANET connection terminals. This provides effective communications with high transmittal cost is retained at the end of the communication that may the network stability. For a Ka-band UAV-satellite communication system, Jiadong Yu et al. suggested using a 3D two-dimensional Markov model (3D-2D-MM) for channel tracking [25]. The 3D-2D-MM priors were used to develop a 3D dynamic turbo approximate message passing (3D-DTAMP) algorithm for tracking the dynamic channel. Hence, this enhances the communication, but the affects the factor of throughput and packet delivery ratio at the time of communication among the vehicles.

In [26] the author, Xiangling Li et.al, employs a common composite channel model with associated coverage provided by UAVs that includes both large-scale and small-scale fading. This technique provides quality of service, but the disadvantage is computational cost is not effective enough to attain stable communication. The authors of [27] investigated the efficiency of a High-Speed Train Network (HSTN) with several cache-enabled Amplify and Forward in Three Dimensions (AF 3D) mobile UAV relays, a global User Equipment (UE), and a multi-antenna satellite. Cache-enabled fully 3D mobile UAV relaying works substantially better than fixed height one due to a lower mean distance between the UAV and the UE, but at the expense of high energy consumption so that results in ineffective communication among the vehicles. In [28], Gaofeng et al. model the combined offloading decision, compute, and communication resource allocation issue for satellite-assisted V2V communication as a mixed-integer nonlinear programming problem. Additionally, Markov decision process is employed for optimization problem. This enhances throughput and reduces the packet delay occurrences, but the computational time is high that can create the routing overhead among the vehicles. In [29] the author Ziye Jia et.al, consider the use of LEO satellites to help UAV data collecting for IoRT sensors. Furthermore, Dantzig-Wolfe decomposition is employed for solving optimization problem. This technique obtains low time complexity, but it consumes high energy to provide communication among the UAVs and the vehicles by the time contrast data communication.

In [30] author Shushi Gu et.al, developed an SUMECS-based framework for mobile edge caching and satellite-UAV integration. To solve the issue of maximizing system availability while minimizing system communication costs, researchers have developed multi-parameter and multi-objective optimization problems to choose optimal coding schemes with optimal code-rates but however the disadvantage is it produce lower throughput and high latency at the time of data transmittal between the vehicles. In [31] the author DONG YAN et.al, examined the channel properties of vehicle communication in the millimeter-wave (mm Wave) band at 22.1-23.1 GHz. Channel properties such as received power, Rician K-factor, root-mean-square delay spread, and angular spreads are also studied. This method is useful for Designing V2X communication system with stability but however the computational cost among the vehicles during data transmittal is not moderate. In [32] In order to provide energy efficient data transmittal the author, Qingquan Huang et.al, employed relay to help for satellite signal delivery. Additionally, Dinkelbach's method is used for optimization problem. This method obtains better throughput and packet delivery ratio with low energy consumption, but the computational process is complex and that increase the delay and power utilization among the vehicles. The performance of asymmetric FSO/RF transmittal in a multi-user SUTN is analyzed in [33], wherein the authors Huaicong Kong et al. describe a selective decode-and-forward (DF) protocol. The compromise between system capacity and service equity will be determined via a revolutionary proportional fair scheduling (PFS) approach. The disadvantage is high computational time and communication complexity among the vehicles.

In [34], the author wang developed a VANET model with satellite networks to reduce the congestion and packet losses during transmittal in heterogeneous networks. The overall performance is moderate, and it requires further improvement. In [35], the author sun developed an internet based vehicular network to enhance the communication between the ground and air medium. For this purpose, in this article a drone-based satellite communication is developed were energy-aware coded caching strategy is incorporated with this to enhance the network performance. But the resource allocation among the network is not stable and that leads to affects the network stability. In [36], the author praveen presented a drone based multiantenna multiuser network with free space optics and Nakagami-m distribution to reduce the network delay constraint but the performance is moderate and it needs further improvement to attain high efficiency. After considering the earlier researches it gets understood that in drone based satellite communication several drawbacks are presents so that in this article resource allocation and edge computing for dual hop communication is concentrated and its detailed elaboration is given in the upcoming sections. Table 1, adescribes the earlier research advantages, limitation, and methodology. In [37], integrating UAVs into VANETs to enhance safety applications, particularly in rural areas with limited terrestrial coverage. UAVs serve as flying relays, transmitting alert messages to vehicles following accidents, thus reducing potential crashes, and saving lives. In [38], a space-air-ground integrated network utilizing satellites, UAVs, and IoT devices for wide-area data collection. UAV trajectory design minimizes the age of information (AoI) by pairing UAVs with IoT devices. Deep reinforcement learning is employed for AoI optimization and UAV positioning.

Table 1 – Earlier Research Summary

Ref. No	Methodology Details	Advantages	Limitations
[17]	Advanced greedy algorithm	Efficient package delivery ratio, Minimum Time delay	High energy consumption
[18]	Relay selection algorithm	Reduces network complexity	Minimum network coverage
[19]	Reliable routing strategy	Minimum energy consumption	Moderate throughput and Latency
[20]	low-cost highways surveillance Application	High packet transfer rate, Low UAV battery energy usage	High Communication cost
[21]	ad-hoc network based on flying Unmanned Aerial Vehicles	Efficient Packet Delivery Ratio, Throughput, and Delay	Restricted to large areas
[22]	New framework with Global Navigation	Improves the stability	High energy

	Satellite System (GNSS)	and precision of relative state estimation	consumption
[23]	Localizer based on generalized approximate message passing (GAMP)	Accurate position of the vehicles	Computational process is complexity
[24]	A designing method based on the Wave protocol	Effective communications	transmittal cost is high
[25]	3D two-dimensional Markov model (3D-2D-MM)	Enhances the communication	Poor throughput, packet delivery ratio
[26]	Common Composite Channel Model	Quality of service	Implementation cost is high
[27]	Fully 3D mobile UAV relay	High stability and reliability	High energy consumption
[28]	Joint Offloading and Resource Allocation with Markov decision process	Efficient throughput, reduce packet delay	Computational time is high
[29]	Joint Trajectory with Dantzig-Wolfe decomposition	Low time complexity	High energy consumption.
[30]	SUMECS-based framework with Fault tolerant codes	optimizing system availability and lowering system communication costs	Poor throughput and latency
[31]	Channel properties of satellite link and global link	Stability of the network	Implementation cost is high
[32]	Energy Efficient Beamforming Schemes	Efficient throughput and packet delivery ratio	Computational process is complex
[33]	Novel proportional fair scheduling (PFS) scheme	Enhances quality of service	High computational time
[34]	Cross-Regional transmittal Control	Network Congestion is low	Overall performance is moderate
[35]	Energy-Aware Coded Caching & Resource Optimization	Network Throughput is high	Resource allocation and network stability is moderate
[36]	UAV-Assisted Multi-user global-Satellite Communication	Network Congestion and delay is low	Overall performance is moderate
[37]	SUMO/NS3 simulation shows rapid alert dissemination	Enhances safety applications, rapid alerts in rural VANETs.	Infrastructure investment, regulatory, privacy concerns.
[38]	Gale-Shapely matching; superior performance in simulation.	Comprehensive data collection, AoI minimization, superior performance.	Coordination challenges, computational complexity.

3. Proposed RAEDH-SAV Approach

At the initial stage the vehicular network is constructed with the presence of basic trusted module which includes the Trusted Authority (TA), Roadside Units (RSU), Vehicles (Nodes), Centralized Reputation Serve (CRS) and Pseudonym.

a) TA: It is the primary component of the VANET. The TA has two primary responsibilities. The main duty is the registration of RSUs, OBUs, and nodes. The secondary duty is ensuring security management by validating the authentication of a node, user identity, and OBU identification to protect the node from potential attacks.
b) RSU: These devices are placed on highways and communicate valuable information to nodes located within the coverage area of the RSU. They are connected to cloud servers using either wired or wireless technologies.
c) Vehicles: Vehicles are essential elements of VANET, equipped with an electronic gadget called the On-Board Unit (OBU) that is permanently installed on them. The primary tasks of the OBU are to establish communication with adjacent OBUs installed on the node, as well as with the RSU. In addition, the Teaching Assistant sends several false names to the registered nodes in the VANET.
d) CRS: The primary duty of CRS is to allocate an initial reputation number to every registered node in the network. Moreover, it is also accountable for overseeing and refreshing repute.

e) Pseudonyms: Pseudonyms are unique identities issued to vehicles in the VANET and used only once. Pseudonyms are mostly used to safeguard the confidentiality of nodes. The allocated pseudonyms are frequently changed by the Central Authority (CA).

