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A NOVEL METHODOLOGY FOR EXIT AND ENTRY OF NODES IN MOVING CLUSTER WITH RESERVED CLUSTER HEAD IN AD-HOC VANET ARCHITECTURE

P. ASHOK KUMAR MCA.,M.PHIL[1], DR. M. RAMALINGAM, MSC.(CS)., MCA,PH.D[2]
[1]RESEARCH SCHOLAR, GOBI ARTS & SCIENCE COLLEGE (AUTONOMOUS), GOBICHETTIPALAYAM-638453,
ashokasvs@gmail.com
[2]ASSOCIATE PROFESSOR, GOBI ARTS & SCIENCE COLLEGE(AUTONOMOUS), GOBICHETTIPALAYAM-638453
ramsgobi@gmail.com

Abstract

Vehicular Ad-hoc Networks (VANETs) are a sub-class of Movable Ad-hoc Networks (MANETs), exclusivelypremeditated for vehicle-to-vehicle (V2V) along with vehicle-to-infrastructure (V2I) communication. Owingtowards the highly dynamic topology with high-speed movement of vehicles, maintaining stable clusters and seamless communication poses significant challenges. This research proposes a novel methodology for managing the entry and exit of nodes in moving clusters by introducing a Reserved Cluster Head (RCH) mechanism in the VANET architecture.The proposed framework ensures robust and efficient cluster management by designating a backup or reserved cluster head in advance, which takes over leadership seamlessly upon the exit of the current cluster head. The approach minimizes cluster reformation time, packet loss, and communication disruption. Entry of new nodes is managed through a priority-based and signal-strength-aware admission process to ensure cluster stability. The methodology is validated using simulation tools (such as NS2 or SUMO with NS3), and performance is evaluated using key parameterscounting Throughput, Packet Deliverance Ratio (PDR), Packet failure Ratio (i.e., PLR), End-to-End Interruption, and Jitter. Results demonstrate that the proposed approach outperforms existing clustering techniques by providing better continuity, reduced control overhead, and improved Quality of Service (QoS) for real-time VANET applications.

Keywords: VANET, Reserved Cluster Head, Mobility Management, Node Entry and Exit, Ad-hoc Networks, Quality of Service.

1. INTRODUCTION
2.

Vehicular Ad-hoc Networks, or VANETs, are a category of wireless association that facilitates communication involvingvehiclesalong with roadside infrastructure [01 – 03]. In this self-organizing network, cars serve as routers, forming a network for exchanging data such as warnings, traffic conditions, and even entertainment. In addition to providing on-the-road services, this communication enhances traffic efficiency and road safety [04].

VANET architecture divides into three types of networks:

Ad-hoc networks, or vehicle-to-vehicle (V2V) networks, are networks in which nodes speak to one another directly without the need for a permanent infrastructure. The technology known as vehicle-to-vehicle (V2V) message enables cars to wirelessly chatteramong one another, exchanging vital information such as position and speed in order to improve traffic efficiency and safety [05]. By using this technology, cars may recognize possible dangers and respond appropriately, possibly averting collisions and enhancing traffic flow in general.

A vehicle-to-infrastructure (V2I) network is one in which the roadside unit and nodes interact. Vehicle-to-Infrastructure (V2I) is the term used to describe wireless communication between automobiles and roadside devices including parking meters, traffic signals, and signage [06]. Numerous applications, such as better navigation, more safety features, and traffic management, are made possible by this two-way communication.

Vehicle-to-Vehicle (V2V) and vehicle-to-infrastructure (V2I) instantaneousmessage is made possible by Vehicular Ad-hoc Networks (VANETs), which have happen to an essential component of Intelligent Transportation Systems (ITS) [07]. These networks are essential for enhancing entertainment services, traffic efficiency, and road safety. However, maintaining robust communication links is made extremely difficult by the highly dynamic topology of VANETs, which is fueled by high-speed node movement and unexpected vehicle density [08]. VANETs frequently use clustering to increase communication efficiency and scalability.

Vehicles are grouped during clustering, and communication inside and between clusters is overseen by a designated Cluster Head (CH) [09]. However, because of their high mobility, nodes—especially CHs—enter and depart the network often, which causes re-clustering, higher overhead, interrupted data transmission, and worse network performance [10]. Using a Reserved Cluster Head (RCH) mechanism, this study suggests a unique approach to controlling node entrance and exit in moving clusters in order to overcome these difficulties. In the case of a CH's departure, the RCH assumes cluster duties as a backup leader without initiating complete re-clustering. To guarantee steady and effective clustering, the addition of additional nodes is also controlled according to location metrics, speed compatibility, and signal strength [11].In high-mobility VANET contexts, this technique guarantees continuity, lowers packet loss, and greatly improves network resilience.

