A Survey on Cognitive Channel Resource Allocation Various Techniques

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Abstract— In order to utilize the frequency spectrum efficiently wireless communication system developed an advanced technology of Cognitive radio. As dynamic allocation of spectrum increase the demand of perfect utilization system. As the growth of the radio spectrum depends on how professionally these resources or spectrum are allocated. This paper gives an brief survey of various approaches of different researchers for resource allocation of cognitive network management. Here different basic techniques are also discussed in detail. So main goal is to discuss the fundamental concepts and relevant features of different radio resource management criteria.

Keywords— **Cognitive radio, genetic algorithms, power allocation, subcarrier pairing**.

I. Introduction

Due to the scarcity of spectrum and also the inefficiency of the regular spectrum usage manner, some insightful spectrum utilization schemes have been introduced to enhance spectrum usage potency [1]. A highly promising technique, authorized spectrum, transmission standards, intervention kept the temperature [3] as their tolerance to the primary users (PUs) as long as the modified access cognitive radio (CR) additional and secondary users (SUs) feeling attracted to radio spectrum environment and dynamically over recent years [2], Allows a very attention. Orthogonal frequency division multiplexing (OFDM system prerequisite to get CR) widely an attractive high performance air interface [4] due to its flexibility between radio resource allocation is identified in CR System. Resource allocation in OFDM-based wireless network (RA) is the most important one of the problems. A customized RA theme will have a maximum power output of OFDM system transmission at least or more users support quality of service (QoS) has been guaranteed. CR OFDM-based network, there are several analysis results but to improve system output. On the other hand, OFDM adaptive modulation technique to form a possible as its versatile ' spectral idle for a coexistence may fill gaps has been known as Thanksgiving. However, due to the non-orthogonality, introducing both the primary and secondary system transmit signals mutual interference and interference from all that does not exceed the total allowable limit subcarriers is important. This project work green wise potential interventions and quality of service (QoS) constraints primary (PUs) users, throughput and QoS constraints secondary power users (SUs) optimizes an energy efficiency down to cognitive radio (CR) system design is our goal. We consider that each have their own QoS needs its own statistical interference Pu on range. Spectrum sharing and all of these separately is pus range of knowledge of applied mathematics intervention. Broadcasting standards, such as different OFDM broadband wireless, digital video broadcasting (DVB), digital audio broadcasting (DAB), etc. several attractive options, such as exploits multipath delay spread tolerance, high spectral efficiency, frequency selective fading channels and cause immune to electrical power already has been posted. However, a broadcasting network is the most consumed of downlink transmitter within. Therefore, it is an energy-efficient broadcast transmission strategy style is very important.

Spectrum Management Functionality

Spectrum Sensing: Here unutilized spectrum of the channel can be detect for allotting this to other users while at the same time interference need to be maintained. So main goal of this step is to find the interference free bandwidth in the channel for SU allocation. Here special functions are utilize which analyze the bandwidth for getting free space.

Spectrum Decision: With the help of call model spectrum access can be done. Fine quality of the model depends upon the spectrum parameters. As multiple objective function leads to change the model, so choice get additionally advance.

Chemical analysis or Sharing: In order to estimate the quality of spectrum sensing results are analyzed. So the quality of sensing spectrum need to be live for the SU before it is being allocation. Here availability of the white space in the sensing spectrum and its quality is measure by the Signal/Noise Ratio (SNR), this help in characterization as well.

Spectrum quality or Handoff: For making the secure communication between the sender and user handoff is done time to time between the hops. This handoff leads to move the sender data to the more accurate or high quality channel of the network. This dynamic spectrum changes leads to switch the robust frequency of communication channel.

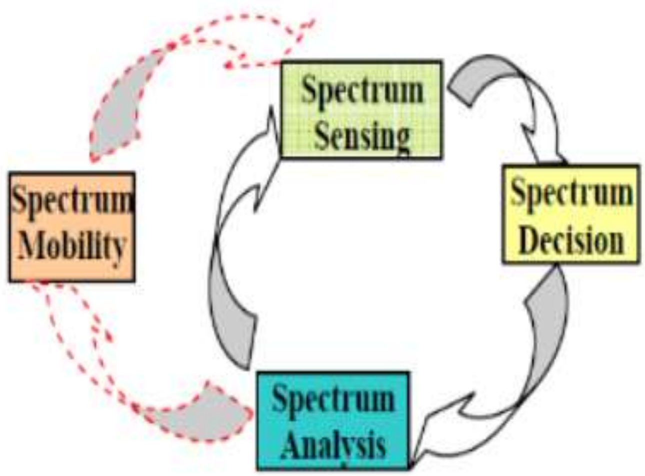

Figure 1: Illustration of spectrum management functionalities.

