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Improving the Performance of VANETS through The Implementation of CRCN Along with Predictive Cluster

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ABSTRACT: With the emergence of information and communication technologies, modern vehicles are well equipped with various applications such as navigators, GPS and other in-vehicle entertainment applications. Also increasing number of vehicles on the road day by day, give rise to the need of providing safety and comfort to the passengers. A new technology named VANET (Vehicular Ad-hoc Networks) has emerged in this field. Using CR –Cognitive Radio in VANETs will enable more efficient radio spectrum usage and also improve vehicular communication efficiency. The main objective of this paper is to improve the safety message delivery, reducing Packet loss and to use the spectrum efficiently. To achieve this, new technique named CRCN is introduced and the proposed scheme is compared with existing schemes. NS2 simulator is used for this comparison.

Keywords: GPS, VANET, CR, CRCN, NS2.

I. INTRODUCTION

As the number of vehicles are increasing day by day, it gives rise to the need of providing safety and comfort to passengers. With development of technologies, the goal of providing safety becomes possible these days. Vehicular ad hoc networks (VANETs) are supposed to become one of the leading technologies in the coming years to achieve this goal. Generally, an ad-hoc network is defined as the network which is built spontaneously when devices connect. The word 'ad – hoc" is a Latin word which means FOR THIS PURPOSE. So, vehicular ad-hoc networks are spontaneously build on road in which vehicles acts as nodes in the same way as mobiles in the case of MANET. That is why VANETs are assumed as sub class of MANETs. Technically speaking, VANETs allow participating cars to connect with each other as wireless nodes when they are in the range of 100-300m from each other. In this way important road information can be easily transferred between vehicles. For example, if a vehicle detects high density traffic in a lane, it can share this information with other vehicles approaching the same location, which then could take decisions for their comfort such as changing lanes etc.
Another example could be when a vehicle detects a mis-happening or road blockage due to accident, it can alert all other vehicles in order to avoid traffic overhead. Some common examples include applications for collision avoidance, safety and traffic monitoring, multimedia streaming, data collection for smart cities in synergy with wireless sensor networks [2].
As VANET nodes are highly mobile in nature, there occur frequent changes in the network topology. VANETs also have highly dynamic scale and network density. VANETs are the largest ad-hoc network ever proposed. Therefore, the issues of stability, scalability, reliability, and security are of great concern. Due to these issues VANETs attract a great intention of both the researchers and developers.
Dedicated short-range communication (DSRC) is a generic name for short-range, point-to-point communication. It is also the name of the older technology mainly used for vehicle to road communication. The DSRC channels are reserved worldwide in 5.9 GHZ band [2].However, a significant rise in vehicular applications, especially in urban environments, with several vehicles, may lead to overcrowding of the band and thereby resulting in degraded vehicular communication efficiency for safety applications. Along with this increasing demand of in-car applications such as multimedia message forwarding, gives rise to congested vehicular networks, which further leads to the problem of spectrum scarcity.
As we know, various wireless standards are using ISM (industrial, medical, scientific) bands and 900 MHZ bands.

According to research, average utilization of these bands varies between 15 to 85 % and also many of these licensed bands are used over limited period. So, it gives rise to the issue of un-exploited spectrum bands and wastage of available spectrum. This fact is used to overcome the problem of spectrum scarcity and to provide efficient vehicular networks. Consequently, regulatory agencies, such as FCC in the USA that regulates spectrum allocations, have now opened the licensed bands to unlicensed/secondary user (SU) [2]. This gives rise to a new technology named *CR (Cognitive Radio).* CR networks do spectrum sensing in regular fashion, whenever it detects absence of primary user, it allows secondary users to exploit that available free spectrum and send its data using over it. When it again detects the arrival of PU's, it leaves that spectrum and switches to another free available spectrum. In this way, CRN relies on the corporation of both the primary and secondary users.

The main challenge of this technique is to avoid interference to primary user's activity and to maintain the PU's privacy.

Formally, *Cognitive radio* can be defined as follows:

(i) A ''Cognitive Radio" is a radio that can change its transmitter parameters based on interaction with the environment in which it operates.

(ii) *Simon Haykin* defined CR as an intelligent wireless communication system capable of being aware of its environment learning, and adaptively changing its operating parameters in real time for providing reliable communication and efficient utilization of the radio spectrum.

