IMPROVEMENT IN THE ENERGY EFFICIENCY BY DYNAMIC CHANNEL IN COGNITIVE RADIO SENSOR NETWORKS

Priyanka B V[1], Prashanth C R[2]

[1] M.Tech Student, Dept of Telecommunication Engineering

[2] Professor, Dept of Telecommunication Engineering

[1, 2]Dr. Ambedkar Institute of Technology, Bengaluru

Abstract: Wireless sensor networks operating in the license free spectrum suffer from uncontrolled interference as those spectrum bands become increasingly crowded. The emerging cognitive radio sensor networks (CRSNs) provide a promising solution to address this challenge by enabling sensor nodes to opportunistically access licensed channels. However, since sensor nodes have to consume considerable energy to support Cognitive Radio functionalities, such as channel sensing and switching, the opportunistic channel accessing should be carefully devised for improving the energy efficiency in CRSN. Here investigation of the dynamic channel accessing problem is done to improve the energy efficiency for a clustered CRSN. Under the primary user's protection requirement, the resource allocation issues to maximize the energy efficiency of utilizing a licensed channel for intra-cluster and inter-cluster data transmission, respectively. Moreover, with the consideration of the energy consumption in channel sensing and switching, the further investigation are done to check the condition like when sensor nodes should sense and switch to a licensed channel for improving the energy efficiency.

Index Terms- **Cognitive Radio Sensor Networks, Dynamic Channel Access, Clustering, Energy Efficiency**

I.INTRODUCTION

WSNs operating over the license-free spectrum suffer from heavy interference caused by other networks sharing the same spectrum. The uncontrollable interference may cause a high packet loss rate and lead to excessive energy consumption for data retransmission, which significantly deteriorates the energy efficiency of the network. Wireless sensor network (WSN), as a promising occasion observing and information gathering strategy, has been broadly connected to different fields including condition observing, military reconnaissance and other mechanical applications. Under the primary user's protection requirement, the resource allocation issues to maximize the energy efficiency of utilizing a licensed channel for intra-cluster and inter-cluster data transmission, respectively. Moreover, with the consideration of the energy consumption in channel sensing and switching, the further investigation are done to check the condition like when sensor nodes should sense and switch to a licensed channel for improving the energy efficiency. These are done with respect to some parameters like packet loss rate, energy efficiency of the license-free channel. In addition to this work, two dynamic channel accessing schemes are proposed to identify the channel sensing and switching sequences for intra-cluster and inter-cluster data transmission, respectively and to increase the packet-delivery-ratio, bit error rate and energy efficiency. Existing works give an exhaustive and from beginning to end examination on streamlining advantage (QoS) shows for CRSNs, reducing the transmission delay or reaching out quite far. In any case, few of them have focused on enhancing the centrality gainfulness for CRSNs, with a sensitive thought of the criticalness use in channel recognizing and exchanging. In existing system there is no concept of intra cluster. There is only inter cluster operation in both primary and secondary user [3].The key issue in existing system is in primary operation the source node is fixed in one particular cluster and destination in different cluster. And uses the licensed-free channel for operation purpose [2].Since there is fixed source path for primary communication, if any interruption occurs there is no chance of choosing other node as primary source. So entire communication may fail. The existing work insults picking the best channel to transmit developments on and this prompts a wasteful utilization of the range.

PROBLEM FORMULATION

The existing system sometimes operates under the license free spectrum this may lead to the interference. This more interference may cause a high packet loss rate and this leads to more energy consumption, high packet loss and over all throughput of the system will be less. The both intra and inter cluster works under the static operation. Hence this will results in the failure of the communication if source or destination gets fail to transmit the data, because there is no option to choose other nodes for transmission purpose.

II. RELATED WORK

Zhan and Chen [1], proposed the data gathering optimization by two methods that is data sensing and the data transmission , then the algorithm for dynamic sensing are also proposed where in it has got the two parts . One is balanced energy scheme this is to manage the energy and next is for sensing rate algorithm for the sensing and transmission, here it will select the less sensing and routing rates which will indirectly improves the data gathering.

Yaoxue Zhang et al., [2] proposed some of the mobile cloud services like data collection, data processing and then some of the data computing. At the proposed system it is indicating about mobile crowd architecture and its application and also it will develop the challenges of mobile crowding. This gives the better performance in terms of throughput, and energy efficiency.

Zhang et al., [3] proposed the proliferation of increasingly powerful mobile devices, mobile users can collaboratively form a mobile cloud to provide pervasive services, such as data collecting, processing, and computing. In this article the investigation of the mobile crowd sourcing architecture and applications are done, then discussion of some research challenges and countermeasures for developing mobile crowd sourcing is carried out.

Zhang et al., [4] proposed about the issues of Dynamic spectrum accessing of sensing and sharing of the spectrum and along with the performance of sensors users. It is proposed that sensing of spectrum with different primary users and it is performed for the better performance of the primary users along with satisfying the secondary users. Here the channel selection algorithm is computed.

Akan et al., [5] proposed the spectrum efficient communication approach has been developed depend upon the event characteristics and also communication. It is also used to realize multiple service network deployment and to erase the collisions between for the nodes for the nodes deployment purpose. The cognitive radio wil give rise to sensor networks. it is proposed to give the new advantages, application and architecture of the cognitive radio networks.

