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Energy Aware Routing in Next Generation Wireless Networks Using Efficient Resource Allocation

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Abstract: ***In last few years because of hick in application of WSNs, it have been in light of the researchers. Sensor node run on limited battery power so numbers of researchers are attempting to increase the lifetime of the WSN by minimizing the–per node energy utilization as well as efficiently used by the sensor nodes. To address this issue of spectrum underutilization in wireless network, Cognitive radio (CR) methodology is used; supporting multimedia applications based on cognitive radio sensor networks (CRSNs) with energy and spectrum constraints is a highly daunting task. The main goal in designing the routing protocols for the cognitive radio network merges the design of routing as well as spectrum management which will jointly overcome the formidable limitations of energy as well as spectrum. In the present system the users those are near to the cluster heads (cell center users) have higher frequency range than the users those are at a long distance from the cluster head (cell edge users).So the cell center user's gets high amount of resources also the cell edge user's gets limited amount of resources. In proposed algorithm we computed a weighted SNR value for every user as well as depending on the computed value cluster head allocates resources to the users. For cluster head selection, the energy spectrum value of every node in the cluster is computed. The node with largest energy spectrum value is considered as cluster head. Proposed system jointly solves the formidable limitations of energy as well as spectrum.***

Keywords: Energy Spectrum Rank, Cluster head, SNR, PRB, CRSN.

1. Introduction

The demand of cognitive radio sensor networks (CRSNs) is needed due to efficient spectrum use. As in the world there is gradually huge development into an internet of things, so the confusion in wireless sensor network(WSN)is accordingly becoming imperative. There is an issue related to use of spectrum in WSNs. The idea of CRSN is needed to solve this spectrum use issue. The CRSN is a distributed network of wireless cognitive radio sensor nodes which senses an event signal. It can commonly communicate readings dynamically in available spectrum bands in a multi-hop manner. It fulfills application-specific requirements. The issue of spectrum allocation is addressed by temporary usage of vacant primary user (PU) spectra by making use of dynamic spectrum access (DSA) but there is a condition that the user will leave that spectrum once the presence of the incumbent is found.

Cognitive radio (CR) technique is introduced as a reliable solution for the increased congestion in the unlicensed band by using vacant spectrum of licensed band opportunistically while neglecting disruptions to the legacy users, like TV broadcast stations, public safety broadcast stations, wireless microphones, and so on. The CR user or secondary user (SU)is eligible for using only locally unused spectrum opportunistically; in a way that it will not create any interferences or collisions to the incumbent or primary users (PUs).When CR users sense the PU on the operating band, they must have to use other spectrum band.

Main advantage of a CRSN is, it takes the intrinsic characteristics of WSNs to achieve any rational meaning, but doing CR functions. The character of throughput is expected to be burst because opportunistic channel utilization. It minimizes the issue of an increased probability of collision in densely redistributed WSN environments. Due to the low throughput in conventional WSNs, congestion as well as over-flooding is not meaningful design problem. Still, with the burst nature of throughput in CRSNs, this problem must be solved, especially in real-time applications that are taken as quality of service (QoS).

The multi-hop cognitive radio networks including small issues of routing in making use of various channels such as traditional multi-channel networks. In this network the set of channels ready for use of every node are not static. An uncommon challenge is the route selection as well as the spectrum decision. The spectrum data is needed when route is chosen due to spectrum bands is dynamically volatile. To accept this variation, routing in multi-hop CRNs must be aware of spectrum. Second important task is the lacks of a fixed common control channel (CCC). Due to a Cognitive radio user has to vacate the spectrum band as early as a PU starts to utilize the network, the implementation of a fixed CCC has been infeasible for CRNs. Thirdly, the spectrum-adaptive route recovery process. With the node mobility, link failure in multi-hop CRNs can be done while PU activities are found. How to vacate the current spectrum band as well as to move to other ready for use spectrum band quickly is still an unknown issue. Lastly, the evaluation metrics for routing with channel assignment are still an unsolved problem. This means how to solve channel switching is a controversial question. At last, the route maintenance is required.

2. Related Work

Christian et al. gives energy as well as cognitive radio aware routing (ECR) [1], that is a routing protocol implemented for CRSNs. It accepts the common hierarchical network architectures; this can coordinate the clustering operations as well as the route search algorithm. The development of cluster formation is not possible in ECR. In route request phase, the route request (RREQ) packet is forwarded as a broadcast towards the sink via a common control channel. In between nodes sends the RREQ. Route maintenance is only performed locally if the damaged node is in near proximity to the sink. Or else, a message must be forwarded back to the source to select a novel route request, which can be nearest.