This research article's first portion provides an overview of VANET. Numerous active research projects that have been subjected to VANET and its sectors are included in the second section. Part three provided further detail on the study work's suggested technique. The fifth portion, the conclusion, analyzes the possibilities and expectations of VANET while applying the suggested methodology with its future scope of study. The fourth section describes the outcomes and compares the suggested methodology with the other protocols that are now in use.

3. REVIEW OF RELATED LITERATURE
4.

Muhammet.et.al.In moderndays, Vehicular Ad-Hoc Associations (VANETs) have expanded a lot of attractiveness because of its strategic importance in the field of smart transportation, which enables communication between vehicles and infrastructure. The improvement of diverse, across-the-board, and decidedlyenergetic VANETs has also been prompted by the sharp rise in the quantity of automobiles on the highway. These networks make it more challenging to meet the strict requirements of the 5G network, which embracesquat latency, elevated mobility, summit security, along withconsiderable connectivity. The primary focus of VANET research is on data security, privacy, and message delivery under stringent latency constraints based on various applications.

In this regard, researchers have conducted a number of studies that offer representation and resolutions related to the improvement of VANET commencing a variety of perspectives, such as applications, security, physical layer fading, Quality of Service (QoS), SimulatedAstuteness (i.e., AI) techniques, Medium Accessing Control (MAC), and direction-findingprocedures. The detailed analysis of VANETs in this work, which embraces details on particular appliances, Quality of Service, conduitevaporation, MAC procedures, conduit admittance methods, direction-findingprocedures, safety measures, moreover challenges, is motivated by these considerations.

There are currently no polls that cover every important facet of VANET in one go. Based on a number of concerns, a comprehensive categorization of VANETs has been presented in this research. Initially, a summary of VANET is shown along with a variety of applications. Next, many suggested MAC protocols and QoS in VANETs are examined. Mechanisms for access and channel fading are introduced. Next, security, clustering in VANETs, and routing protocols are presented. A summary of the AI techniques suggested in VANET is also provided. Lastly, a description of the path of future study for each element is provided. When developing and implementing VANET appliances, associating and announcementmechanisms, and informationsafety measures, this editorialmay serve as a manual or a summit of suggestion[12].

Arijit.et.al.In regulate to ensure vehicle protection, mobility administration, with vehicular applications, it is imperative that Wireless SensoryAssociations (i.e., WSNs) and the IoT be strategically integrated into VANET infrastructure. Without depending on conventional internet access, the integration gathers data on traffic and road conditions. Additionally, it covers applications like air monitoring without relying on conventional TCP/IP internet access, protection and physical conditioncrisis alerts in very crowded regions, and prematurecautions in regions with inadequate coverage.

In order to maximize Vehicle-to-Everything (V2X) transportation in VANETs, this article offers a thorough overview of network technology, data collecting tools, clustering strategies, and energy-efficient routing algorithms. The potential for creating a wide range of applications devoted to isolated ambient, interchange, and securitysupervisingdevoid of sacrificing associationconcert is increased by this study, which also discusses how to take use of the 802.11p protocol's frequency channels. Additionally, the latest advancements in energy-efficient techniques and clustering algorithms for these VANET applications are examined from a fresh angle [13].

Pratima.et.al. A novel discipline described Vehicular Ad-hoc Networks (VANETs) utilizes wireless restrictedregionassociations (i.e., WLANs) through an ad-hoc architecture. Vehicular Ad-Hoc Associations (i.e., VANETs) are made up of many components that are combined to create efficient communication between them and with other related services. Direction-findingcomplication and elevatedmanagetransparency are two regularissues faced by vehicular ad-hoc associations (i.e., VANETs). Nevertheless, most of these efforts disastrous to endow withthe widespreadresolution to tackle the issues of direction-finding and organizevisual projection reduction. In organize to subordinate the amplifiedorganizeoverhead; the presentresearchillustrates an EnhancedProfoundStrengthening Learning (i.e., IDRL) technique for direction-finding.