This proposed RAEDH-SAV is mainly developed to attain effective satellite based drone communication in vehicular networks. The major sections which are involved in this approach are mobile edge computation for UAV network, proper resource allocation among the vehicles and the UAVs and the dual hop communication among the vehicles and the UAVs. The workflow of the proposed RAEDH-SAV is illustrated in figure 2.

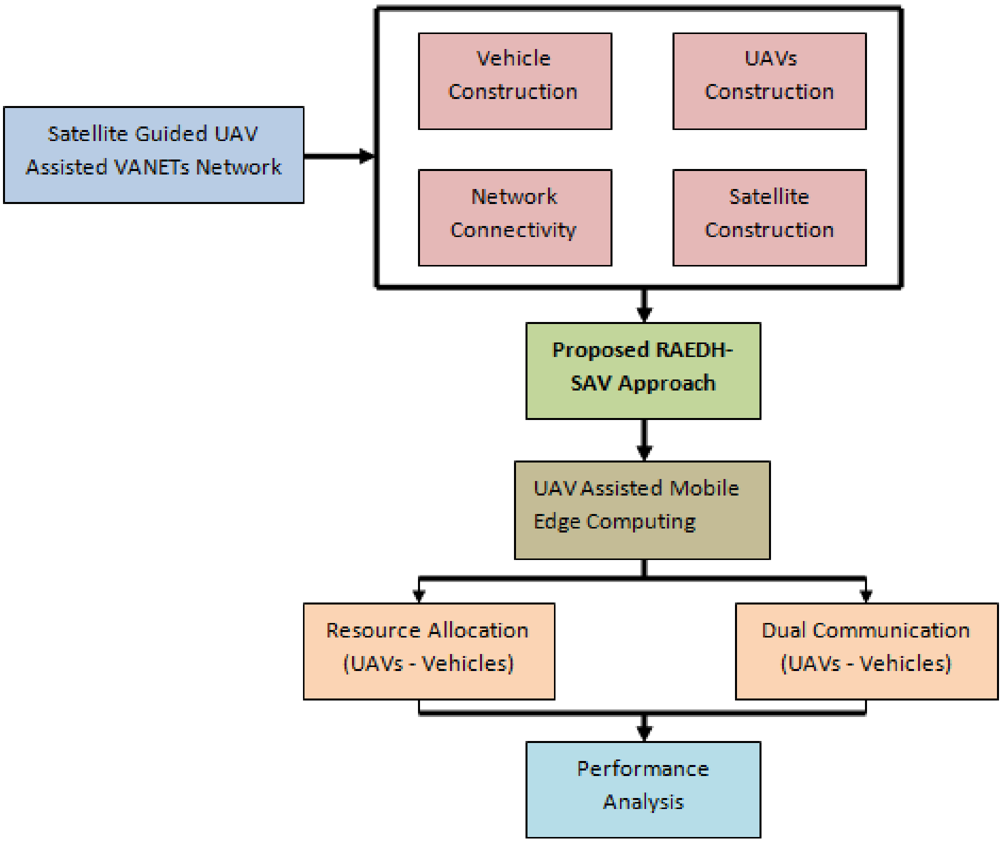

Figure 2 - Workflow of Proposed RAEDH-SAV

3.1 UAV Assisted Mobile Edge Computing

a potential solution to solve these issues is the mobile edge computing network with enabled UAV. The following is a summary of the heterogeneous vehicular network's performance while using UAVs.

- The UAV-enabled heterogeneous vehicular structure prevails resilient along possesses an expansive variety of applications since it uses a line of sight (LoS) connections for communication.
- This network with UAV capabilities may also help users' computing performance greatly.
- Energy savings and increased processing speed are only two of the many benefits of computation offloading that this system with UAV support provides.

Studies on the simultaneous optimization of UAV deployment and job scheduling are currently limited. Three main versions exist: local execution, heterogeneous vehicular network execution, and the hovering UAV model. The processing task is carried out using the mobile device's local execution paradigm. The server aboard the UAV will carry out any tasks that have been assigned to it. The uploaded job for the UAV hover model must be uploaded for a certain amount of time at a predetermined location. The main drawback is that the UAV's flight time limits the computation's performance. The reason is that the acceleration and velocity of the UAV influence its trajectory. In an ad hoc network with several UAVs and users, the interference with mobile devices is affected by the UAV's flight path and the height at which it travels.

The next generation of 5G networks is characterized by their widespread availability, extremely low latency, and exceptionally fast data transmittal rates. Recent advancements in satellite technology, including improved manufacturing processes, spot-beam antennas, and laser transmittal, have made satellites, particularly those in low Earth orbit (LEO), more affordable, compact, and capable of handling high data throughput. These advancements have paved the way for the development of rapid satellite-global networks (STNs) that meet the growing demand for enhanced quality of service (QoS) in terms of high bandwidth, comprehensive scope, minimal delay along energy-saving input processing, and transmittal.

The future growth of the 5G network relies heavily on the development of 5G STNs. Figure 3, a three-tier architecture for high-speed mobile edge computing along with a core requisition in 5G network. This architecture comprises a geostationary orbit (GEO) network, global stations, and a low Earth orbit (LEO) constellation. By leveraging both global stations along LEO asteroid for relaying, STN users gain access to the Internet. Consequently, global stations located consumers can deploy satellite mobile edge computing (SMEC) servers, which serve as gateways for the global backbone network (TBN) through LEO satellites.

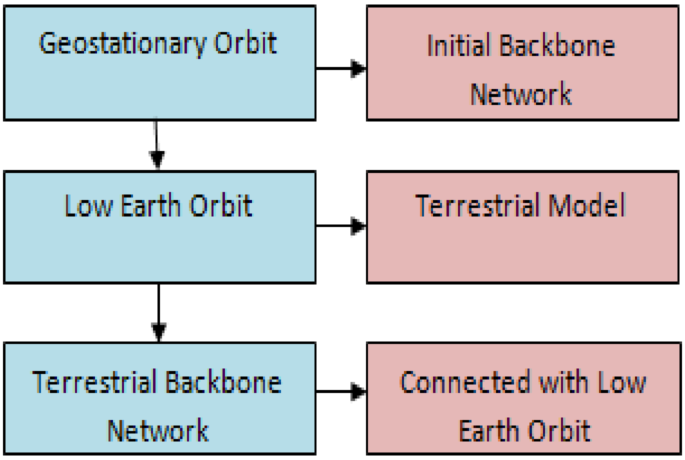

Figure 3 - Architecture for High-Speed Mobile Edge Computing

The benefits of 5G fast satellite globally aided digital phone moves computer storage are summed up in such a way as compared to existing heterogeneous network architecture.

- Since interactions with faraway clouds are not necessary, the model lowers the latency for mobile STN users with limited resources.
- The user-perceived latency will be greatly decreased for several delay-sensitive applications, such as gaming and vehicle networks.
- The processing capability for certain applications with high computational costs is increased for mobile user devices.

As a result, energy use is also decreased. In addition, there are the following problems.

- The LEO constellation has very limited energy and computing resources.
- In addition to inter-satellite linkages, space-global connection be a certain way considered, making the scheduling model more complicated than heterogeneous network.
- Lobal transmittal, space-global transmittal, and satellite-to-satellite communication may all have an impact on energy costs. As a result, modeling the cost of energy in this current network is more difficult than in normal network.
- A LEO satellite's throughput is often not substantially higher than that of eNBs. As a result, the latency limitation should be less strict than it is for heterogeneous network.

3.2 Resource Allocation Using Whale Optimization:

Since the 1980s, SI (Swarm Intelligence) has made way for a novel kind of algorithm, sparking extensive debate and study across several fields. The application of SI has expanded to various fields, such as electronics, communications, and control. SI approaches involve utilizing multiple individuals as the subject of study. They make assessments and interact with other groups using social information to effectively guide individuals' search for optimal outcomes. In 2016, a new approach called Whale Optimization (WO) was introduced, which mimics the social behavior of humpback whales in SI techniques.