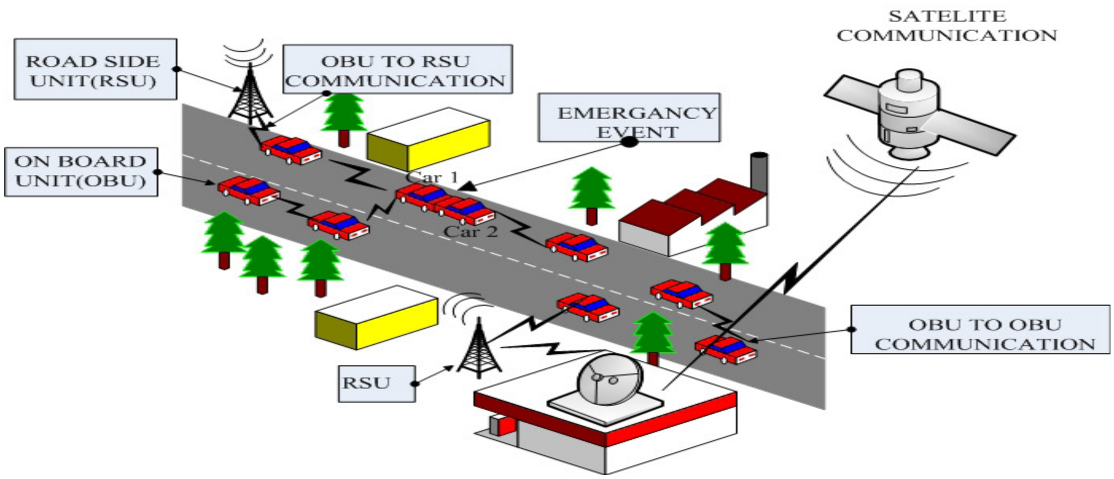


Fig. 1. Vehicular communications.

Vehicles in VANETs may communicate with one another either through vehicle-to-vehicle (V2V) or vehicle to-infrastructure (V2I) so as to generate the safety and alerts messages to the passengers [1].

It means VANETs support two types of communication:

In V2V communication, vehicles directly connect to each other according to concept of ad-hoc routing. These vehicles are not only equipped with global positioning system (GPS) and navigation systems, but also more advanced features. Vehicles have an on-board unit (OBU) installed in them which makes these communication possible. Vehicles may act as intelligent machines having components such as sensors, actuators which are deployed on the on-board units [1].

In V2I communication, vehicles communicate with road side units (RSU's). These RSU's are the access points along the road. RSUs are geographically fixed units (such as towers) used to provide uninterrupted services to the moving vehicles. RSUs are geographically fixed units used to provide uninterrupted services to the moving vehicles. Vehicles driving from one RSU to another or overlapping ranges between adjacent RSUs result in handoff mechanisms to avoid load imbalances in the network [1].

Since in VANETs the vehicles have high mobility, so this characteristics in the main challenge in order to ensure network connectivity. Vehicles may loss connection due this characteristic. To overcome this problem, researchers proposed a new idea named *CLUSTERING.* Clustering is a technique in which vehicles are grouped together based upon some predefined criteria. One of these vehicles is elected as the cluster head (CH), which takes decisions on behalf of all the other nodes to reduce the communication overhead. Various clustering algorithms have been proposed by researchers such as predictive clustering, distributive clustering etc. [1,11,13,15].

The remaining part of this paper is organized as follows: Section 2 explains the related work to this paper. Section 3 explains our contributions to this work and simulation results. The proposed scheme is compared with existing one. Section 4 explains the conclusions of this work.

II. RELATED WORK

A number of protocols are proposed to improve the performance of VANETs and to reduce the packet loss in past. This section discusses various existing works in this category with relevance to the current proposal.

Rasmeet S. Bali *et al.* [1] proposed an efficient energy-aware predictive clustering scheme for vehicles. Efficient algorithms are designed for future mobility predictions and average variations of vehicles on the road. The performance of the designed algorithms is studied using extensive simulations by varying the number of vehicles and cluster durations in comparison with existing benchmarked scheme.

