IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 17, Issue 4, Ver. II (July – Aug. 2015), PP 112-115
www.iosrjournals.org

Spectrum Scheduling using Markov Chain Model in Cognitive Radio Networks

[1]Dr. ArunKumar B R, [2]Reshma C R
Professor &HoD, BMSIT, Bengaluru & Ph.D Research Supervisor, VTU, RRC, Belagavi.
Asst. Prof., Dept. of MCA , BMSIT, Bengaluru & Ph.D Research Scholar, VTU, RRC, Belagavi.

Abstract: *Cognitive radio is an emerging technology for the effective frequency utilization. The fixed spectrum allocation has resulted in spectrum holes.The Cognitive Radio solves the problem for unused spectrum by the mechanism of spectrum assignment. This research work proposes an efficient spectrum assignmentby Markov scheduling, banker's algorithm for deadlock avoidance and applying the graph coloring problem for the fair allocation of resources.The CRN spectrum assignment problem is modeled using Bigraph and Markov analysis carried out has demonstrated to show the efficient scheduling and indicated the possible performance improvement in spectrum allocation/ scheduling in CRN.*

Keywords: *Cognitive Radios, Markov chain, scheduling, communication,bipartite, Bankers algorithm.*

I. Introduction

Cognitive radio networks (CRN) are the software defined radios which can change the transmitter parameter with its environment.The cognitive radios are capable of sensing the idle spectrum and associate the channel to the user. The cognitive radios are the intelligent to sense the spectrum. Primary users have higher priority access to the spectrum rather than secondary user.The functionalities of cognitive radio are spectrum sensing, sharing, management and mobility[1][8].

This research paper proposesK-connected bipartite CRN(K-connected CRN). A K-connected is a graph even if the removal of (K-1) vertices/ edges still the graph remains connected. The K-connected CRN is basically a bipartite with k-connectivity.The k-edge connected graph ensures that if removal of any edge , the graph remains still connected. WhereA and B are the two disjoint sets with A∪B=V, such that all the edges e connects to the vertices from A to B. A bipartite CRN is said to be k-connected if removal of any k-node, results in disconnected network [9]. An edge-1 connected indicates that if removal of any one edge the network remains connected.An edge-2 connected indicates that if removal of any one edge the network remains connected. An edge-3 connected indicates that if removal of any one edge the network remains connected.

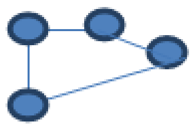

Figure 1: Edge-connected Graph

In a wireless network, the discrete time Markov chain can be used for scheduling. A Markov chain is a sequence of random variables X1, X2 with the Markov property, given that the present state, the past and future state are independent which discrete time Markov-chain (DTMC) [7]. It is defined as

$Pr(X_{n+1}=x| X_1=x_1, X_2=x_2 \ldots X_n=x_n)$

$Pr(X_{n+1}=x |X_n=x_n)$ if $pr(X_1=x_1 \ldots x\ n=x_n)>0$

The system is deterministic when it involves continuous time and chooses a random variable as a input to produce the output.A semi-Markovmodel was proposed for analysis of traffic in primary radio network. The semi-Markov consists ON state to indicate the channel is busy and OFF state for channel is idle [6]. The change in the behavior of spectrum is represented through state diagram, which indicates whether the frequency spectrum is ideal or busy. The change of state from one state to another is called the state transition. The spectrum is allocated based on scheduling. For spectrum allocation the mathematical model can be prescribed by representing the parameters in the form of matrix[1]. The resource allocation for the spectrum can be compared as similar in cloud. The process of assigning ideal spectrum to the users is called the resource allocation [2]. The allocation of spectrum can be modeled by Bankers algorithm.

There can be fair scheduling like max-min fair, throughput and proportionally fair scheduling amongst the available spectrum to allocate for the users[3]. In max-min scheduling, with the minimum number of available resources, the maximum number of users can utilize the resources due to the scarcity of spectrum. In proportionally fair scheduling, to maximize the sum algorithm of utility functions and assign to individual user which is inversely proportional to its resource consumption [4].

The paper is organized in the different sections. The section II describes the bipartite spectrum allocation for scheduling the spectrum. The section III explains the methodology of scheduling through the Marko chain rule. The section IV concludes the paper.

II. Spectrum Allocation using Bipartite Graph

A complete bipartite graph is a graph whose vertices can be partitioned into two subsets V1 and V2 such that no edge has both endpoints in the same subset, and every possible edge that could connect vertices in different subsets is part of the graph.

