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Performance comparison of AODV and DYMO Routing Protocols, for Congestion Detection in VANET

Rajashree Dutta
Mody University, Lakshmangarh
duttarajashrre92@gmail.com

Ranjana Thalore
Mody University, Lakshmangarh
thalorer1603@gmail.com

Abstract: Vehicular Ad Hoc Networks (VANET) is a subclass of Mobile ad hoc networks which provides a distinguished approach for Intelligent Transport System (ITS). VANET's provide communication between vehicles moving on the roads. Congestion detection and control in VANET is very essential and necessary for smart ITS in order to avert an accident. Special considerations are required to develop more sophisticated techniques to avoid and detect congestion. The constrained resources of the Wireless Sensor Networks (WSN) must be considered while devising such technique to achieve the maximum throughput. In this paper we have implemented congestion detection in a collision avoidance scenario in two routing protocols, AODV and DYMO, on the basis of sent and received beacons and packets dropped while nodes communicate with each other or the Base Stations. This paper also discusses and compares the advantages/disadvantages of AODV and DYMO based on battery usage, energy used in transmit mode, throughput, message received and sent. The various ways of congestion control are further discussed.

Keywords: AODV, Beacon, Congestion Detection, DYMO, VANET.

I. INTRODUCTION

The Vehicular Ad-hoc Network (VANET) is an up-and-coming standard for data communication between moving vehicles and fixed equipment. VANET is a special application of Mobile Ad Hoc Networks for road traffic, which can autonomously organize networks without infrastructure. Each vehicle which is fit with a VANET device will be a node in the Ad-Hoc network and can receive and pass on others messages through the wireless network within a 300 meters range. VANET that has many community nodes is characterized by short of guaranteed connectivity. Such network requires that nodes have to cooperate on the level of packet forwarding for right operation. When a node wants to transmit a message to another node, the message routed through relay nodes on the hypothesis that each node is ready to participate to forward.

Two kinds of communication (V2I) and (V2V) can be done in VANET to provide a list of applications like emergency vehicle warning and safety measures [10]. These are between various vehicles known as a vehicle to vehicle and between vehicles and roadside units known as a vehicle to roadside communication. Vehicular AdHoc Network also provides value added services like email, audio, video sharing etc. Vehicular Ad-hoc Networks (VANET's) have gained significant attention due to they're perspective to support a variety of services of societal and environmental impact [3], [4], e.g. safety of passengers, reducing traffic congestion, driver assistance, etc. Nowadays, the vehicle users have increased, due to which the number of accidents is also increased. Vehicular Ad hoc network is specially developed to avoid such a dangerous situation before it occurs. The development of vehicle-collision-warning systems that detect oncoming collision dangers and provide warning messages to the driver has become, particularly over the past decade, a very important research field and application area. Statistics indicate that the primary cause of most road accidents is vehicles' excessive speed and delayed driver's reaction. [1]Congestion control is a very important area within Wireless Sensor, and AdHoc Networks (WSN), where traffic becomes greater than the combined or individual capacity of the basic channels. Therefore, different techniques are used to develop more sophisticated techniques to detect, avoid, and resolve congestion. Formerly, the congestion avoidance is performed by the sink node which causes topology reset and bulk traffic drop. As a consequence, the latter mentioned congestion control protocols addressing the congestion avoidance, detection, and resolution were introduced at the node level. In this dissertation, we explore mechanisms for detecting and controlling congestion in the WSN's.

Congestion detection/ control are of critical importance, as congestion control helps in preventing loss of traffic in bulk. Congestion detection is a critical area of research as time variant quantities, such as network traffic and that buffer frequently changes with time. Current sensor network solutions attempt to solve the collision problem in the MAC layer, mostly by using TDMA [11] mechanism.

II. RELATED WORK

In VANET, every participating vehicle is a wireless router or node. When vehicles are intersected at the crossing, at that time accident situation will be occurred. To avoid this situation congestion control concept is present. Here are various existing MAC protocols used for congestion avoidance.

1. *Time-Division Multiple Accesses (TDMA)*

Time-Division Multiple Access (TDMA) is used to enable multiple nodes to transmit on the same frequency channel. It divides the signal into different time frames. Each time frame is divided into several time slots, where each node is assigned to a time slot to transmit [10]. The goal of any assignment scheme is to make the process of assigning slots easy and straightforward.