3.2.1 Whale Optimization Method

The method of bubble-net hunting is the origin of the WO technique. The main focus of WO is to target prey as the top priority. To avoid the target prey, other search agents adjust their positions based on the hunting strategy discover a best search agent. Equations and the hunting tactic are comparable:

$$D = \| CX^*(t) - X(t) \quad (1)$$

$$X(t+1) = X^*(t) + AD \quad (2)$$

A and C are vectors of coefficients where D is the direction in which the target prey is travelling. The target prey is represented by $X^*(t)$ The iteration counter, t, is used to calculate vectors A and C.

$$A = 2ar - a \tag{3}$$

$$C = 2r \tag{4}$$

Each iteration reduces a linearly from 2 to 0 where r is a random vector in the range [0, 1]. During the exploration and exploitation phases, the humpback whale has the ability to migrate in various directions in pursuit of its prey due to the potential for both positive and negative values for vectors A and C. The technique of bubble netting used by humpback whales involves the utilization of two methods: shrinkage bracketing and spiral updating position. The shrinkage bracketing method is achieved by gradually reducing the value of a. A trajectory shape is calculated using the spiral updating position technique:

$$X(t+) = De^{bl} \cos\left(2\pi l\right) + X^*(t\ c) \tag{5}$$

Where D represents the separation between whale i and its intended prey, b is a constant used to specify how the spiral will look, and l is a random value within the range [-1, 1]. In WO, the combination of (2) and (5) produces novel solutions. Each equation has an equal chance of being utilized.

3.2.2 Adaptive Strategies

Shrinkage bracketing, which are marked as (2) and (5), play a crucial role in controlling the search behavior in the WO technique. These techniques bear a strong resemblance to the hunting methods of humpback whales, giving them a physical association. However, further clarification is needed to fully understand the physical significance of shrinkage bracketing. This article covers three distinct shrinkage procedures, including the original linear reduction. In physics, a small ball moves between two points on a plane as it descends. The Brachistochrone curve, which is not a straight line but rather a curved line, is known as the fastest rolling curve. Along with the linearly reduced curve C1, this article also explores two other curves - the uphill convex curve C2 and the downward convex curve C3. The upward convex curve is symmetrical to the linear reduction curve known as Brachistochrone, while the downward convex curve is identical to Brachistochrone. All three adaptive techniques support the WO approach: AWO1 represents WO technique with adaptive approach C1, AWO2 for adaptive approach C2, and AWO3 for adaptive approach C3.

There are three WO methods that are used to tackle the problem of HWSN relay placement. The process of optimization is shown in Algorithm 1. In lines 4 and 7, the adaptive WO technique is utilized. It is evident that the algorithm can be integrated with all three WO approaches. For reducing vehicle delay and overhead, it is essential to determine the placements of NR and relay nodes through the adaptive WO approach.

Line	Algorithm: procedures of solving (4) b adaptive wale optimization
1	Input: HWSN setting parameters, AWO setting parameters
2	Output: optimal solution
3	For each iteration t
4	Use adaptive WO method to search candidate solution of N_R, and positions of relay nodes
5	Check and regenerate positions if relay nodes are located in unreachable area.
6	Compute distance and energy consumption for (4) or (5)
7	Update a value for adaptive WO method
8	End For

3.3 Dual Hop Communication between UAVs and VANETs

In this scenario, we have a dual-hop communication system comprising several components. These include a satellite functioning as a relay node with a single antenna, a source node on the global side equipped with N antennas, a destination node on the global side equipped with M antennas, as well as other global nodes. Because of the great propagation attenuation and great distance, direct communication between a source and destination is impossible. As a result, there is no cooperative diversity, and the performance of the system as a whole is anticipated to be greatly influenced by the diversity gain acquired from the many antennas. Two transmittal phases are used to establish the end-to-end connection (either in orthogonal frequency bands or successive timeslots). The source executes MRT in the first phase along with beam forms its signal with energy $E_s^{(1)}$ towards relay. The relay receives the signal, which is provided by:

$$r_{SR} = \sqrt{E_s^{(1)}}\ {}^{\dagger}_{SR}\ W_T\, s + n_{SR} \tag{6}$$

Where s and n_{SR} stand for the spectral density of one-sided additive white Gaussian noise $N_o^{(1)}$ and the transmit signal meeting $[s] = 1$ respectively. Additionally, $W_T \triangleq \frac{h_{SR}}{\|h_{SR}\|}$ is a transmit beam forming a weight space, and $h_{SR} \in \mathbb{C}^{N\times 1}$ comprises N i.i.d RVsThe channel fading coefficients between the source and relay will be described in the following section. Next, the received signal is amplified by a G designated gain at the relay and transmitted to the terminus during a second phase. As a result, the destination receives a signal expressed as:

$$r_{RD} = \sqrt{E_s^{(2)}} h_{RD} G(\sqrt{E_s^{(1)}} {}^{\dagger}_{SR} \; W_T s + n_{SR}) + n_{RD} \tag{7}$$

An relay-to-destination link consists about three components. Firstly, there is the energy allocated per symbol for this link. Secondly, there is the AWGN vector that represents the Additive White Gaussian Noise affecting the relay-to-destination transmittal. Lastly, there is the channel vector which comprises M separately along probability distribution (i.i.d.) random variables (RVs) representing the fading coefficients of the channel between the relay and the destination $E_s^{(2)}, n_{RD} \in \mathbb{C}^{M\times 1}$ and $h_{RD} \in \mathbb{C}^{M\times 1}$. The variance of n_{RD} is $N_o^{(2)} I_M$, where I_M stands for a identity matrix of size M. Because MRC is used at destination, $r_{RD} \times W_R$, where W_R is the receive weight vector and $W_R^{\dagger} \triangleq h_{RD}/\|h_{RD}\|$. Consequently, it is simple to determine SNR a end-to-end:

$$\gamma = \frac{\frac{E_s^{(1)}\|h_{SR}\|^2}{N_o^{(1)}} \frac{E_s^{(2)}\|h_{RD}\|^2}{N_o^{(2)}}}{\frac{E_s^{(2)}\|h_{RD}\|^2}{N_o^{(2)}} + \frac{1}{G^2 N_o^{(1)}}} \tag{8}$$

When using CSI-assisted relaying is chosen as the variable gain.

$$G \triangleq \sqrt{\frac{1}{E_s^{(1)}\|h_{SR}\|^2 + N_o^{(1)}}} \tag{9}$$

$$\gamma CSI = \frac{\gamma_1 \gamma_2}{\gamma_1 + \gamma_2 + q} \tag{10}$$

Where $q = 1$ and $\gamma_1 \triangleq \|h_{SR}\|^2 E_s^{(1)}/N_o^{(1)}$, $\gamma_2 \triangleq \|h_{RD}\|^2 E_s^{(2)}/N_o^{(2)}$, respectively. It is commonly known that by setting $q = 0$, CSI may be appropriately approached in areas with medium to high SNR. However, with regard to fixed gain relaying,

$$\gamma Fixed = \frac{\gamma_1 \gamma_2}{\gamma_2 + U} \tag{11}$$

The parameter U is defined as $\triangleq \frac{1}{G^2 N_o^{(1)}}$, where G represents a resolute and the fixed gain value. In accordance with existing scientific composition, there will be widely recognized preceding program for U, in particular which specific described in equation (12).

$$U = \begin{cases} (\mathbb{E}[\frac{1}{\gamma_1 + 1}])^{-1} & \triangleq U_1 \\ \mathbb{E}[\gamma_1] + 1 & \triangleq U_2 \end{cases} \tag{12}$$

Through these calculations the dual hop communication is effectively performed in vehicular network and that leads to increase the heterogeneous network stability. On the whole the proposed RAEDH-SAVs model greatly increases the communication quality when compared with the earlier methods.

4. Simulation Environments:

The simulation of the proposed work is performed in the NS3 simulator (version – 3.29) and the simulation area allocated for this research is 2000m*2000m. The 500 vehicles are equipped to communicate in Omni-directional way and those vehicles are controlled and monitored by 10 drones. The drone transmittal range is 25 Km. In this implementation both the vehicles and the drones follow same mobility model which is the waypoint mobility model. The simulation of this network model is carried out in two ways one is according to number of vehicles and other is about the speed of the vehicles. The other input parameters which are considered in this research are given in table 2.

Table 2 – Simulation Parameter Settings

Parameters	Values
Simulator	NS2
Drone Mobility Model	SUMO

Time	500 ms
Network Coverage	2000m*2000m
No of vehicles	500 vehicles
No of Drones	10 Drones
Drone transmittal Range	25 Km
Antenna Type	Omni-directional Antenna
UMTS Threshold	-94 dBm
Queue Type	DropTail
Drone Speed	100Km/hr to 300Km/hr
Drone Bandwidth	50 Mbps
transmittal Power	0.500 Joules
Receiving Power	0.050 Joules
Drone Transmitted Messages	100 to 200

4.1 Results Concerned with Number of Vehicles

This section presents simulation findings that center on the quantity of nodes. The results are visually displayed for a range of techniques, such as CRTC-SAVs [34], ECRO-SAVs [35], MTSC-SAVs [36], and RAEDH-SAVs. The performance evaluation utilizes multiple output measures, including energy efficiency, packet delivery ratio, throughput, routing overhead, end-to-end delay, and packet loss. These metrics will be thoroughly discussed in the subsequent section, providing a detailed analysis of their impact and significance.

