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Cluster Based Architecture for Preventing Accident and Rear-End Collision in VANET

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Abstract

Objectives: To prevent accident and rear end collision in VANET, we propose to develop a method that will first create a cluster for preventing accident and rear collision in VANET **Method/Statistical Analysis:** Hence, to prevent accident and rear end collision in VANET, we propose to develop a scheme. First, with vehicles of same group moving in same road and direction, a cluster is formed. Among transmitted power and Contention Window (CW) size occasionally, every automobiles bounds an algorithm individually that's adjusted. **Findings:** In urban areas, Traffic accidents occur because of sudden brakes, which demand a quick response from drivers. Therefore, a driver should be informed of the emergency events earlier. The proposed scheme applied each vehicle nodes in the network. Within the contention window metrics, the probability of collision between nearby vehicles is calculated and included which ensures the occurrence of appropriate modernize of transmission power and CW (Access Category) standards derived from the limited automobile density and the network circumstance correspondingly. The cluster with the header nodes maintain every unwanted or accident event and inform to every node to prevent accidents and rear end collision. This is significant to every sub cluster members of an SCH entity. An automobile can securely reject communication initiated from automobiles next to it. The recipient automobile can take; action derived from the primary and rejects the remaining replacement copies in case of redundancy. **Applications/Improvements:** The proposed scheme focused to enhance the delay, delivery ratio, energy and throughput compare to existing schemes.

Keywords: Cluster Formation, Cluster Head, Rear-End Collision, Vehicular Ad hoc Networks (VANETs)

1. Introduction

To create a mobile network, expertise that uses stirring cars as nodes is VANET, which turns all cars into a wireless router or node, permitting cars roughly 100 to 300 meters of all other to attach, in twist, and generate a network with a extensive series. Additional cars can bond in, linking vehicles to dissimilar ones so that a mobile Internet is produced as cars drop out of the indication and fall out of the network[1]. Vehicular Ad hoc Networks (VANETs) have come out as a platform to maintain intellectual inter vehicle message and get better traffic security and presentation. To generate VANETs a challenging research topic the road-constrained, elevated mobility of automobiles, their unrestrained power foundation, and the appearance of pavement wireless infrastructures[2, 3]. The different Intelligent Transportation Systems (ITS) services involved to maintain clearance about the collision in the VANET[4].

The VANET can be considered as a subcategory of MANETs, but due to some exceptional characteristics, the VANET varies from MANET. There are some unique characteristics of VANET like High Dynamic Topology, Frequent Disconnected Network, Mobility Modeling and Prediction, Unlimited Transmission Power, Higher Computational Capability, Rapidly Changing Network Topology, Potentially Unbounded Network Size, Time-Sensitive Data Exchange. Congestion control is a challenging issue in VANETs.

The unwanted issues in the road side create big

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problem i.e. chain reaction. The leading cause of these accidents is driver error, particularly slow driver reaction time. In a high-speed highway scenario, this slow reaction time can often lead to catastrophic multi-car pileups. To lessen the numeral vehicular disasters in the street with respect to the ITS established in the network[5].

The below section describes the survey of the existing methods such as follows: in[6] have proposed a technique. Meant for distribution location statistics to other vehicles, a unique V2V message scheme derived from Wi-Fi tags are used. This method provides the number of automobiles concerned is too advanced. For mechanical cars, this organizer had built-in the AUTOPIA program management. The technique in deals only with breaking system and used for automatic cars.

ITS utilized to perform collision avoidance schemes with the limited amount of urgent connection messages related to the accidental events. They have offered a cluster-based association of the objective automobiles. The different node and routing metrics are used to create the clusters that are vehicle mobility due to movement, relative velocity and distance between neighboring nodes. The proposed CCA scheme connected with the risk-aware MAC protocol to make the protocol as effective one.

In[8] have proposed an innovative broadcast algorithm, which limits the control packets in terms of limited resource in the routing path. Cooperative collision avoidance in two-way multi-lane highway, this protocol is suitable. The multiple receiver case are suitable for entire routing path with the relaying receiver end.

A stochastic model[9] is derived from the number of disasters in a platoon of automobiles outfitted by means of a collision notification system. This system is capable to inform all the automobiles regarding a crisis event. The statement of communications being used is the key, to shorten the origin of a stochastic model. They deal only with sending the emergency message when an accident is occurred, but the technique will not deal with avoiding the collision. In this technique, only the number of collisions can be calculated.