II. Related Work

ArunKumar and Reshma [4] have implemented a solution to spectrum allocation using Markov model, Banker's deadlock avoidance algorithm in combination with the graph coloring problem. This method has ensured fairly distributed spectrum allocation quickly and efficiently. Koroupi et al. [8] have approached the problem using the ACO technique. This method has worked well for dynamic networks, providing a fast and low-cost solution. The method has proved to be superior to the PSO approach as proposed in [9], but takes a slightly higher running time.

Zhao et al. [9] have designed spectrum allocation algorithms for cognitive radio using GA, Quantum GA and PSO. They have considered interference parameters applied on channel availabilities. These methods have displayed better performance than general graph coloring algorithms.

Liu et al. [10] developed the Maximal Independent Set algorithm to address this problem. This mechanism ensured a fair distribution of resources while requiring very less overhead on the network.

Pradhan [11] has applied GA, PSO and ABC in different modes of operation for allocating spectrum in a time-varying environment. Spectral interference is taken into consideration. The author finds better performance of ABC over PSO and GA.

Wang et al. [12] have developed a heuristic cost and connection based algorithm which performed spectrum allocation considering power control. The algorithm was found to show better performance than the existing Maximal Independent Set algorithm, both in terms of Quality of Services as well as the number of Satisfied Users, even on bad networks.

Liu et al. [13] proposed a technique using simulated annealing approach to determine the optimal spectrum assignment. This technique aims to optimize the cumulative utility under constraints of capacity, rate requirement and interference for various traffic classes. It performs better than the previous greedy migration method.

Ni et al. [14] used game theory for efficient and flexible spectrum assignment in cognitive radio networks. They have classified allocation problems into co-operative and non-cooperative models. Then they have identified the suitability of the various game theory models to the different kinds of spectrum allocation problems. This work serves as a guideline for selecting the best game theory model depending upon the problem in hand.

Hou et al. [15] have put forward a spectrum allocation method based on an improved GA. It aims to maximize the transfer rate of a system, under the constraints of error rate, power consumption and a fairness of spectrum distribution. It provides quite a noticeable improvement over the simple GA method.

Tang and Xin [16] have applied co-evolution chaotic PSO to maximize energy efficiency, under the constraints of interference power and total transmit power. Anandakumar and Umamaheswari [17] have performed efficient social cognitive handover using socially intelligent secondary users and integration of primary and secondary holes, by applying a SpecPSO technique.

Xu et al. [18] have targeted to maximize the average weighted sum rate of throughput, within the constraints of total power and probabilistic interference. They have applied a hybrid PSO (SVM+PSO) for effective optimization. In another work,

REN HAN et. al. [19] paper addresses the spectrum allocation problem with respect to both spectrum utilization and network throughput in the cognitive-radio-based IoT. On the one side, each link in a transmission path intends to improve the transmission performance on the assigned spectrum channel to maximize the end-to-end throughput. On the other side, these links share the same spectrum channel to concurrently transmit as much as possible to achieve the maximum spectrum utilization. In order to solve the problem, we propose a concurrent transmission model in the network which reveals the constraints of mutual interference and resource competition in links concurrent transmissions. Based on this model, we formulate the spectrum allocation plan for links as the chromosome (solution) in genetic algorithms. Then, we apply the nondominated sorting genetic algorithm-II to solve the multiobjective spectrum allocation problem.

Multi Objective Optimization In Cognitive Radio

Multi objective function has been considered to optimize the cognitive radio. The parameters has been decided in such a way that we use best user‟s output.

Minimization of bit error rate (B.E.R) BER is used to find the quality of each link in terms of number of bit errors per unit time. The information which are transmitted in the system contains less number of error due to this complexity of the system isreduced whileminimizing errors.

Maximization of throughput Throughput is another important optimization objective in certain objectives like multimedia and computer applications. Thus, throughput is total rate at which something can be produced. With this throughput after maximizing, the large of information are produced.

Minimization of power consumption The life of battery usage and power consumed are important factors for reducing power consumptions. The fitness function is obtained to optimize the minimization of power consumption.

Minimization of interference Interference is main problem occurred in CR due to the shared spectrum environments. Interference is main priority that secondary user‟s cannot collapse with primary user‟s while use in the system.

Maximization of spectral efficiency Spectral efficiency is the total amount of information that is transmitted over a given bandwidth.