4.1.1 Energy Efficiency Analysis

The process of determining the remaining energy that is stored during the final stage of simulation, which focuses on different numbers of vehicles, is crucial for achieving optimal energy efficiency. This is especially important for improving communication in drone assisted VANETs, including satellite communication. A visual representation in Figure 4 demonstrates the calculation of energy efficiency, and it shows that the proposed RAEDH-SAVs outperforms previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs.

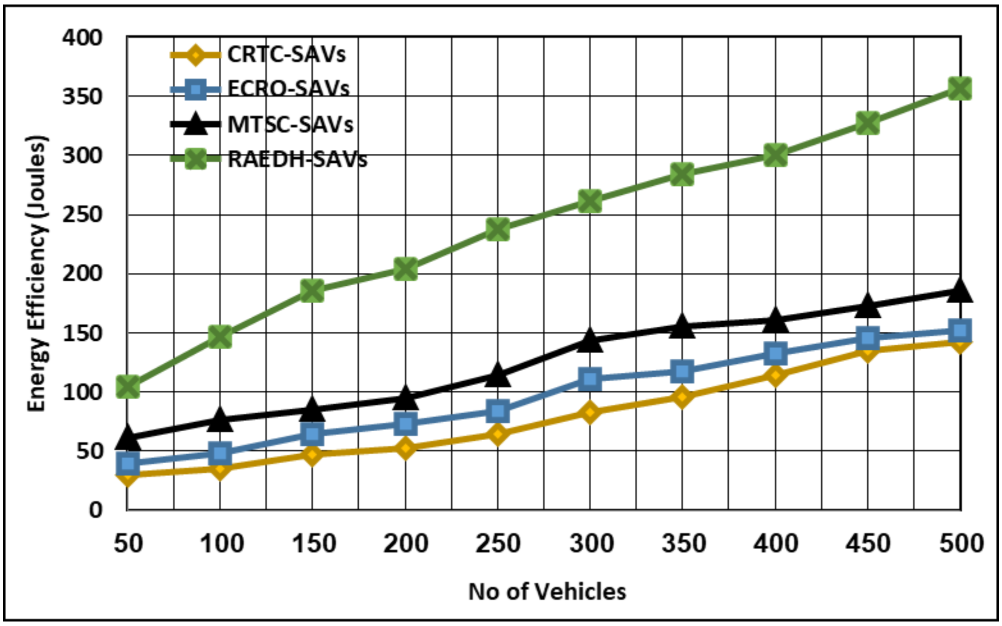

Figure 4 - Energy Efficiency Calculation

4.1.2 Packet Delivery Ratio Analysis:

The quantity of information gathered by the recipient and transmitted by multiple source vehicles is known as the delivery ratio. Figure 5 illustrates the visual representation of how the delivery ratio is calculated, and it shows that RAEDH-SAVs outperforms previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. Through effective dual communication and resource allocation in the proposed RAEDH-SAVs the data success rate is higher than other baseline methods.

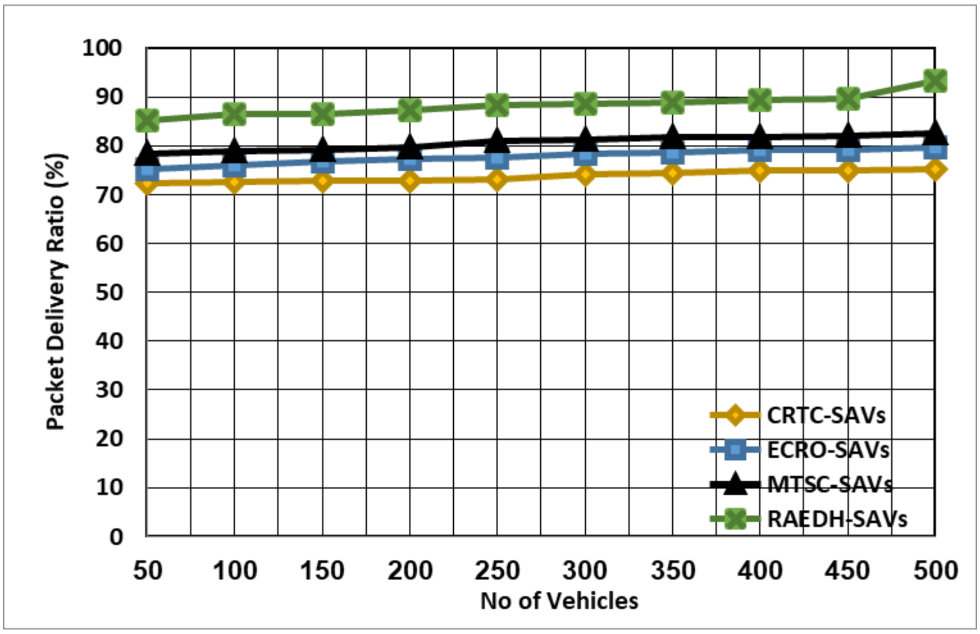

Figure 5 - Packet Delivery Ratio Calculation

4.1.3 Throughput Analysis:

The maximum number of data packets transmitted by all nodes, including forwarded packets, is determined. Figure 6 illustrates the process used to calculate the throughput of the methods examined in this study, and it demonstrates that RAEDH-SAVs achieved a higher throughput than previous approaches such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. Through effective communication among the high-speed vehicles and UAVs the communication quality is increased and that leads to attain maximum throughput in RAEDH-SAVs.

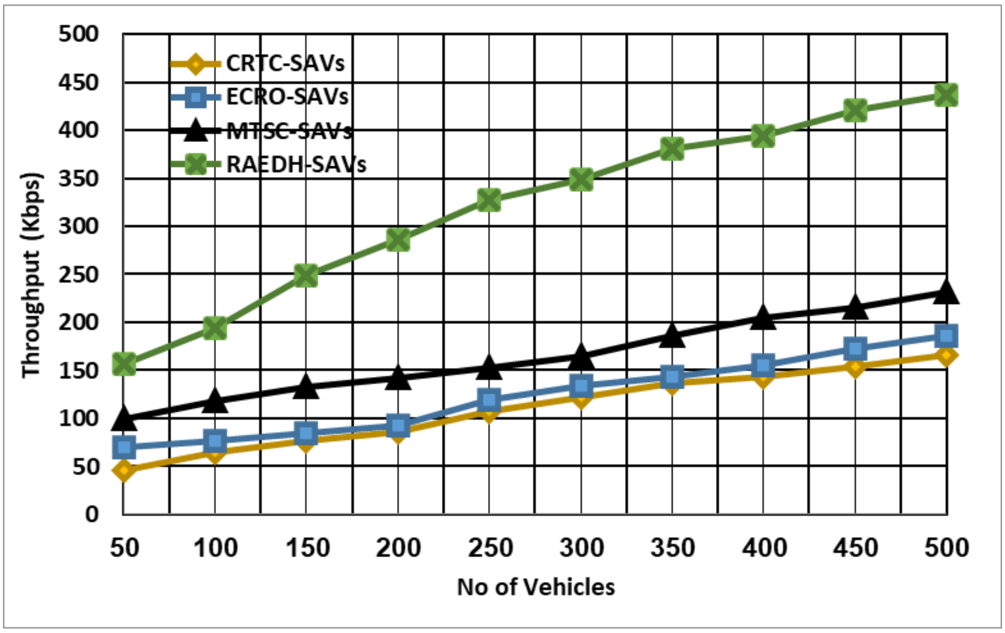

Figure 6 - Throughput Calculation

4.1.4 End to End Delay Analysis:

In this study, the time it takes for a node to create data packets and send them successfully is measured. Figure 7 illustrates the calculation of end-to-end delay for different methods used in this research, considering different numbers of vehicles. The results show that RAEDH-SAVs have lower end-to-end delay compared to previous approaches such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. With the help of dual hop communication process the data transmittal is performed without any time delay and that leads to reduce the end-to-end delay of the proposed RAEDH-SAVs.