In[10] have addressed the analytical design of a communications system. Drivers who are uninformed of an imminent collision this system tries to locate and offer timely protection information. The prevention method of vehicle system not useful for recent environment network and limits the basic information about the delay models. The technique in deals has only breaking system.

In[11] have proposed a technique, the power control system of transfer rate is rearranged from the evaluated local automobile density. The computed density utilized to allow service differentiation the CW size is modified according to the instantaneous collision rate.

The priority based limiting factors used to arrange the system order for promoting timely propagation of information and the EDCA mechanism is engaged for their propagation. In this technique, the clustering mechanism is not explained evidently. We can observe the following drawbacks are associated in paper from the literature review

- There is a chance of accident within a cluster if the driver does not react quickly.
- No action is taken to maintain the Quality of service of the messages.

To form a cluster of vehicles the technique is used, with this method the CH, SCH and OV are formed. In this technique, a collection of automobiles moving on the similar street and track is measured. The clustering with the cluster members are upholds and maintains the cluster table by the individual cluster heads. Based on local density of automobiles, the transmission range and transmission power are calculated and the transmission power is assigned. The priority is assigned which helps to maintain the QoS derived from the nature of messages. By means of the assist of this message priority the congestion window value is assigned. The collision probability is estimated and the transmitting power and congestion window (CW) are dynamically modified based on the collision rate and local vehicle density. The emergency event will be detected, with the help of collision probability. On detecting an emergency event, to every member of its cluster, an automobile concerns a caution message. By an SCH entity this message enters to its entire sub clusters members. An automobile can securely abandon messages originating from automobiles subsequent it[12,13]

Advantages

- The transmission energy is avoided and it enhances the length of the communication link lest of low traffic density for inter-vehicle communication.
- QOS is maintained hence the messages are forwarded without fail and the vehicles will not get the same messages repeatedly.
- It also detects whether the message is coming from the front or back side thus it helps to take decision whether to consider the message or no[14,15]

2. Overview

Vehicles moving in same road and direction are grouped and a cluster is formed. Each vehicle can be categorized either as a cluster head or as an ordinary vehicle or Sub cluster head. Based upon the number of vehicles in front or behind it, a vehicle may become a cluster head or an ordinary vehicle in an existing cluster.

The proposed algorithm adapts the transmission energy consumption and contention window size of control vectors. The possibility of collisions is retrieve from every cluster in the predetermined area with the related windowing metrics. Therefore derived from the restricted automobile density and the network circumstances, this authenticate the survival of appropriate renews of transmission power and contention window values. The occurrence of any crisis occurrence or collision is updated to all automobile by its cluster head thus to prevent accidents and rear end collision. This message is forwarded to each of its sub cluster members by the SCH. An automobile can securely refuse the messages instigating from automobiles subsequent to it. The recipient automobile takes action derived from the first one only and rejects the remaining replica copies in case of idleness. The system model of proposed scheme is shown in Figure 1.

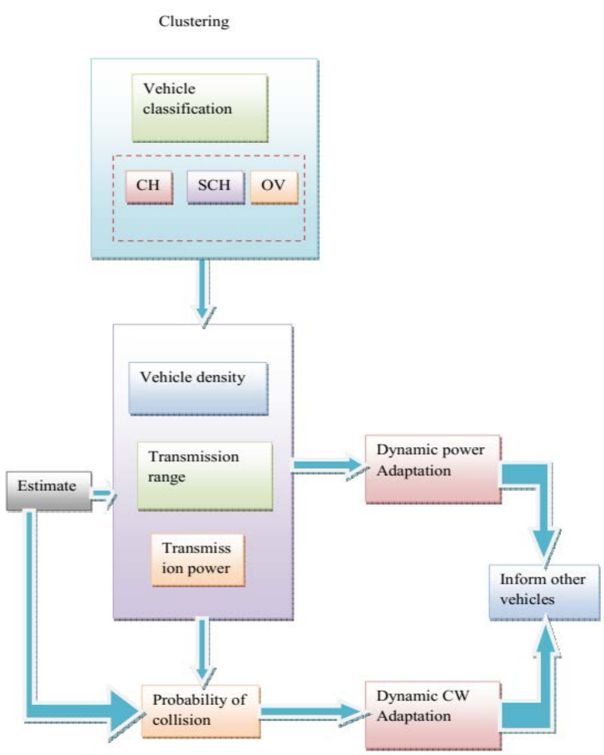

Figure 1. System model of proposed scheme.