2. *Location Division Multiple Accesses (LDMA)*

Location Division Multiple Access (LDMA) [2] is proposed to achieve bounded latency in multi-hop relaying of safety messages in VANETs.[3] LDMA provides medium access to vehicles equipped with a Global Positioning System (GPS) receiver based on their geographic location, time, and a predefined location-to-time mapping as in Time Division Multiple Access (TDMA).

3. *Space Division Multiple Access (SDMA)*

SDMA is a scheme for medium access control in vehicle ad hoc networks [4]. SDMA relies on real-time position information by the users and provides a mapping of the user position to a share of the bandwidth.

4. *Vehicular Self-Organizing MAC (VeSOMAC)*

The Vehicular Self-Organizing MAC (*VeSOMAC*) is designed to be vehicle location and movement aware so that the MAC slots in a vehicle platoon can be time ordered based on the vehicles' relative locations for minimizing the multi-hop delivery delay.

III. CONGESTION DETECTION

1. Congestion detection and adaptive congestion control

Vehicular ad hoc network (VANET) provides the communication framework for the dissemination of safety critical messages such as beacons and emergency messages. Congestion in the communication channel results in packet drops, throughput reduction and degradation of channel quality. So, congestion detection/control schemes are necessary to regulate the traffic level at an acceptable level.

In congestion mitigate channel congestion by reducing beacon transmission duration, which is achieved by using higher 802.15.4 data rates. When a large number of vehicles transmits beacons at a higher frequency then bandwidth can be exhausted very easily. As a result, significant number of packet collision occurs. And in a scenario of an emergency message, if the channel is already congested then highly life-critical event-driven message which will be deprived of channel access will either get lost or delivered to its intended recipients with a much higher delay. Thus the loss of beacons and the emergency message will severely affect the safety of a vehicle. The vehicle density is very high then the channel will get congested easily. So, congestion in the communication channel should be detected. After congestion detection, if there is any emergency message then we will provide dynamic time slot reservation to the vehicle which generates an emergency message. [1][2][4] This can be done by pulse based reservation system in the communication channel. If the vehicles in segment do not find any time slot then they can use unoccupied time slots from adjacent segments. This is done by intersegment slot transfer. The time slots can be slotted by time division multiple access schemes. Each segment will have a number of time periods for transmission of packets and beacons and vehicles can transmit their beacon in that transmission period. The proposed approach can adaptively control congestion in the communication channel.

2. Periodic beacon message and event-driven message

In vehicular ad hoc network, a vehicle to vehicle crash intersection is a common problem. To avoid crash intersection problem, there are two safety messages provided, first periodic beacon message and another is the event-driven message. Vehicles and roadside units equipped with short-range Wireless communication devices based on IEEE 802.11b communicate with each other in self-organized networks called VANETs. In principle, V2R communications combined with vehicular on board and road-side sensors may support road safety by two means: broadcasting periodic safety messages and event-driven safety messages. These safety messages typically get delivered within a geographical area with convinced reliability and delay limit. Beacon message is nothing but periodic messages, also called Hello message, it gives the idea about vehicles status information such as positions, speeds, and location ID. Beacons can be generated at the application layer or at the network layer, and are used by neighboring Vehicles to become aware of their surrounding and to avoid potential dangers. Event-driven safety messages are generated when an abnormal condition or an imminent danger is detected, as shown in fig 3. Beacon messages send periodically by vehicles to inform their condition such as position, direction, and Speed to their neighbor vehicles. The beacon messages are used by the neighboring vehicles (nodes) to be aware of their environment as well as preventing potential dangers. The event-driven safety messages are generated when an anomaly in the condition is detected and are distributed within a certain range with higher priority. The event-driven safety messages are delivered to the neighboring node with high reliability and limited time. [1][2][7]A single delayed or lost message could result in loss of life. Dedicated short range communication (DSRC) is specially design for vehicular ad hoc network for the application of vehicle to vehicle communication (V2V), Vehicle to road Side (V2R), a vehicle to infrastructure (V2I). MAC protocol IEEE 802..11b/wave is specially developed for vehicular ad hoc network. WAVE is a layered architecture for devices complying IEEE 802.11b to operate on Dedicated Short Range Communication (DSRC) band.

IV. SIMULATORS

1. Network Simulator (NS2) is a discrete event simulator targeted at networking research [7]. NS2 provides substantial support for simulation of network based protocols over wired and wireless (local and satellite) networks.

2. OMNeT++ [10] is also available as an open-source simulator, mainly use for ad-hoc simulations and internet simulations. Its component-based design helps Performance evaluation of VANET's through modules, over the high-speed environment.