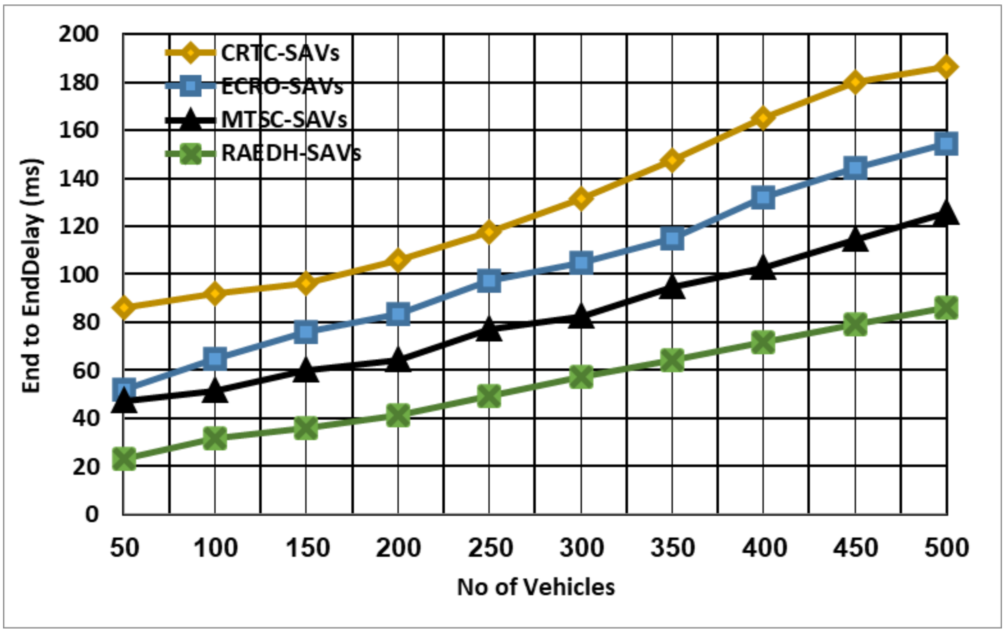

Figure 7 - End to End Delay Calculation

4.1.5 Routing Overhead Analysis:

The calculation involves adding up the number of data packets sent from the source to all vehicles and comparing it to the total number of data packets forwarded. Based on Figure 8, it can be seen that RAEDH-SAVs have lower routing overhead compared to previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. By allocating resources effectively in this method, the data forwarding ratio during transmission is decreased, resulting in a reduction of routing overhead in the heterogeneous network.

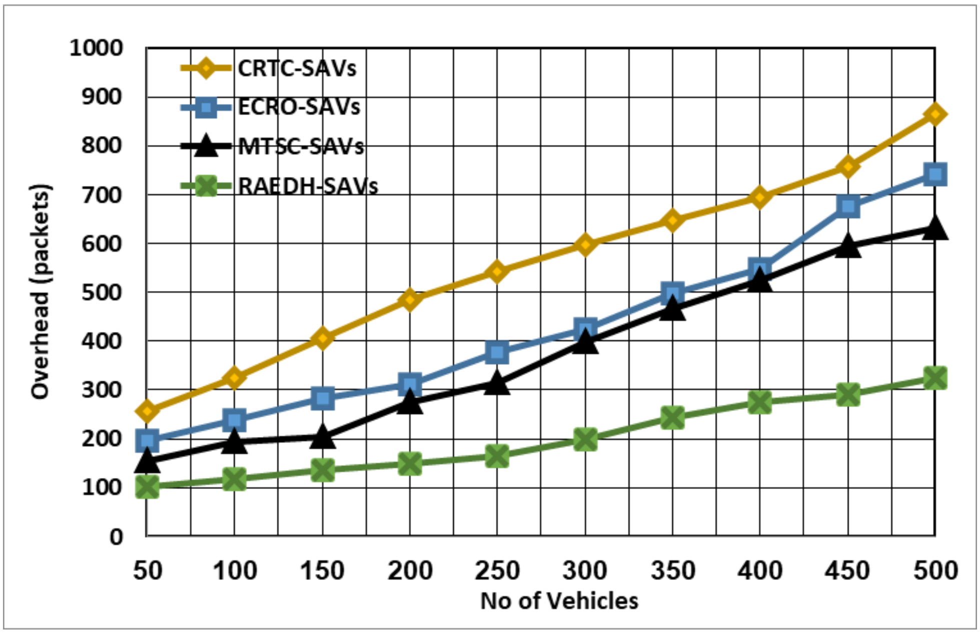

Figure 8 - Routing Overhead Calculation

4.1.6 Packet Loss Rate Analysis:

The process involves determining the number of data packets that are not successfully transmitted between the nodes. Figure 9 displays the calculation of packet loss for the methods examined in this study, demonstrating that RAEDH-SAVs have a lower packet loss rate compared to previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. By implementing efficient edge computing techniques, the data loss ratio is decreased, ultimately leading to improved success rates and throughput.

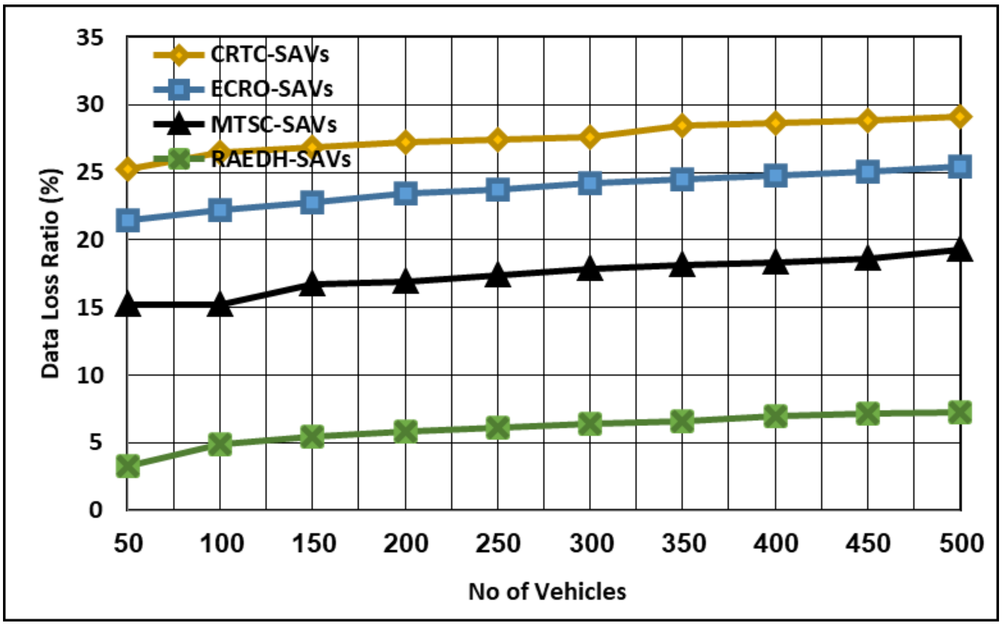

Figure 9 - **Packet Loss Rate Calculation**

4.2 Vehicles based Results and Discussion

In this section, the vehicles based results are discussed in a detailed way to study the concert of the baseline models and proposed one. The performance assessment involves a set of output matrices, including energy efficiency, packet delivery ratio, throughput, routing overhead, end-to-end delay, and packet loss rate. These performance measures are displayed in Tables 3 and 4.

Table 3 – Measurement of the parameters such as energy efficiency, packet delivery ratio and throughput concerned with varying vehicles.

No of Vehicles	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs
	Energy Efficiency (%)				Throughput (Kbps)				Packet Delivery Ratio (%)			
50	29.47	39.17	61.23	104.56	45.23	69.28	99.24	156.27	72.23	75.28	78.26	85.27
100	34.89	48.21	76.28	146.32	64.92	76.32	117.92	194.52	72.64	76	78.84	86.52
150	46.78	64.25	84.57	185.45	76.14	84.18	132.12	248.74	72.81	76.84	79.25	86.45
200	52.84	72.63	95.21	204.56	85.32	92.56	142.32	285.64	72.94	77.34	79.64	87.34
250	64.75	84.35	114.37	237.69	107.21	119.64	152.85	327.45	73	77.65	81	88.21
300	82.63	110.69	143.45	261.87	121.47	134.52	164.35	348.62	74.21	78.24	81.35	88.62
350	95.48	117.24	154.97	284.63	136.56	143.76	185.64	381.24	74.54	78.58	81.67	88.84
400	114.69	132.89	161.25	300.85	142.63	154.96	204.36	394.56	74.84	79	81.85	89.47
450	134.56	145.75	172.54	327.48	154.23	172.56	215.74	421.16	75	79.25	82	89.64
500	142.23	152.47	186.14	356.17	165.28	186.27	231.28	436.28	75.14	79.56	82.47	93.26

The performance metrics of energy efficiency, throughput, packet delivery ratio, end-to-end delay, packet loss ratio, and overhead ratio are evaluated for the transmission of a network. This is done by comparing the proposed system, called RAEDH-SAVs, to existing systems like CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. Our proposed approach is named RAEDH-SAVs.