2.1 Clustering Mechanism

In similar highway and direction are collected and a cluster is produced in automobiles moving. As a cluster head (CH) or a sub cluster head (SCH), or might merely drive as an ordinary vehicle (OV)[6], where an automobile may act as a special node. While sustaining and updating their individual cluster tables a CH is created by the automobiles willingly promotion for the cluster. The last automobile accessible by the CH is selected as the initial SCH node.

- The SCH entities are described from the limited resources of respective SCH node and so forth.
- The SCH of one cluster contact with the neighboring system through only the SCHs and the additional automobiles within the same cluster that lie exterior the CH's (or the front SCH's) transmission range.
- In addition, a SCH also cumulative details from OVs inside its reach and broadcasts them to the CHs/SCHs in front.
- Wherein the cluster size resolve considerably large, and hence automobiles tend to go gradually. Thus, chain collisions will be evaded.

2.2 Design Metrics for Cluster Formation

Let us clarify some notations used in clustering before illustrating the clustering process. The notation with the respective explanations is given in Table 1.

Table 1. Common notations

Notations	Descriptions
V_i	Node ID
V_{i-1}	Node ahead of i
V_{i+1}	Node immediately behind i
$s_{j,k}$	Distance between V_j and V_k nodes
v_j	Node velocity
$v_{j,k}$	j^{th} node relative velocity with respect to vehicle k.
T_j^a	Time required by vehicle V_j to reach vehicle V_{j-1} immediately ahead of it $T_j^a = s_{j-1,j} / v_{j-1,j}$
T_j^b	Time required by vehicle V_j to be reached by vehicle V_{j+1} right behind it $T_j^b = s_{j,j+1} / v_{j,j+1}$
d_e, d_r	Emergency deceleration and regular deceleration warning messages respectively.
λ	The average reaction time of individual drivers ($0.75 \le \lambda \le 1.5$ sec).
τ	Tolerance factor

Each vehicle V_i and its immediately following vehicle V_{i+1} is said to be without collision between these vehicles and safe, when their distance $s_{a,a+1}$ convince the subsequent situation for $H_{a,a+1}$

$$H_{a,a+1} \Leftrightarrow s_{a,a+1} > Min\left(s_{\max}, \tau.\left(v_{i+1}.\tau + \frac{v_{a+1}^2}{2d_r} - \frac{v_a^2}{2d_e}\right)\right) \quad (1)$$

$\overline{H_{a,a+1}}$ is the negation point of the threshold condition and τ is a factorial dealing tolerance factor. s_{max} is the distance between the two vehicles with the control system originated distance starting point to end point and the corresponding velocities are consider as the existing velocity values, $v_{max} = 180$ km/h, $s_{max} = v_{max} \cdot 1.5$ sec = 75 m.

An automobile might survive in any of the subsequent three states in the envisioned clustering operation.

- The formation startup with the each vehicle engine and road factors.
- It chooses to travel in a various direction. Hence, it leaves its old group g_o and connects a new group of automobiles, g_n.
- It profits to take a trip on the similar highway with no change in its course. Though, it enlarges or reduces its traveling rate. Hence the below Figure 2 shows the example of three clusters

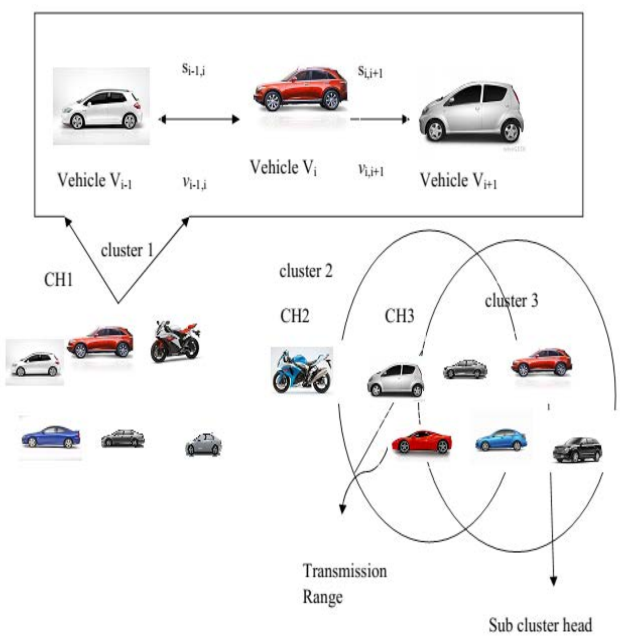

Figure 2. Example of three clusters.

