International Journal of Innovative Research in Technology and Management (IJIRTM), Volume-3, Issue-2, 2019
ISSN: 2581-3404 (Online)

Routing Mechanism for Cognitive Radio Wireless sensor Network: Survey and Discussion

Devesh Sarathe[1], Prof. Jitendra Mishra[2]
[1]M. Tech Scholar, Department of EC, PIES, Bhopal (India)
[2]Head & Professor, Department of EC, PIES, Bhopal (India)
[1]deveshsarathe18@gmail.com, [2]jitendra.mishra260@gmail.com

ABSTRACT
Cognitive radio networks (CRNs) have emerged as a paradigm addressing the problem of limited spectrum availability and the spectrum underutilization in wireless networks by opportunistically exploiting portions of the unused spectrum by licensed primary users (PUs). Routing in CRNs is a challenging problem due to the PU activities and mobility that are beyond the control of CRNs. On the other hand, energy aware routing is very important in energy-constraint CRNs. In this article we present the comparative study for the cognitive radio sensor network for the ad-hoc network and their application and routing protocol.

Keywords:. Cognitive Radio Networks, Primary Users, Secondary Users, Dynamic Spectrum Access.

INTRODUCTION
Ad hoc networks are made up of an autonomous system of mobile devices which act as both hosts and routers [2]. This permits the mobile devices to interconnect one another through multi-hops without a predefined communication. Ad hoc networks may support different wireless standards, the present state-of the-art remains to be mostly limited to their operations in the 900 MHz and the 2.4 GHz industrial, scientific and medical (ISM) bands. With exponentially growing growth of wireless devices, these bands are increasingly getting congested. Simultaneously, there are lots of frequency bands licensed to operators, for example in the 400–700 MHz range, that are used sporadically or under-utilized for transmission. The FCC has recently approved the usage of unlicensed devices in licensed bands. Consequently, dynamic spectrum access (DSA) techniques are proposed to solve these current spectrum inefficiency problems.

Cognitive Radio Networks (CRNs) present a promising solution for spectrum scarcity in wireless networks to cope with the ever-increasing demand for higher bandwidth in mobile communications [1]. In CRNs, unlicensed secondary users (SUs) opportunistically utilize vacant portions of the spectrum without interfering with licensed primary users (PUs). This promises a large set of potential applications, given the scarcity of the unlicensed wireless spectrum, including distributed mobile applications for high-demand and highly-crowded scenarios such as the Internet of Things, high-quality mobile video, and disaster or emergency response settings.

Energy-efficiency is generally required to extend the lifetime of the network. These schemes are highly desirable for Cognitive radio sensor networks since the sensor nodes in Cognitive radio sensor networks have limited power supply capability. However, these schemes are focused on energy conservation and energy minimization and cannot achieve maximum performance. Energy-efficiency is very important for energy-limited sensor nodes and is therefore desirable for all types of application of Cognitive radio sensor networks. However, there are certain applications where replenishing the battery of sensor nodes may be inconvenient e.g., underground mines monitoring, forests fire detection, situation management in disaster affected areas, etc. In this type of applications, the energy-efficient schemes should be used to achieve energy efficiency and prolong the sensors as well as the network lifetime [10].