3. QualNet is a discrete-event simulator. In such simulators [11], the system is modeled as it evolves over time by a representation in which the system state changes as soon as an event occurs, where an event is defined as an instantaneous occurrence that causes the system to change its state or to perform a specific action. The arrival of a packet, a periodic alarm informing a routing protocol to send out routing update to neighbors, etc. are examples of such occurrences. Examples of actions to take when an event occurs are: sending a packet to an adjacent layer, updating state variables, starting or restarting a timer, etc.

V. ROUTING PROTOCOLS USED

1. *AODV (Ad-Hoc On Demand Distance Vector)*

AODV is a reactive routing protocol. Routes are calculated on demand when a node wants to send a data packet. The route discovery process is started when a source node S wants to send a data packet to a destination node D for which no route is available in the routing table of S. Node S floods a route request packet (RREQ) [2] into the network. A route request packet contains various parameters such as source identifier, source sequence number, a destination identifier, destination sequence number, broadcast identifier and a time to live (TTL). An intermediate node replies with a route reply packet (RREP) if it knows a valid route to the destination node, otherwise, the route request is forwarded to its neighbors. [8] When forwarding a route request packet, a node sets up a reverse path to node S which uses the neighbor of S from which the request packet has first been received. A route request flooded into the network will cause a large amount of routing packets generated throughout the network even if the destination node is only a few hops away. The source node successively increases the search area into which RREQ packets are flooded. [8]This is done by adapting the initial time to live (TTL) value in the RREQ packets. Nodes periodically send HELLO messages in order to detect link failures. If a link failure is detected, a node sends a route error packet (RERR) towards the source node.

2. *DYMO (Dynamic MANET On-demand)* DYMO is a protocol that has been proposed recently currently defined in an IETF Internet-Draft [10] in its sixth revision and is still work in progress. DYMO is a successor of the AODV routing protocol [6]. It operates similarly to AODV. Routes may be discovered on-demand whenever a node needs to send a packet to a destination currently which is not in its routing table. A route request message is flooded in the network using broadcast and if the packet reaches its destination, a reply message is sent back containing the discovered, accumulated path.

VI. PROPOSED WORK

Congestion is an important mechanism that may result in degradation of QoS in VANET's. When the networks load exceeds the capacity of the networks, congestion has occurred. Packet loss and delay will increase in case of congestion, and decrease in the throughput by saturating the channels in the high-density networks. Congestion control is a most effective approach to improve the performance of VANETs. Indeed, congestion control helps to provide a safer and more reliable environment for VANETs' users.