2.3 Energy Consumption Strategy

The proposed scheme applied on each node individual to combine the energy consumption due to the transmissions and the CW size. The proposed updates of both values are involved in the CW with the limited amount of resources. The size of CW describes the relative speed of both the derived and general density of each node in the network. The proposed scheme consist of two stages: transmit energy and CW size adaptation[11]. The computation of transfer and receiver energy depends on the predetermined windowing system with the amount of nodes present in the network. The relative mobility factors are considered as node priority allocation for dissimilar messages according to their importance.

2.3.1 Adaption of Transfer Energy Consumption

The power delivery metrics depends on the broadcast power and unwanted attacks from external link in the limited source nodes. The mobility control values of each vehicle nodes are rearranged in the selective manner with the packet transfer architecture. The dependency between new limited accesses channels with the allowed channel are computed by the normal condition path in the long pack network. The acceptable areas are derived from the node density and corresponding mobility of control values region with the transfer energy consumption. It enlarges the period of the communication link, in case of short traffic density for inter-vehicle communication.

On observing the number of packets currently received, the automobile density inside its transmission range is intended and doesn't initiate significant network overhead to recognize the fellow citizens of the automobile.

2.3.1.1 Node Density

The ratio of numbers of automobiles (an) on the street and total automobiles (tn) within transmission range, journey speed and security division distance as follows:

$$D = \frac{an}{tn} \quad (2)$$

The number of nodes is represent by node density and the control overheads arranged in the order of a given automobile with other network. A known automobile interacts its position with bordering automobiles about ten times all second, and individual automobiles utilize this data to guess the definite number of automobiles (an) in their vicinity by using the 12-bit sequence number in dedicated short range communication (DSRC).

2.3.1.2 Node Transfer Rate

Transfer rate is computed by the algorithm that utilizes the estimated automobile density as per equation (1) and then sets up the equivalent transmission power by means of the look up Table 2

Transmission range described as follows:

$$Tr = \min\{l(1-D), \sqrt{\frac{l\ln l}{D}} + kl\} \quad (3)$$

Where k is a known constant, l is the length of road segment in the limited node guess with the original node density, and D is an uncountable node density and it is represent as the unknown factor.

2.3.1.3 Transmission Power Adaptation

After estimating transmission range using equation (3), we have to plan it to a definite transmission power value by operating the research table which has the transmit power values equivalent to various transmission series. For different VANET scenarios, the simulation of basic wireless propagation models is conducted and for a known transmission range period to contain urban, city, and rural surroundings so as to enter the data, an exact power value is allocated. As no computations are required the lookup table approach is quicker[11].

2.3.1.4 Message Prioritization

Meant for service discrimination to run QoS for various kind of messages: voice traffic, video traffic, fine attempt traffic and environment traffic the IEEE 802.11e EDCA is used. EDCA mechanism is integrated in VANET by classifying different messages derived from their urgency and delay necessities. Table 2 shows the message priorities used for proposed scheme.

Table 2. Message Priorities

Priority level	Traffic model	VANET message types
1	Voice-AC(3)	Accident messages etc
2	Voice-AC(2)	Accident incident messages
3	Best effort-AC(1)	Warning related messages
4	Background-AC(0)	General messages

2.3.1.5 Algorithm for Transfer Energy Adaption

The utmost transmit power equivalent to utmost transmission range is selected, if local automobile density D is thin or when the automobile wants to broadcast high priority messages[3]. The functionality between the limited resources maintained at each nodes. The threshold value Th_1 is important for executing the algorithm and modified derived from the local density. The control values with the threshold condition solve the threading effects in the bundle of total transfer rate from waited rejoins. Threshold values differ for various automobiles, as the algorithm is engaged in a disseminated manner.

2.4 Vehicle Collision Probability Model

The exponential distribution system used to compute the data transfer in the limited reallocated table with the prior network conditions.

- Condition if an automobile could discontinue without crash and the constant kinematic parameters, it forever travels the similar distance dis.
- Condition if crash exists, automobile traveling parameters differentiate from limited resource usage and the node distance between the control and contention overhead.

Hence, by the preceding automobile, we guess the collision possibility trained on the distance traveled. The control parameters with the collision populations are derived from the constant temporal individuals supported from exact access points.