Kamaldeep Singh *et al.* [2] reviewed novel approaches and discusses research challenges related to the use of cognitive radio technology in vehicular ad hoc networks. The aim is to focus on recent advances and open research directions on applying cognitive radio in vehicular ad hoc networks (CR-VANETs) focusing on architecture, machine learning, cooperation, re-programmability, and spectrum management as well as QOE optimization for infotainment applications.

Hyoungsuk Jeon *et al.* [3] proposed a scheme to ensure secrecy of primary users, and presented coding techniques for channels, that the PU's can allow the SU's to sense and relay the message, while ensuring that the SU's are ignorant of the PU's messages.

Ali J. Ghandour *et al.* [4] presented a novel cognitive network architecture to dynamically extend the Control Channel (CCH) used by vehicles to transmit safety-related information. To this aim, a cooperative spectrum sensing scheme, through which vehicles can detect available spectrum resources, is proposed.

Jie Zhang [5] described that the goal of incorporating trust is to allow each peer in a VANET to detect dishonest peers as well as malicious data sent by these dishonest peers, and to give incentives for these peers to behave honestly and discourage self-interested behavior.

Jianzhao Zhang et al. [6] in this paper, a distributed clustering algorithm based on soft-constraint affinity propagation message passing model (DCSCAP) is proposed. The objective of the algorithm is to group neighboring CRs with similar spectrum availability into smaller number of clusters.

Morales *et al.* [7] proposed an efficient clustering approach using the mobility of the nodes. The algorithm was based on final destination of vehicles to enhance the clustering stability.

Ali J. Ghandour *et al.* [8] the goal of this paper is to ensure that all safety packets get generated and transmitted during the same interval. The system monitors the contention delay experienced by cars on the control channel where all safety packets should be transmitted.

Jianzhao *et al.* [9] proposed a clustering scheme based on local common channels and the cluster maintenance phase. It optimizes cluster size and clusters are updated making use of potential following network variations.

Apart from the above discussions, there are many other proposals in the literature that describes the routing issues and reasons of packet loss in VANETs and also give their appropriate solutions. Some other papers related to our work are referenced in the last section of this paper.

III. SIMULATION RESULTS AND DISCUSSIONS

As we discussed in section 1 and 2, different solutions are proposed to improve the performance of VANETs. In this paper, we work to reduce the packet loss between vehicle nodes when they communicate with their CHs. It was observed that when a node is transmitting while continuously moving, it goes out of the range of its cluster Head. A new advancement in this area is CRCN which handles this task. It ensures the connection when vehicle changes their path or suddenly takes turns. We make use of existing NS-2 to extend it to support cognitive radio network simulation. For each node in this simulator, a reconfigurable multi-radio multi-channel PHY layer is available by customizing the spectrum parameters such as transmission power etc.

Based upon the above discussions, following are the major contributions in this paper:

To develop energy efficient VANET-CRN using predictive clustering approach.

1.) To improve safety message delivery through VANET CRN.

2.)To compare the proposed work with existing work.

A. Methodology

VANET'S scenario is used for transmission of various messages is the vehicle communication. Various phases have been derived for proposed work, are described below:

Phase 1: In this phase VANET'S scenario is initialized by defining the no. of vehicle/nodes in reverse direction of their mobility.

Phase 2: In this phase various communications between different vehicles and roadside unit will take place using energy efficient predictive clustering approach for the communication process.

