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A Survey on Dynamic Resource Allocation in MIMO Heterogeneous Cognitive Radio Networks based on Priority Scheduling

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***Abstract*— In cognitive radio networks (CRN) an intelligent spectrum allocation is an immense subjects because of its deficiency of spectrum demand. Resources in CRN would be allocated based on dynamic access methods with respected to sensed radio environment. A principal research trial is that how would be allocated or assigned presented unused spectrum to unlicensed users. In this paper we provide a comprehensive survey of dynamic resource allocation and priority scheduling in MIMO-CRN. The appropriate portion of unmoving recurrence range existing together intellectual radios while amplifying all out transmission capacity utilization what's more, reducing impedance is required for the dynamic range use in MIMO-CRN. The system for established extent segment came to achievement to less range utilization over the entire range. In this paper we presented the different approaches used for dynamic resource allocation and scheduling in heterogeneous MIMO-CRN.**

Keywords-Cognitive Radio; Dynamic Scheduling; Priority Queue; Heterogenetive Services, MIMO

I. INTRODUCTION

In modern centuries, the cognitive radio network is an emerging innovation. It gives an incredible arrangement and enhance the powerful range use by secondary users when primary users in idle [1]. Primary Users (PU) (licensed user) utilized authorized recurrence range for exceptional applications. For the most part, Secondary Users (SU) (unlicensed users) utilizes more spectrum usage contrasted with PU [2]. CR is a scholarly plan which would insight its surroundings and change range. And furthermore makes a shrewd correspondence framework like transmitting and accepting signs. CR distinguished what channel is being occupied or not and exchanged to unused channels. These strategies lessened impedance with different clients and make it best utilization of offered radio recurrence range. [3].

CR is an intelligent wireless communication system which should be sense their environment and dynamically adjust their communication signal, channel access method, effective use of spectrum, and required protocols for good network and application routine [1]. CR makes intellectual communication such as transmitting and receiving, and also recognized which channels are used and not and transfer to unused channels. This method minimizing interference with other users and make it best use of existing radio frequency band. We can formulate efficient utilization of the CR spectrum by allocate a secondary user (SU) to utilize a licensed frequency band when the primary user (PU) is absent [2]. So the detection of spectrum hole is significant as shown in Figure 1.

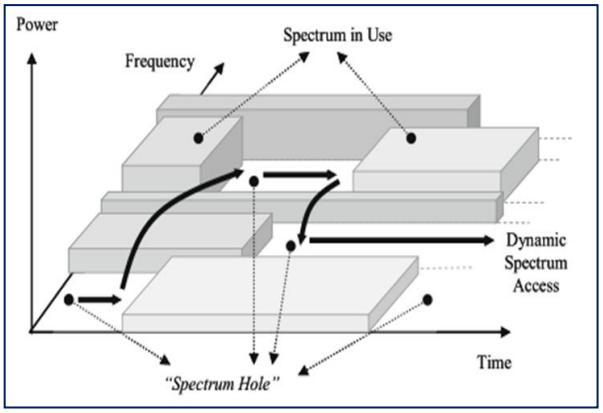

Figure 1. Spectrum hole technology[2]

In this paper, we presents as follows: Section I: Introduction, Section II: MIMO (Multi-Input Multi-Output), Section III comparative analysis and section: IV conclusion of this article.

II. MIMO (MULTI-INPUT MULTI-OUTPUT)

MIMO is an intelligent wireless communication system and makes the use of multiple transmitter and receiver antennas. MIMO system transmits multiple data on the same channel to increase the wireless data rate, transmission reliability and rang. MIMO has the advantages like independent and parallel communication with multiple channels [3].

MIMO-OFDM combines the advantages of both MIMO and OFDM features. MIMO combines multiple input multiple output technologies, which multiplies capacity by transmitting

different signals over multiple antennas, and OFDM (orthogonal frequency division multiplexing) splits a radio channel into a huge number of closely spaced sub-channels to deliver more reliable communication at great speed. MIMO-OFDM is a powerful combination because MIMO alone does not attempt to mitigate multipath transmission and OFDM avoids the need for signal equalization. MIMO-OFDM can achieve very high spectral efficiency in any given network of operation [3].