The graph is complete bipartite graph where all the users are assigned to the channels. But if the number of users requesting for the channel is more than the available channel then the channel has to be scheduled for efficient usage.

The k-connected bipartite CRN can improve the utilization of the spectrum efficiently.In the algorithm GOW, a 4-coloring is used to determine the link between the adjacent nodes, by considering the SINR[5]. Assume that let A be the set of channels and let B be the set of users(both PU and SU). Now based on priority based scheduling, the primary users can be allocated to the channels. When the channel is idle the secondary user can be allotted to the channel as shown in Figure 2.

2.1 Mathematical Approach

Let m be the number of the primary users and let n be the number of secondary users.

V be the set of vertices

E be the set of Edges

According to the bipartite graph definition G(v1, v2, E) the vertices are partitioned into v1 and v2.

|v1| =m |v2|=n

By the graph theory, it is denoted as Km,n.

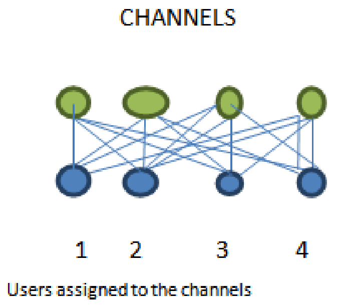

Figure2. Allocate the channels to the users [6]

The edge labeling is defined with a set of attributes. Here edge label denotes the channel and its attributes like channel capacity, signal-to-noise ratio, channel type. The edge labeling of CRNas shown in the Figure 3.

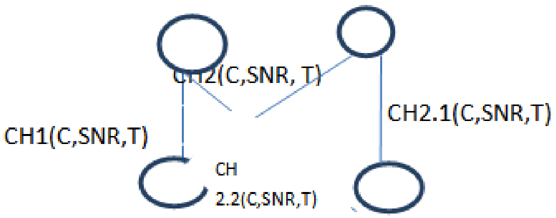

Figure 3: Edge labeling with attributes

The k-edge connected graphs are shown below in Figure 3.1

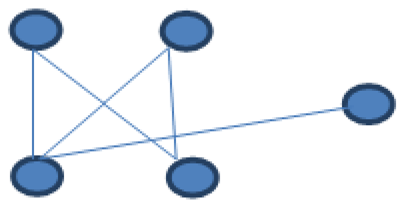

Figure3.1: 3-Edge Connected

The state information can be obtained from the channels, by using the Markov chain rule.The primary users who are not currently using the bands are identified through the Markov model which defines the state of the spectrum such that the spectrum can be scheduled for the next allocation to the user without causing deadlock.