III. Techniques of Channel Allocation

• **Greedy algorithms**: In greedy algorithms, the heuristic is developed in such a way that it selects whatever is currently or immediately the best next step, regardless of whether or not there could be some better steps later. Variants of the greedy algorithm are selective greedy and distributed greedy algorithms. In [13] have all employed greedy algorithms in obtaining solutions to their RA problems in CRN. Solutions provided are not usually optimal but they can be obtained at a reasonably good time.

• **Water-filling schemes**: Several water-filling heuristics (and its variants) have been developed to solve RA problems in CRN. The water-filling schemes developed from the idea of the water jug problem. Examples where these schemes have been employed in solving RA problems in CRN can be found in [14]. The methods are simple to develop and they give very close-to-optimal solutions with reduced complexities.

• **Genetic algorithms**: In this technique possible solutions are treated as the chromosomes and regularly updated for getting the set of chromosomes having high fitness values. In [15] similar kind of work was done which focus for optimizing the spectrum resource allocation. There are different types of genetic algorithm which can be used for solving these multi-objective problem. As number of possible solutions are quit large so evaluating all of them is not possible, so genetic algorithm come in existence. So these kind of algorithms are inclined towards the genetic approach of selecting the good solution than crossover and mutate for getting the better chromosome of same problem set. Examples are ant colony, particle swarm optimization, coco search, bee colony etc. In [17], authors used the PSO was finding the power allocation pairing between the transmitters and receivers of cognitive radio network. Some work utilizes the ant bee colony approach for finding the shortest path in the network as well.

• **Simulated annealing**: In this technique, basic concept was to make cyclic heating and cooling of the possible solutions set. An optimal temperature is obtained which act as the final solution of the algorithm. In [16] this simulated annealing approach was used for proper allocation of resources of wireless communication system.

IV. Classification of DSA Models

As shown in Figure 2 dynamic spectrum access strategies can be classified as dynamic exclusiveuse, open sharing model, and hierarchical access model.

Dynamic Exclusive

Use model The basic structure of the current spectrum regulation policy are maintained in this model: Spectrum bands are licensed to services for exclusive use. The main concept is to improve spectrum efficiency by introducing flexibility. Two approaches have been considered under this model [5]: i) Spectrum property rights and ii) dynamic spectrum allocation. Spectrum property rights approach allows licensees to sell and trade spectrum and to choose technology freely. Therefore, economy and market will play a more important role with the most profitable use of this limited resource. Dynamic spectrum allocation approach aims to improve the efficiency of spectrum through dynamic spectrum assignment by using the spatial and temporal traffic statistics of different services i.e., spectrum is allocated to services for exclusive use in a given region and at a given time.

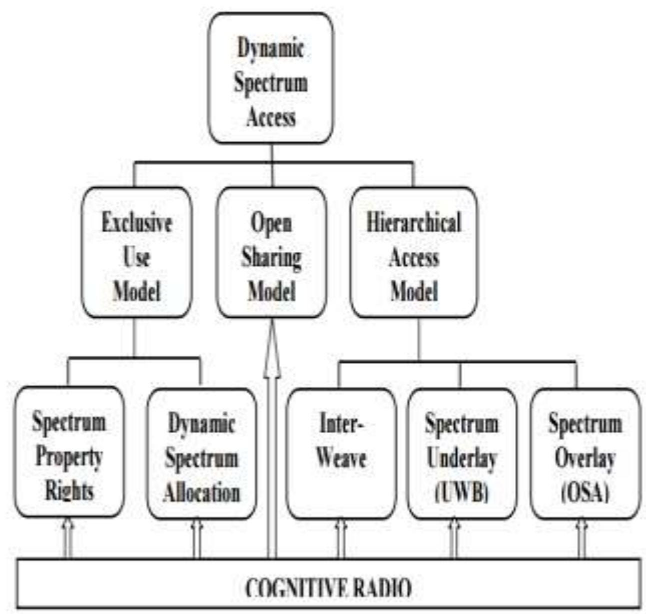

Figure 2. Dynamic Spectrum Access Models

Open Sharing Model

Open sharing model is also called spectrum commons model. In spectrum commons model, every user has equal rights to use the spectrum. This is also known as open spectrum model, has been successfully applied for wireless services which operates in the unlicensed industrial scientific and medical (ISM) radio band (e.g., WLAN). Open sharing among users as the foundation for managing a spectral region used by this model [12]. There are three types of spectrum commons model [9]: i) Uncontrolled- commons, ii) Managed-commons and iii) Private-commons.

Uncontrolled-commons: When a spectrum band is managed and uses the uncontrolled commons model, no entity has exclusive license to the spectrum band.

