Efficient Hybrid Clustering Scheme for Data Delivery Using Internet of Things Enabled Vehicular Ad Hoc Networks in Smart City Traffic Congestion

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Abstract

Vehicular Ad Hoc Network (VANETs) has improved significantly in the recent years, specifically in emerging Intelligent Transportation Systems (ITS). Internet of Things (IoT) enabled VANETs are exceedingly efficient wireless networks which maintain and improve vehicular network safety, network traffic monitoring, and some commercial applications. Conversely, competent routing in IoT enabled VANETs is exigent for many reasons like changeable vehicle density, network size and fading channel due to high motion and natural disorder in metro environments. The main concern in VANET is cluster routing where the presence of less number of vehicles creates greater challenge to send and receive a packet from source to destination. In such scenario, efficient IoT VANET routing plays a major role. We proposed a cluster based IoT enabled routing technique which is based on hybrid scenario that includes both static and dynamic transportation. The technique applied in cluster based routing aids in transmitting packets in a network even with low vehicle density efficiently.

Keywords: VANET, IoT, Communication networks, Clustering, Traffic congestion

1 Introduction

The Internet of Things (IoT) experienced enormous growth right from its commencement, particularly by interconnecting communication network to enterprise network service providers in 1988 by the NSFNET project [1].

The important factor for IoT success is the ease of its network environment architecture, often referred to as “dumb network, smart ends” [2]. This facilitated the development of complex applications with minimum changes in the sub network. Vehicular Ad hoc Network (VANET) is widely used for driver safety enhancement [3] that provides communication between moving vehicles which is applied in Intelligent Transportation System (ITS).

Vehicles connected with pervasive devices which are performing like computers will be on transportation systems which will reform the transportation concept of travelling. Data transmission in VANET supports a broad variety of secure and non-secure applications. The VANET incorporates the pervasive devices for all data allocation capabilities, the vehicles can be moved into a transportation network only if similar services are available in the networks. In general, VANET can be categorized as vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) networks [4].

VANET is a challenging concept of IoT enabled ubiquitous computing for future transportation technology which is considered as a derivative of IoT. There are lot of similarities between VANETs and IoT operations. IoTs and VANETs are quickly deployable without the requirement of an infrastructure. VANETs have some unique features in various ways [5]. The network structure of VANET nodes follows certain patterns. IoTs are incessantly characterized by deficient storage ability, exemption of power and low battery whereas VANETs don’t have any restrictions in their limits and the node moves at enhanced rapidity. This decreases the life span of links between network nodes and variable density during congestion.

The VANET Architecture shows in Figure 1. The topology administration in VANETs could be performed based on clustering scheme. The scheme is the most efficient manner of supervising and soothing these networks [6]. A steady clustering based scheme minimizes the overheads in performing re–clustering and lakes the administration within the network easy. Clustering is a collection of nodes which is capable enough to perform transmission with one another without any interruptions. Each and every cluster has a head which directs the transmission among the nodes

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DOI: 10.3966/160792642020012101014

of the clusters and with other nodes within the clusters [7]. The scheme could possibly aid in enhancing the synchronization among the nodes minimizing the node counts without disturbing one another and eradicates hidden terminal issues [8].

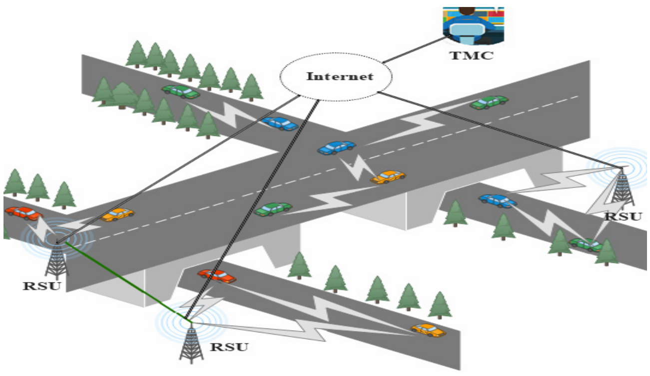

Figure 1. VANET architecture

The purpose of a hybrid clustering based scheme is designed which makes use of a combination of comparative displacements for choosing heads for the cluster. The primary intention of the scheme serves as a support termed as cluster management which is arranged based on the connection among the extent of node arranging a cluster management. This management then aids in choosing heads for clustering with the aid of a combination of nodes comparative displacements. The scheme also makes use of disagreement based schemes designed to avert regular cluster re – arrangement where two cluster heads are present in one another limits. Effective medium access and hardware will provide greatest physical layer properties for upper layer's data, providing efficient QoS, resulting in minimum use of network resources. The two supporting technologies, namely cross-layer architecture, have created a fresh outlook or research based on which various research projects have been undertaken [9].

