RESEARCH ARTICLE OPEN ACCESS

# Review of Adhoc Routing Protocols for Cognitive Radio Network

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**ABSTRACT**
With the rapid deployment of new wireless devices and applications, the last decade has witnessed a growing demand for wireless radio spectrum. However, the fixed spectrum assignment policy becomes a bottleneck for more efficient spectrum utilization, under which a great portion of the licensed spectrum is severely under-utilized. Cognitive radio (CR) technology is the most juvenile technology that promises to allow devices to share the wireless spectrum with other users that have a license for operation in these spectrum bands. This improves the inefficient spectrum utilization in the bands reserved for the licensed users. However, the opportunistic use of the available spectrum by the CR users must not affect the licensed users. To achieve these features of CR networks, an efficient routing algorithm is required.

In this paper , an elaborative survey of spectrum sensing protocol along with routing protocols like AODV and DSDV for CRN is done .A comparison between these Routing Protocols is presented based on parameters such as Throughput, Delay, jitter etc. In the proposed work, we are trying to analyze the performance of these routing protocols with the view to find the best performing protocol for CRN networks.

***Keywords* -** Cognitive radio (CR), Routing, spectrum handoff, Proactive, reactive ,AODV, DSR, DSDV**.**

## I. INTRODUCTION

As the most precious natural resources, available electromagnetic radio spectrums are becoming more and more crowded. The restricted spectrum and low utilization ratio require a new communication paradigm to exploit existing spectrum resources. With the fast growth in wireless technology in the last few decades , there is an increased use of devices and services in the unlicensed band. So unlicensed frequency bands in the 2.4GHz and 5.8GHz range are being many a times used by wireless sensor networks, Wi-Fi hotspots, wireless mesh networks and mobile ad-hoc networks for a variety applications. Spectrum scarcity in the unlicensed band is further affected by the interfering radiation caused by commercial microwave ovens and electrical machinery. While the frequencies reserved for licensed use such as television broadcast, are not always occupied, leading to inefficient utilization of the resource. The newly up-coming CR paradigm has promised to address these issues. CR technology aims to enhance the spectrum utilization in the licensed frequencies, and also alleviate the congestion in the 2.4GHz ISM band by allowing the CR users to opportunistically transmit in the vacant portions of the licensed spectrum [10]. These radios are enabled with the ability to decide transmission parameters such as modulation type, power, transmission rate and channel through local coordination based on their perception of the state of the network and the physical environment. The Federal Communications Commission (FCC) has encouraged work in spectrum sharing issues by initiating steps to free up bandwidth in the 54 − 72MHz, 76 − 88MHz, 174 − 216MHz, and 470 − 806MHz bands. The FCC assigns these completely vacated spectrum bands to licensed holders also termed as primary users, for large geographical regions on a long-term basis.

Cognitive radio is the key technology for next generation communication, i.e for dynamic spectrum access (DSA) networks. It utilizes the spectrum more efficiently in an opportunistic fashion without interfering with the primary users. It differs from conventional radio, as it can equip users with cognitive capability and reconfigurability. Cognitive capability implies that secondary users can identify the best available spectrum – by sensing and gathering information from the surrounding environment, such as information about transmission frequency, bandwidth, power, modulation, etc. While reconfigurability refers to the ability to rapidly adapt the operational parameters according to the sensed information in order to achieve the optimal performance. This enables secondary users to sense the available spectrum, then select the best available channel, synchronize spectrum access with other users, and release the channel if a primary user reclaims the spectrum usage right.[9]

When constructing cognitive radio networks, quality of service (QoS) of primary users must be highly ensured. Otherwise, the arbitrary deployment of secondary network will inevitably bring lots of interference to primary users, violating the essence of cognitive radio. When secondary users coexist with primary users, primary users have priority to use the spectrum. They have to perform real-time wideband monitoring of the licensed spectrum to be used. When secondary users are allowed to transmit data simultaneously with a primary user, certain parameters like the radius of keep-out region around primary receiver, acceptable interference levels, and transmission power control should not be violated. If secondary users are only allowed to transmit when the primary users are not using the spectrum, they need to be aware of the primary users' reappearance through various detection techniques and a good spectrum handoff mechanism is required to provide secondary users with smooth frequency transition with low latency.