- The velocity of all nodes consider as common one.
- Then maintain the constant deceleration d as constant one.
- The delay between every node are consider as similar one with the caution message repeatedly in the order of priority basis only. As s_i, v_i, and t_i are constants,

$$d_a = \frac{v^2}{2d} + v\lambda \quad (4)$$

$$p_i = P(d_a \geq s_{a-1} + vs_i) = P(s_{a-1} + vs_a \leq d_a \mid s_{a-1} \leq d_a)P(s_{a-1} \leq d_a) + \\ + P(s_{a-1} + vs_a \leq d_a \mid s_{a-1} > d_a)P(s_{a-1} > d_a) \quad (5)$$

s_{a-1} is a random variation between the range of covered regions with the vehicle node mobility.

2.4.1 Algorithm for CW Size Adaption

The network conditions are depends on the behavior of node in the network with the CW size and it is resizing methods. The control parameters are derived from the limited resources used for whole process in the entire route cause of collision. The CW metrics affects the node local variable density with the control overhead with the normal mutant vectors and assessing the sequence figures at MAC layer[11]. The Table 3 shows the priority specific parameters of proposed scheme.

Table 3. Priority Specific parameters

Traffic model	CW minimum	CW maximum	AIFS
AC(0)	CWmin	CWmax	2
AC(1)	CWmin	CWmax	1
AC(2)	(CWmin+1)/2 1	CWmin	1
AC(3)	(CWmin+1)/4-1	(CWmin)/2	1

The normal transmission energy with the number of channel allocated in the normal access controls are developed from the higher intensive factor. The controls overhead with the Acknowledgement signals established between every node with the original value of CW size and the channel implant parameter for all nodes. The low priorities channels are computed from the channel utilization of manage nodes by the limited access points in the collision coverage area. The driver node with forward node selection method enhances the class priority levels in the order of IFS code. The small number of collisions vectors allowed for all queues in the limited virtual collision handling system in the order of bandwidth.

In the CW size and IEEE 802.11 algorithms always have a drop or rises and organize the CW edition whereas it follows two factors such as the size of window doubled if the size increased and reduced by half if the size decreased based on the size of the window CW [AC]. The CWmin get re-initializes by CWmax [AC] if there is a constant rise in the CW size till reach the utmost window size in CW.

- For reducing the network load while broadcasting and rebroadcasting when the network is packet to raise the CW [AC] values make the AC's having lesser possibilities(for all ACs upholding hierarchy of CW [AC] values as in EDCA)
- If there is no collision or less collision in the network then the CW [AC] values get decrease that grants ACs an network has less or no collision, the decrease in CW [AC] values thereby give ACS an better opportunity.(for all ACs maintaining hierarchy of CW values).

The hierarchical augmented in equivalent CW [AC] values are preserved in the above both cases.

3. Performance Analysis

3.1 Simulation Setup

The proposed Cluster Based Architecture for Preventing Accident and Rear-end collision (CBAPA) protocol implemented in network simulator[11] (NS-2) tool. The MAC layer protocol with the limited access schemes are consider as the coordination function and it has the functionality to advise the network layer about connection breakage. To consider the packet transfer rate as 250 to 1000 kb with the varying flow rate as 1 to 4. The complete analysis takes the 100 seconds of simulation time. The constant bit rate (CBR) and exponential traffic used to perform the simulation analysis. The detailed simulation setup with the parameters is given in Table 4.

Table 4. Simulation setup

Number of Nodes	73
Network size	2500 X 700m
Physical layer	MAC 802.11
Radio Range	400m
Simulation Time	100 sec
Traffic model	CBR and Exp
Packet Size	512 bytes
Antenna	Omni Antenna
Rate	250,500,750 and 1000Kb
No. of Flows	1,2,3 and 4

By means of cluster-based risk-aware CCA (CRACCA) technique[6], the CBAPA technique is evaluated. We assess mostly the presentation according to the subsequent metrics.

Average Packet Delivery Ratio: The total number of packets broadcast, is the ratio of the number of packets established effectively.

Delay: The time in use by the packet to achieve the receiver.

Energy: The average energy inspired for the data transmission.

Throughput: It is the total number of packets established by the receiver.

A. Varying Packet Transfer Rate for CBR Traffic

In this subsection, the number of packet transfer rate varying as 250-1000 kb and also considers the traffic as normal one (CBR).