The proposed RAEDH-SAVs strategy has an energy efficiency of 356.17%, compared to 142.23% for the CRTC-SAVs strategy, 152.47% for the ECRO-SAVs strategy, and 186.14% for the MTSC-SAVs plan. By values of 213.94, 203.7, and 170.03, respectively, the RAEDH-SAVs system outperforms the CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs in terms of energy efficiency.

CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, in contrast, have throughputs of 165.28, 186.27, and 231.28 respectively. The throughput of the proposed RAEDH-SAVs approach is 436.28. As a result, the performance of the proposed RAEDH-SAVs system is better than that of CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs by values of 271, 250.01, and 205, respectively.

The proposed RAEDH-SAVs system achieves a packet delivery rate of 93.26 when compared to earlier techniques like CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, which each achieve a packet delivery rate of 75.14, 79.56, and 82.47, respectively. This is a major advance above past approaches. As a consequence, the RAEDH-SAVs system that is offered has a greater packet delivery rate than the CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs by values of 18.12, 13.7, and 10.79, respectively.

Table 4 – Measurement of the parameters such as end to end delay, packet loss and routing overhead concerned with varying vehicles.

No of Vehicles	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs
	End to End Delay (ms)				Packet Loss Ratio (%)				Overhead (Packets)			
50	86.25	52.14	47.23	23.28	25.23	21.42	15.23	3.26	256	196	154	102
100	91.74	64.98	51.27	31.47	26.47	22.18	15.21	4.85	325	237	194	118
150	96.45	76.21	59.74	35.82	26.84	22.76	16.75	5.45	405	284	204	137
200	105.87	83.41	64.23	41.37	27.21	23.41	16.94	5.81	485	312	274	148
250	117.45	97.25	76.94	49.17	27.42	23.75	17.34	6.1	542	376	314	164
300	131.25	104.63	82.61	57.31	27.64	24.22	17.84	6.37	597	425	398	198
350	147.52	114.75	94.62	64.27	28.47	24.52	18.11	6.62	647	498	467	244
400	164.85	132.24	102.84	71.96	28.62	24.75	18.35	6.94	694	548	524	275
450	180.14	144.14	114.32	79.24	28.85	25.04	18.64	7.15	756.42	675	594	290
500	186.25	154.26	125.46	86.17	29.14	25.46	19.23	7.25	865	742	632	325

The RAEDH-SAVs offers an 86.17 ms processing delay as contrasted to the 186.25, 154.26, and 125.46 ms of the previous attempts by the CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, respectively. The end-to-end delays of the shown RAEDH-SAVs system are, respectively, 100.08, 68.09, and 39.29 ms fewer than those of CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs.

The proposed RAEDH-SAVs system achieves a packet loss ratio of 7.25 when compared to previous methods like CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, while CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs gain a packet loss ratio of 29.14, 25.46, and 19.23 respectively. Therefore, the proposed RAEDH-SAVs system outperforms CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs by a difference of 21.89, 18.21, and 11.98 points, respectively, in terms of the packet loss ratio.

As a result, the computational overhead of RAEDH-SAVs is projected to be lower than that of CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, which was dispersed across 865, 742, and 632 packets, respectively, in the past. As a result, the proposed RAEDH-SAVs approach has a reduced computational overhead by 540, 417, and 307 correspondingly than those of CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs.

4.3 Results Concerned with Varying Speed

This passage examines the calculation of VANETs network outcomes, utilizing speeds ranging from 50 Km/Hr to 250 Km/Hr. The findings were compared against the standard models (CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs) and a new method known as RAEDH-SAVs. The assessment of performance considered multiple factors such as energy efficiency, throughput, packet delivery ratio, end-to-end delay, packet loss ratio, and overhead ratio.

4.3.1 Energy Efficiency Analysis:

Figure 10 presents a graph showcasing the energy efficiency calculation of the methods analyzed in this research, specifically at varying speeds from 50 Km/Hr to 250Km/Hr. The findings indicate that RAEDH-SAVs have notably superior energy efficiency in comparison to earlier methods like CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. As these results it is proven that the performance of energy efficiency is reduced moderately with the increase of vehicles speed but for the proposed RAEDH-SAVs it is quite negligible.

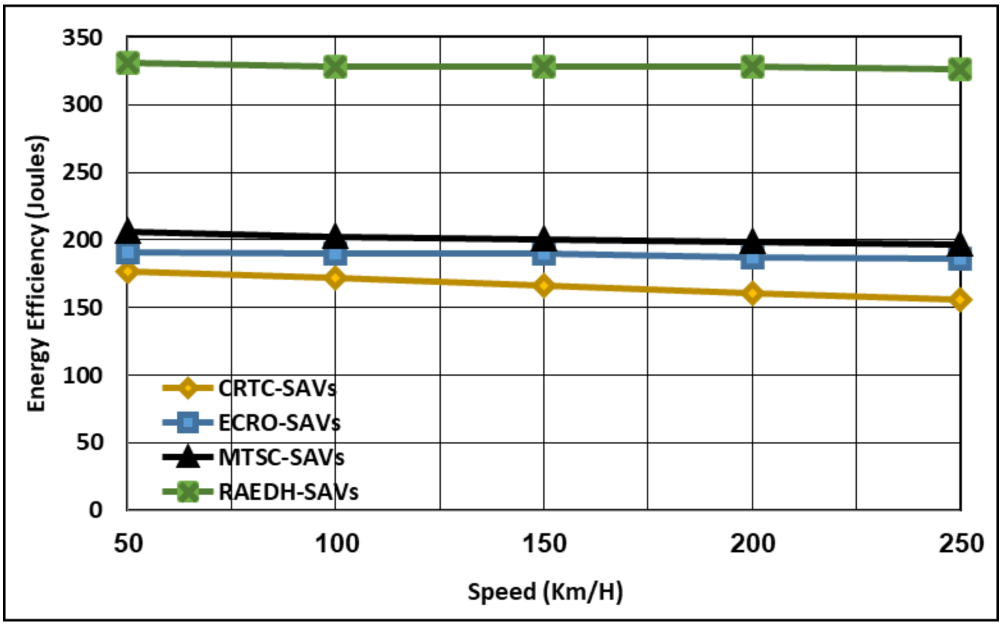

Figure 10 - Energy Efficiency Calculation

4.3.2 Packet Delivery Ratio Analysis:

The graph in Figure 11 depicts the calculation of packet delivery ratio at speeds ranging from 50 Km/Hr to 250Km/Hr. It is evident from the graph that RAEDH-SAVs outperforms previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. As these results it is confirmed that the routine of delivery ratio is reduced with the increase of vehicles speed but for the proposed RAEDH-SAVs the overall success rate is high when compared with the earlier methods.

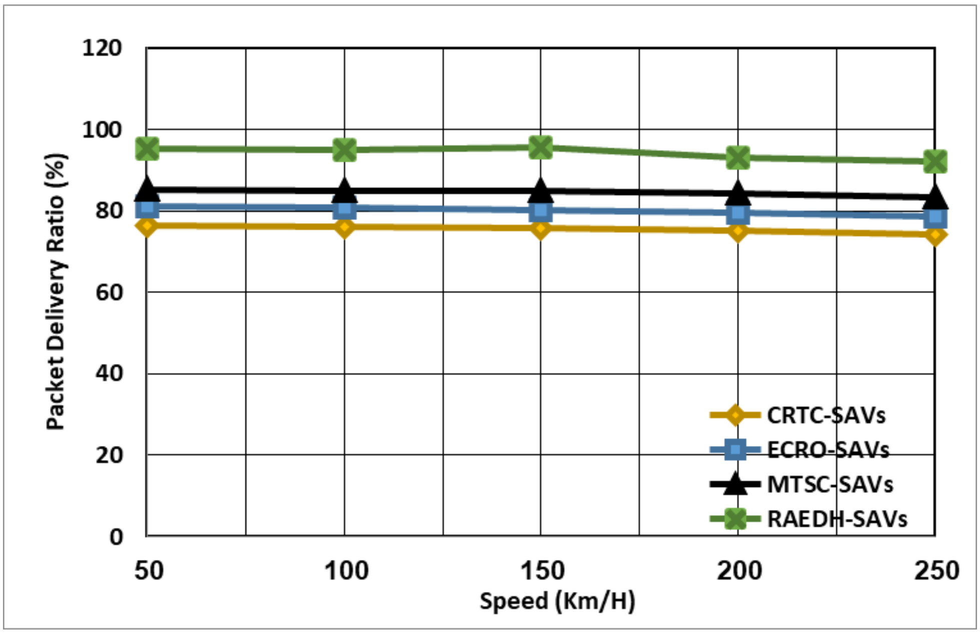

Figure 11 - Packet Delivery Ratio Calculation

4.3.3 Throughput Analysis:

Figure 12 illustrates the calculation of throughput for the methods examined in this study, considering a range of speeds from 50 Km/Hr to 250 Km/Hr. The results demonstrate that RAEDH-SAVs have a higher throughput than previous approaches such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. As speed increases, the throughput decreases for the baseline methods, but remains stable for RAEDH-SAVs, providing greater stability in heterogeneous communication.