This manuscript investigates the significance of IoT enabled VANET data and the network consequential of data transferring. The IoT data is calm from a simulated background which supports IoT enabled VANET data based on some literature. The numerical uniqueness of this data is analyzed, based on which an IoT enabled VANET modulated cluster wavelet method is proposed to study the uniqueness of the data. The association between data transfer and network routing technique values are analysed.

The proposed work is presented as follows, Related work in Section II, recapitulate traffic uniqueness of IoT enabled routing techniques in Section III, problem analysis of clustering forwarding scheme in Section IV, and elaborated IoT enabled VANET scheme deign in Section V. The Result and performance analysis is discussed in Section VI and concluding the paper with discussion on future research works in Section VII.

2 Related Works

Traffic model is considered in the framework of vehicle-to-vehicle (V2V) and wireless sensor networks. The authors [10] proposed distribution and off distribution allocation method can be described. In [11], body temperature monitoring system and electrocardiogram were studied using autocorrelation function. [12] discussed the tree based clustering scheme which generates a tree based clusters with at least four hop radius. The scheme holds medium access and program based communication of message within the cluster to assure dependable transmission. The intention is to generate clusters within the radius higher than the one hop as rapid as possible.

The function of the clustering based scheme is performed in the manner of comparison in vehicle displacement forms. The head of clusters is on the base of the flow since due to congestion. The vehicle with utmost cluster head management is chosen as head for cluster [13]. [14] design a clustering scheme which makes use of a combination of local displacement parameters for commencing cluster re – arrangement.

In [15] case two cluster heads are present within the transmission range of one another than one cluster head sacrifices their responsibilities and finally, the clusters are combined. In case two cluster heads perform transmission with one another soon before the conflict expiration time the node with minimal combined local displacement is chosen as head for the cluster [16]. Therefore the node with no cluster head might not predict the local cluster to append and might become the cluster head. Here in these circumstances, clustering scheme will be uneven due to recurrent alteration in cluster heads [17].

[18] proposed V2V and transportation traffic in many aspects with temporal analysis and traffic network patterns, application usability, device mobility management and overall network recital.

[19] clustering scheme termed as precedence based clustering where each and every clustering framework is resolute by the physical position related data and the precedence are allocated to the vehicles. The scheme is based on the selection of cluster head which is identical to the estimation of minimal leading sets in the graph theory.

The [20] vehicles are categorized into classes based on the range of displacements. The intention is to describe seven classes of displacements which are used by the vehicle belonging to the identical cluster.

3 IOT Enabled VANET Routing Techniques

Network routing and protocol design are one of the majority research topics in IoT enabled VANET. However, the major dispute to design an IoT enabled

VANET routing which is proper to all scenarios and a condition is still open. More or less, researchers have consent that static routing method cannot convince changeable VANET network conditions. Summary of IoT enabled routing in VANET [21].

3.1 IoT VANET Deployments

Cognitive network defined hardware can offer IoT enabled VANETs [22] for heavy network congestion. This enhances the application of radio spectrum and improves vehicular networks efficiency. Globally, communication regulators are utilizing available primary bands in support of unavailable services in various vehicle communications. Available communication bands, makes software defined radio hardware an excellent option for VANET.

3.2 Typical IoT Applications

Typical IoT applications used to design for a wide range of technologies. Commonly, the devices and sensors are connected through gateway to the Internet. Machineries play a vital role in IoT communications when compared to conventional communication where humans mainly convey the information [23].

3.3 VANET Traffic Control and Application Management

Traffic management involves increasing traffic flows, reducing the travel congestion, and updating the road conditions to the drivers. This can be achieved by the use of a number of road corner sensors like intelligent sensor signals and digital sign (e-sign) boards. Prior knowledge regarding the road traffic will assist in decreasing the traffic. Overcrowding at heavy road intersections can be handled well with the help of traffic signals. These traffic signals in turn act accordingly and communicate the situation to the other intersections. This information can be displayed on the e-sign boards thus resulting in efficient traffic management.

4 Problem Analysis

The drawback in device-based routing system as mentioned in is the development of unnecessary paths which are not within the transmission assortment of each other. Figure 2 to Figure 4, described in previous work explains an occasion highlighting the unnecessary multi-path creation issue in the current sensors scheme.