In the setting of energeticautomobilecompactness, the proposed IDRL routing approach seeks to minimize the convergence time while optimizing the routing path. The IDRL uses vehicle data and transmission capacity to efficiently monitor, analyze, and forecast routing behavior. Therefore, using nearby cars to transfer packets using Vehicle-to-Infrastructure (V2I) announcement reduces transmission time.

The imitation results were used to evaluate the model's scalability and durability in providing effective routing while simultaneously reducing the increased overheads. The technique in question exhibits a high degree of effectiveness in sending communications that are protected by vehicle-to-infrastructure (V2I) announcement. According to the imitation findings, when compared to other routing strategies now in use, the IDRL direction-finding methodology as suggested offers a reduction in latency, an augment in PDR, and an enhancement in information dependability [14].

Nasir.et.al. InIntellectual Transport System (i.e., ITS), Vehicular Ad-hoc Associations (i.e., VANETs) are essential because they allow cars and infrastructure to communicate with one another. The purpose of this communication is to increase passenger comfort, traffic efficiency, and road safety. While vehicle and message authentication is crucial to preventing harmful activity and unauthorized access, safe and trustworthy information sharing is crucial to guaranteeing the integrity and confidentiality of data.

A thorough examination of the current authentication methods suggested for cluster-based VANETs is presented in this survey report. These mechanisms' advantages, disadvantages, and applicability to different situations are thoroughly investigated. To improve the whole authentication process, the use of secure key management mechanisms is also covered. In order to create cluster-based VANETs, the network is divided into smaller groups, or clusters, with one or more vehicles serving as designated cluster leaders. Additionally, by examining earlier surveys, this article finds gaps in the body of literature.

A number of systems based on various techniques are critically assessed, taking into account end-to-end latency, security, packet deliveranceproportion throughput, along with detection rate. This study emphasizes AI- and ML-based routing-based techniques to offer the best authentication solutions for cluster-based VANETs. These methods improve authentication in the cluster-based VANET network by utilizing machine learning and artificial intelligence techniques. Lastly, this study examines the unresolved research issues in the sector of cluster-based vehicular ad-hoc network authentication, highlighting areas in need of more study and advancement [15].

5. METHODOLOGY

6.

It is challenging to think about the message transmission between the roadside unit and the cluster head in a moving cluster. Because they have distinct destinations, a node or nodes in a VANET may use the exit lane from the moving road to leave the cluster. Similarly, some nodes may cross the entrance lane and enter the current cluster in order to obtain the most recent knowledge regarding transport-related matters. The admission of nodes is a frequent occurrence in moving clusters, but node exits from moving clusters must be taken into account.

The creation of the cluster will not be impacted if a normal node leaves the moving cluster, but it will be difficult to transmit the cluster's data to the roadside unit if the cluster head (CH) of the moveable cluster leaves the cluster. To sustain continuous cluster communication to the road side unit in that case, the next level idea must be established and implemented if the cluster head (CH) leads to departure from the moving cluster.

The problems with the cluster head (CH) leaving the moving cluster are solved by the Active Cluster Head (ACH) and Reserved Cluster Head (RCH) approaches. At the time of cluster formation, the roadside unit registers the cluster nodes and assigns the Active Cluster Head (ACH). At that same moment, another node in that moving cluster is also designated as the Reserved Cluster Head (RCH). The Reserved Cluster Head (RCH) receives a departing notification from the Active Cluster Head (ACH) the moment the ACH leaves its moving cluster.

The Reserved Cluster Head (RCH) waits until the Active Cluster Head (ACH) leaves the moving cluster after receiving the notification from the Active Cluster Head (ACH) and is prepared to activate. The Reserved Cluster Head (RCH) becomes the Active Cluster Head (ACH) as soon as the Active Cluster Head (ACH) leaves the moving cluster.

At the same time, the cluster head changes information and is handed to the road side unit. After receiving information from the moving cluster about the cluster head shifting, the road side unit once more designated one of the nodes in that moving cluster as the Reserved Cluster Head (RCH). The same information was then sent to that cluster, and the Reserved Cluster Head (RCH) was created.

This type of arrangement will prevent communication from being cut off to the roadside unit and the moving cluster as well. In the moving cluster VANET design, the nodes (regular nodes and cluster head node) enter and depart as shown in Figures 1 and 2. The process used by the suggested approach to confirm node entrance and departure in the moving cluster VANET architecture is shown in Table 1. The process for altering the cluster head nodes in the moving cluster VANET architecture is shown in Table 2.