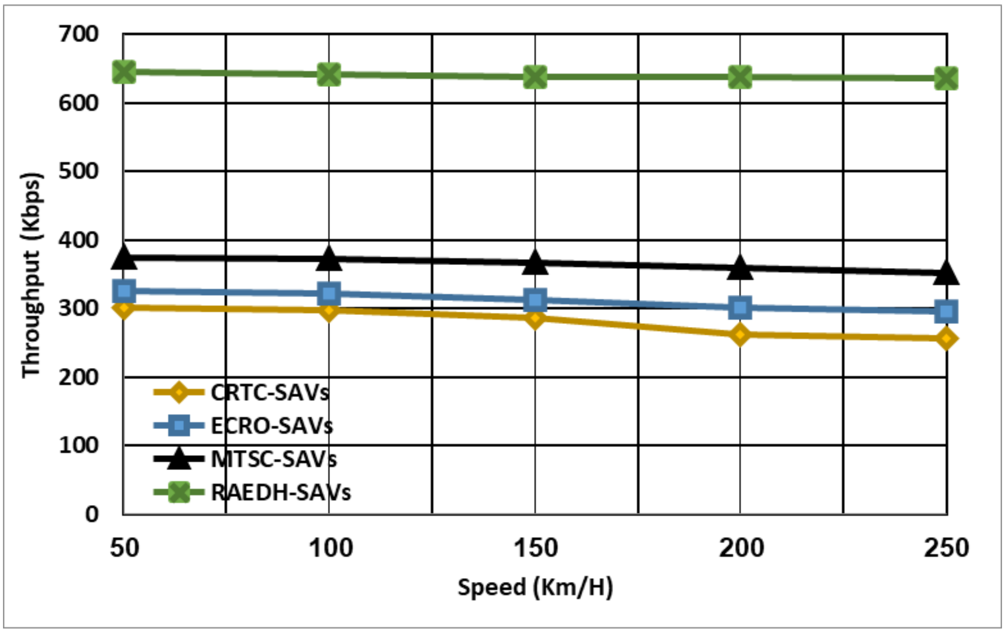

Figure 12 - Throughput Calculation

4.3.4 End to End Delay Analysis:

The diagram in Figure 13 shows the complete calculation process for the techniques examined in this study, while examining speeds ranging from 50 Km/Hr to 250Km/Hr. The results demonstrate that RAEDH-SAVs have a lower end-to-end delay compared to previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. Increase of speed results in the increase of communication delay and from the results it is proven that the delay difference is very minimal to the proposed RAEDH-SAVs even compared with the earlier methods.

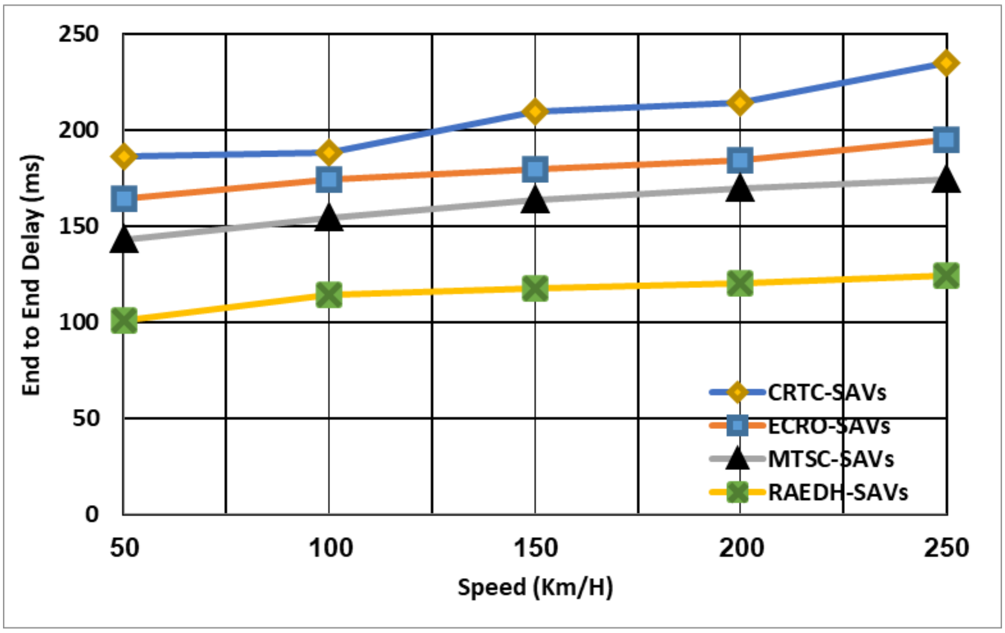

Figure 13 - End to End Delay Calculation

4.3.5 Routing Overhead Analysis:

Figure 14 depicts a graph that shows the calculation of routing overhead based on different speeds ranging from 50 Km/Hr to 250Km/Hr. The results demonstrate that RAEDH-SAVs have significantly lower routing overhead than previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. Basically, if the speed of the vehicle increases the changes for link failure and data forwarding is high but in case of the proposed RAEDH-SAVs it is proven that the network is highly stable in maximum of the times.

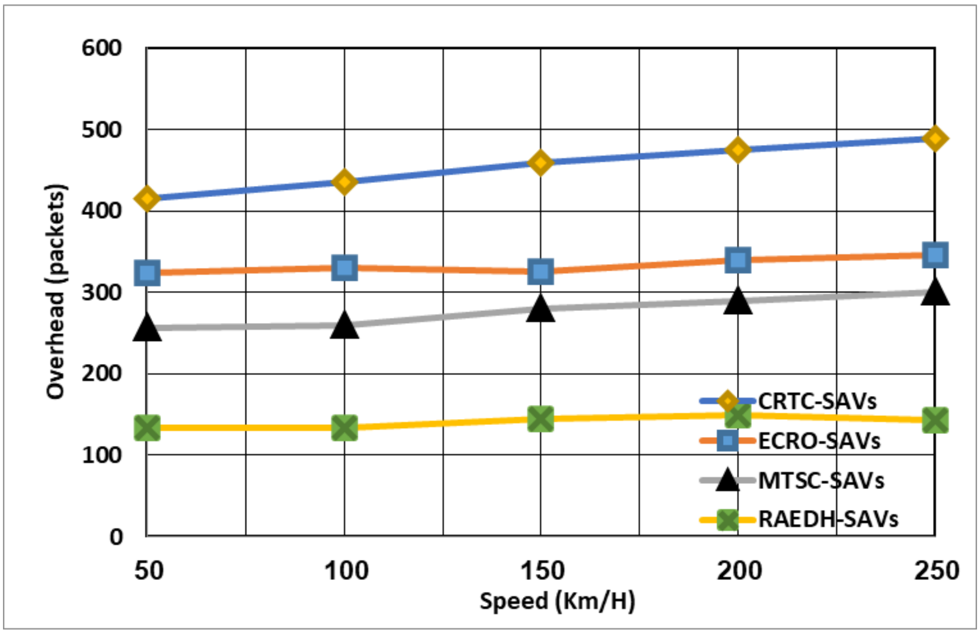

Figure 14 - Routing Overhead Calculation

4.3.6 Packet Loss Rate Analysis:

In Figure 15, the calculation of packet loss for the methods studied in this research is shown. It demonstrates that RAEDH-SAVs have lower packet loss than previous methods such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs when varying speeds from 50 Km/Hr to 250Km/Hr. The dual communication model and efficient resource allocation process of RAEDH-SAVs result in consistently low packet loss even during high-speed changes in heterogeneous vehicular networks.