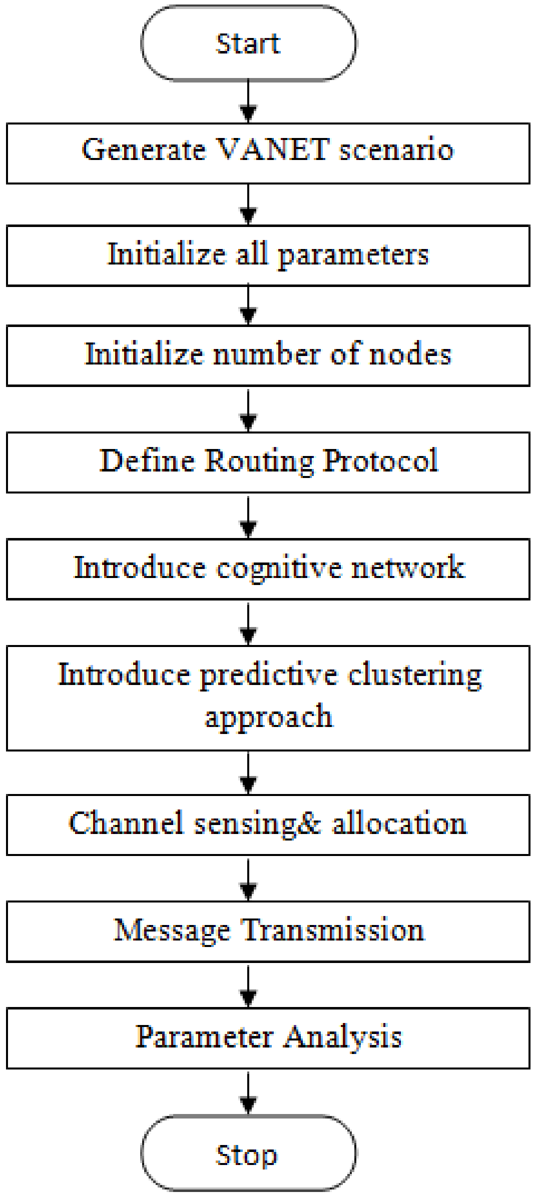
Phase 3: In this phase cognitive radio bandwidth has been utilized for the transmission of packets from vehicle to vehicle and vehicle to RSU and RSU to vehicle by sensing channel. The channel which is free that can be allocated for communication.

B. Flow of Work

We work on NS2 simulator to get the results and to compare the performance of our work with existing work we use different parameters. The parameters are describes as follows:

Throughput: it counts the average number of packets that are successfully received in unit interval of time.

Packet delivery ratio**:** it is defined as the ratio of number of packets that are successfully received by a destination to the number of packets that have been sent out by the sender.



Delay*:* The Delay of a network specifies how long it takes for a packet of data to travel across the network from one node or end point to another. It is typically measured in multiples or fractions of seconds.

Loss**:** Packet loss is the discarding of packets in a network when a router or other device is overloaded and cannot accept additional packets at a given moment. It occurs when data travelling across network failed to reach the destination. It causes due to the congestion or disconnection can be calculated as:

Loss= no. of packets send- no. of packets received

Jitter: Jitter is any deviation in, or displacement of, the signal pulses in a high frequency digital signal. The deviation can be in terms of amplitude, phase timing or the width of the signal pulse. In simple words, it is defined as a variation in the delay of received packets.

C. Simulation settings and results

The Network Simulator, ns-2.3.1 is a networking event simulator, which simulates such events as sending, receiving, forwarding and dropping packets, etc. The events are sorted by time (measure in seconds) in ascending order. For simulation scenario and network topology creation it uses TCL (Tool Command Language). The simulator work in all the wired, wireless and satellite networks. Figure 3shows the ns-2 system architecture as a simple block diagram.

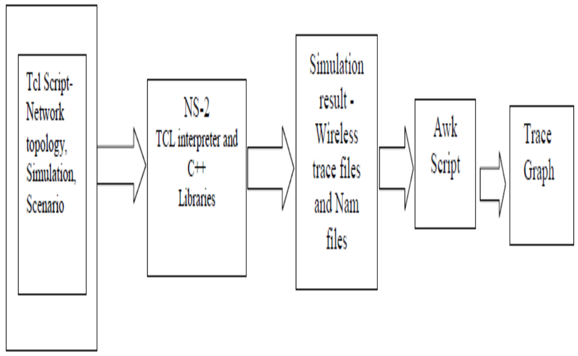


Fig. 3. Block diagram of NS2.

Ns-2 has a companion animation object known as the Network Animator. In this work, we make use of CRCN which is based on open-source NS-2. We create the TCL script to configure the number of radios and channels needed for simulations. In this work we use DSDV protocols. Omni antenna is selected for transmission purpose. For simulation on 2.31 version of NS2 is used and the following set ups are defined:

Table 1: Simulation setup.

