LOAD BALANCING CHANNEL CAPACITY FLOW ASSIGNMENT FOR DYNAMIC SPECTRUM ACCESS NETWORK

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ABSTRACT

Cognitive radio network (Dynamic Spectrum Access Network) is a network with a well-organized channel assignment scheme can to a great extent relieve the spectrum resource sharing. Unlike previous heuristic approaches, we accurately formulate the joint channel obligation and load occurrence problem. In this paper we proposed a novel cluster based load balancing channel capacity and flow assignment solution for our crisis with the intention of optimizing the whole dynamic spectrum access network (DSAN) throughput. Through simulation results we proved our proposed work has increased the DSAN performance than existing schemes.

Keywords: Access Point (AP), CA (Channel assignment) , CCFA (Channel Capacity Flow Assignment) , CRN (Cognitive radio network) , Dynamic Spectrum Access Network (DSAN).

I. INTRODUCTION

The rapid development of wireless devices has led to a dramatic increase in the need of spectrum access from wireless services. Taxonomy of channel assignment algorithms for spectrum access network is presented in as well. SAFE [20] scheme is introduced in which channel assignment is performed in a randomized and distributed manner, which maintains network connectivity and minimizes the channel assignment problem for routing.

In [21] authors study a Polynomial-Time Approximation Scheme (PTAS) to develop a channel assignment algorithm for a multi-channel CRN. In [22] authors evaluates a multi-hop cognitive network architecture that can be built using standard hardware by equipping each node with multiple interface cards operating on different channels.

The CR technology allows Secondary Users (SUs) to seek and utilize “spectrum holes” in a time and location-varying radio environment without causing harmful interference to Primary Users (PUs). This type of opportunistic use of the spectrum leads to new challenges to make the network protocols adaptive to the varying available spectrum. Specifically, one of the most significant functionalities of CR networks is spectrum migration. This enables SUs to change the operating frequencies based on the accessibility of the spectrum. CRN Nodes mobility pattern gives rise to a new type of handoff called spectrum deadlock, which refers to the process that when the current channel used by an SU is no longer available, the SU needs to break its on-going communication and find out a new available channel to prolong the transmission.

In this paper we propose a new load balancing spectrum allocation through clustering process. In order to validate the channel allocation in the mobility pattern we used bird flock mobility model for dynamic spectrum access network to analyze the accessibility of the spectrum. Two types of assignment are proposed in this . One is Channel assignment and second is Capacity & flow assignment.

II. RELATED WORK

Channel assignment, capacity assignment, flow assignment are studied for wireless networks [23] are representative study of various channel assignment problems. For ad-hoc networks [7], [8], [9] there are many clustering algorithms have been discussed. In ad-hoc networks, the major focus of clustering is to preserve connectivity (under static channel conditions) or to improve routing. For clustering in sensor networks [6], the special importance is given to longevity and coverage .Thus, none of this work takes into account the robustness as well as the channel availability in CRNs. In [10], the balance between the number of idle common channels within cluster and cluster size is considered and an algorithm is proposed which increases the number of common channels within clusters. But its drawback is that it doesn't take into account the connectivity between clusters. Cogmesh [2] gives a practical MAC protocol for clustering but it doesn't consider the set of common channels and sizes of clusters. Chen et al. proposed a cluster-based CSS scheme [11], to give better results in the cooperation overhead as well as the sensing reliability. This scheme can reduce the amount of direct cooperation with the fusion center but cannot reduce the communication overhead between CR users and the cluster head. One of the clustering schemes proposed in [12], in which the same problem is observed. Distributed coordination of CRs via locally computed control channel that changes in response to PR activity [13], was proposed by Zhao et al. in which, overhead of cluster management are reduced by minimizing the number of distinct frequency bands needed for control. For control in each neighborhood the band available to the largest set of one-hop neighbors is selected. Because of the variations in PR activity this results in re-clustering repeatedly. In [14], a clustering algorithm is proposed which is based on the conception of control cloud. In this a common channel is shared by CRs which is defined as control cloud. It make up a cluster and for decreasing the control overhead, the largest clusters are found. The main drawback of the scheme is that the architecture is not stable and re-clustering is easily caused by few mobility of CRs or little activity change of primary users (defined as ripple effect).In [15], the Max Node Degree clustering algorithm and the Lowest ID clustering algorithm [16] are discussed . But, main drawback of these two clustering algorithms is that, the heterogeneity of available channels is not considered in these two algorithms. Another multi-hop clustering scheme with load-balancing capabilities is Adaptive multi-hop clustering [17]. It is not capable to decide that which node is to be selected as the cluster head for the newly detached cluster.