Timmers et al., [6] proposed the unused licensed are used without interrupting with licensed. It proposes cognitive networks along with the spectrum scarcity and the energy efficiency is main thing to this proposed system. And it is also shown that proposed work gives or improves energy by protecting the primary users from interference. This gives better performance in the terms of energy efficiency from proposed system.

Bayhan and Alagoz et al., [7] proposed the cognitive radio is considered along with the proposed work it focuses the base station of cognitive in terms of the channels switching and frequency, here the problem is reduced by developing polynomial time heuristic algorithm which gives the idle frequency for the CR operations and also analysis of error efficiency is done along with the spectrum scenarios.

Liang et al., [8] speaks about license free channel and the spectrum this leads to more interference as using of licensed channel by proposing CRSN where there is no channels available in the spectrum it can switch to other it makes use of periodic switching and triggered switching to improve the energy efficiency.

Lin and Chen [9] speaks hat it has been developed in the network computation to accommodate the transmission and to reduce the transmission delay in the given network. For the further usage for improving the end to end delay this can be done by using the algorithm called greedy algorithm. Here it improves the energy efficiency which can be applied to the multiple networks. It is performed good compared to existing work.

Quang and Kim [10] proposed the algorithm called routing is proposed this in terms enhances the throughput, energy efficiency and reduces the end to end delay. This is formed using different clusters along with the sink by the maximum throughput it can be viewed that data can be used in the best path. The data can also be forwarded in the different clusters and all given to the sink i.e base stations.

Spachos and Hantzinakos [11] proposed the cognitive has introduced with the routing protocol, the main aim of this proposed system is to improve the energy performance by building accurate channels and by building discrete event simulators compared with the routing protocols. So that proposed work gives the better performance in terms of energy efficiency and throughput of system.

Shah and Akan [12] proposed the existing work facing the problem to provide performance in the CRSN. Hence it is proposed by the two fundamental metrics in CRSN that is the band width and delay by using the secondary users to negotiate the band width and by accessing the traffic channels in the region where interference occurs , it was not in the case of the existing so it will provides the good performance.

Shah and Akan [13] proposed the energy consumptions activity is adapted by using MAC in the cognitive radio networks which becomes the CA MAC protocol as the proposed system where it consists of two modes periodic wake up and periodic sleep mode after the operation it goes to sleep mode after the operation it goes to the sleep mode. Hence it is produces the solutions for energy consumption.

Han et al., [14] proposed by considering the cognitive radio the energy efficiency needs to be considered in both terms that is primary users and secondary users and then the new channel is proposed with the channel management. Here this channel management is used for channel switching , data transmission and the reception purpose. This proposed simulation provides the results in energy efficiency in the primary users.

Oto and Akan [15] proposed the cognitive radio is the system that has been a promising solutions related to spectrum challenges in the wireless sensor. In existing packet size was the huge dis advantage because it was applicable for the CRSN system. Hence it proposes the optimal packet in order to enhance the energy efficiency for the primary users which was detecting at the sink. So the metrics of network parameters also produce the good performance.