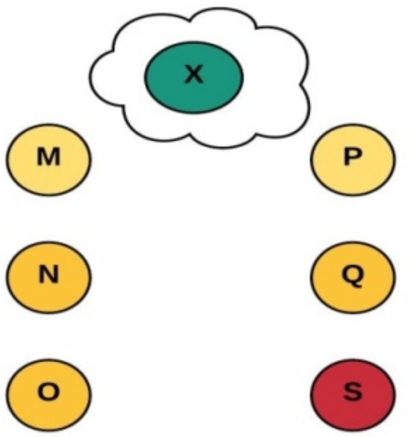

Figure 2. Multipath formation

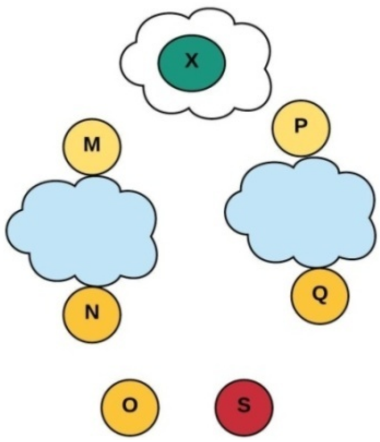

Figure 3. Multipath network formation

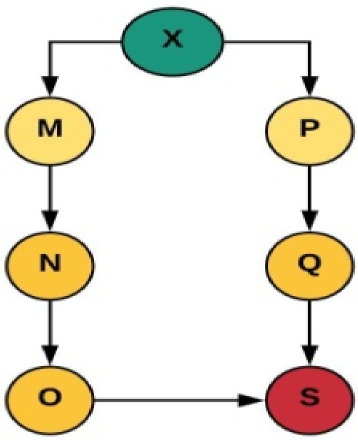

Figure 4. Multipath network formation

4.1 IoT Enabled VANET Multipath Formation Issues

In Figure 2, X and O are represented as the source and destination nodes, M, P, N, Q and S nodes act as the source to destination intermediate nodes. In Figure 2, X delivers the packets in its network range. M and P receive the packet as they are within the X network range. Assuming both M and P are within the forwarding zone, they set their waiting time. The packet will be broadcasted when the waiting time of M expires. Figure 3 shows both M and P nodes are not in the network range; hence P wills podcast the packet one time its time expires. This results in the development of X-M-N-O and X-P-Q-S-O as shown in Figure 4. Unnecessarily multiple paths are created which causes network congestion. The need for forming a forwarding zone is avoided preventing creation of multi-path arrangement in receiver-based techniques. This can be achieved if the forwarding zone is set in such a way that the highest distance between any two nodes located in the forwarding zone is less than the network range.

4.1.1 Receiving Packets

This procedure is called when this node receives a packet on its network interface from some other node.

```
Start Receive;
        Receive = R;                    R (p);
        if p = RIVER then
                E (p);
                Process B (p);
        Could be explicit or implicit
        if p = {P- Start, P-Back} then
              orgn = p.SourceLoc
              dest = p.destLoc
```

Where

P – Packet; E – Edge; B – Beacon; V – Vertex; Dp – Data Packet;

Two street vertices' ranges can overlap. Don't consider the destination reached if we are closer to the origin than the destination.

```
if Array(dest) < (Dis(dest) < Dis(orgn)) then
        Pro.IncomingProbe(p)
        return
            end if
                else if p.mode = ROUTING then
                ProRouteWeights(p)
                nearV tx ← NearStreetV
if InRange(nearV tx) then - We are "at" a vertex.
```

Our receipt of this packet implies that an incident edge is reliable.

```
Trav.RouteE(p)
        end if
        if AcceptDataP(p) then
                return
                end if
end if - packet must be outgoing at this point
        FrwdP(p)
                end if
end procedure
```

4.1.2 Accept Data Pkt

This function returns TRUE if the packet should be accepted (consumed) by this node. Returns FALSE if the packet's delivery failed and process should be executed again the flow of work mentioned in below method.

```
Function Accept
        DP(Dp);
        if Dp.destAddr = IP-transmit then
RecvDp(Dp) - but continue broadcast
        if InRange(destLoc) then
        RecvDp(Dp)
                return TRUE
        else - continue delivery
end function
```