Performance parameters	**Values**
Antenna model	Omni directional antenna
Propagation model	Two ray Ground
Queue type	Drop tail queue
No. of packets per queue	500
No. of nodes	51
Protocol type	DSDV
X-axis distance	1300
Y-axis distance	1000

RESULTS

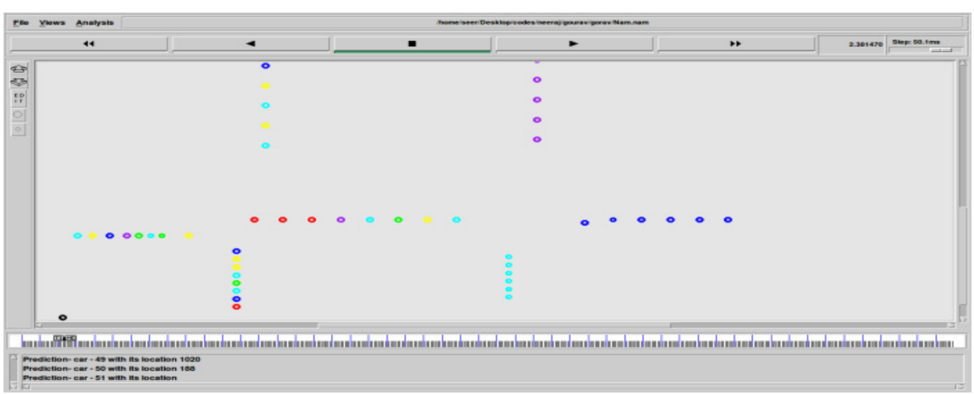


Fig. 4. Initialization of nodes.

This scenario is used to represent the initialization of nodes.

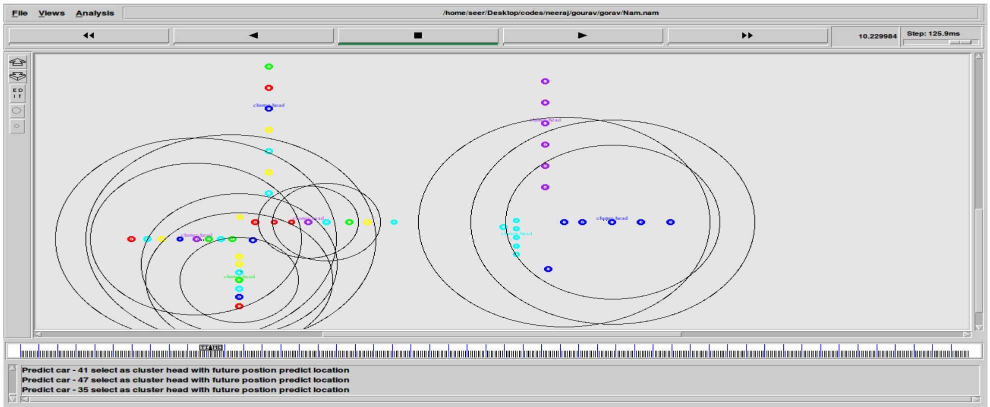


Fig. 5. Routing of nodes.

This scenario is used to represent the routing of nodes.

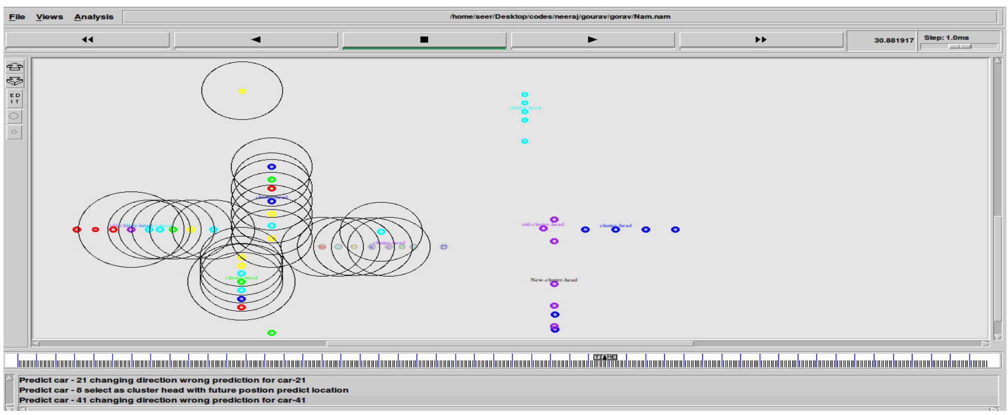


Fig. 6. Clustering.

This Scenario is use to represent the Cluster Heads which is chosen on the basis of Position, Prediction & Future. After the cluster formation, the user information is transmitted in the form of packets from one node to another through cluster heads. There can be number of clusters in a single network scenario depending upon the traffic density. Whenever a node/vehicle wants to send/ receive the traffic related information it directly connects with cluster head.