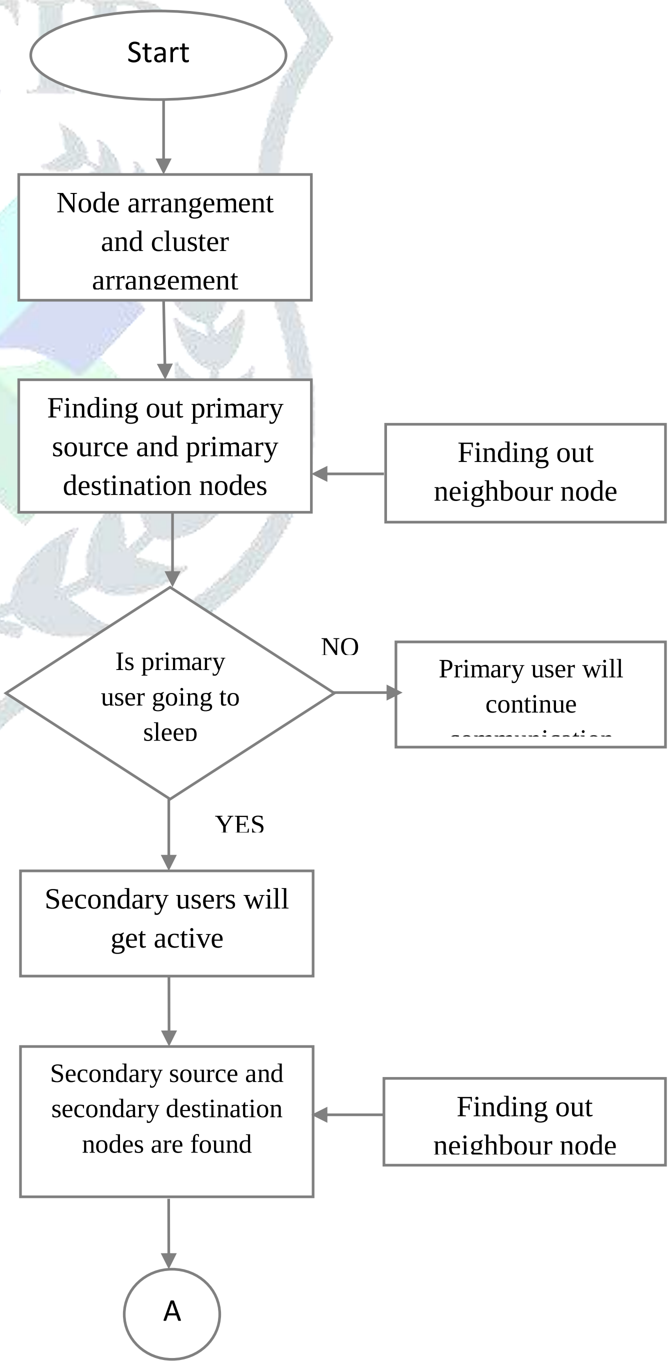
III. METHODOLOGY

A. *DESIGN GOALS*

1) To enhance the energy efficiency a dynamic channel accessing are used for both the intra and inter cluster transmission which gives the idea when to access the channel and when to switch over the channel.
2) Here in there is concept of both intra cluster which works in the dynamic manner where the source and destinations will keep on changing in each and every routine in different clusters [2].
3) The inter clusters works under the static operations where the secondary source and the secondary destinations are in the same clusters and they start to communicate through the neighbor nodes present in both clusters [1].
4) Here the main issue is to examine the conditions when the nodes have to use the license free channels for their communication purpose from the source to the destinations. Here fixed amount of data are used to determine the conditions.
5) This proposed work is challenging task because it is depending on various factors like packet loss, energy efficiency and through put of the system and to give the protection for the primary users.
6) Here the primary user operation are dynamic, so that there will be high energy efficiency and less chance of getting failure while intra cluster communication.
7) The secondary users (SU's) will have one source node and one destination node with neighbor nodes, this will operate when primary user goes to sleep mode [3].
8) Hence the first part of the proposed system also chooses the best channels for the communication purposes then it starts its operation for next part of the proposed system. For further enhancement of the energy efficiency, two sources and two destinations are found in the different clusters.
9) Here the time consumption will be less for reaching the packets/data to the destination because here are the two destinations way so that the first source can able to communicate with both destination paths.

10) The remaining packets/data are transmitted by the second source nodes to both the destinations. Hence these packets/data are distributed within two source and are delivering two destination paths through neighbor nodes.
11) Here the packets are reaching the destiny in less time with no loss in packets compared to intra cluster, inter cluster and existing system.

B. *PROPOSED MODEL*



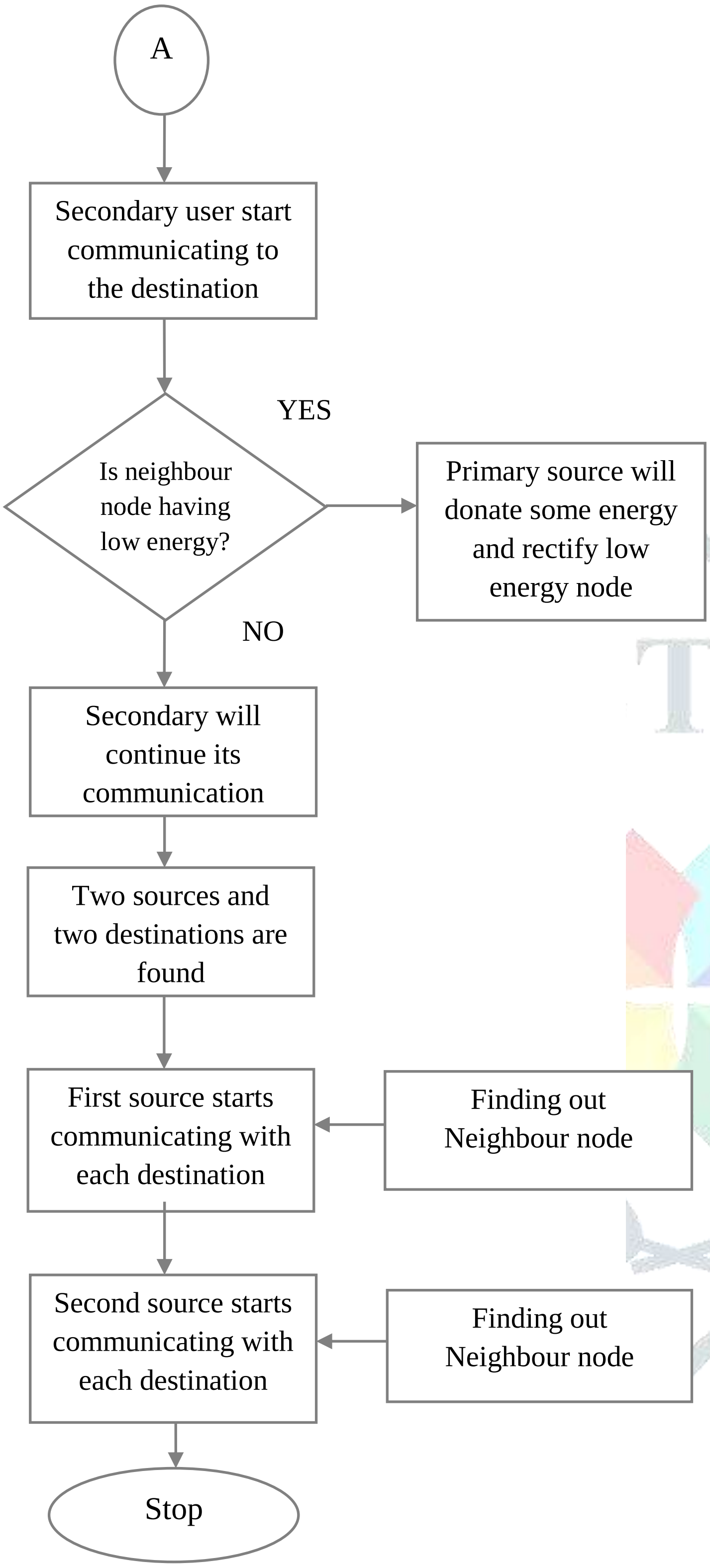


fig 1: flow chart of proposed model

VI. PROPOSED WORK

The above fig 1 shows the flow chart of the implemented work. The detailed function of the flow chart is as mentioned in the below modules.