III. SYSTEM MODEL

We propose a linear programming based load balancing algorithm for channel assignment. We define a novel metric called system utility, which take average throughput and average packet delay into description and include a parameter that can be used to accentuate one over the other. This paper has two part as : 1. channel scheduling and 2. capacity-flow scheduling. The two phases of the optimal CCFA algorithm are perform repeatedly to progress the system utility which allow designed for a swap between delay and throughput that can be achieve in a cognitive broadcasting network.

Usually when spectrum network needs to share multimedia resources, the multimedia resources are converted in to stream packets and streams are transmitted to receiver in the allocated channels. The channel allocation is dependent on the size of the multimedia resources. When source node wanted to share the spectrum resources to the receiver, depends upon the type of data the channel capacity and flow is allocated. The access point (AP) in the cluster is responsible for balancing the resource load and allocates the flow assignment.

This paper resembles the minimum channel allocation without the maximum amount of data lost. Based on the type of resource required. by secondary users the channel is allocated. The proposed cognitive cluster mechanism reduces the load across the dynamic spectrum access network (DSAN) and TDMA scheduling will add advantage to avoid spectrum collision.

1) *Mobility model and cluster formation*

The mobility pattern plays a vital role in network link maintenance. In this paper we are using bird flock mobility model for mobility pattern. In this mobility model the node's direction is chosen according to the bird flock behavior. This behavior is summarized as at each time step a host gets the list of its all neighborhood. From this list, the host has a tendency to select the one hop neighboring nodes. This tendency constitutes the new direction. In real flocks, a bird can move away from the group of various reasons like avoiding obstacles. To translate this we introduce a probability Φ. Thus at each time step the nodes is moved in the network according to the flock mobility model with a probability Φ. The mathematical expression for the mobility model is follows,

$$S = \{(c_i, c_j, z_r, \text{q}) \ \text{U} \ \{(c_i, \text{q}\} \qquad (1)$$

Where "s" is the finite state space, "c_i" is the current location occupied, "c_j" is the destination location, "z_r" is the speed and "q" is the indicator of node moving towards the target location.

Cluster formation plays a vital role in load balancing and increasing the network life time. In our work , the clusters are formed using the harmony search algorithm. It is expected to minimize the intra cluster distances between the clusters and optimize the energy distribution of the dynamic spectrum access network (DSAN). As it is reducing intra cluster distance between the clusters, a direct communication range among cluster members is formulated.

Algorithm – cluster formation

Repeat

Initialize k randomly distributes nodes

For i=1 to N do
    Calculate the distance d (node (i), node (j)) between all nodes of cluster
    Assign node to cluster c in which d (node (i), node (j)) belongs to direct transmission range
End for
    Compute the cost of cluster formation
    Form cluster with minimum distance

Stop

1) *Channel Assignment*

The main issue in channel allocation in dynamic spectrum access networks are connectivity, error minimization, and load balancing. One of the first works on channel allocation in spectrum system is the common channel assignment design in which the radios at each user are allocating the similar set of channels. Such a channel allocation conserves the system connectivity. But the advantage obtained is partial because of its static nature. This channel assignment algorithm first sort the access point of a cluster, based on the approximate traffic on diverse links. The mathematical derivation for channel allocation is as follows,

$$CA = \min \sum_{xi}^{xj} a_{ij}\, x_i r x_j r \qquad (2)$$

Where CA is channel assignment, "a_{ij}" is the number of channels assigned by the source "i" to the transmitter "j", "x_ir" is the resource transmitted by the source node to the receiver "x_jr". The equation (2) states that the channel allocation depends upon the size of the spectrum resources.