III. COMPARATIVE ANALYSIS

Years of Publication	Algorithm Used(Methodology)	Result
2014. [3]	Distributed Algorithm	Achieved significant improvement of the network throughput while reducing the delay. Future Work To develop a new algorithm for MIMO with CR to improve the network performance.
2016 [4]	Dynamic Resource Allocation Based Priority Scheduling (DRAPBS)	Achieved 26% of efficient network throughput with minimum delay. Future Work We can use DRAPBS algorithm with artificial intelligent and human like decision making qualities, to enhance the performance during handoff and channel accessing.
2016 [5]	Predictive Channel Sensing Algorithm with tailed PU OFF time distribution approach	Achieved significant reduction in channel switches and power consumption. if ON-OFF time distributions of the PUs are accurately modelled Future Work To develop CRN-MAC algorithm to improve the channel occupancy pattern of PUs and to get optimal network performance.
2016 [6]	Adaptive win-shift lose-randomize (WSLR) algorithm.	Maximizes the total network payoff and fairness among the Cognitive Nodes Reduced collision among Cognitive Nodes. Requires a small number of sensing methods to find a channel free of PU activity.
2016 [8]	Cognitive radio scheme based on quality of experience (QoE).	Improved the resource assignment in wireless communication.
2016 [9]	multi-user greedy algorithm	Achieved Complete utilization of spectrum bandwidth with minimum power along with maximum data rate. Future Work To develop an algorithm for multi-secondary user communication system and achieve significant network efficiency.
2016 [12]	Unique model to assign priorities to the secondary users based on the required Quality of Service and on the interference delay to minimize the switching of secondary users.	Achieved significant network throughput
2012 [13]	Distributed system for optimal resource allocation without exchanging spectrum dynamics information between remote nodes.	Maintained the network stability
[14]	Two level Stackelberg game model	Achieved better energy consumption.
2016 [15]	Efficient Resource Allocation algorithm is proposed.	They achieved successful data transmission between reliable nodes and good network performance. Future Work: To develop effective channel sensing and scheduling algorithm for heterogeneous MIMO-CRN.
2016 [16]	Proportional Fair Scheduling (PFS) based resource allocation. Fuzzy Logic Decision (FCD) model is used for selecting the transmit power level.	Proposed technique reduces the energy consumption and limit interface.
2016 [17]	Proposed Centralized algorithm to provide efficient transmission power for every secondary users in network. Proposed Dynamical system approach is used to model system behaviour in existing network. and also A forecasting engine based on deep neural network is proposed	Better transmission power allocation is achieved. Deep neural network can improved the performance by 46% on average. Each proposed solutions achieved an outstanding performance. Future Work To develop an algorithm to achieve best