- Set up the required environmental settings like channel type, radio propagation model, antenna type, link layer, queue type, network interface type, MAC type, routing protocol and so on. There are 90 nodes created in grid layout form.
- Create the simulator
- Set the trace and logging information.
- Set the NAM animation window.

Module 1: Cluster construction

The project design in NS2 takes place in the form of cluster construction. Each node should send hello packets to its neighbor node which are in its communication range to update their topology. In this module, the proposed scheme cluster construction design in NS2 is done. Source/destination and Cluster Member are identified. The steps involved in implementing this module are as follows.

- A total of 90 nodes are created.
- Local grouping of nodes is formed. Out of 90 nodes, 6 groups are then formed.
- The distance between each and every pair will be calculated. If the distance is less than the transmission range then that node will be considered as neighbor (i.e. Cluster Member).
- The node which has a highest number of energy is being considered as a source or destination node.

Module 2: Detection of source and destination nodes for Intra cluster

Neighboring nodes are considered according to the distance that is less than 70. Each of them will carry the information received from the source and reaches that information to the required destination. Here there is one source node and four destination nodes. The steps will be followed in this module are:

- Source communicates to its neighbor node takes place.
- Neighbor nodes will receives the information and reaches to required destination.
- Here intra cluster keeps on changing in every new routine as it is dynamic in nature.

Module 3: Inter cluster formation when primary user goes to sleep mode

Inter cluster communication takes place when the primary user comes to sleep mode. Here in secondary user there is one source node and one destination node both starts communicating through neighbor node when primary user in sleep mode. Given below are the steps.

- After the intra cluster stage, inter cluster starts the communication.
- It makes use of neighbor nodes to communicate to the destination path.

- Then inter cluster will come to sleep mode and primary starts the communication.

Module 4: If neighbour node has low energy then primary source node will recover low energy node

While the secondary user's starts communicating through their neighbour nodes and found any node are suffering from low energy, then primary source node will recover that node. Given below are the steps:

- Neighbor node is suffering from low energy.
- Primary nodes start recovering the low energy node.
- Then neighbor node gets recovered.
- And start communicating to the destination nodes.

Module 5: For further enhancement in energy efficiency two sources and two destinations are selected

After the completion of both intra and inter cluster formation for further enhancement in terms of packet-delivery-ratio, bit error rate, through put and energy and energy efficiency two source path and two destination paths are formed. Given below are the steps:

- Two sources and two destinations are formed based on the highest probability of nodes which should be greater than average distance.
- Here first source node communicates with first destination path, and next it communicates to second destination path likewise second source node starts communicating with first destination path and next it communicates to second destination path.
- Here the time taken to reach the data to destiny will be less compared to existing and intra/inter cluster system.
- Hence there will be more energy efficiency.

V. DESIGN OUTPUT

The above output shows a total of 90 nodes that are created. From Node 0 which is in green colour to Node 90. A local group of 15 nodes each is formed out of 90 nodes is shown in multiple coloursIf the distance is less than transmission range i.e (70) then that node will be considered as neighbour (i.e. Cluster Member). The node which has a highest number of probabilities is being considered as a source node or destination node and is shown in red colour.

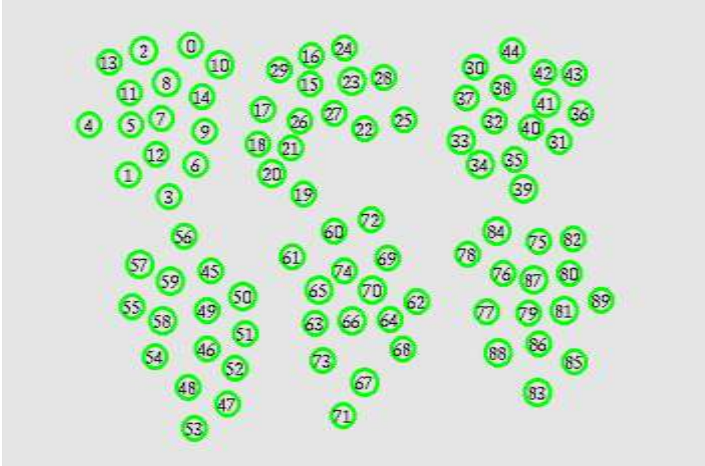


fig 2: cluster formation

As show in fig 3 it indicates the different clusters of total 90 nodes that are created in different clusters from Node 0 which to Node 90 in different colours. From node 0 to node 14 shown in orange colour is known as cluster 1, node 15 to node 29 shown in blue colour is known as cluster 2, node 30 to node 44 shown in pink colour known as cluster 3, node 45 to node 59 shown in maroon colour known as cluster 4, node 60 to node 74 shown in green colour is known as cluster 5 and finally from node 75 to node 89 shown in colour black is known as cluster 6.