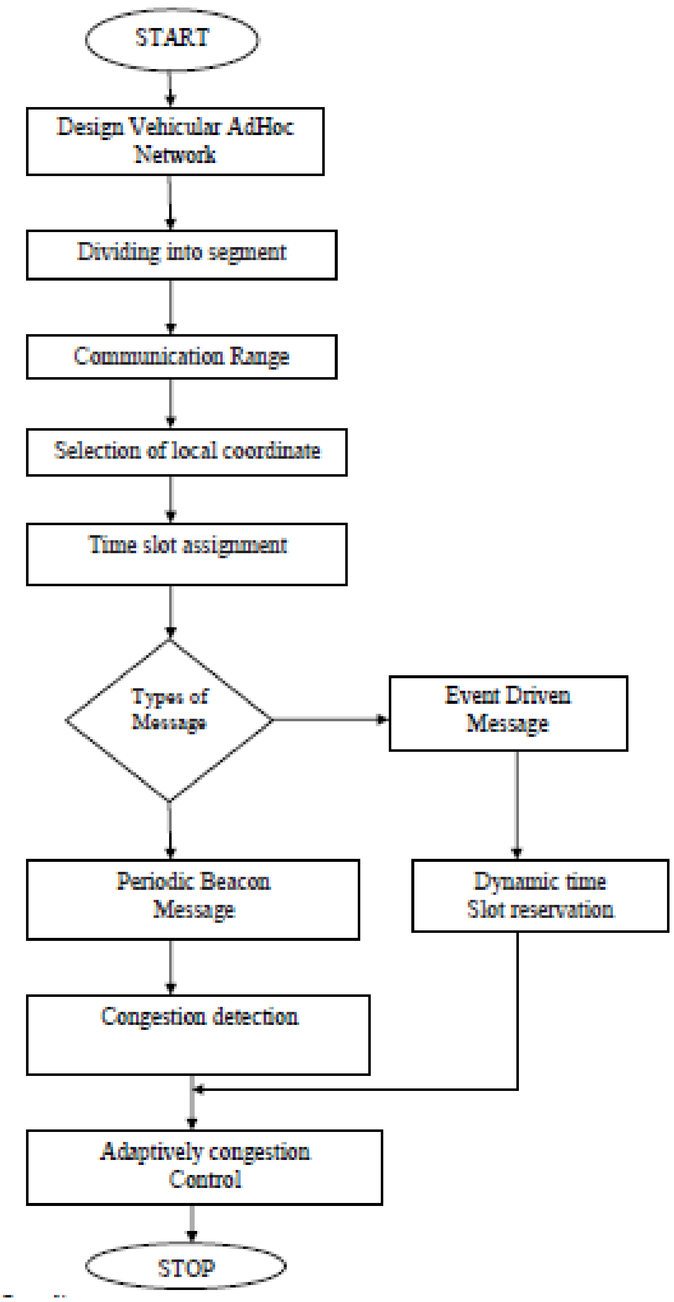

Figure 1: Proposed workflow diagram

These vehicles are having the transmission range of 100 m and RSU having transmission range 250-300m. These vehicles are authenticated so that they can communicate securely with another vehicle in their range. The aim of this proposed work is to detect congestion based on beacons received and sent and packets dropped while the nodes communicate with each other or with their base stations in vehicular ad hoc network. Beacon message is status message giving the idea about location ID. Speed, the velocity of vehicles and event-driven messages are generated when an emergency will occur.

According to DSRC, every vehicle will generate beacon message after 300ms, if vehicle density will very high at that time bandwidth will be congested easily So, collision in the communication channel should be detected. After collision detection, if there is any emergency message then we provide dynamic time slot reservation to the vehicle which generates an emergency message.

VII. SIMULATION AND RESULT

The following wireless scenario has been developed and implemented as follows.

1. IEEE 802.15.4 wireless standard for PHY and MAC layer.
2. AODV (Ad hoc On-Demand Distance Vector) routing
3. DYMO (Dynamic MANET On-demand)

Table 1. Simulation Table

Simulator	QualNet version 6.1
No. of nodes	10
No. of Base Stations	2
Topology	Star
Fixed setup	RSU, VANET Authority
Mac type	802.15.4
Antenna type	Omnidirectional
Routing protocol	AODV,DYMO
Transport agent	UDP
Application agent	CBR
Simulation time	100 seconds

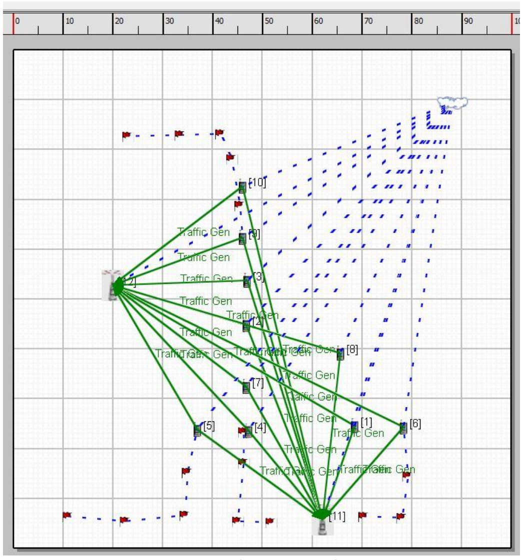

Figure 2: Scenario of Nodes before Simulation

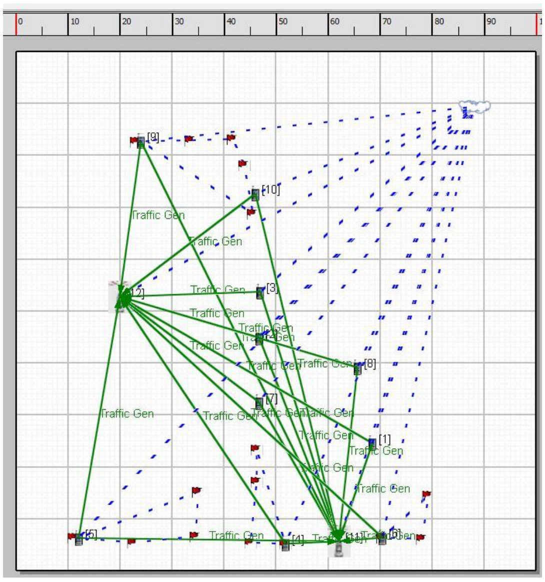

Figure 3: Scenario of Nodes after Simulation

It has been observed in figure 4 that in both the cases number of beacons sent, graph shows that DYMO protocol will give better performance than AODV protocol.