The above spectrum management-related challenges necessitate novel design techniques spanning several layers of the protocol stack on a single device. In addition, the interaction between several nodes and its impact needs to be considered. Thus much of the research work today is focused on requirements for cognitive radio ad hoc networks protocol applicable to all the layers- physical, link, network and transport. Effective Routing algorithms are needed to accommodate the spectrum dynamics and ensure satisfying network performance such as high network capacity and throughput, short latency and low packet loss. Due to the heterogeneity of spectrum availability among nodes, routing problem cannot be well solved without considering the spectrum allocation. In this survey paper, elaborates on the inter-dependence between selection of route and spectrum management is done and spectrum sensing and routing protocols are studied.

The rest of the paper is organized as follows: In Section II has Literature survey , Section III covers Proposed methodology, section IV overviews the fundamentals of cognitive radio technology such as its characteristics, duty cycle, architecture and applications. Different routing protocols Proactive, reactive and hybrid are briefly discussed in section V. This survey paper presents a number of on-demand routing protocols for cognitive radio networks with the view to select the protocol performing better on CRN and in section VI evaluations are carried out for AODV based on Delay and energy consumption , and finally in section VII we conclude the paper.

## II. LITERATURE SURVEY

Network performance is governed by the qualitative and quantitative network parameters which can be manipulated using appropriate routing protocol. Substantial researches have been investigated by authors to inspect the performance of the popular routing protocols in adhoc networks. Many of these works went to conclusion that, routing protocols behaviors mainly vary according to scenario specifications introduced and performance metrics examined.

Qutaiba Razouqi, Ahmed Boushehri, Mohamed Gaballah, Lina Alsaleh in [1] have performed extensive simulation analysis for DSDV, DSR and AODV MANET routing protocols under various traffic conditions i.e when the network size and nodes mobility are varied. DSR proved to be reliable choice for different traffic conditions for throughput metric. DSDV shows potent response over other protocols for energy consumption. For packet delivery fraction and total dropped packets metrics Both DSR and AODV show better simulation results .While for varying nodes mobility, AODV and DSR maintained a high PDF almost 100% most of the times due to their on demand nature and their fast recovery when the nodes move at moderate and high speeds

Thriveni H.B., G. Manoj Kumar, Rinki Sharma- Department of Computer Engineering,M. S. Ramaiah School of Advanced Studies in [2], have taken proactive routing protocol DSDV and reactive routing protocol DSR for analysis . The network performance is measured in terms of Packet Delivery Ratio (PDR), End-to-End Delay and Throughput using simulations-NS2. By varying node density and node mobility values, it was observed that DSR protocol outperforms DSDV protocol for chosen scenario specifications. They propose to study the effects of different pathloss and propagation models on the performance of MANETs in future.

Amandeep Makkar, Bharat Bhushan, Shelja, and Sunil Taneja,in [6] have mentioned the desirable properties of MANET routing protocols and have done the behavioral study and performance analysis of various prominent routing protocols viz. DSDV, DSR, AODV and TORA on the basis of quantitative and qualitative metrics. Their analysis concludes that both protocols have good performance in their own categories and have proposed to find a solution for secure and power aware routing as future study.

Manikonda Aparna, Motahar Reza,Premraju sahu, Suvendhu das ,Department of Computer Science and Engineering in [3] have proposed MODIFIED-AODV protocol which works well under low mobility and tends to improve the packet delivery ratio by finding stable routes. However the routing overhead increases when the network size becomes large. Therefore clustering mechanism is considered to improve the network performance and scalability. The security challenges of their proposed protocol were the subject of future work.

T.Poongkuzhali, V.Bharathi, P.Vijayakumar, in [4] have focused exclusively on energy consumption metric. They have proposed an Optimized Power Reactive Routing protocol based on cognitive routing metrics and AODV protocol concept. . Their simulation results has shown that Optimized Power Reactive Routing reduces the burden of network resources and maintain the stability of the network.

M. Shobana and Dr. S. Karthik, in [6] have analyzed different MANET routing protocols on the basis of different performance metrics such as packet delivery ratio, transmission delay and path length. The traditional routing protocols such as AODV are being compared with the geographic-based routing such as POR and RGR. The geographic based routing have performed better when compared to other traditional routing protocols as per their analysis

Latif Ullah Khan, Faheem Khan, Naeem Khan, M. Naeem Khan Bilal Pirzada, in [5] have evaluated the performance of AODV, TORA, OLSR and DSR for the networks with different connectivity probabilities that significantly affect the performance of these routing protocols. The performance of AODV is fine for all values of the connectivity probability in terms of average throughput and routing traffic sent. DSR has better throughput and end-to-end delay performance for low values of connectivity probability and degraded performance for high connectivity probability.