Fig. 7. Packet loss.

Fig. 8. No packet loss witn CRCN.

In this work, we did a comparison between the performance of a VANET network and the CRCN network. When it comes to the packet transmission through CHs, it is observed that a simple VANET network has packet drop limitations. As compared to that, CRCN shows the better performance as packet drop is In this work, we work on five parameters in order to compare our work with the existing one : throughput, packet delivery ratio, loss, end to end delay and jitter. The results obtained show that the proposed scheme is reduced to greater extent. Figure 7 shows the packet loss when packets are transmitted between node 6 and node 27. The black colored blocks are representing the packet loss from node 6 to node 27. But when then results are checked for same location after implementing CRCN, there is no packet loss as shown in figure 8.
superior in comparison with the existing scheme of its category. The graphs of this comparison are shown below :

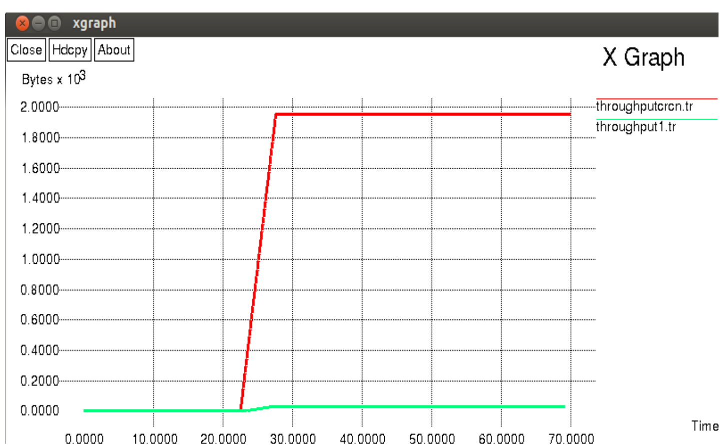


Fig. 9. Comparison for throughput.

In this graph, to check the results time is plotted on x-axis and no. of packets that are received successfully are plotted on the y-axis of graph. In the above graph, time is plotted on x-axis and y-axis shows loss of packets corresponding to the time. From graph it is clear that initially both the previous and proposed work has almost similar performance, but as the time increases and position of nodes is also changed as they are moving continuously, loss of packets in previous work is increased. But CRCN has comparatively less loss of packets and shows constant performance when time is above 40 seconds.

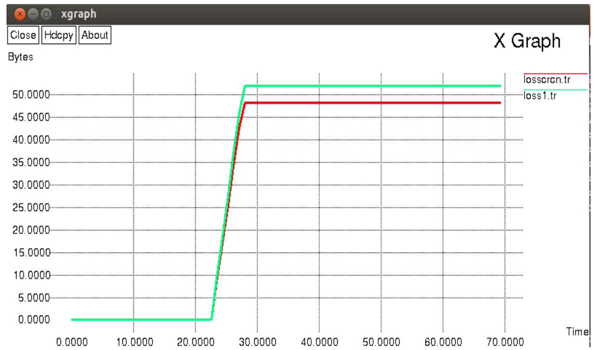


Fig. 10. Comparison for loss.

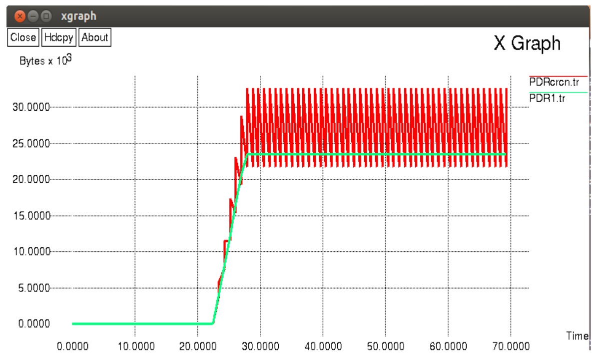


Fig. 11. Comparison for PDR.

PDR can be defined as the ratio of number of packets that are successfully received by a destination to the number of packets that have been sent out by the sender. This ratio is plotted on y-axis corresponding to time on x-axis. Similar to that of loss, initial conditions are same for both the previous work and CRCN. But when nodes start falling out of range with time, PDR ratio for previous work is less. But as CRCN provides a virtual path for packet delivery, there is less probability of packet loss. After 40 seconds, values for previous work are 23460 bytes (approx.) and CRCN has approx. 32640 bytes compared to previous work.