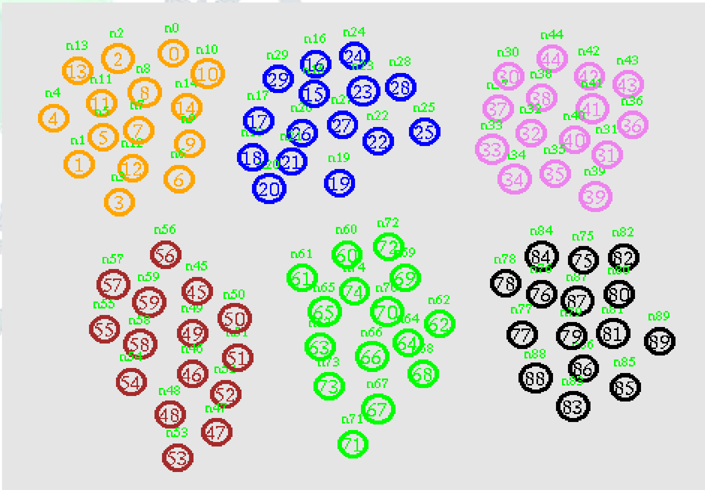


fig 3: different clusters

As show in fig 4 it indicates that one node is considered as primary node and four nodes in same clusters as destination node which is red and in purple colour. The node which is considered as source node is located at same cluster where destination nodes are found, but in every new routine this clusters will change which is indicated in red colour and purple colour. Other colour nodes indicate different group cluster members.

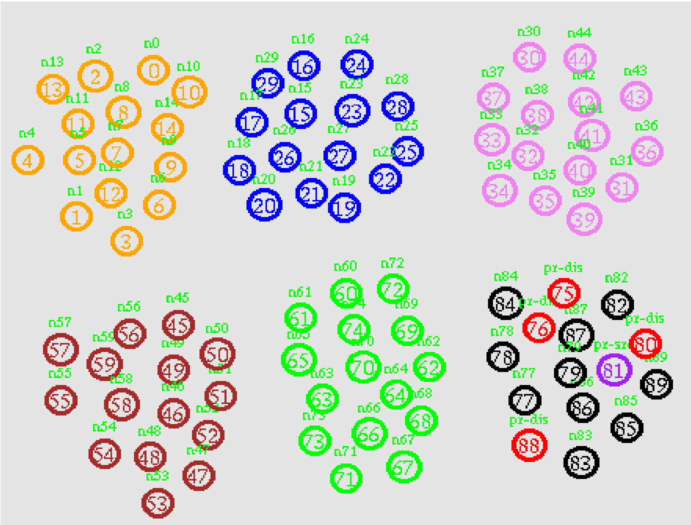


fig 4: primary user's source and destination

The fig 5 shows that nodes are identified as neighbour nodes in each clusters which are having the distance less than 70. These nodes are used to carry the information or the data from primary source node to primary destination nodes located in same clusters. The nodes with AN label and blue in colour is identified as neighbour nodes. Other cluster members are shown in pink, orange, maroon, green and black in colour. When this primary user goes to sleep mode then the secondary will get active and start the communication which will be shown in next part of implemented work.

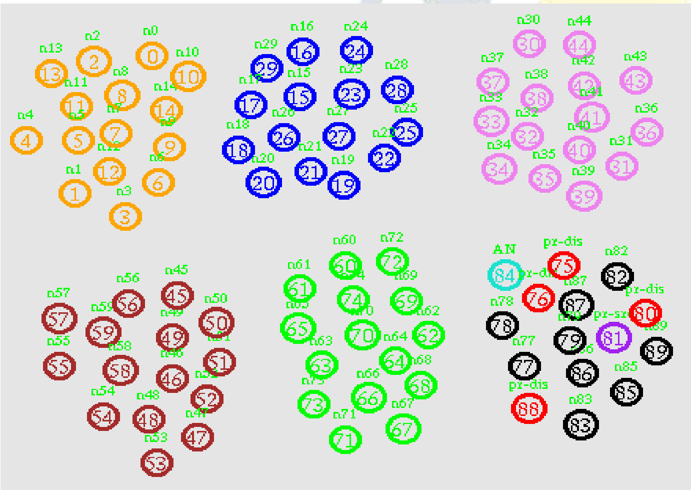


fig 5: primary user's source and destination with neighbour nodes

As show in fig 6 it indicates that nodes are identified as secondary source and secondary destination node in 1st and 2nd cluster which are indicated in red and purple colour. These nodes are active when primary user goes to sleep mode, so that the secondary source node starts communicating with secondary destination node. The nodes with red and purple in colour are identified as secondary source and destination node.

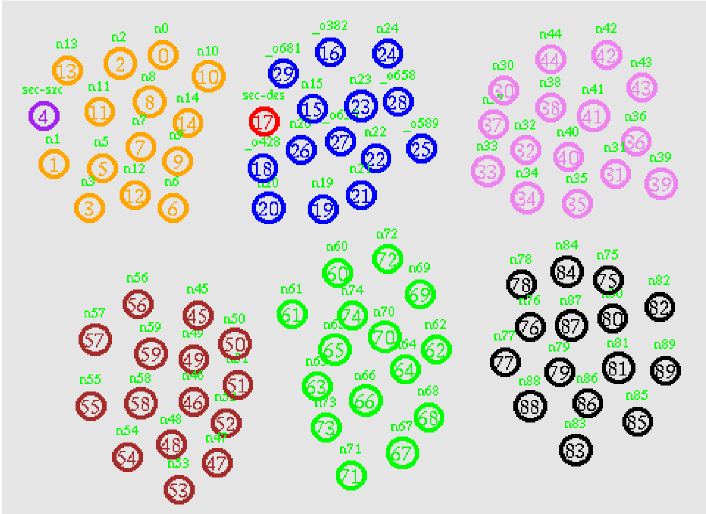


fig 6: secondary user's source and destination

The fig 7 shows that node which is suffering from low energy during secondary user communication that are identified with yellow colour. During the secondary user communication through the neighbour node if any neighbour node is suffering from low energy that is indicated in yellow colour in above fig 7 the primary source node will rectify the low energy node. The node with 'recovering' as label tells that low energy node are getting recovered and will be labelled as 'node' after getting recovered completely.