Matteo Cesana , Francesca Cuomo , Eylem Ekici,in [9] have briefed on the basic working concepts of CRN network .They have focused on the issues related to the design and maintenance of routes in multi-hop CRNs, routing in CRNs, clearly highlighting their design rationale, and their strengths/drawbacks. In a nutshell, the main challenges for routing information throughout multi-hop CRNs include: spectrum-awareness, setup of ‘‘quality” routes and route maintenance/reparation has been considered.

Ravinder Ahuja ,Student M.Tech(CSE),Department of E&C,IIT, Roorkee, Uttrakhand,in [10] have conducted comparison of Reactive (AODV), hybrid protocols (ZRP) and Proactive protocol (OLSR) of MANET using metrics Packet delivery ratio, Average end-to end delay and Throughput when subjected to change in no. of nodes and pause time. Simulation results show that Reactive protocols better in terms of packet delivery ratio and throughput. Future work will be to evaluate the performance of these protocols by varying the speed, pause time and for other parameters like Jitter, Routing Overhead.

Amja Ali,Muddesar Iqbal,Adeel Baig1Xingheng Wang,in [11] have considered design challenges for routing protocols in CRNs followed by a comprehensive survey of different routing techniques. Furthermore these routing protocols are classified into spectrum aware-based, multipath-based, local coordination-based, reactive source-based and tree-based routing techniques depending on the protocol operation.

## III. PROPOSED METHODOLOGY

Simulations will be carried out in NS2 which allows node mobility, thereby providing for simulation of mobile ad hoc networks. In ns-2, protocols used in ad hoc networks have been supported. Network performance will be calculated in terms of End-to-End Delay, Throughput, Jitter and Energy consumption. A specific speed and duration will be chosen to represent the transmission. After the stipulated transmission duration ends the node may pause for a specific duration of time (pause time) before starting its next transmission. We will compare the routing protocols by generating different network scenarios.

The proposed project work will be based on the effective spectrum utilization for Cognitive Radio Networks using better performing Adhoc routing protocol .This shall involve spectrum sensing for finding the spectrum hole in CRN, then evaluating the Adhoc routing protocols DSDV and AODV based on various network parameter metrics Throughput, Delay and Jitter. Next step would involve selection of the protocol that performs better. To identify the unused spectrum that is available and to utilize unused spectrum for secondary users using selected routing protocol will be conducted

## IV. FUNDAMENTALS OF COGNITIVE RADIO TECHNOLOGY

The two fundamental resources of communications namely energy and bandwidth, being scarce, severely limit the increase of service quality and channel capacity in wireless networks. New researches focus mainly on new communications and networking paradigms that can intelligently and efficiently utilize these scarce resources

### 4.1 Cognitive Radio Characteristics

Cognitive radio (CR) is one critical enabling technology for future communications and networking .It differs from traditional communication models as the radio devices can adapt their operating parameters, such as transmission power, frequency, modulation type, etc., to the variations of the surrounding radio environment and can utilize the limited network resources in a more efficient and flexible way.[11]. Before CRs must first gain necessary information from the radio environment and then adjust their operating mode to environment variations. This ability is referred to as cognitive capability [11].It enables CR devices to be aware of the transmitted waveform, communication network type, protocol radio frequency (RF) spectrum, geographical information, locally available resources and services, user needs, security policy, and so on. After gathering their needed information from the radio environment, CR devices can dynamically change their transmission parameters according to the sensed environment variations and achieve optimal performance, which is referred to as reconfigurability

4.2 Cognitive Radio Functions

A typical duty cycle of CR will include - detecting spectrum white space, selecting the best frequency bands, coordinating spectrum access with other users and vacating the frequency when a primary user appears.