The spectrum-aware cluster based on energy efficient multimedia (SCEEM) routing protocol for CRSNs [2], that will support the quality of service (QoS) as well as energy-efficient routing by restricting the participating nodes in identifying routes. The proposed protocol in the literature is thus a cross layer routing protocol as well as only useful for wireless multimedia sensor networks (WMSNs) application case, that comprised of sensor devices having audio and also visual data collection modules, can have the ability to get multimedia information, store or process data in real-time, correlate as well as fuse multimedia information originated from heterogeneous sources, as well as wirelessly transmit received information to proper destinations.

The virtual cluster-based reliable opportunistic routing (ROR) method for the purpose of routing in CRSN is proposed in [3]. It is like all on-demand routing protocols, where a path is only wanted when it is needed, as well as it is kept up to the mark for end of the message sending procedure. This protocol provides a robust routing system which is treats the link quality of communicating nodes for information sending. The route request phase is utilized to find for all possible routes from the source node to the sink. The sink chooses the best route which provides specific quality of service (QoS) guarantee levels, normally depending on bandwidth and delay.

The low-energy adaptive uncommon clustering hierarchy (LEAUCH) is given in [4] for CRSN. It just not takes the advantage of channel resources taken by cognitive function in CRSN but also exploit the uneven clustering techniques depending on the channel resources. More commonly, in the proposed algorithm, the number of idle channels of each node is taken as its weight as well as the nodes with more empty channels are selected as candidate cluster head (CH) nodes. Depending on the concept of the uneven clustering technique, there are some members in the clusters closer to the sink. In this manner, the energy of CHs near sink can be freed, as well as energy can be utilized for sending information, that can balance energy utilization from CHs under numerous hops transmission means in CRSN.

In paper [5] given a cognitive LEACH (CogLEACH) for CRSN which makes use of the number of vacant channels as a weight in the probability of every node to get a chance to be a CH as well as this can increase the network lifetime with respect to LEACH algorithm. Still, the algorithm will not take the balance of energy utilization from CHs under numerous hops transmission means that will be leading us towards the premature death of the nodes near the sink due to of their excessive energy utilization.

In paper [6], authors have given an event-driven clustering algorithm. The qualified nodes are determined depending on the distance from sensor nodes to the event happening point as well as the sink. CHs are chosen from the qualified nodes based on node degree, available channels, also on the distance to the sink in their neighborhood. The clusters in the case are rapidly dismissed after finishing information sending, and every node enter the sleeping state again in order to rescue the energy.

In paper [7], authors have given a distributed scheduling algorithm for video streaming over multichannel multi radio devices in wireless networks, aiming to save the QoS for every separate stream. Distributed scheduling algorithm don't want a CR for dynamic spectrum access as well as assumes which the set of given channels are always available to the nodes, i.e. fixed channels. Routing protocol in this does not include the energy metric in its routing decision as well as is therefore unsuitable for low-power devices.

3. Proposed System

A spectrum aware clustering based energy efficient multimedia (SCEEM) routing protocol for CRSNs which combinly solves the formidable issues of energy as well as spectrum. Given freamwork consist of number of clusters with cell edge cluster members also cell centre cluster members and with a cluster head. Cell edge members are placed at a long distance from cluster head but cell center members are close to cell head. All these clusters are communicated via base station which shares multimedia information through base station. For this communication frequency is assigned by cluster head to cluster members one at a time. Still there is a issue of equivalent frequency distribution from multiple members. Cell center members are closer to cluster head that's why they have immediate resource allocation also where same case is not happen with cell edge members due to wide distance. This is outcome into more waiting time for resource allocation to the cell edge members. This issue is solved by our system. The main goal of this system is to provide same amount of resource allocation in all cluster members for achieving the routing. This optimal clustering gives energy-efficient multimedia delivery with the desired QoS support and also helps to reduce delay with a higher delivery ratio.

The description of the system is as follows:

- Network Generation:

At start the network is created by utilizing the primary idea of graph, in that it has vertices that is nodes as well as edges. Nodes are linked with the edges.