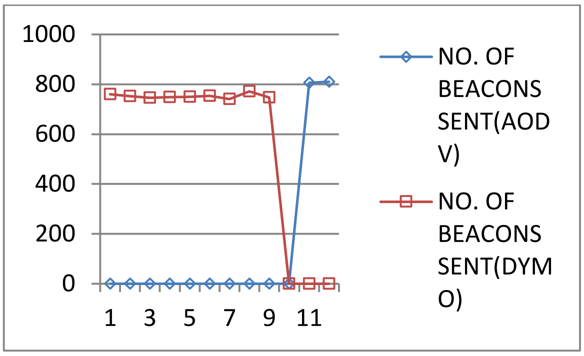

Figure 4: No. Of Beacons Sent

It has been observed in figure 5 that in both the cases number of beacons received, the graph shows that AODV protocol will give better performance than DYMO protocol.

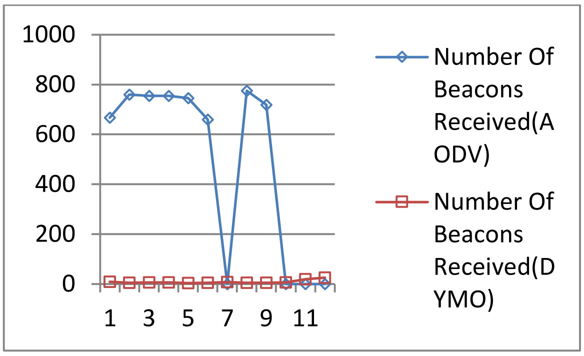

Figure 5: No Of Beacons Received

It has been observed in figure 6, packets are dropped by both the routing protocols, hence there is congestion in the network and also, that in both the cases number of packets dropped, the graph shows that DYMO protocol will give better performance than AODV protocol.

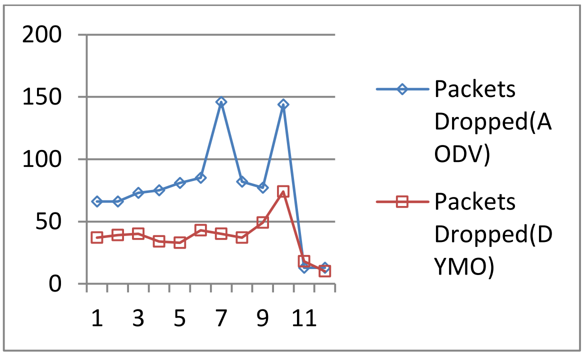

Figure 6: No. Of packets dropped while communicating

After congestion detection, we compare the two routing protocols based on other parameters such as *Battery Usage, Energy Used in Transmit Mode, Throughput, Message Received and Sent.*