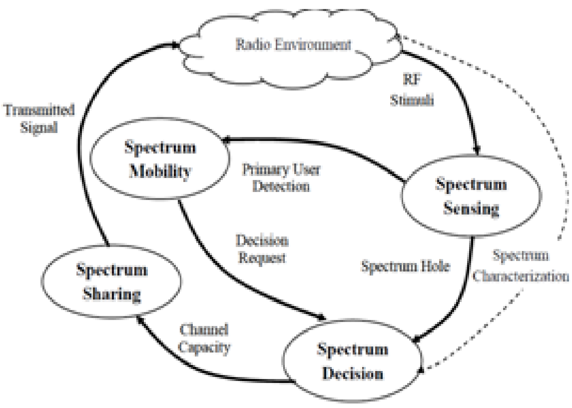


**Fig. 1 The cognitive radio cycle.**

Figure 1 above shows the steps of the cognitive cycle .It consist of four spectrum management functions: spectrum sensing, spectrum decision, spectrum sharing, and spectrum mobility. The main features of spectrum management functions are as follows:

a) Spectrum Sensing: In Spectrum sensing, CR user should monitor the available spectrum bands, capture their information, must detect portion of frequency band that is not being used by the primary users called as spectrum white space or spectrum holes, and utilize the vacant spectrum. On the other hand, when primary users start using the licensed spectrum again, CR can detect PU activity through sensing, to reduce any harmful interference generated due to secondary users' transmission. Spectrum sensing is a basic functionality in CR networks which is closely related to other spectrum management functions as well as layering protocols to provide information

b) Spectrum Decision: After recognizing the spectrum white space by sensing, spectrum management and handoff function of CR enables secondary users to choose the best frequency band according to their QoS requirements and hop among multiple bands according to the time varying channel characteristics to meet various Quality of Service (QoS) requirements. Spectrum decision involves undertaking spectrum selection and the route formation jointly. When a primary user reclaims frequency band, the secondary user who is using the licensed band can direct his/her transmission to other available frequencies, according to the channel capacity determined by the noise and interference levels, path loss, channel error rate, holding time, and etc.[9,11]

c) Spectrum Sharing: To achieve high spectrum efficiency in dynamic spectrum access, a good spectrum allocation and sharing mechanism is critical to achieve, as secondary user may share the spectrum resources with primary users, other secondary users, or both. Primary users own the spectrum rights. So when secondary users co-exist in a licensed band with primary users, the interference level caused by secondary spectrum usage should be limited by a certain threshold, and their access should be coordinated to alleviate collisions and interference. This coordinated spectrum sharing functionality will prevent multiple users from colliding in overlapping portions of the spectrum. Thus Spectrum sharing includes channel and power allocations and an intelligent packet scheduling scheme along with spectrum sensing.

d) Spectrum Mobility: If the specific portion of the spectrum in use is required by a PU, then the Secondary user must switch communication to another vacant portion of the spectrum. To prevent link breakages and delay in communication, proper spectrum handoff mechanism and reliable end-to-end connection management schemes, using protocols at the transport layer that are closely coupled with the lower level spectrum sensing, neighbour discovery in a link layer, and routing protocols is required.

4.3 Cognitive Radio Network Architecture

The development of CR technologies has enabled secondary users who are not authorized with spectrum usage rights, to utilize the temporally unused licensed bands owned by the primary users. Therefore CR network architecture includes both a secondary network and a primary network.

A secondary network is composed of a set of secondary users with/without a secondary base station. Both secondary users and secondary base stations are equipped with CR functions.

When the licensed spectrum it is not occupied by a primary user, secondary users can access the spectrum opportunistically .Such an access of secondary users is usually coordinated by a secondary base station. Such a BS is a fixed infrastructure component serving as a hub of the secondary network. To tackle several secondary networks sharing one common spectrum band, their spectrum usage may be coordinated by a central network entity, called spectrum broker [9]. The spectrum broker collects operation information from each secondary network, and allocates the network resources to achieve efficient and fair spectrum sharing.

A primary network is composed of a set of primary users who are authorized to use certain licensed spectrum bands under the coordination of one or more primary base stations. It is crucial that secondary networks should not interfere with their transmission. Primary users and primary base stations are in general not equipped with CR functions. Therefore, if a secondary network shares a licensed spectrum band with a primary network, it shall perform following operations as - detecting the spectrum white space, utilizing the best spectrum band and also immediately detecting the presence of a primary user and directing the secondary transmission to another available band so as to avoid interfering with primary transmission. Because CRs are able to sense, detect, and monitor the surrounding RF environment such as interference and access availability, reconfigure their own operating parameters to best match outside situations, cognitive communications can increase spectrum efficiency and support higher bandwidth service. They are also equipped with capability of real-time autonomous decisions for efficient spectrum sharing thereby reducing the burdens of centralized spectrum management. As a result, CRs can be employed in many applications.