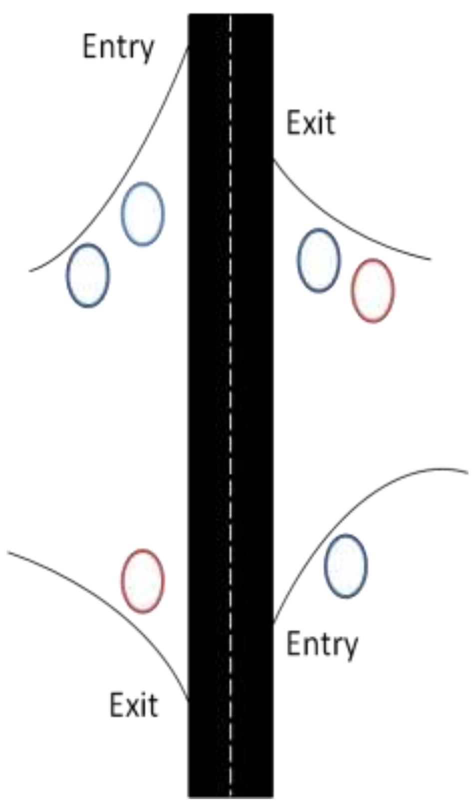

Figure.01. Entry and Exit in the Transport

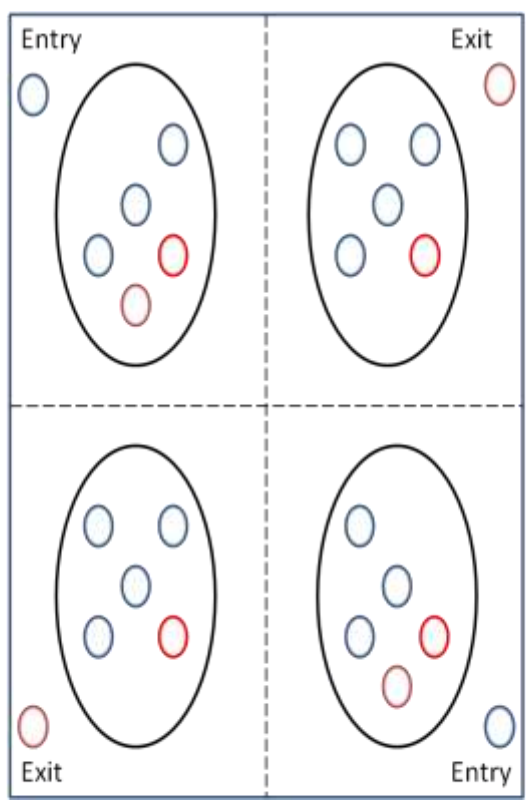

Figure.02. Entry and Exit of CH and Node

Table.01. Proposed methodology's procedure to verify the entry and exit of nodes

Step 1:	Start the Process
Step 2:	Processes the node exit procedure at each exit lane
Step 3:	Verifies the size of the cluster before crossing the exit lane
Step 4:	Verifies the size of the cluster after crossing the exit lane
Step 5:	If the cluster size varies then process, gather and transfer the exit node details to the road side unit infrastructure
Step 6:	Else transfer the size of the cluster as same after crossed the exit lane and close the exit procedure
Step 7:	Processes the node entry procedure at each entry lane
Step 8:	Verifies the size of the cluster before crossing the entry lane
Step 9:	Verifies the sizes of the cluster after crossing the entry lane
Step 10:	If the cluster size varies then process, gather and transfer the newly entered node details to the road side unit infrastructure
Step 11:	Else transfer the size of the cluster is same after crossed the entry lane and close the entry procedure
Step 12:	Stop the Process

Table.02. Proposed methodology's procedure to change the cluster Head nodes

Step 1:	Start the Process
Step 2:	If the active cluster head (ACH) leaves from the cluster and leads to the exit then that exiting cluster head send an alert message to the reserved cluster head (RCH) to become active
Step 3:	When the reserved cluster head (RCH) received the message to become active from the existing active cluster head (ACH) then the reserved cluster head (RCH) ready to become the active cluster head.
Step 4:	The cluster head changing information transferred to the road side unit by active cluster head (ACH)
Step 5:	Once the road side unit get the update regarding the cluster head changing information from a newly active cluster head (ACH) again one of the nodes in the cluster will assigned as reserved cluster head (RCH)
Step 6:	That updated information transferred to cluster head changed cluster and then one of the nodes in that cluster will be assigned as reserved cluster head (RCH)
Step 7:	The reserved cluster head (RCH) allocation information transferred to the active cluster head (ACH)
Step 8:	Stop the process

Comparison Parameters:

Comparison Parameters (also known as Performance Metrics or Evaluation Criteria) are quantitative measures used to appraisewithevaluate the performance of routing protocols, clustering algorithms, or communication methodologies in a Vehicular Ad-hoc Network (VANET).