4.1.3 ForwardPacket

```
Procedure FrwdP(fP)
        Loc ← Curr.Loc
                destLoc ← fP.DestLoc
nextHop ← Reset ◁ Reset the next hop for the packet
    if fP.destAddr = IP-transmit then
    nextHop ← IP-transmit ◁ Beacons are broadcast
        end if
    end procedure
```

The standards of VANETs are extremely uneven due to autonomous modification which is accomplished due to the increased displacement of the vehicles [24]. Clustering is an efficient manner of balancing these networks. The intention of the clustering scheme is to reduce re – arrangement and modifies the cluster heads which is obvious due to autonomous nature of VANETs. In case the number of nodes taking part in re – arrangement is restricted to a minimal number, constancy and effectiveness of clustering based scheme could be improved. The intention of the clustering scheme restricts the node counts by initially arranging the clustering management. These nodes are chosen as head for the cluster which could take part in the selection of cluster and re – arrangement process. A head with a minimal combination of comparable displacement is chosen as a cluster head.

4.2 IoT Enabled VANET Modulated Cluster Wavelet Model

The investigation of Probability Density (PD) function in the IoT enabled VANET traffic. Proposed IoT cluster function to the PD is given to the time point of the contact denoted as $(y_1, y_2, \cdots, y_n)$ be an self-determining and exactly circulated from allocation with an anonymous density X. The density calculation is shown in equ (1).

$$x_a(y) = \frac{1}{n}\Sigma_{i=1}^{n} k_a(y - y_i) = \frac{1}{ba}\Sigma_{i=1}^{n} k\left(\frac{y - y_i}{a}\right) \quad \textbf{(1)}$$

Where

K is denoted as non negative value that joins to one with zero mean value.

a > 0 is a supporting factor.

The wavelet transforms in the PD of the sampled data. The capability of Wavelet bases to approximate a huge number of functions is applied. Their intense quality helps in attaining global estimate which leads to calculate the PD of IoT traffic which has knocks and unexpected distractions.

Density is derived as wavelet bases of linear fixation as shown in equ (2), (3), (4)

$$x(y) = \sum_{p_0,q} N\, p_0, q\, \phi\, p_0, q\,(y) + \Sigma_{p>p_0,q}\, Mp, q\varphi p, q(y) \quad \textbf{(2)}$$

Where

y and x(y) denotes reference data PD.

ϕ (y) denotes measures and φ (y) indicates wavelet basis functions,

NP_0, $_q$ and Mp, k are measures with wavelet basis function coefficients.

$$\phi p_{0,}\ q(y) = 2\ p_0 / 2\, \phi(2p_0\ y - q) \quad \textbf{(3)}$$

$$\phi p_{,}\ q(y) = 2\ p / 2\, \phi(2p\ y - q) \quad \textbf{(4)}$$

Assume that ϕ (y) and φ (y) with their measured and converted versions outline orthogonal bases for their particular spaces. In the given X samples, the coefficient can be calculated as sample standard as shown in equ (5).

$$N_{p_{0,q}} = \frac{1}{x}\Sigma_{i=1}^{X}\, \phi\ p_0, q(y_i) \quad \textbf{(5)}$$

ϕ (y) is set up by solving equation and φ (y) which is availed using the wavelet equation as shown in equ (6).

$$\phi(y) = 2\,\Sigma_p^1\,(p)\,\phi\,(2y - q) \quad \textbf{(6)}$$

Where (p) represents low-pass filter coefficients connected to particular measurement. Iterative application is applied to avail the solution. Once ϕ (y) is obtained, φ (y) is derived from high pass filter coefficients h(p) as per the equ (7).

$$\varphi(y) = 2\,\Sigma_p^m\, h(p)\,\varphi\,(2y - q) \quad \textbf{(7)}$$

Gamma function is applied with varying factors to suit the scale coefficient NP_0, $_q$ and polynomial to adjust to the wavelet coefficient NP_0, $_q$ of density probability function x(y).

Gamma allocation offers increased flexible parameterization compared to heavy-tailed density for histogram wavelet experiment description f(x) as shown in equ (8) and equ (9).

$$f(x) = \frac{1}{n7(m,n)}\,(\frac{y}{n})^{m-1}\ e^{-y/n} \quad \textbf{(8)}$$

$$1(m,n) = n^m \int_0^{\infty} y^{m-1}\ e^{-yn}\ dy \quad \textbf{(9)}$$

Where

m denotes shape factor.

n denotes scale factor.

1 denotes Gamma function.

Note that as an approximating signal, N being a nearby signal, it displays maximum data of the standard function, and M denotes every measure in detail. Hence polynomial function is best to suit M which eases the functioning of the model.