4.4 Cognitive Radio Network Applications

Using dynamic spectrum access CR can alleviate the spectrum congestion through efficient allocation of bandwidth and flexible spectrum access. Therefore, CR can provide military with adaptive, seamless, and secure communications. It can also be implemented to enhance public safety and homeland security.

A natural disaster or terrorist attack often tends to destroy existing communication infrastructure. So to aid the search and rescue, an emergency network becomes indispensable. CR can recognize spectrum availability, reconfigure itself, performs dynamic spectrum selectivity and reliable broadband communication to minimize information delay. Moreover, CR can facilitate interoperability between various communication systems. CR devices can also support multiple service types, such as voice, data, video, and etc. CR's another very promising application is in the commercial markets for wireless technologies. It provides additional bandwidth and versatility for rapidly growing data applications. Without human intervention, the CR frequency management software will change the operating frequency automatically. CR can utilize a wide range of frequencies, some of which has excellent propagation characteristics. So CR devices are less susceptible to fading due to growing foliage, buildings, terrain and weather etc. Thus, CR is viewed as the key enabling technology for future mobile wireless services anytime, anywhere and with any device.

## V. ROUTING PROTOCOL CLASSIFICATION

All network nodes in traditional wireless networks will be provided with a certain fixed spectrum band for use. For example, WLAN uses 2.4 and 5 GHz bands, and GSM uses 900 and 1800 MHz bands. In Dynamic Spectrum Access networks, however, there may be no such pre-allocated spectrum that can be used by every node at any time. The frequency spectrum used for communication varies from node to node, which imposes even greater challenges on wireless networking, especially on routing. Due to the heterogeneity of spectrum availability among nodes, routing problem cannot be well solved without considering the spectrum allocation. Thus, new routing algorithms were needed with the goal of finding a short and optimized route and accommodate the spectrum dynamics thereby ensuring satisfying network performance such as high network capacity and throughput, short latency, low packet loss etc.

For the class of cognitive radio networks without any fixed infrastructures or centralized entities, SUs have to cooperate between themselves in an ad hoc manner to exchange information and obtain necessary knowledge, such as network topology and PUs' presence. Thus, the routing protocol should satisfy the requirements of both cognitive radio networks (CRNs) and ad hoc networks. The main concern of cognitive radio communication by SUs is to avoid interruptions in the PUs' transmission.

The SUs should select appropriate channels for their communication: once at the beginning of the data transmission, and the other time is at the route repair occasion. The channel availability information is obtained from the spectrum sensing mechanism on the physical layer or spectrum occupancy database, if any [4]. Since the spectrum information is a crucial part of route determination, routing protocol should consider cross-layer approach with the physical layer, creating the so called 'spectrum awareness' [5]. The properties of ad hoc networks must also be covered in designing routing protocols for CRNs. Routing protocols are mainly classified into 3 categories:- Centralized versus Distributed - Static versus Adaptive, and Reactive versus Proactive [6, 5].

5.1 Proactive Protocols

Proactive protocols are called table driven protocols in which, the route to all the nodes is maintained in routing table. Packets are transferred over the predefined route specified in the direction-finding table. In this scheme, the packet forwarding is done faster but the routing overhead is greater because all the routes have to be distinct before transferring the packets. Proactive protocols have lower latency since all the routes are maintained at all the times. For Example: DSDV, OLSR, WRP, CGSR, TBRPF [6, 10].

5.2 Reactive (On-Demand) Routing Protocols

In this group of protocol there is an initialization of a route discovery mechanism by the source node to find the route to the destination node when the source node has data packets to send. When a route is found, the route preservation is initiated to maintain this route until it is no longer required or the destination is not reachable. The benefit of these protocols is that overhead messaging is reduced. One of the disadvantages of these protocols is the delay in discovering a new route. The examples of reactive routing protocols are Dynamic Source Routing (DSR), Ad-hoc On-Demand Distance Vector routing (AODV), and Temporally Ordered Routing Algorithm (TORA) [5, 10].

**5.3 Hybrid Routing Protocols**

A hybrid protocol means the combinations of reactive and proactive protocols and takes advantages of these two protocols .So routes are found quickly in the routing zone. Example Protocol: ZRP. In this case various approaches of routing protocols are combined to form a single protocol. ZRP protocol combines the proactive and reactive approach. Combinations of selected features of proactive and reactive protocols and Adaptive to network condition are main characteristics of ZRP.We shall now discuss and summarize AODV and DSDV Protocol.