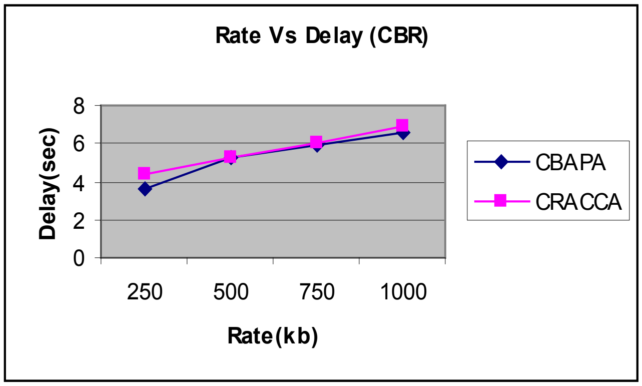

Figure 3. End-to-end delay.

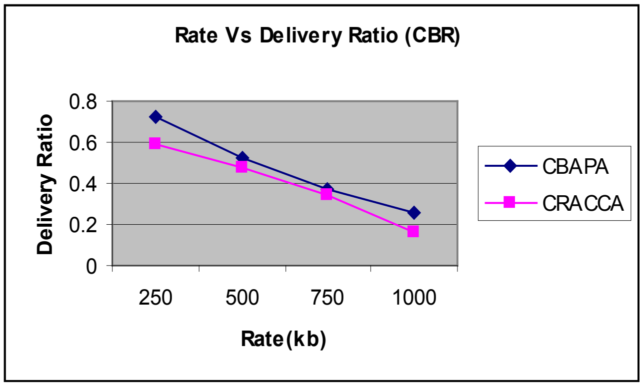

Figure 4. Packet delivery ratio.

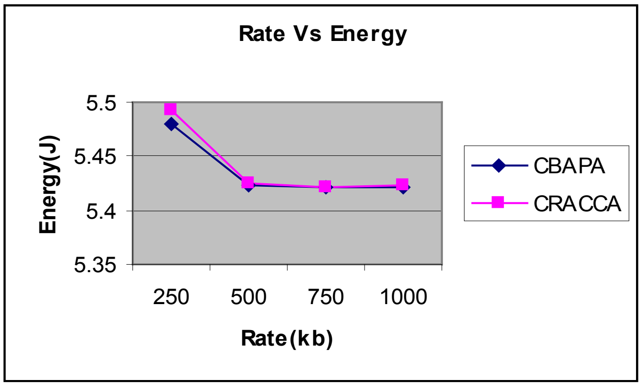

Figure 5. Energy consumption.

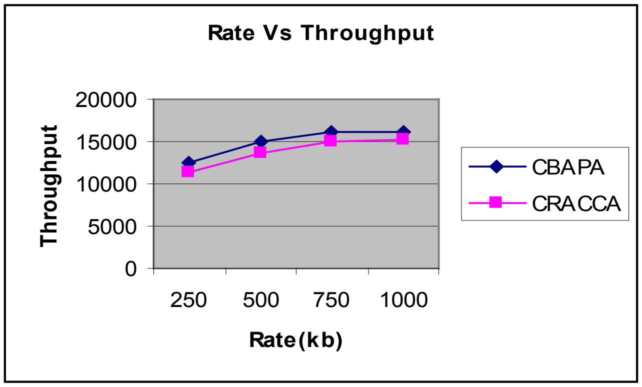

Figure 6. Throughput.

The performance analysis of proposed and existing protocols is present in the Figure 3 to 6. The simulation plot clearly depicts the performance of proposed CRACCA protocol very efficient than existing CBAPA protocol. From the Figure 3, the end-to-end delay of proposed CRACCA protocol 6% improved than existing CBAPA protocol. From the Figure 4, the packet delivery ratio of proposed CRACCA protocol 18.4% improved than existing CBAPA protocol. From the Figure 5, the energy consumption of proposed CRACCA protocol 8% improved than existing CBAPA protocol. From the Figure 6, the throughput of proposed CRACCA protocol 8% improved than existing CBAPA protocol.

B. Varying Packet Transfer Rate for Emergency Traffic

In this subsection, the number of packet transfer rate varying as 250-1000 kb and also considers the traffic as emergency one (Exp).