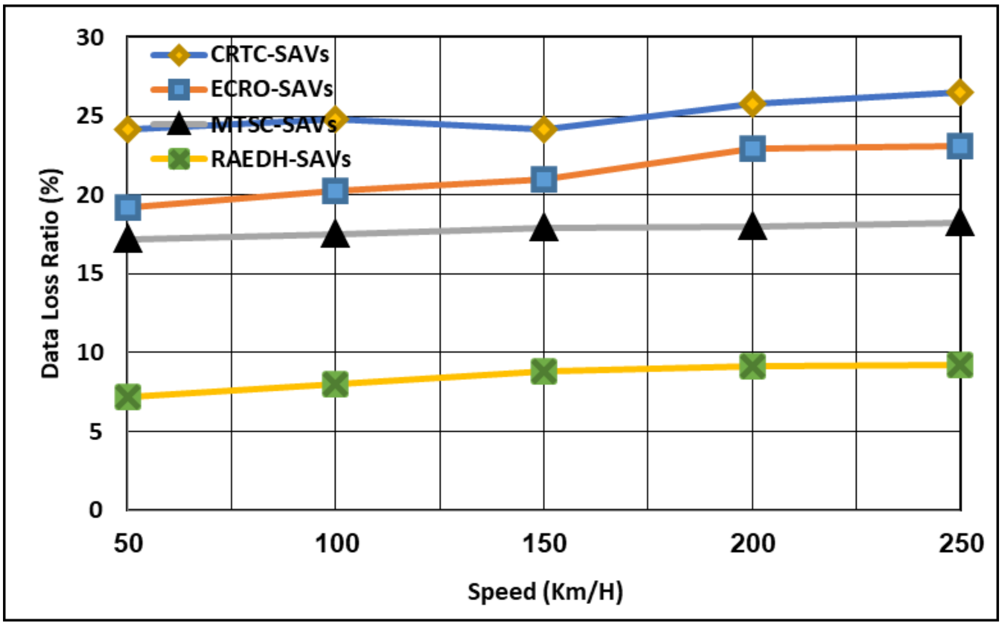

Figure 15 - Packet Loss Rate Calculation

4.4 Speed Based Results Discussion

The packet delivery ratio, end-to-end delay, energy efficiency, throughput, packet loss ratio, and overhead ratio during network transmittal are compared among a proposed system—noted RAEDH-SAVs and the existing systems, such as CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs. The computed parameter measurements are depicted in Tables 5 and 6, suggested a method as RAEDH-SAVs.

Table 5 – Measurement of the parameters such as energy efficiency, packet delivery ratio and throughput concerned with varying vehicles.

Speed (Km/H)	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs
	Energy Efficiency (%)				Throughput (Kbps)				Packet Delivery Ratio (%)			
50	176.25	191.23	206.35	331.25	302.12	326.14	374.23	645.28	76.36	81.25	85.23	95.28
100	171.84	190.27	202.41	328.49	298.46	322.76	371.52	641.91	76.04	80.94	85.04	95.08
150	166.47	189.76	200.74	327.74	285.74	312.34	367.15	638.27	75.86	80.15	84.92	95.64
200	161.04	187.42	198.15	327.94	263.07	300.91	359.84	637.89	75.14	79.56	84.34	93.18
250	156.25	186.25	196.14	326.25	256.23	296.15	352.26	635.25	74.26	78.56	83.28	92.25

The proposed RAEDH-SAVs strategy has an energy efficiency of 326.25%, compared to 156.25% for the CRTC-SAVs strategy, 186.25% for the ECRO-SAVs strategy, and 196.14% for the MTSC-SAVs plan. By values of 170, 140 and 130.11 respectively, the RAEDH-SAVs system outperforms the CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs in terms of energy efficiency.

CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, in contrast, have throughputs of 256.23, 296.15 and 352.26 respectively. The throughput of the proposed RAEDH-SAVs approach is 635.25. As a result, the performance of the proposed RAEDH-SAVs system is better than that of CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs by values of 379.02, 339.1, and 282.99, respectively.

The proposed RAEDH-SAVs system achieves a packet delivery rate of 92.25 when compared to earlier techniques like CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, which each achieve a packet delivery rate of 74.26, 78.56, and 83.28, respectively. This is a major advance above past approaches. As a consequence, the RAEDH-SAVs system that is offered has a greater packet delivery rate than the CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs by values of 17.99, 13.69 and 8.97, respectively.

Table 6 – Measurement of the parameters such as end to end delay, packet loss and routing overhead concerned with varying vehicles.

Speed (Km/H)	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs	CRTC-SAVs	ECRO-SAVs	MTSC-SAVs	RAEDH-SAVs
	End to End Delay (ms)				Packet Loss Ratio (%)				Overhead (Packets)			
50	186.58	164.23	143.26	101.23	24.12	19.23	17.17	7.23	415.28	324.17	255.46	134.23
100	188.34	174.36	154.56	114.26	24.78	20.28	17.48	8.01	434.87	329.45	259.84	133.56
150	209.84	179.4	163.87	117.74	24.15	21.01	17.94	8.85	458.31	325.78	279.64	144.32
200	214.65	184.46	169.71	120.46	25.78	22.94	18.02	9.12	474.85	339.45	288.46	149.75
250	234.77	195.25	174.23	124.23	26.48	23.13	18.25	9.23	488.23	346.24	300.15	142.23

In comparison to the 234.77, 195.25, and 174.23 ms of the CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs' prior efforts, the RAEDH-SAVs gives a processing delay of 124.23 ms. The end-to-end delays of the shown RAEDH-SAVs system are, in comparison to those of CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, respectively, 110.54, 71.02, and 50 ms less.

When compared to earlier techniques like CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, the proposed RAEDH-SAVs system achieves a packet loss ratio of 9.23, while CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs gain a packet loss ratio of 26.48, 23.13, and 18.25, respectively. Therefore, in terms of the packet loss ratio, the proposed RAEDH-SAVs system performs better than CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs by a difference of 17.25, 13.9, and 9.02, respectively.

Because of this, RAEDH-SAVs are expected to have a reduced computational overhead than CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs, which were previously spread over 488.23, 346.24, and 300.15 packets, respectively. As a consequence, the computational overhead of the proposed RAEDH-SAVs technique is lower than that of CRTC-SAVs, ECRO-SAVs, and MTSC-SAVs by 346, 204.01, and 157.92 respectively.

5. Conclusion

In order to improve the vehicular performance in heterogeneous network and to increase the network coverage area the concepts of UAVs and satellite communication is introduced. To manage this huge vehicular network certain additional qualities are becoming highly essential. The integration of UAV-assisted mobile edge computing, efficient resource allocation using Whale Optimization, and dual communication between vehicles and UAVs ensures high-quality communication. By leveraging trusted components like TA, RSUs, and CRS, the network is securely constructed.

Additionally, mobile edge computing reduces energy consumption through computation offloading and optimized UAV trajectory selection. For that purpose, here the concepts of UAV assisted mobile computing, resource allocation among the vehicles and the UAVs and dual communication among the vehicles and the UAVs are incorporated with the heterogeneous vehicular networks. Resource allocation, facilitated by Whale Optimization, efficiently allocates resources among vehicles. Finally, dual-hop transmission enhances delivery ratio and throughput. The implementation is performed in NS3 and there are mainly two scenarios they are number of vehicles and its speed. The output criterion that calculated further performance evaluation energy efficiency, packet loss, routing overhead, packet delivery ratio, throughput, end-to-end delay along those results are correlate along previous methods like CRTC-SAVs, ECRO-SAVs and MTSC-SAVs. The performance in terms of number of vehicles proves that the performance of proposed RAEDH-SAVs is 200 joules higher energy efficiency, 270 Kbps higher throughput, 18% higher packet delivery ratio, 100ms lower delay, 21% lower packet loss ratio and 540 packets less communication overhead compared to previous methods. A performance in terms instead speed proves that the performance of proposed RAEDH-SAVs is 170 joules higher energy efficiency, 380 Kbps higher throughput, 18% higher packet delivery ratio, 110ms lower delay, 18% lower packet loss ratio and 490 packets lower communication overhead when compared with the earlier methods. In future direction to further reduce the energy utilization the idea of innovative clustering models are need to get concentrated.

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None

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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