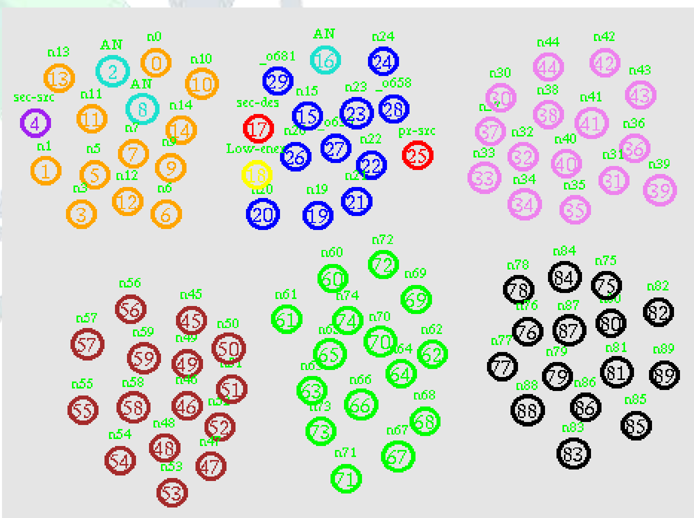


fig 7: neighbour node suffering from low energy

As show in fig 8 it indicates that node with two sources and two destinations which are identified in red and purple colour. For enhancing the energy efficiency of proposed work two dynamic channels are created so that the packets that wanted to send are shared between the two sources then reaches the destinations. This two dynamic channel also communicates through neighbour nodes which gives high energy efficiency compared to existing system.

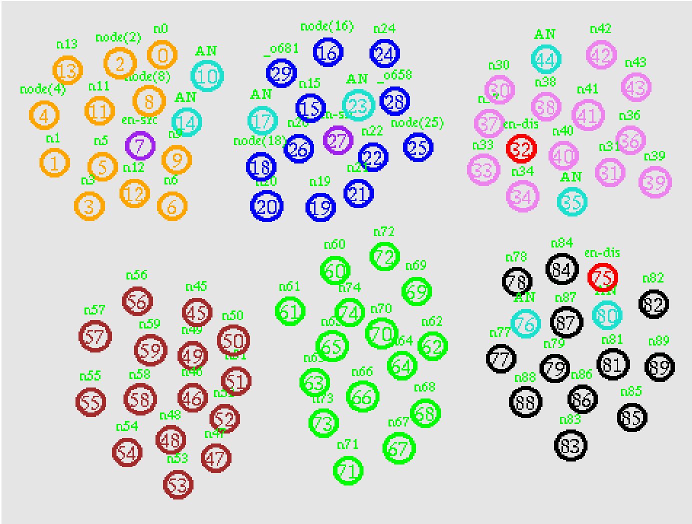


fig 8: two sources and two destinations

VI. EXPERIMENTAL RESULTS

As show in fig 9 it indicates the experimental result with respect to packet to delivery ratio, where compared to existing the proposed work having high packet delivery ratio. Because the existing system works with static primary while the proposed work works with the dynamic intra cluster. Hence it's proved that the proposed work is more efficient than existing system.

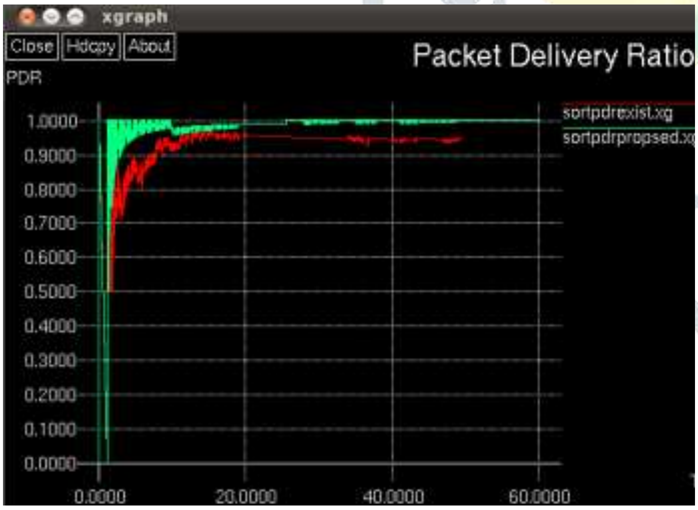


Fig 9: Packet delivery ratio v/s time

As show in fig 10 it indicates experimental result with respect to throughput, where compared to existing the proposed work having high throughput. Because the existing system works with static primary while the proposed work works with the dynamic intra cluster. Hence its proved that the proposed work is more efficient than existing system.