- Clustering:

The procedure of clustering is done on the created network. The nodes are spilted in different clusters. Groups are created in which it has sevral nodes

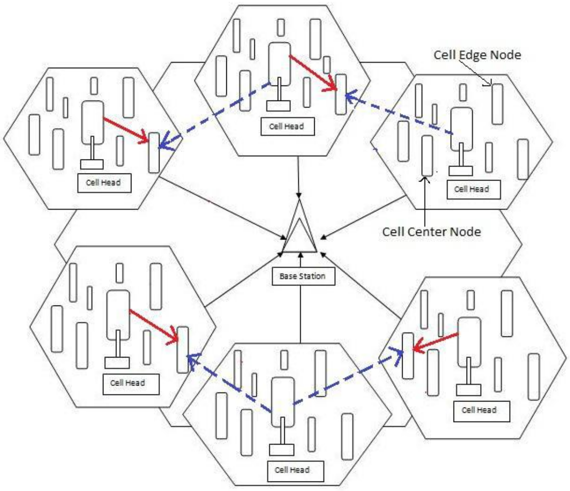

Figure 1: Architectural View

- Cluster Head Selection:
  For choosing the cluster head, energy spectrum rank of every node is calculated for every cluster. The node having highest energy spectrum value is selected as cluster head.

- Allocating Weighting Factor:
  In every cluster, cell center and cell edge user are recognized. Weighting factor is assign to every node depending on the node whether it is cell center and cell edge user.

- PRB Allocation Algorithm:
  PRB allocation algorithm is developedas well as SNR value is computed, the value is computed depending on the weight given to every node. PRB resource is given to the proper nodes.

- Send Data:
  At last the information is forworded to the base station from those node to which the resources have allocated.

4. Algorithm

Algorithm 1: Proposed Algorithm

1) Generate a network graph as Graph G(V, E) where V are vertices/nodes and E are edges.
2) Perform the clustering on the number of nodes and divide the nodes in to number of clusters.
3) Calculate the Energy Spectrum Rank at each node in each cluster.
4) On the basis of energy spectrum rank select the efficient Cluster Head.
5) Identify Cell Center as well as Cell Edge users.
6) Assign the weighting Factor to each node on the basis of whether it is Cell center or Cell Edge User.
7) Run the PRB Allocation Algorithm and calculate the SNR value with respect to weight given to each node.
8) Allocate the available PRB resource to the appropriate nodes.
9) Send the data to the base station from each node who have the resource.

Algorithm 2: PRB Allocation Algorithm-:

Input: G (V, E)
Output: $A^j M^j * N\ for\ j \epsilon J$
Initialization: $A^j M^j = 0, \forall j \epsilon J;$

For n=1 to N do % PRB loop
$k = 1;\ \Delta_k^n = v$
While $K \le J\ and \Delta_k^n \ne \emptyset\ do$
$m^* = argmax_{m \epsilon \Delta_k^n}(W_m SNR_m^n)$
$a_{mn}^{j*} = 1;$ j^* is the servicing cell of the user m^*
$R_{m*} = \emptyset$

5. Mathematical Model

1) Relative Energy Spectrum Rank-
   Consider System
   $S = \{N, C_m, C_h\}$
   $N\ \{j_1, j_2, j_3 \ldots j_n\}$
   $Cm\ \epsilon\ \{i_1, i_2, i_3 \ldots i_n\}$
   Ni =Set of neighbors of node i
   i(t) =Energy spectrum rank of node i
   ei =Energy of node i
   ek =Energy of node k
   $$Y_i^{(t)} = \sum_{j \epsilon N_i} Y^{ij}(t)\left[\frac{e_i}{max \forall k \epsilon N_i \{e_k\}}\right]$$
2) Physical Resource Block Allocation-
   A] User request to Base Station
   R ={r1,r2,r3}
   Where R = set of request
   And r1,r2,r3 are the number of requests.
   B] Check for user cell location
   L ={c1,c2,c3}
   Where L = Set for user cell location
   And c1,c2,c3 are the number cell location
   C] Channel Availability
   Ca={ca1, ca2, ca3}
   Where Ca = set of channel availability
   And ca1,ca2,ca3 are the number of channels available
   D] Greedy PRB allocation based on weighted SNR
   P ={p1, p2 ,p3}
   Where P = set of sub carriers
   And p1,p2,p3 are number of sub-carriers.