Throughput

Throughput referring to the velocity at which information packets are successfully conveyed and conventional over a communication channel within a given time period. It's essentially a measure of how much data can be moved from one point to another within a network, often expressed in bits per second (bps). High throughput is desirable as it indicates efficient data transfer and network performance.

Packet Delivery Ratio

The PDR is a crucial concertparameter that indicates the percentage of data packets productivelyconveyed to their projectedtarget compared to the entirenumeral of packets transmitted. A high PDR signifies efficient and reliable data transmission, while a low PDR indicates potential issues like packet failureowing to network overcrowding, interference, or other aspects.

Packet Loss Ratio

The PLR is a critical concertparameter that designates the proportion of information packets that not succeed to arrive at their intended destination. It's a key factor in evaluating network reliability and quality of service (QoS). A higher PLR signifies degraded network performance, while a lower PLR indicates better reliability and efficiency.

End to End Delay

End to End Delayillustrates to the entiretyinstance it takes for ainformation packet to travel from its resource node to the designated sink (target) node. It's a crucial performance metric, especially for real-time applications where timely data delivery is essential. Minimizing end-to-end delay is critical for efficient network operation and reliable data transmission in WSNs.

Jitter

Jitter illustrates to the dissimilarity in the occasion it takes for information packets to pass through from one node to another within the network. This variation can lead to significant issues in time-sensitive applications and synchronization, especially in real-time data transmission.

7. RESULTS AND DISCUSSIONS
8.

To validate the proposed methodology involving the Reserved Cluster Head (RCH) and improved node entry/exit mechanisms in a dynamic VANET environment, simulations were conducted.The evaluation was carried out based on five key concertparameters: Throughput, Packet Loss Ratio (PLR), Packet Delivery Ratio (PDR), Jitter, and End-to-End Delay. Below is a summary of the findings:

Table 3 and Figure 3 illustrate the throughput analysis of proposed methodology implementing by using the existing protocols names as DSDV, AODV and OLSR. In those existing protocols the OLSR is compared to better that the other two protocols named as DSDV and AODV.

Table.03. Throughput Analysis

No.of.Nodes	20	40	60	80	100
DSDV	3	2.8	2.4	2.1	1.5
AODV	3.4	3	2.9	2.5	2
OLSR	3.8	3.5	3.2	2.9	2.5