		performance of entire network using machine learning techniques. Higher level of sophistication and self-adaptability technique will support to reduce the network complexity.
2016 [18]	Proposed benefit-fairness algorithm based on weighted-fair Queuing model.	Proposed algorithm provided the better efficiency and fairness at priority level. Future Work More pragmatic algorithm can be devised using several other combination of scheduling schemes like, Shortest Job First (SJF) with priority or SJF with weighted fair queue, or round-robin with SJF etc. Grouping of tasks can be done based on complexity of task, or group by location etc., before resource allocation.
2015 [19]	QoS-Aware Tethering in a Heterogeneous Wireless Network using LTE and TV White Spaces (QTHN) is proposed to improve QoS for Constant Bit Rate (CBR) and Best Effort (BE) users.	The proposed QTHN reduced the significant numbers of blocked users and improved to increase the overall heterogeneous network performance.
2016 [20]	Stackelberg game exploiting the cognitive radio (CR) technology is proposed.	The proposed method can significantly improve the throughput of victim licensed nodes with slightly decreasing network total throughput.
2016 [21]	Multi-channel learning-based distributed sensing fusion mechanism (MC-LDS) is proposed.	The proposed scheme provided outperforms IEEE 802.22 recommended algorithms, i.e., the AND, OR and VOTING rules. Furthermore, MC-LDS should be integrated to boost the sensing performance in other promising technologies and standards such as White-Fi (IEEE 802.11af WLANs) wireless personal area networks and ZigBee (IEEE 802.15 family), cognitive WiMAX (IEEE 802.16h) and the recent IEEE 1900.6b standard emerged to support spectrum databases using spectrum sensing information.
2016 [22]	They proposed analytical framework based on a pre-emptive repeat identical (PRI) M/G/1 queuing network model, which applicable for providing a service time distribution of both primary and secondary connections, multiple interruptions and transmission delay resulting from the appearance of primary connections.	Proposed system is achieved reasonable and optimal spectrum handoff strategy scheme achieved to maximize the energy efficiency during the whole data transmission process. And designing the admission control rule for the SU in cognitive radio networks.
2016 [23]	Prioritized channel allocation (PCA) scheme is proposed.	Achieved better throughput and fairness in supporting SU prioritized traffic. Future Work Improved modelling of DSA for prioritized traffic considering dynamic spectrum fragmentation/defragmentation and improved spatial channel reuse based on the geolocation of Sus will be conducted.
2016 [25]	They proposed game theory to achieve power transmission between nodes in the network.	Achieved significant power allocation and channel gain during data transmission.
2016 [26]	They proposed Resource Allocation with heterogeneity concept to improve optimal solution in CRN.	Achieved optimal solutions such as the average data rate, throughput, and outage probability. And also achieved the overall performance of the network. Future Work To develop heuristics that must reach even less computational complexity, particularly for greater networks.
2010 [27]	They proposed Discrete Time Markov Chain (DTMC) model	Improved sensing accuracy and better time-bandwidth. And also maximize the throughput over the network.
2016 [28]	Preferable Channel List (PCL) algorithm is proposed to achieve best channel selection scenario.	The proposed algorithm will provide higher throughput and collision free access by secondary users. The channel selection is done on common control channel using single transceiver radio.
2016 [29]	They proposed to assign the network resources based on	Resource allocation strategy performs

	the buffer sizes of the PUs and Sus in the uplink (UL) and downlink (DL) directions.	significantly better than other relevant resource allocation techniques.
2013 [30]	They proposed a dynamic spectrum handoff scheme with finite-size buffer queues	The buffer mechanism can improve the channel utilization considerably.
2016 [31]	They proposed queuing theory, markov chain and The matrix-analytic Method for calculating the Stationary probabilities of the network.	The proposed system achieved the performance of the system is satisfactory when primary and secondary users share the network. The system consumption is 94.35%, the average of the mean number of jobs in the system is 91, the mean waiting time of secondary users is 3.062 ms and the average of mean response time is 81.0 ms.
2012 [32]	Proposed a channel access scheduling scheme that differentiates the quality-of-service (QoS) by assigning priority values and provides a certain level of fairness by taking the queue waiting time into consideration.	The proposed scheme achieved the QoS differentiation among competing SNs while improving both the throughput and fairness performance in CRNs
2014 [33]	They proposed two queue buffered system at SUs to achieve significant throughput and overall performance of CRN.	The proposed system achieved great network throughput and fairness.
2015 [34]	They proposed routing and scheduling algorithm.	Proposed algorithm improved the throughput and delay performance by relaying packets through cable backhaul.
2015 [35]	They proposed orthogonal space-time block coding and distributed algorithm at the secondary users. Transmit antenna selection algorithm used for comparison purpose.	The proposed distributed algorithm provides a better improvement in the capacity performance of secondary users, thereby increasing the capacity of the system.
2014 [36]	They proposed Two-stage resource allocation scheme with combinatorial Auction and Stackelberg Game in spectrum Sharing (TAGS) algorithm.	The proposed scheme TAGS should be improved the utilities of primary spectrum owners, enhance the spectrum efficiency and provide economic incentives for all users to participate in spectrum sharing.
2013 [37]	proposed a Distributed Consensus Algorithm to address the problem of distributed CCC allocation in CRAHNs.	Achieved significant increase of network capacity and spectrum efficiency
2016 [38]	Proposed an algorithm to divide the design problem into three sub-problems, which can be solved using	Proposed algorithm minimized the average interference power between PU and SU.
	the convex optimization methods.	Future Work To study robust transceiver design in the system over frequency selective fading channel.
2015 [39]	Proposed a novel cooperative sensing scheme with attack-aware capability in the presence of a malicious primary user emulation attack (PUEA).	Achieved significant performance improvement.
2015 [40]	Proposed a discrete time Markov chain (DTMC) and semi-Markov chain (SMC).	The proposed models are verified through various simulations and achieved good network performance. Future Work Future studies in this research area could include: (1) obtaining a closed-form formula for the mean sending rate of CR collecting sensors; (2) proposing a rate-based congestion control scheme for cognitive radio networks, (3) investigating on the optimality of rate-based congestion control schemes in CRNs and (4) studying the possible impacts of CR user mobility on the sending rate distribution of source nodes.
2016 [41]	Proposed (1) a power-pricing model without game theory power-pricing model without game theory approach. (2) a non-cooperative game is applied to the proposed pricing model among the system users (i.e., PUs and SUs), to create balance between them. (3)Nash equilibrium algorithm.	Proposed algorithm has maintained balance between the different goals of users. provided better utilization of the channels.
2016 [42]	Proposed an eigenvalue based spectrum sensing technique with double threshold system.	Proposed system achieved better detection Performance under noise uncertainty conditions compared to existing conventional Methods in the network.
2013 [43]	They proposed evolutionary game framework Proposed an entropy based coalition formation algorithm.	The proposed scheme can guarantee the detection probability at a low false alarm rate. Future Work Intend to jointly study the two problems of which