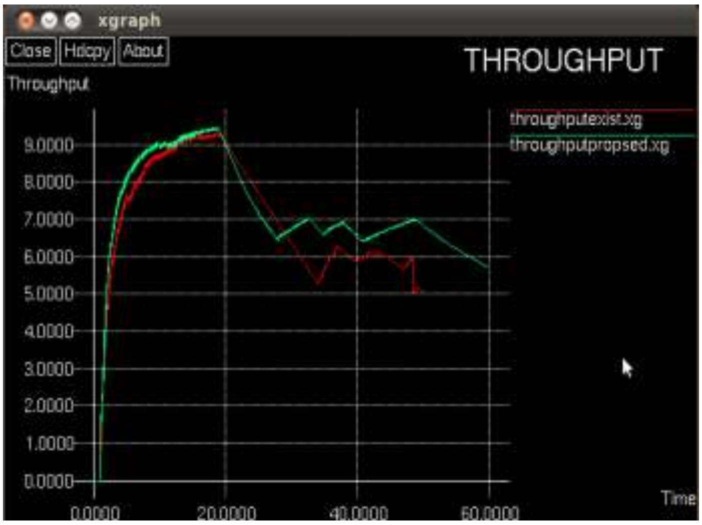


fig 10: throughput v/s time

In the fig 11 shows the cluster level energy consumption. . Here it clearly states that in the existing system which is having fixed primary source for communication is having less energy efficiency compared to the proposed system which is implemented by considering dynamic intra cluster for communication purpose and by having secondary users i.e inter cluster and by creating the two dynamic channel where the packets/data wanted to reach the destination is shared between the two sources so that in less time all data or the packets reaches the destination. Hence it is proved that proposed work is more efficient than existing system

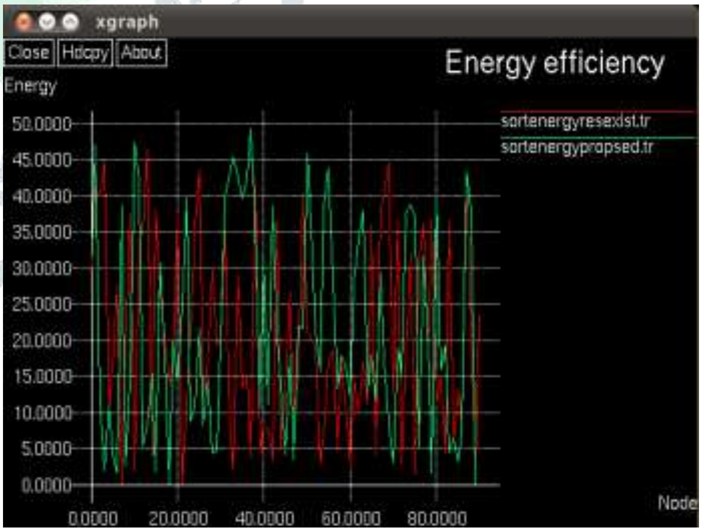


fig 11: energy efficiency v/s nodes

As show in fig 12 it indicates the experimental result with respect to bit error rate, where compared to existing the proposed work having low bit error rate. Because the existing system works with static primary while the proposed work works with the dynamic intra cluster. Hence its proved that the proposed work is more efficient than existing system.

fig 12: bit error rate v/s time

VII COMPARISON TABLE OF BOTH EXISTING SYSTEM AND PROPOSED SYSTEM

Table 1: Comparison with respect to network parameters

System	Packet Delivery Ratio	Energy in Joules	Bit Error Rate in Kbps	Throughput in Kbps
System with static primary user	0.87	46.59	88336	5.26
System with dynamic primary user	0.98	49.154	1100	7.02

The above table 1 results are viewed by considering 90 nodes in both existing system and proposed system. Here it clearly states that in the existing system which is having only one path for communication is having high error rate compared to the proposed system which is implemented by considering multiple paths for communication purpose and by having secondary users i.e inter cluster and by creating the two dynamic channel where the packets or data wanted to reach the destination is shared between the two sources so that in less time all data or the packets reaches the destination. The throughput of the overall proposed system is high compared to existing system. Hence it clearly states that the proposed system is having high energy efficiency than the existing system. Therefore in the implemented work the packets delivery ratio is high compared with existing system.

11. CONCLUSION AND FUTURE WORK

In this paper the dynamic channel is considered in intra cluster system. Moreover by finding the two sources and two destinations the packets are reaching the destinations at less time. Hence the overall efficiency of proposed work is high, packet to delivery ratio is high and throughput of system is high with less in error rate. For further enhancement dynamic inter cluster is also possible and can introduce a node in between two sources and two destination nodes to check whether the two sources are sending same data or different one.

REFERENCES

[1] Y. Zhang, S. He, and J. Chen, “Data Gathering Optimization by Dynamic Sensing and Routing in Rechargeable Sensor Networks,” *IEEE/ACM Transactions on Networkin.*, vol 24, no. 3, pp. 1632-1646, 2015.

[2] Yaoxue Zhang, Ju Ren and Ning Zhang “Dynamic Channel Access to Improve Energy Efficiency in Cognitive Radio Sensor Networks,” *IEEE Transactions Wireless Communications*, vol. 15, no. 5, pp. 3143 - 3156, 2016.

[3] J. Ren, Y. Zhang, K. Zhang, and X. Shen, “Exploiting Mobile Crowd-Sourcing for Pervasive Cloud,” *IEEE Communications Magazine*, vol. 53, no. 3, pp. 98–105, 2015.