2) *Capacity and Flow Assignment (CFA)*

In the CFA problem, the system topology, channel allocation, and transmitter-receiver traffic load are well-known. The crisis is to allot link capacity and flow. We assume to facilitate around N channel and each one of AP (Access Point) can offer a capacity of C bps at the packet interface to which they are allocated. A suitable channel allocation to the entire radio interface at every node is assumed. The interfering constraint has to take into account the channel allocation at various nodes. Unlike the CA crisis both link capacity and flow are variables now. The target can be either to exploit the system throughput or to minimize the average network delay.

Initially, let us believe minimizing the average system delay as in the CA crisis. The common system delay is no longer a convex task of both link capacity and flow. Therefore, minimizing the traffic delay directly may not be possible. Hence we enclose to route to indirect method to decrease the average system delay. While the traffic in a dynamic spectrum access network (DSAN) is twisted headed for the gateways, it is expected that dead lock links will take place near the gateways as the system load is increased. To reduce the delay within an acceptable limit it is finest to switch the flows so that dead lock links are avoided. This can be completed by maximize the bare minimum lasting link capacity in the DSAN. This method results in a load balancing behaviour that minimizes the maximum link congestion in the network. We successfully used this technique in the channel allocation problem. However with both the link capacity and flow being variables in the CFA crisis. This approach might lead to improvement in network throughput for the reason that both flows and capacities on cluster links might be resulted in an effort to balance the load on different access point. The capacity and flow assignment are allocated on the basis of minimum path cost. The mathematical derivation for CF assignment is follows,

A capacity flow of network N is a function CF: E ->RR (resource routing). Capacity flow is feasible flow , it satisfies the following two conditions :

1. Capacity flow is depending on number of edges in between the source and destination.

$$\text{For every } e \in E,\ 0 \leq cf(e) \leq c(e) \quad (3)$$

For every v € V\ {i, j},

2. The flow assignment is done based on the 1-hop neighbor

$$\sum_{1-\text{hop neighbour } (i)} cf(e) = \sum_{1-\text{hop neighbour } (j)} cf(e) \quad (4)$$

The value of CF is defined as,

$$CF = \min \sum_{1-\text{hop neighbour } (i)} cf(e) \quad (5)$$

Where equation (3) represents the capacity assignment . The capacity is assigned based on the minimum edge cost (e) . The flow assignment is represented using equation (4) , based on the 1-hop neighbor the flow is assigned. Equation (5) represents the capacity flow assignment based on minimum path from transmitter to receiver.

Algorithm1: For Scheduling

```
For (i=0; i>2; i++)
{

Verify (user_id, receiver)
If (resource_id, receiver == type of resource)
  Enter to scheduling process
Else
   Do not have access to resources
}
```

Algorithm 2: Channel Allocation

// Resource allocation process

If $user1_{size\ of\ file} > user2_{size\ of\ file}$

```
{
    Allocate the resources with allocated channel to user1 in higher priority
Then      Simultaneously allocate the resources to user2 in second higher priority
}
Else
{
    Allocate resource with allocated channel to user2 in higher priority
  Then
      Allocate resource to user1 in second higher priority
}
```

IV. SIMULATION RESULTS

In this section, we discuss the simulation results of dynamic spectrum access network's (DSAN's) clustering method. The simulation set up uses the network area 2100*2110 meters, the mobility model used is the - bird flock mobility model. The no. of nodes - 49.avg. no. clusters = 6, initial energy level 100joules and simulation time =50 sec.

Totally 49 nodes are distributed to form a spectrum network, nodes are grouped to form a pair of three clusters. Each cluster has an around six nodes and each cluster has an access point (AP) and gateway node. All clusters are interconnected with access point and gateway node. Gateway node is act as an entry node for intra cluster communication and access point serves as accessing medium for capacity and flow allocation.