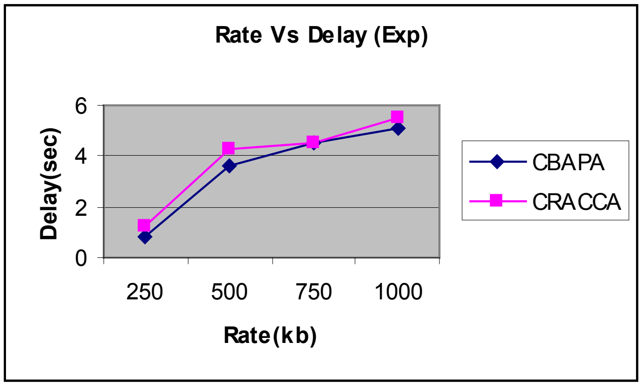

Figure 7. End-to-end delay.

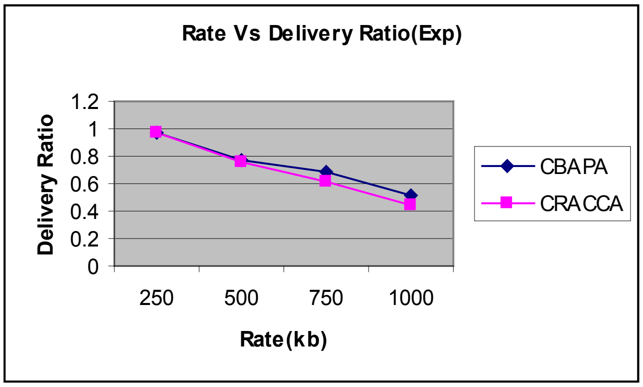

Figure 8. Packet delivery ratio.

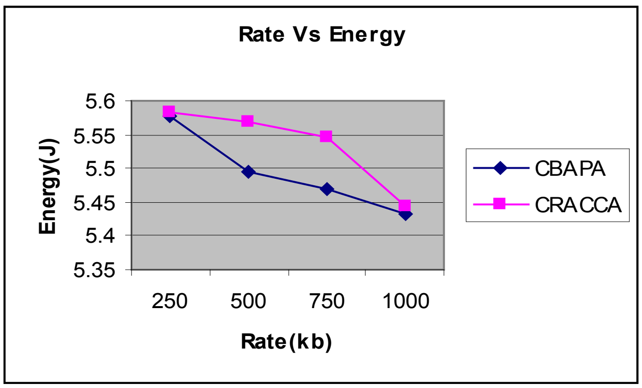

Figure 9. Energy consumption.

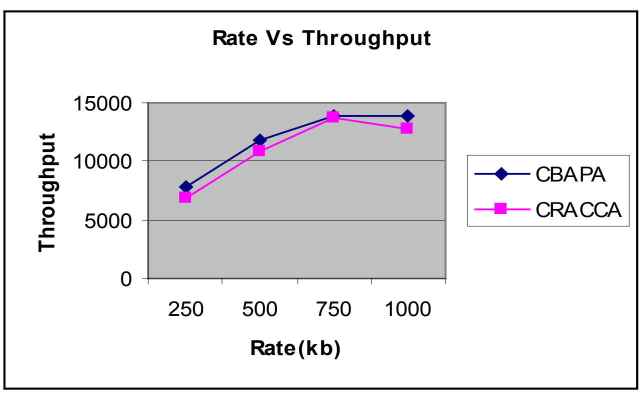

Figure 10. Throughput.

The simulation plot clearly depicts the performance of proposed CRACCA protocol very efficient than existing CBAPA protocol. From the Figure 7, the end-to-end delay of proposed CRACCA protocol 14% improved than existing CBAPA protocol. From the Figure 8, the packet delivery ratio of proposed CRACCA protocol 7% improved than existing CBAPA protocol. From the Figure 9, the energy consumption of proposed CRACCA protocol 0.75% improved than existing CBAPA protocol. From the Figure 10, the throughput of proposed CRACCA protocol 8% improved than existing CBAPA protocol.

C. Varying Number of Flows for Normal Traffic

In this subsection, the number of data flows varying as 1, 2, 3, and 4 also considers the traffic as normal one (CBR).

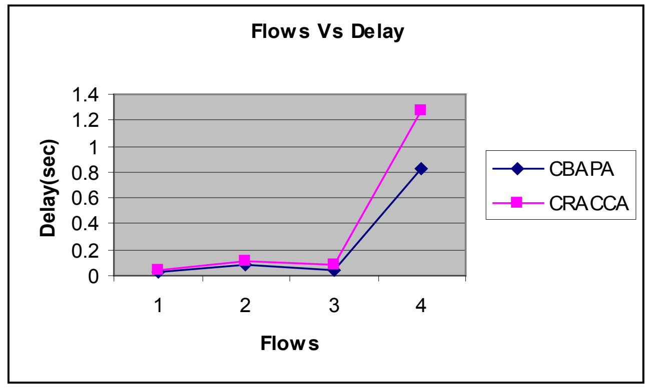

Figure 11. End-to-end delay.