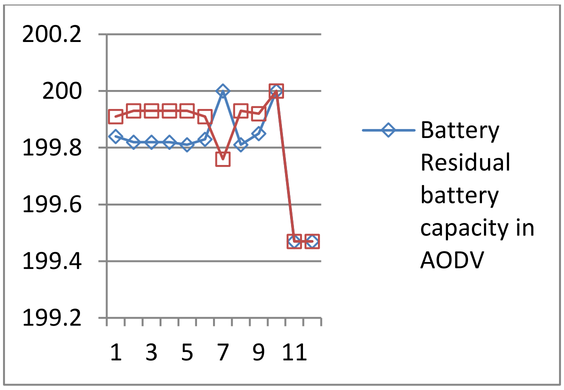

Figure 7: Residual Battery Level

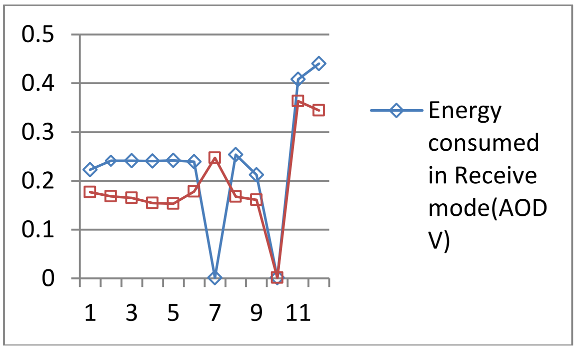

Figure 8: Energy Consumed In Receive Mode

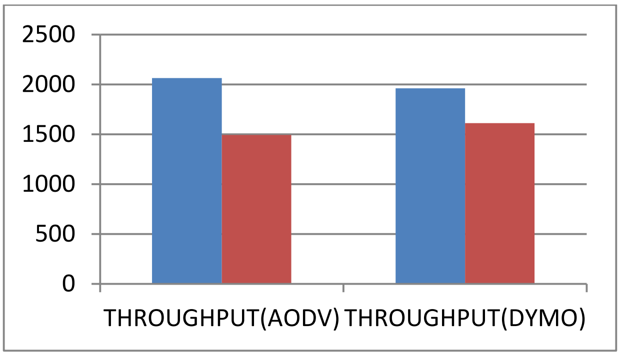

Figure 9: Throughput

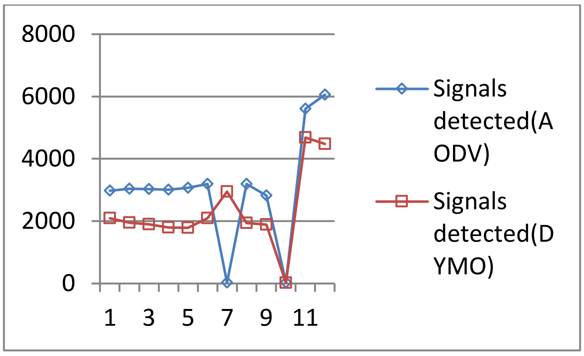

Figure 10: Signals Detected

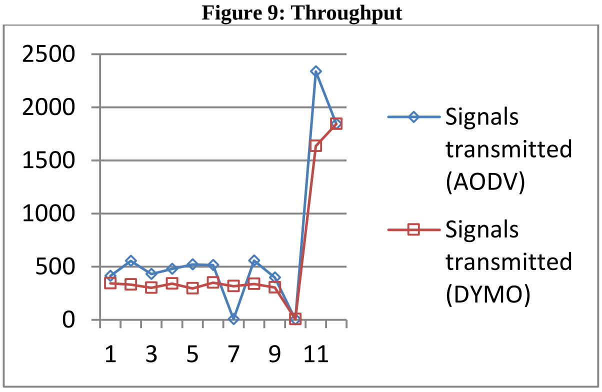

Figure 11: Signals Transmitted

CONCLUSION

In this paper it has been observed that the efficiency of routing algorithms can be computed and two algorithms have been being compared using their parameters like throughput, signals detected and received, energy consumed. Here AODV and DYMO routing algorithms have been considered for analysis. In figure 6, packets are dropped by both the routing protocols, hence there is congestion in the network and also, that in both the cases number of packets dropped, the graph shows that DYMO protocol will give better performance than AODV protocol. AODV is found to consume more energy as compared to DYMO. In terms of throughput, AODV is more than DYMO. In terms of signals detected and transmitted, AODV is better than DYMO. Also, number of beacons received is also less in DYMO and more in AODV. It can be clearly observed from the graph in Figure-5. Therefore AODV has been said to be a better routing protocol than DYMO. Vehicles equipped with GPS will give the exact location and speed of the vehicle will give the alert message to the drivers and also integrated information will be transmitted between source and destination by using 802.15.4 and is considered for dedicated short-range communications (DSRC), in both MAC Layer and PHY layer.

Future work will focus on implementing the above algorithm in real – time terrain which will definitely avoid the traffic congestion.

1. In order to control congestion recently, there have been a number of research works attempting to increase the sensor node data transmission throughput, packet delivery ratio and data security via multipath routing.
2. Congestion-aware and Rate-controlled Reliable Transport [9] uses efficient MAC retransmission to increase one-hop reliability and end-to-end retransmission for loss recovery.
3. Decentralized, Predictive Congestion Control (DPCC) for wireless sensor networks (WSN) consists of an adaptive flow and adaptive back-off interval selection schemes that work in concert with energy efficient, distributed power control (DPC).

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Rajashree Dutta
Department of ECE, CET, Mody University, Lakshmangarh (332311), India
Email: duttarajashrre92@gmail.com
Ranjana Thalore
Department of ECE, CET, Mody University, Lakshmangarh (332311), India
Email: thalorer1603@gmail.com