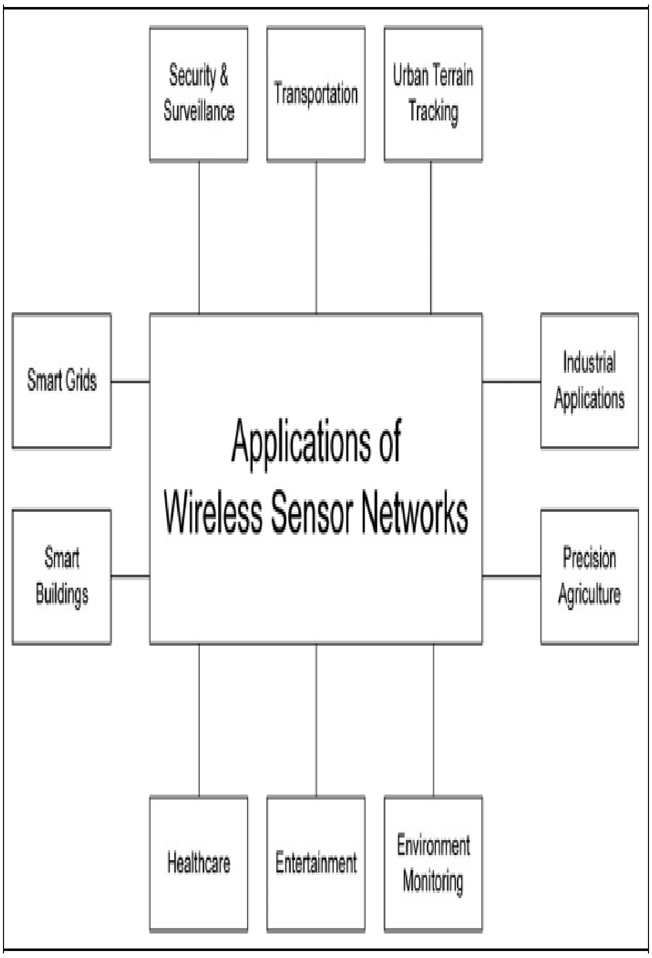

Figure 1: Applications of wireless sensor networks [9].

In CR networks, there are two types of devices. Namely, primary user (PU or licensed user) and secondary user (SU). The PUs are legacy users who own licensed channels (LC), but do not fully utilize it. The UHF TV and public safety broadcast stations are examples of LC. The SUs are next-generation CR devices who opportunistically exploit locally unused LC without disrupting operations of PUs. This scheme is often referred to as opportunistic spectrum access (OSA). The SU must vacate the channel as soon as the PU reappears, which leads to the forced termination of the SU connection.

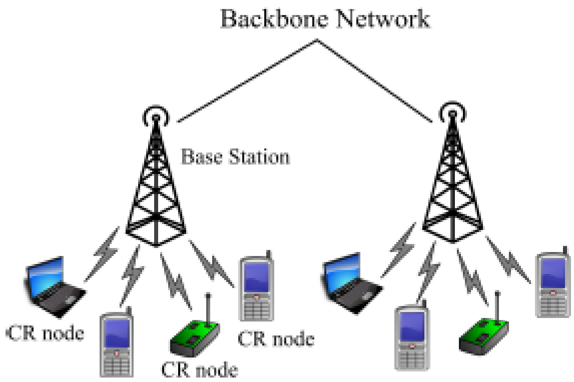

Figure 2: Architecture of infrastructure based Cognitive Radio Network [4].

Cognitive Radio Networks (CRN) has evolved to solve the fixed spectrum assignment problem by dynamically assigning spectrum to secondary users. There are two types of users in CRNs: Primary Users (PUs) and Secondary Users (SUs). PUs are licensed users which can utilize available spectrum at any instance of their licensed time. SUs are unlicensed users which can utilize spectrum only when PUs are not utilizing the spectrum band. By dynamic utilization of spectrum band by SUs, the efficiency of CRN increases and spectrum scarcity problem gets reduced [4].

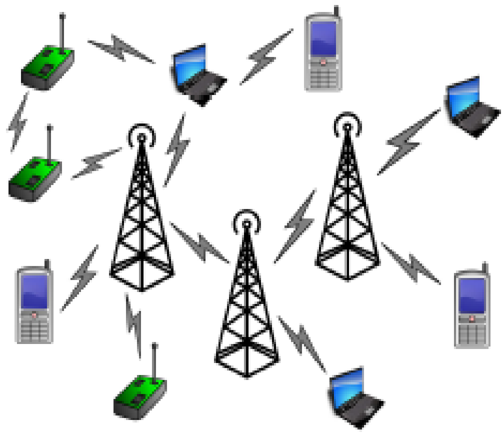

Figure 3: Hybrid based Cognitive Radio Network [4].

In order to use the Cognitive Radio (CR) in practice, many challenges need to be considered. Since one of the biggest goals is ensuring the integrity of the PU transmissions, all components of the CR cycle are developed such that this goal is attained [6]. For example, various spectrum sensing and sharing techniques have been developed, each with varying levels of complexity and efficiency [7]. In addition, different spectrum management policies have been envisioned which are better suited for different CR scenarios. For example, an overlay access policy allows a SU to access a spectrum only if a PU is not detected. In contrast, an underlay access policy would allow the co-existence of PU and SU transmissions provided that the level of interference incurred at the PU is not excessive [5].

Evolutionary or heuristic algorithms are bio-inspired solutions that follow the natural behavior of living systems. These solutions are widely adopted in many fields owing to their flexibility, proficiency, and robustness, to solve optimization problems where a number of constraints are significant, and search space is enormous that makes them very challenging for conventional computing techniques.