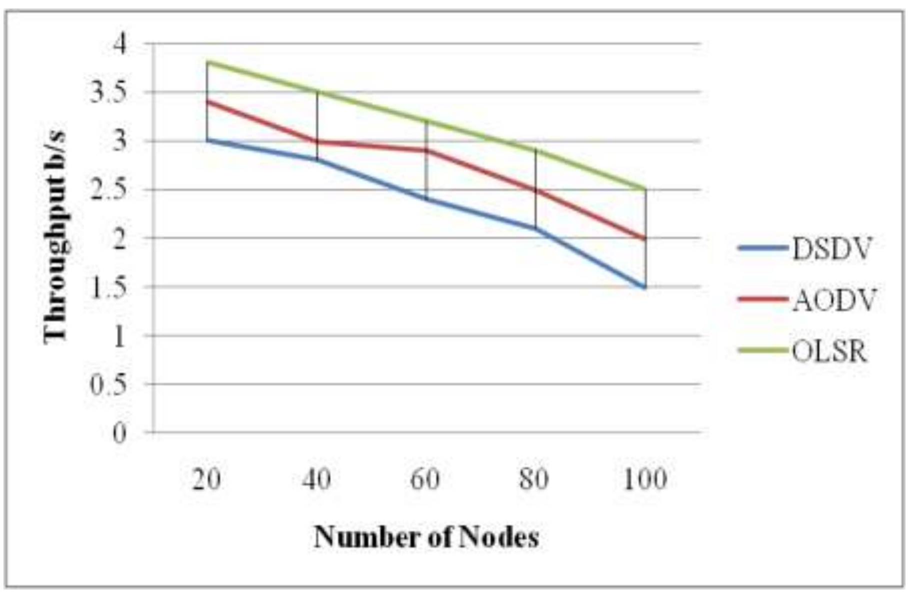

Figure.03. Throughput Analysis

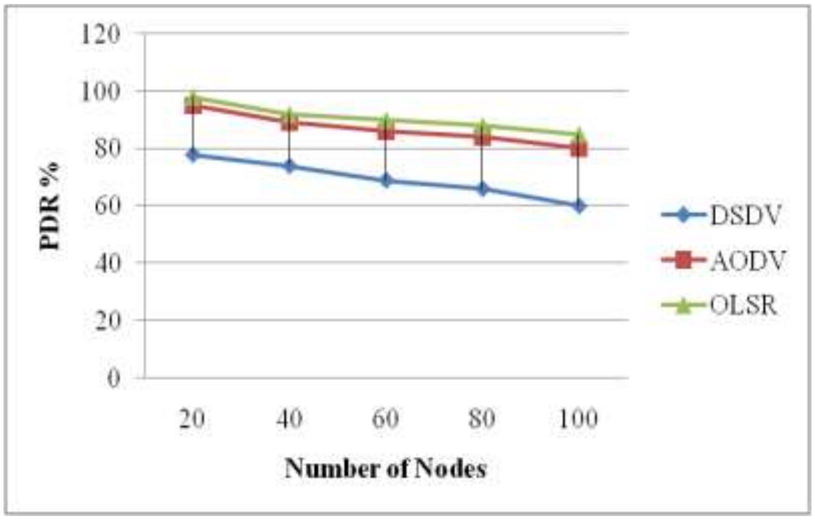

Figure.04. PDR Analysis

Table.04. PDR Analysis

No.of.Nodes	20	40	60	80	100
DSDV	78	74	69	66	60
AODV	95	89	86	84	80
OLSR	98	92	90	88	85

Table.05. PLR Analysis

No.of.Nodes	20	40	60	80	100
DSDV	22	26	31	31	40
AODV	5	11	14	16	20
OLSR	2	8	10	12	15

Table 4 and Figure 4 illustrate the packet delivery ratio analysis of proposed methodology implementing by using the existing protocols names as DSDV, AODV and OLSR. In those existing protocols the OLSR is compared to better that the other two protocols named as DSDV and AODV.

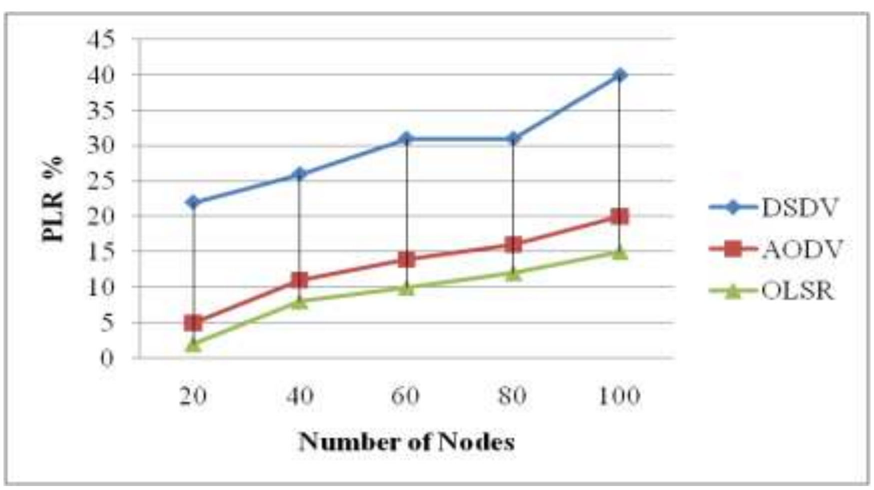

Figure.05. PLR Analysis

Table 5 and Figure 5 illustrate the packet loss ratio analysis of proposed methodology implementing by using the existing protocols names as DSDV, AODV and OLSR. In those existing protocols the OLSR is compared to better that the other two protocols named as DSDV and AODV.