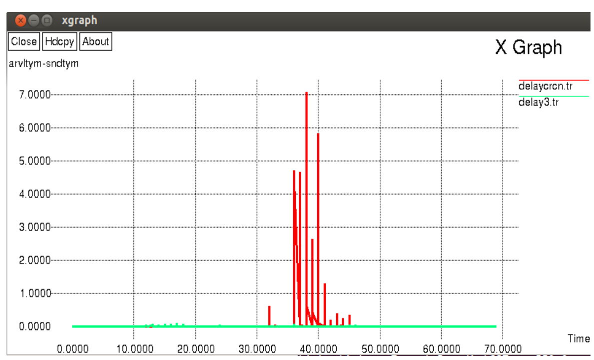


Fig.12. Comparison for delay.

In this graph, x-axis has time coordinates and on y-axis time (arrival time – send time) is plotted. We find in the graph that delay for CRCN is showing frequent fluctuations. Intially delay values are less varying between .001 to .013 ms approximately. But as the time increases delay suddenly increases for few seconds and then again falls to lower values. These fluctuations occur due to sensing process of CRCN, when it senses the available free channels to provide virtual path, delay is increased for few seconds. But once after the path is provided, the packet transmission is re-continued and delay is decreased significantly as compared to previous work.

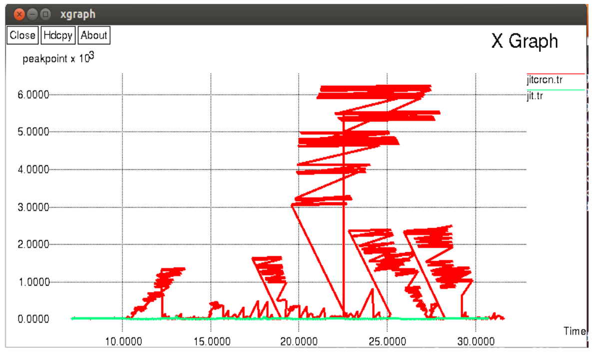


Fig. 13. Comparison for jitter.

After the comparison, it is clear from the graphs that CRCN gives better performance The comparative analysis of all the parameters (stated above) is summarized in table 1.

Time (sec.)	**PDR** (bytes)		**Throughput**		**Loss** (bytes)		**Delay** (ms)	
	Previous Work	Present Work	Previous work	Present work	Previous Work	Present Work	Previous Work	Present work
0	0	0	0	0	0	0	0.0011	0
10	0	0	0	0	0	0	.0114	.001212
20	4140	3840	5.51	11.52	9.19	8.53	.0151	.008
30	1242	7680	16.55	46.07	27.6	25.60	.011424	.011
40	2070	32640	27.6	103.68	46.0	42.66	.016150	.243
50	23460	32640	31.22	725.75	52.13	48.35	.011781	.003
60	23460	32640	31.22	1681.92	52.13	48.35	.0106	.0038
70	23460	32640	31.22	195800	52.13	48.35	.005	.003681

IV. CONCLUSIONS

In this paper, we work on NS2 simulator, to improve the performance of VANETs. CRCN technique is used to reduce the packet loss. We have done parameter comparison in the form of graphs for performance evaluation. It is observed from comparison that the proposed scheme gives better results than the previous work. In future, for the proposed work LTE can be used. LTE i.e. long term evaluation is GSM/EDGE network topologies .it improves support for mobility. It provides support for all frequency bands currently used. Basically this technique is the development of GSM standards and the goal is to increase the capacity and speed of wireless data networks using new DSP(digital signal processing) techniques and modulations. It fullfilles all the requirement of 4G technologies for smart phones. So in future work, a new 4G technique named LTE can be used to enhance the coverage range of nodes. The following results are calculated in simulation which shows great improvement in reducing packet loss:

Performance metrics	**Previous work**	**Present work**
No. of Nodes	51	51
Generated Packets	7147	6763
Received Packets	6971	6719
PDR	97.5374%	99.3494%
Dropped Packets	176	44
Average Delay	14.7361 ms	3.75964 ms

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