   Resource allocations: For a cell j where j ϵ J let$A^j_{M*N} = [a^j_{mn}]$
   and
   $P^j_{M*N} = [p^j_{mn}]$
   be PRB and power allocation matrices, respectively, with elements.a_{mn}^j andp_{mn}^j defined as-

$$a_{mn}^j = \begin{cases} 1 & if\ PRB\ n\ is\ allocated\ to\ user\ m \\ 0 & otherwise \end{cases} \ldots (1)$$

$$p_{mn}^j = \begin{cases} p \in (0, P_{max}) & if\ a_{mn}^j = 1 \\ 0, & otherwise \end{cases} \ldots (2)$$

6. Results

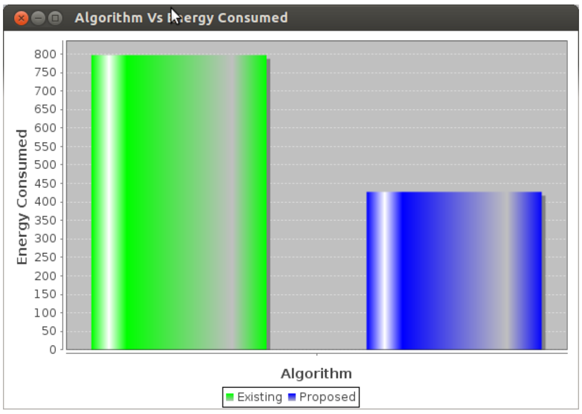

Figure 2: Energy graph

Figure 2 show the energy comparison graph which compares the energy utilized by the proposed system and existing system. Form graph we can say that the proposed system is preferable due to its low power consumption.

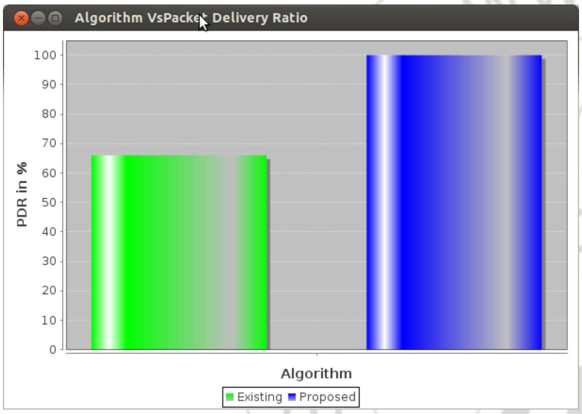

Figure 3: Packet delivery ratio

Figure 3 shows the graph which compares the packet delivery ratio of the proposed and existing system. Here from graph we can see the packet delivery ratio is increased in proposed system.

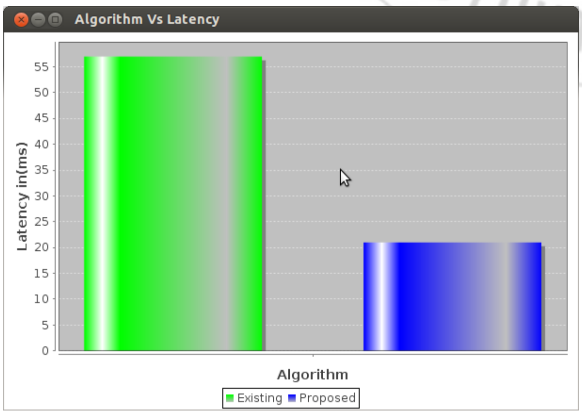

Figure 4: Latency graph

Figure 4 shows the latency graph in which we have compared the time to send the packet/data in the system. In the above graph the comparison of existing and proposed system is done and from figure we will see that the latency in proposed system is very less.

7. Conclusion

For radio resource allocation, the fine-scale PRB assignment algorithm is developed to effectively manage ICI as well as maximizing performance of the network in a centralized manner. The proposed system achieves significantly balanced performance improvement in cell-edge and cell-center users in multi-cell networks compared with other systems. Optimal clustering gives energy-efficient multimedia delivery with the desired quality of service that minimizes delay with a higher delivery ratio.

8. Future Enhancement

A noteworthy design for routing in CRNs is the coordinated effort amongst routing and spectrum decision. We explore the uncommon difficulties in routing protocols of CRNs from that we infer that there is a need of further research in the field of CRNs routing. In future we attempt to give the security to the system, for example, encrypting the information and after that sending information to the base station.

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