Table.06. End to End Delay Analysis

No.of.Nodes	20	40	60	80	100
DSDV	15	17	18	19	19.5
AODV	14	15	16	17	17.5
OLSR	12	13	14	15	16

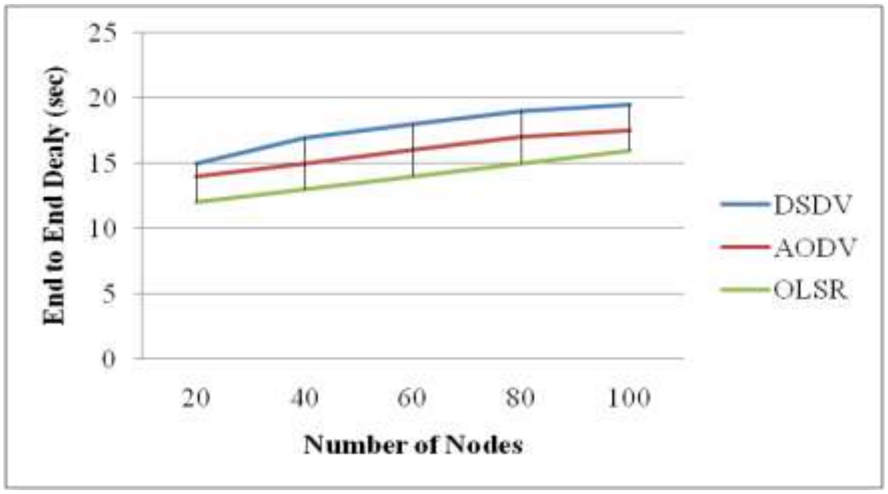

Figure.06. End to End Delay Analysis

Table 6 and Figure 6 illustrate the end to end delay analysis of proposed methodology implementing by using the existing protocols names as DSDV, AODV and OLSR. In those existing protocols the OLSR is compared to better that the other two protocols named as DSDV and AODV.

Table.07. Jitter Analysis

No.of.Nodes	20	40	60	80	100
DSDV	11	19	25	30	35
AODV	18	25	34	50	60
OLSR	19	30	43	60	78

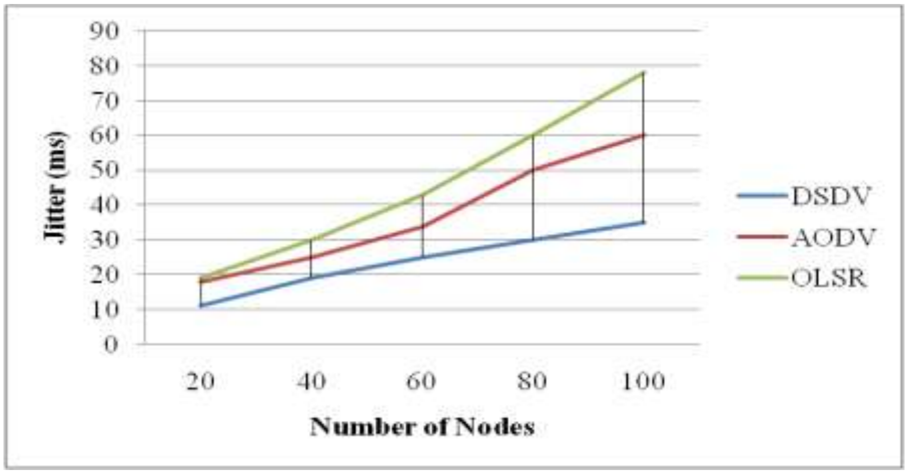

Figure.07. Jitter Analysis

Table 7 and Figure 7 illustrate the jitter analysis of proposed methodology implementing by using the existing protocols names as DSDV, AODV and OLSR. In those existing protocols the OLSR is compared to better that the other two protocols named as DSDV and AODV.

9. CONCLUSION AND FUTURE ENHANCEMENT
10.

The proposed methodology introduces an efficient and adaptive solution for managing dynamic node behavior in VANET clusters through the use of a Reserved Cluster Head and intelligent node entry/exit policies. By anticipating the departure of cluster heads and ensuring smooth transitions, the framework minimizes cluster reformation overhead and communication disruption. Simulation results confirm that the proposed model improves containerdeliverancepercentage, diminishes end-to-end impedimentalong with jitter**,** and augmentsoverall throughput in highly mobile vehicular environments.This novel approach is particularly suited for safety-critical applications and real-time data exchange in VANETs, where stability and quick recovery from topology changes are essential. Future work may spotlight on incorporating machine-learning method for predictive CH/RCH switching and extending the model to support heterogeneous vehicular networks involving 5G and IoT-enabled infrastructure.

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