		action to take and which channel to sense as a secondary user can want to decide which action to take based on the channel it desires to sense.
2012 [44]	A modified hybrid scheduling rule is proposed	Proposed algorithm achieved fairness, and the optimal growth rate for the secondary throughput.
2013 [45]	Proposed a very general scheduling model accomplishing goals such as making frequency, time slot, and data rate allocation to secondary users with possibly multiple antennas, in a heterogeneous multi-channel and multi-user scenario. And also propose a heuristic algorithm for our fair schedulers	The proposed system achieved a better performance in terms of both total throughput and fairness for varying number of secondary users, frequencies, antennas, and window size.
2013 [46]	Finite Rate of Innovation in a Cognitive Radio Network with centralized Spectrum Management based Spectrum Broker algorithm is proposed.	The proposed algorithm provides the collision probability are decreased by more than 90% by using the compressive sensing technique (FRI) Future Work To improve the performance in radio cognitive networks about different states and architectures. Cooperative and distributed architectures, are still of interest in this type of networks, but have limitations in terms of quality and speed of the signals involved, issues on which the compressed sensing can make significant contributions.
2013 [47]	They proposed the dual decomposition technique and The joint allocation of the resources in suboptimal low complexity algorithm.	The proposed system achieved a near-optimal performance with much less complexity. and network performance also improved because of deploying multiple antennas at the SUs.
2013 [48]	They proposed multi-SU resource allocation game with Nash bargaining solution (NBS) under the cognitive radio scenario (CR-MSU-NBS game, the energy efficient suboptimal resource allocation scheme for multi-SUs.	Proposed scheme achieved a good tradeoff between fairness and efficiency and outperforms the familiar distance-pairing schemes. Proposed NBS resource allocation scheme achieved a good performance in the system efficiency (33.4%) and fairness in the cognitive radio networks.
2012 [49]	They proposed the Stackelberg equilibrium algorithm to achieves an energy efficient resource allocation in heterogeneous CRN.	The proposed scheme should improve energy efficiency significantly in heterogeneous wireless networks.
2013 [50]	The proposed algorithm an efficient power distribution schemes and fast barrier method	The proposed algorithm might be achieved lower complexity and fairness.
2016 [51]	Adaptive Greedy Algorithm is proposed.	Achieved a good network performance.

IV. CONCLUSION

In this article we presented a comparative study and analysis of dynamic resource allocation in MIMO heterogeneous services in cognitive radio networks. In this literature survey we studied different technique used to achieve best performance over secondary networks, effective resource utilization, channel allocation throughput, delay; power consumption etc., each method provides better performance based on them approaches. In future we can develop an efficient priority scheduling and channel allocation algorithm for MIMO heterogeneous CRN to achieve a significant overall network performance like throughput, delay.

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