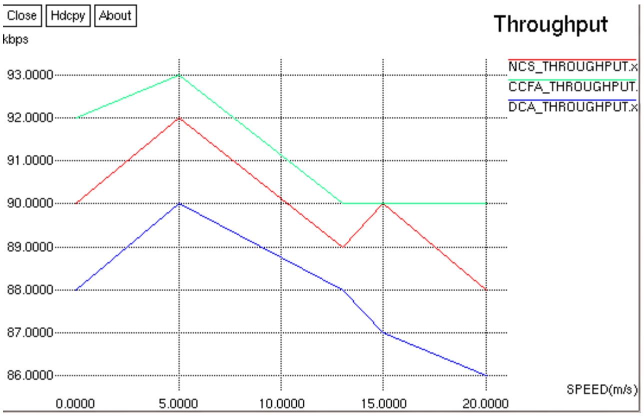

Fig. 2 – Throughput Analysis

The figure 2 represents the throughput performance of our proposed CCFA over existing NCS and DCA schemes with respect to speed. From the graphical analysis we observe the throughput rate of proposed system is higher than the existing systems.

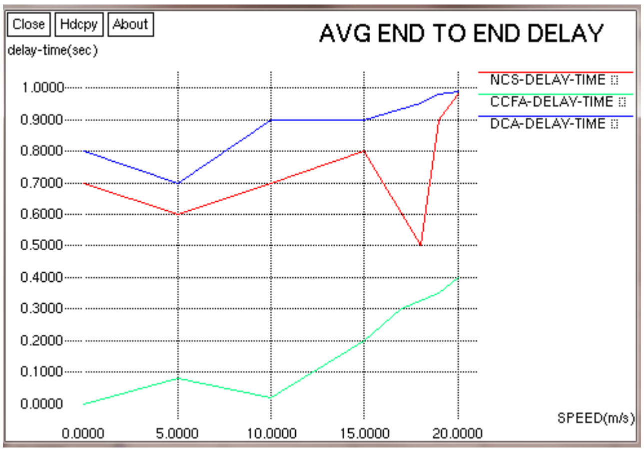

Fig. 3 - Delay Analysis

The figure 3 represents the average end to end delay analysis of our proposed CCFA over existing NCS and DCA schemes with respect to speed. From the graphical analysis we observe the end to end delay of proposed system is lower than the existing systems.

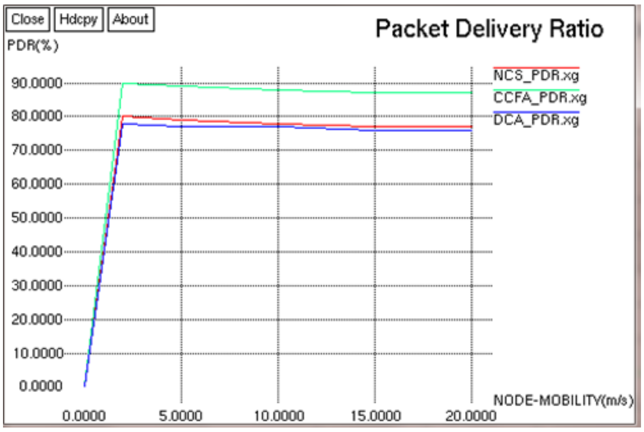

Fig. 4– PDR Analysis

The figure 4 represents the PDR (Packet deliver ratio) analysis of our proposed CCFA over existing NCS and DCA schemes with respect to speed. From the graphical analysis we observe the PDR of proposed system is higher than the existing systems.

V. CONCLUSION

In this we evaluated cluster based load balancing channel allocation schemes based on the resource allocation for dynamic spectrum access network (DSAN). The proposed work minimize the wastage of channels, which increases the DSAN performances and manages the system utility using TDMA in case of multiple users accessing the same resource at the same time. The simulation results proves that our research work is highly optable for dynamic spectrum access network (DSAN) for efficient resource sharing. Security issues are left for future research.

VI. REFERENCES

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