**5.4 Ad Hoc On-demand Distance Vector Routing (AODV) Protocol:**

The Ad-hoc On-demand Distance Vector Routing (AODV) protocol is a reactive routing protocol based on Distance Vector Algorithm [4,6,5]. It is the combination of DSDV and DSR protocol .It only needs to maintain the routing information about the active paths. A next hop routing table is maintained by very mobile node, which contains the destinations to which it currently has a route. If no route is available to the destination, it initiates a route discovery process.

In the route discovery process, the source node broadcasts route request (RREQ) packets which includes Destination Sequence Number. When the destination or a node that has a route to the destination receives the RREQ, it checks the destination sequence numbers it currently knows and the one particular in the RREQ. If the destination sequence number is equal to or greater than the one specified in RREQ, a route reply (RREP) packet is created and forwarded back to the source node only. This assures the freshness of the routing information. It uses only symmetric links and a RREP follows the reverse path of the respective RREQ. Upon receiving the RREP packet, each intermediate node along the route information updates its next-hop table entries with respect to the destination node. [1, 4].

The AODV supports both unicast and multicast packet transmissions even for nodes in constant movement..It has great advantage in having less overhead over proactive protocols, responds quickly to the topological changes in the network, updates only the nodes that may be affected by the change, using the RRER message. The Hello messages, which are responsible for the route maintenance, are also limited. Thus unnecessary routing overhead in the network is minimised. The limitations of AODV protocol is all nodes in the broadcast medium can detect each other's broadcasts. The nodes are in mobility and their sending rates may differ widely .So even if a valid route is expired, the determination of a reasonable expiry time is difficult. In addition, as the size of network grows, various performance metrics begin decreasing. A route discovered with AODV may no longer be the optimal route further along in time. This situation can arise because of network congestion or the fluctuating nature of wireless links.

**5.5 Distance Sequence Distance Vector (DSDV) Protocol**

DSDV Protocol, as was developed by C. Perkins and P. Bhagwat in 1994, is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm. This algorithm aims to solve the routing loop problem. Destination Sequence Distance Vector (DSDV) is a proactive routing protocol and it is based on the distance vector algorithm. In table-driven routing protocols, each node constantly maintains up-to-date routes to every other node in the network. Each node maintains a table with next-hop neighbour information and number of hops to the destination. To determine "freshness" of a particular route, it uses sequence numbers for the destination nodes to provide loop freedom. The sequence number is incremented upon every update sent by the host nodes. The routing table is updated at each node periodically with the routing information to maintain an updated view of the network. In case, if a route has already existed before traffic arrives, transmission occurs with no delay. In case of route failure, the node instantly updates the sequence number and broadcasts the information to its neighbours. The tables can be updated in two ways, either incrementally or through a full dump. DSDV guarantees loop free routes to each destination and find the optimal path based on an average settling delay which is a delay before advertising a route. In DSDV, the routing tables require regular updates, which use battery power and a small amount of bandwidth even when the network is idle. As a result, amount of nodes that can join the network are limited. Also routing tables may contain routes to destinations which are not required so more memory consumption at each node as the size of the network increases.

5.6 Performance Metrics

Average End-to-End Delay: The average time it takes a data packet to reach the destination. This includes all possible delays caused by buffering during processing delay, queuing delay route discovery latency, queuing at the interface queue, retransmission delay at MAC, and propagation delay. This metric is calculated by subtracting time at which first packet was transmitted by source from time at which first data packet arrived to destination. Mathematically, it can be defined as:

Average end-to-end delay = S / N

where, S = Sum of time spent to deliver packets for each destination, and

N= Number of packets received by all the destination nodes.

Average Energy consumption: It is the ratio of sum of total energy consumed by each node to the total number of nodes .The energy consumption of the on-demand protocols increases as the maximum motion speed grows. A protocol is described to be more efficient when less energy is consumed during the simulation time.

AEC = ∑ (Initial Energy - Final Energy)/Total number of Nodes.