[4] N. Zhang, H. Liang, N. Cheng, Y. Tang, J. W. Mark, and X. Shen, “Dynamic Spectrum Access in Multi-channel Cognitive Radio Networks,” *IEEE Journal on Selected Areas Communication*, vol. 32, no. 11, pp. 2053–2064, 2014.

[5] O. B. Akan, O. Karli, and O. Ergul, “Cognitive Radio Sensor Networks,” *IEEE Transactions on Networking*, vol. 23, no. 4, pp. 34–40, 2009.

[6] M. Timmers, S. Pollin, A. Dejonghe, L. Van der Perre, and F. Catthoor, “A Distributed Multichannel Mac Protocol for Multihop Cognitive Radio Networks,” *IEEE Transactions on vehicular Technology*, vol. 59, no. 1, pp. 446–459, 2010.

[7] S. Bayhan and F. Alagoz, “Scheduling in Centralized Cognitive Radio Networks for

Energy Efficiency," *IEEE Transactions on vehicular Technology*, vol. 62, no. 2, pp. 582–595, 2013.
[8] Z. Liang, S. Feng, D. Zhao, and X. Shen, "Delay Performance Analysis for Supporting Real-time Traffic in a Cognitive Radio Sensor Network, "*IEEE Transactions on Wireless Communication*, vol. 10, no. 1, pp. 325–335, 2011.
[9] S.-C. Lin and K.-C. Chen, "Improving Spectrum Efficiency via In-Network Computations in Cognitive Radio Sensor Networks," *IEEE Transactions on Wireless Communication*, vol. 13, no. 3, pp. 1222–1234, 2014.
[10] P. T. A. Quang and D.-S. Kim, "Throughput-Aware Routing For Industrial Sensor Networks: Application to isa100. 11a," *IEEE Transactions on Industrial Information*, vol. 10, no. 1, pp. 351–363, 2014.
[11] Spachos and D. Hantzinakos, "Scalable Dynamic Routing Protocol for Cognitive Radio Sensor Networks," *IEEE Sensors Journal*, vol. 14, no. 7, pp.2257–2266, 2014.
[12] G. A. Shah and O. B. Akan, "Performance Analysis of Csma-Based Op-portunistic Medium Access Protocol in Cognitive Radio Sensor Networks", *Ad Hoc Network*, vol. 15, pp. 4–13, 2014.
[13] G. Shah and O. Akan, "Cognitive Adaptive Medium Access Control in Cognitive Radio Sensor Networks," *IEEE Transactions on Vehicular Technology*, vol. 64,no. 2, pp. 757–767, 2015.
[14] J. A. Han, W. S. Jeon, and D. G. Jeong, "Energy-Efficient Channel Management Scheme for Cognitive Radio Sensor Networks," *IEEE Transactions on Vehicular Technology*, vol. 60, no. 4, pp. 1905–1910, 2011.
[15] M. C. Oto and O. B. Akan, "Energy-Efficient Packet Size Optimization For Cognitive Radio Sensor Networks," *IEEE Transaction on Wireless Communication*, vol. 11, no. 4, pp. 1544–1553, 2012.
[16] B. Chai, R. Deng, P. Cheng, "Energy Efficient Power Allocation in Cognitive Sensor Networks," in *IEEE Global Communication proceedings*, pp. 416-421, 2012.
[17] G. Ding, J. Wang, Q. Wu and Y. Chen, "Spectrum Sensing in Opportunity Heterogeneous Cognitive Sensor Networks," *IEEE Sensors Journal*, vol. 13, no 11, pp. 4247-4255,2013.
[18] S. Maleki, A. Pandharipande, and G. Leus, "Energy Efficient Distributed Spectrum Sensing for Cognitive Sensor Networks," *IEEE Sensors Journal*, vol. 11, no. 3, pp. 565-573, 2011.
[19] G. A. Shah, F. Alagoz, E. A. Fadel and O.B. Akan, "A Spectrum Aware Clustering for Efficient Multimedia Routing in Cognitive Radio Sensor Networks," *IEEE Transaction, Vehicular Technology,* vol. 63, no. 7, pp. 3369-3380, 2014.
[20] M. Ozger and O. Akan, "Event Driven Spectrum Aware Clustering in Cognitive Radio Sensor Networks," in *IEEE proceedings*. pp. 1483-1491.

BIOGRAPHIES

Priyanka B V received the B E degree in Telecommunication Engineering from BMS College of Engineering, Bangalore and currently pursuing her Masters in Digital Communication and Networking in Dr. Ambedkar Institute of Technology, Bangalore. Her research interests include Communication Engineering, Wireless Sensor Networks and Digital Communication.

Dr. Prashanth C R received the B E degree in Electronics in Digital Communication and Networking and the Ph.D. degree in Computer Science from Bangalore University, Bangalore. He is currently Professor, Department of Telecommunication Engineering, P G Coordinator, and Deputy Controller of Examinations, Dr. Ambedkar Institute of Technology, Bangalore. His research interests include Image Processing, Pattern Recognition, Biometrics, Computer Networks, Communication Engineering and Nano Physics. He has served as a member of Board of Examiners for Bangalore University and Visvesvaraya Technological University. He is a member of IEEE, ACM and IACSIT, and life member of Indian Society for Technical Education, New Delhi and Fellow of Institution of Engineers (India).