5 IOT Enabled VANET Scheme Design

The clustering scheme, the designed rather making use of a single cluster head a cluster comprises several leaders which are chosen as cluster management. The node is chosen as a leader in case the extent of links is higher than or identical to a fixed value. The scheme designed is made use for designing and arranging the management of clusters. The head for the cluster is chosen from all the prevailing leaders within the management. The choosing a head for cluster the scheme of vehicular displacements is employed. Here the position related details of the vehicle are employed for regulating the comparative displacements of a vehicle.

5.1 Sensing Adjacency

The every node will be identifying its adjacency using its straight forward links. In order to detect their adjacent nodes periodic transmission of hello or a signal message with data like ID of the node combined comparative displacements, position, rank and velocity which are mandatory for estimating combined comparative displacements.

5.2 Management of Cluster

The primary segment of the scheme is a great support termed as cluster management which is created based on the extent of the node linkage (φ) and combined comparative displacements. Preliminarily all the node will commence in an unidentified state where soon after identification of adjacent nodes and the number of nodes in the adjacency list along with the outcome each and every node estimates its combined comparative displacements.

5.3 Electing Cluster Root

The operation of selecting root for the cluster is commenced after the arrangement of leader node. The node with minimal combined comparative displacements is chosen as the head for the cluster of all the nodes within the management.

Algorithm 1. Cluster Management

$\varphi_i = \sum adjacency(n_i)$ // aggregation of 'm' nodes in 2. the adjacency

$d^c_{n_i}(n_i) = | d_{n_i} - d_{n_j} |$

$d_{n_i} = diff\ (d^c_{n_i}\ (n_{j_m}))$

$\Omega_{n_i} = \varphi_{n_i} - d_{n_i}$

If $\Omega_{ni} \geq c_t$

Set status 'n_i' ← head

else

Set status 'n_i' ← member of cluster

end if

forward choose a head for the cluster (d_{ni})

acquire choose a head for the cluster (d_{ni}) at node n_i

if ('n_j' ε management) then

if ($d_{ni} < d_{nj}$) then

set status 'n_i' ← head for the cluster

end if

end if

end

In case if the statement 1 happens then both the clusters must be re – arranged. The cluster re – arrangement is entailed in Algorithm 2. In case if statement 2 happens there is no need to replicate the entire clustering process. A fresh cluster head is chosen from all the prevailing nodes within the management. Finally, if the statement 3 happens then the entire clustering operation must be reiterated again.

Algorithm 2. Cluster Re – Arrangement

Initiate

If (status 'n_i' = cluster head and status 'n_j' = cluster head)

then

Set status 'n_i' = disagreement state

Initiate disagreement timer (d_t) for node 'n_i'

end if

if (status 'n_i' = disagreement state) then

if (d_t > present time) then

if ($d_{ni} < d_{nj}$) then

set status 'n_i' ← cluster head

forward combined management

else

set status 'n_i' ← head

end if

end if

else if d_t deceases

set status 'n_i' ← cluster head

end if

end if

end

5.4 Cluster Re-Structure

In case if the node is representing as head for cluster it identifies that no adjacent nodes are present and it will become an unidentified state and initiates a time to halt the node to enter within their transmission range and initiates the arrangement operation again. In case if the timeout happens and no node is identified then it will announce it as head for the cluster.

The routing for cluster re-arrangement is entailed in Algorithm 2.

6 Results and Performance Analysis

The proposed method is implemented by using a 64-bit system with a core i3 processor (clock speed of 2.8 GHz) and 4 GB RAM. A simulation development has been planned for the proposed route verdict algorithm, which can correspond to the shortest path and probably travel time. The designed scheme is implemented and tested using NS 3. The vehicle displacements are implemented with the help of tiny traffic simulator. The values of the key metrics are employed in the simulation is entailed in Table 1.

Table 1. Simulation setup - choice based

Metrics	Values
Vehicles	100 to 500
Range of Transmission	150m
Maximum Speed	10,30 m/s
Displacement Rate of Vehicle	0.6 m/s^2
Slowing Rate of Vehicles	3.8 m/s^2
Routing Standard	AODV

6.1 IoT Lifespan of Cluster

It is entailed as the average of the non – stop time period where a node presents them as head of the cluster as shown in Figure 5 to Figure 7. The increased value of these estimates represents the cluster with improved constancy shown in Figure 5, Figure 6 and Figure 7. The designed scheme offers quite higher value than the ALM scheme. The value of the average cluster head lifespan is minimized with an enhancement in maximum displacement at an improved speed where the cluster head continues within the cluster for a minimal time.