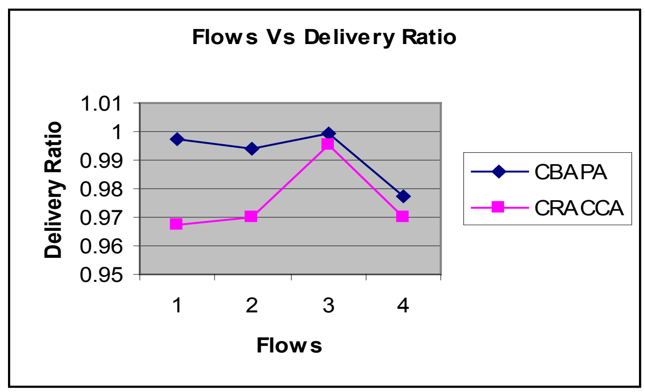

Figure 12. Packet delivery ratio.

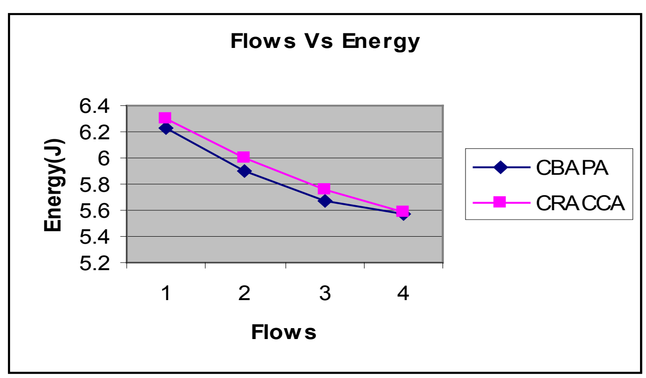

Figure 13. Energy consumption.

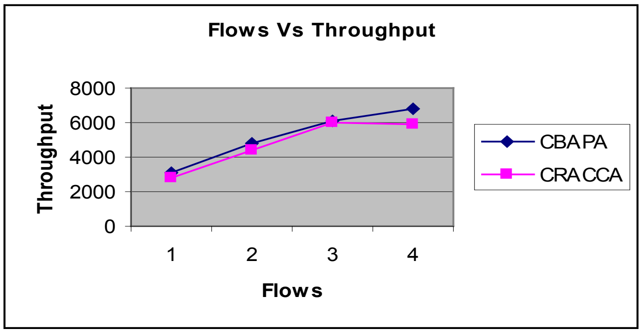

Figure 14. Throughput.

The simulation plot clearly depicts the performance of proposed CRACCA protocol very efficient than existing CBAPA protocol. From the plot 11, the end-to-end delay of proposed CRACCA protocol 34.3% improved than existing CBAPA protocol. From the Figure 12, the packet delivery ratio of proposed CRACCA protocol 1.63% improved than existing CBAPA protocol. From the Figure 13, the energy consumption of proposed CRACCA protocol 34.3% improved than existing CBAPA protocol. From the Figure 14, the throughput of proposed CRACCA protocol 8.4% improved than existing CBAPA protocol.

4. Conclusion

In this paper we mainly considered the VANET and introduced the scheme for avoiding the accident and the collision in rear end in VANET. In the first stage the cluster is formed but the vehicles which are moving in the same direction in a same road. The automobile are categorized into the normal automobile or cluster head or the sub cluster head. The cluster head are selected in the vehicle based on the arrangement the vehicle stand at front and back or the cluster head is selected from the existing cluster. In this every vehicle follows the algorithms that are periodically adapted to the Contention Window (CW) size and transmitted power. In the contention window metrics, the values of CW are derived using the circumstance of network and the density of local automobiles. The occurrence of transmission power information gets ensured and calculates the probability of collision among the nearby vehicles. Hence the accidents and rear end collision are prevented by the cluster head which inform about the crash or the causes of any emergency criteria. This communication is taken place by the SCH entity to its entire sub cluster members. Thus the automobile discard the messages that are initiated by the subsequent automobiles. From the primary one the recipient vehicle get derived or exploited and thus in the time of redundancy the relaxed replacement copies are discarded.

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