## VI. EXPERIMENTAL RESULTS

The routing protocols are evaluated using Network Simulator-2 (NS-2) in its version 2.34, since it is open source free software in which different specifications in the environment can simply modified and changed. The network consists of 30 nodes placed randomly in a terrain 300m*300m with flat grid topology and with packet size of 1000 bytes. The capacity of the channel is kept as the default one: 2 Mbps. For MAC layer protocol we have used the Distributed Coordination Function (DCF) of IEEE 802.11 for wireless Network as it captures link breakages effectively. Constant Bit Rate (CBR) traffic is exchanged among the nodes with transport layer protocol being UDP. All the nodes in the simulation has omni-directional antenna. In CBR the packet size remains constant during the packet transmission where the source is not busty, and the source is active during the connection. In this paper, the AODV protocol performance was observed in NS-2.34 for the parameters end-to-end delay and energy consumption. The simulation results as in figure 2 3 and 4 show that as the simulation time proceeds the end-to-end delay increases due to increase in congestion, since we are in casting all packets to node 0. Similarly the energy consumption will also increase.

Figure2 shows the Network formation that consists of 30 nodes . Data being incast at node no '0'.In figure 3 showing the end-to-end delay, it is observed that the delay induced is increased and packet are dropped due to congestion in the network. Figure 4.show the energy consumption of the node that increases with the simulation time.

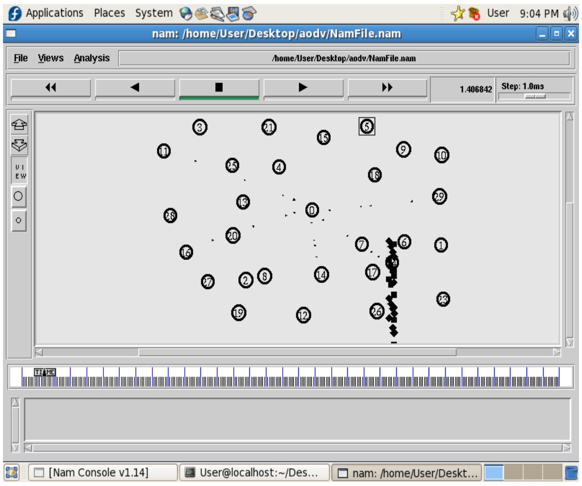


**Fig.2 Network Formation and data traffic generation**.

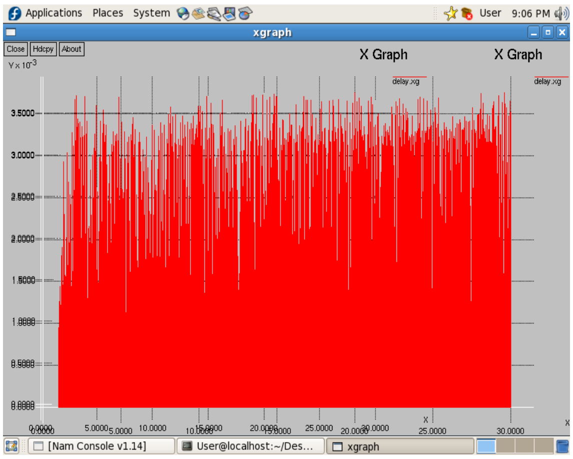


**Fig.3 End-to-end Delay**.

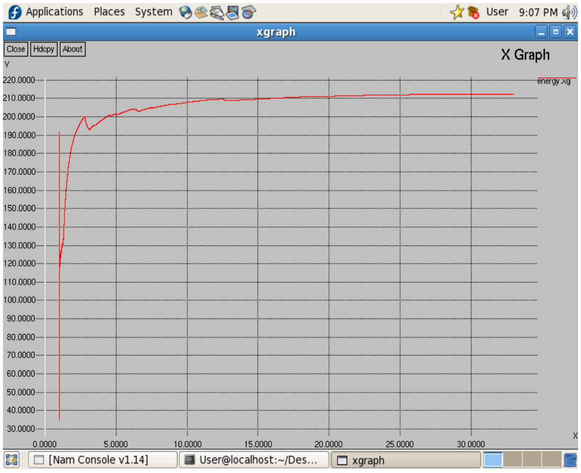


**Fig.4 Energy Consumption.**

## VII. CONCLUSION

The proposed research work will presents extensive simulation analysis for DSDV and AODV MANET routing protocols under various traffic scenarios for CRN. Routing protocols will be evaluated for the optimum performance on all chosen metrics i.e End-to-End Delay, energy consumption, throughput and jitter. A future work can be considered by carrying out simulation to analyze and compare the performance of TORA protocol as an example of hybrid routing protocol with the routing protocols analyzed in this work where different scenarios could be inspected while introducing randomness to the packet size and rate.

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