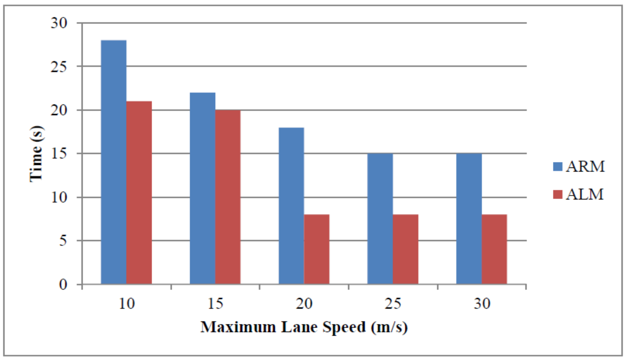

Figure 5. Maximum lane speed upto 100 Vehicles

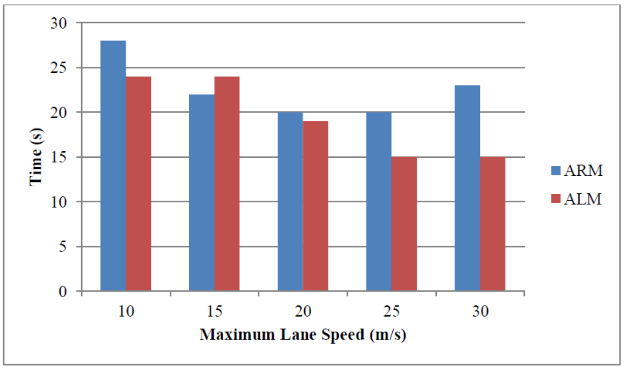

Figure 6. Maximum lane speed upto 300 vehicles

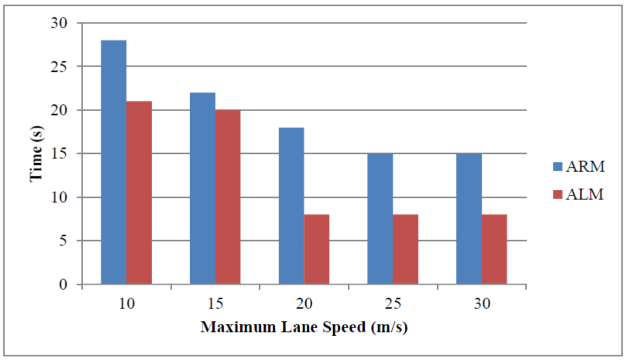

Figure 7. Maximum lane speed upto 500 vehicles

The designed clustering scheme retards these conditions by enhancing the number of clusters and aids in offering improved network connections among the vehicles.

6.2 Status Modification

It is entailed as the average number of status modification by a node in its lifespan. Increased value of these estimates represents non-static clusters. From Figure 8 it is clear that the average count of status modified by a node during its lifespan is minimized with the escalation in lane speed.

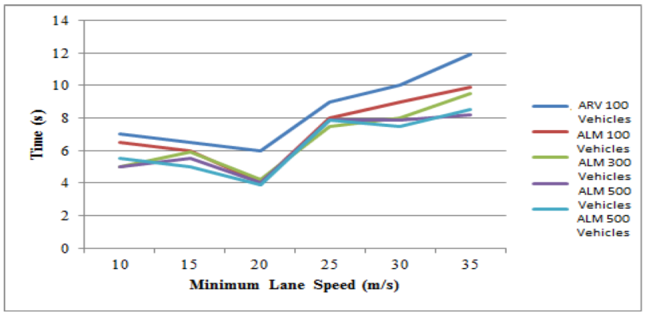

Figure 8. Average status cluster modifications

7 Conclusion

We discuss the IoT enabled VANET data forwarding approach that prevents unnecessary multipath creation. In the proposed approach, data forwarding zone determines the eligibility for the receiver-based contention. The hybrid support based clustering scheme is designed with help of supports termed as cluster management for making the decision for cluster heads. From the results of simulation, it is evident that the designed scheme minimizes the overheads in choosing cluster heads and re – selection which leads to some status modifications by a node within the cluster and reveals the lifespan of the cluster which is further evaluated against ALM scheme with minimal enhancement in minimal vehicle concentration conditions. Therefore the presentation of the proposed scheme will be examined under varied conditions through simulations that are currently under study and will frame the next level research.

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Biographies

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