Managed-commons: Managed-commons represent an effort to avoid the tragedy of commons by imposing a limited form of structure of spectrum access. This is a resource which is owned or controlled by a group of individuals or entities and it is characterized by restrictions on when and how the resource is used.

Private-commons: The concept of Private Commons was introduced by FCC in its Second Report on the elimination of barriers to development of Secondary markets for spectrum [14]. This concept grew on allowing use of advanced technologies which enable multiple users to access the spectrum.

Hierarchical Access Model

In hierarchical access model, SUs use the primary resources such that the interference to the PU is limited. There are three approaches under this model [15]: Inter-weave, Underlay and Overlay. Inter-Weave: The inter-weave model is based on the idea of on opportunistic re-use the spectrum in the spatial domain i.e., the primary spectrum is utilized by CRs in the geographical areas where primary activity is absent. Exploitation of the so called “spatial spectrum holes” is attracting an interest, since many current licensed systems like, e.g., TV broadcasting and cellular systems. Figure 5 [15] shows where “CR 1” can ideally serve some of the SUs because no PU activity is present in its proximity.

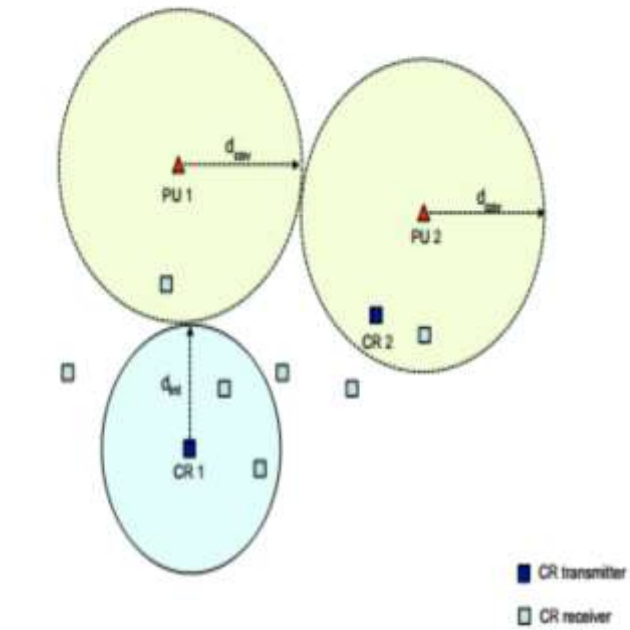

Figure 3 Exemplification of spectrum opportunities.

Underlay: Underlay technologies operate in the used spectrum at a very low power level for other licensed or license exempt uses but does not impair the users. Underlay use is not licensed [16]. Underlay access ideated CRs to operate below the noise floor of the PUs, involving an undercurrent of Cognitive Radio communications without PUs being aware of. Overlay: An overlay approach allows higher powers that could result interference to existing users but overcomes this possibility by only permitting transmissions at times or areas where the spectrum is currently unused [16].

V. Application

Leased network: The primary network can provide a leased network by allowing opportunistic right to use its licensed spectrum with the concurrence with a third party without compromising the service excellence of the main user. As the main network can rent its spectrum admittance right to a mobile virtual network operator (MVNO). Also the primary network can provide its spectrum access rights to a regional community for the purpose of broadband access.

Cognitive mesh network: Wireless mesh networks are emerging as a cost-effective technology for providing broadband connectivity. As the network density increases and the applications require large throughput, mesh networks require large capacity to meet the requirements of the applications. The cognitive radio technology enables the access to larger spectrum, CR networks can be used for mesh networks that will be deployed in dense urban areas with the possibility of significant contention.

Emergency network: Utilization of the wireless network is widly done for the public safety as well as for emergency networks. This can be understand as the natural disasters required temporary and quick arrangement of the communication system for the emergency handling. Here emergency need higly reliable network with minimum latency in the transferring data, of the users.

Military network: As military is one of the most important system which is higly depend on these woireless congnitive networks. As CR network allow to dynamically change the radio frequency, intermediate routes, modulation technies for the better communication and coding techniques for valurable radio network. So the security of the channel have strong requirement for communication in unfriendly environment.

VI. Conclusions

As CR network has resolved the various issues of the present limited wireless spectrum. Here paper has given the introduction of different techniques of resource management for wireless communication. In this survey inherent properties and current research issues of spectrum management in CR networks solved by different researchers were discussed. Here fundamental concept about cognitive radio characteristics, functions, network architecture and applications are presented. In the future it is highly desired that algorithm need to be developed which can efficiently utilize the available resources with minimum loss.

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