Methodology of scheduling

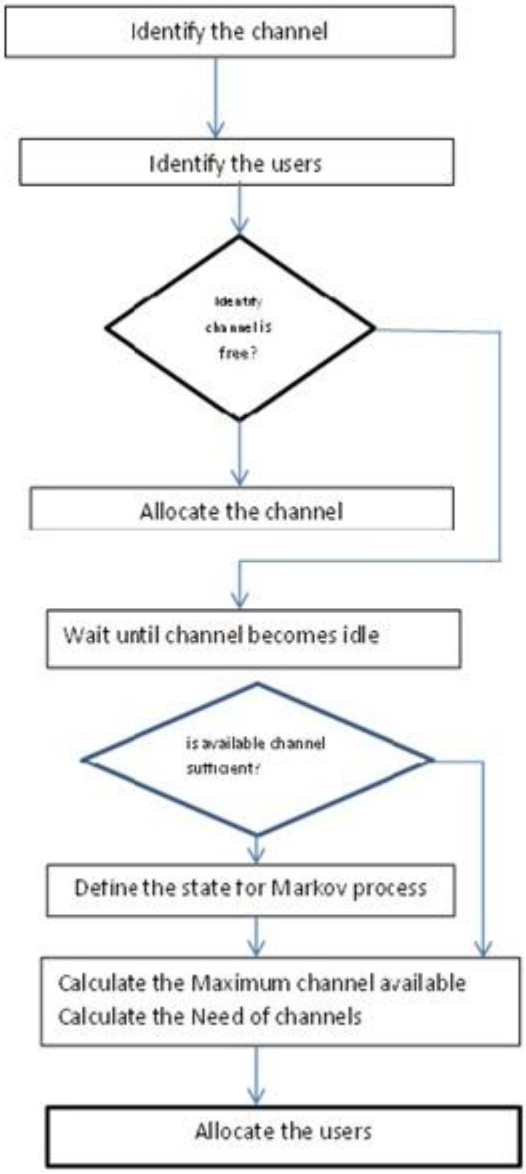

Figure 3: Markov channel allocation in CRN

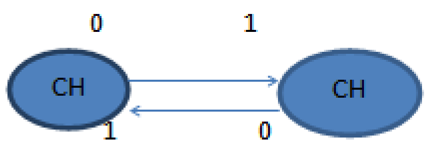

Figure 4. Change of channel state in Markov model

User	CH	State space
U1	1	1
U2	0	0

Figure 5: Channel state space inMarkov model

In the above Figure 4, it shows the state transition by applying Markov chain process. In the process, the state will change when the primary user doesn't use the channel; it changes from the state 1 to 0. When the secondary user's job has completed its communication the state changes from 0 to 1. Let c1,c2,c3….Ci be the channels, S={0,1} and Pr (Cn=j |C1=c1,…..Ci=ci) where i=1,2,3……n is the set of channels. The previous state will be 1 if the channel is allocated.
The state transition matrix Tp = a[i] [j], a[i][j]=1 ,
Tp=pr (Ci=0) if j=0; else Tp=Pr(Ci=1);

III. Banker's Algorithm

Dead-lock free is important for the allocation of the resources. The following assumptions are made 1) more number of frequency channels as resources 2)should not exceed the maximum resources. If the available resources are limited then spectrum can be shared by the cognitive users with limited transmission power so that it introduces interference and keeps below the threshold. The cognitive user can share the licensed bands when the primary user is not utilizing. This deadlock can be avoided by implementing the banker's algorithm. The spectrum can be allocated using the state information from the Markov channel allocation. The state space indicates the availability of the channel for the cognitive users.
Applying bankers algorithm for spectrum allocation
Let A be the set of channels and B set of users, according to the scheduling the user request for the channel, if all the available channels are allocated then the user will be in waiting state until the channel is realized.
Steps for the allocation of spectrum using banker's algorithm [10]

1. Let A be the array of channels, then A[j] = k, where k is the instances that are available for the channel allocation.
2. Define the matrix of the order n×m
3. Determine the total number of channels that are available by,
   Max[i] [j] =k, then Bi may request for the channel C j.
4. Allocate[i][j]=k
5. To allocate for next sequence the need can be evaluated as

Need[i][j]=Max[i][j]-Allocate[i][j]

IV. Conclusion

This paper investigates the modeling of channel allocation problem in CRN using K-connected bipartite graph. This research work introduces k-edge connected CRN which is used in the study of Channel allocation problem. Further, Markov chain is applied to theCRN spectrum allocation problem and model is analyzed. The allocation of spectrum is done by applying the banker's algorithm.

References

[1]. F Koropi, s.Talebi, H.Salehinejad " CRN Spectrum Allocation: An ACS perspective" ScientiaIranica.
[2]. V. Vinothia, Dr. R Sridaran dean, Dr. PadmavathiGanapati " A Survey on Resource Allocation Strtegies in cloud computing" IJACSA, vol3,No6,2012.
[3]. Didem Gozupekmordechai shalom, FatihAlagoz" A Graph Theortic Approach to scheduling Cognitive Radio Network,IEEE/ACM,2012.
[4]. Elias Z Targos, SheraliZeadlly, Alexandros G Fragkiadakis and vasilios " Spectrum Assignment in Cogitive Radio Network: A Comprehensive study" IEEE Communications surveys and tutorials.
[5]. D M Blough" Approximation algorithm for wireless link scheduling with SINR Band Interference, IEEE/ACM Transactions on Network December,2010.
[6]. Milan Bradonji, Loukas " Graph-based criteria for spectrum aware clustering in CRN, Adhoc Networks.
[7]. AlenndaKornad, Bar Y Zaho, Anthony D Joseph, Reiner Ludwig " A Markov-Based Channel model Algorithm for wireless Network".
[8]. GouthamGhosh, prasum Das and subhajitChatterjee " Simulation and analysis of Cognitive Radio system using Matlab" IJNGN, vol.6, June2014.
[9]. Dr. ArumKumar B R, LokanathaC Reddy, Prakash S Hiremath" Restoring the connectivity in k-connect MANET where all Edge disjoint is minimum spanning tree" IJCA, Mobile Ad-hoc Network 2010.
[10]. AbrahramSilberschatz, Peter Baer Galvin and Greg Gagme, "operating system and concepts" 8th edition.