The rest of this paper is organized as follows in the first section we describe an introduction of about the cognitive radio network and their application. In section II we discuss about the Spectrum Allocation, In section III we discuss about the Spectrum Sensing, In section IV we discuss about the rich literature survey, finally in section V we conclude the about our paper.

II SPECTRUM ALLOCATION

Spectrum allocation strategy should be efficient, because without efficient spectrum allocation the routing protocol cannot perform well [4]. Every single node identifies the best possible spectrum band, as well as the favored channels inside of that band during spectrum allocation phase. To enable this, we use the proposed accumulative EBP metric combined with the number of hop count form source to destination. Based on the gathered sensing information, the spectrum allocation data structures, residing in each node (i.e. SU), make an adaptive decision on the order of operating LCs according to the activities of PUs in its vicinity. Where each SU is equipped with data structures called Free Hopping Channel List (FHCL). The FHCL data structure is used to record the list of all idle LCs and UCs list order. FHCL is predefined sequences used by each SU to determine the order in which the free LCs and UCs are to be visited in the case of suddenly appearance of the PU. This step can be done by applying the reactive channel selection strategy is used [2]. In this strategy, SUs monitors the spectrum for PU activity and whenever PU activity is detected, this information is passed to other SUs and then SUs switch to another available LC or UC according to the sequences defined in the FHCL data structure. The UCs are randomly ordered and visited after visiting all the LCs order list. The data structure for the FLCH at each node can be described as follows: FLCH(i).type denotes the channel type, where its value is set to 1 for LC and 2 for UC. FLCH(i).priority denotes the priority of the idle LC i. FLCH(i). Sub-priority denotes the priority of the LC i within the LCs set with same EBP values. The visited orders of the free LCs with the same priority are selected based on the sub-priority value. The priority of each LC is assigned based on the proposed EBP metric.

III SPECTRUM SENSING

To take advantage of spectrum sensing in the SCSN, an efficient solution is needed considering both sensor network resource limitations and DSA network challenges. Considering the high numbers of sensor nodes in large-scale smart grid systems and low-cost requirements, it may not be feasible to equip sensor nodes with multiple radios and highly capable processors. Therefore, sophisticated spectrum sensing algorithms cannot be used. Spectrum sensing should be performed with limited node hardware, possibly using a single radio. Assuming that deployed sensor nodes in smart grid environments have single radios due to their scalability and low-cost requirements, sensing durations should be minimized as much as possible with the consideration of possible transmission activities and energy efficiency.

There are various spectrum sensing methods, such as energy detection, feature detection, matched filter, and interference temperature. Incorporating of one (or hybrid) of these techniques, detection of dynamically changing noise components in smart grid, and modeling of their interference with respect to time and space can be achieved. Overall, the benefits of DSA, such as lower packet collisions due to the capability of switching to the best available channel, less contention delay and more bandwidth, come with the additional energy consumption caused by spectrum sensing and distribution of these sensing results. The tradeoff between energy efficiency and sensing accuracy is should be addressed and a detailed analysis of cost vs. benefits for a specific smart grid environment should be performed [6].

III RELATED WORK

[1] In this paper they propose a primary user-aware k-hop routing scheme where k is the discovery radius. This scheme can be plugged into any CRN routing protocol to adapt, in real time, to network dynamics like the number and activity of primary users. The aim of this scheme is to cover the gap between local and global routing protocols for CRNs. It is based on balancing the routing overhead and the route optimality, in terms of primary users avoidance, according to a user-defined utility function. They analytically derive the optimal discovery radius (k) that achieves this target. Evaluations on NS2 with a side-by-side comparison with traditional CRNs protocols show that our scheme can achieve the user defined balance between the route optimality, which in turn reflected on throughput and packet delivery ratio, and the routing overhead in real time. [2] In this paper they propose a heterogeneous cognitive radio routing protocol (HCR) operates in heterogeneous environment (i.e. the route from source to destination utilize the licensed and unlicensed spectrum bands). The proposed routing protocol is carefully developed to make a tradeoff between the channel diversity of the routing path along with the CRMANETs throughput. Using simulations, they discuss the performance of the proposed HCR routing protocol and compare it with the AODV routing protocol using a discrete-event simulation which we developed using JAVA platform. [3] In this paper author proposed an energy aware multipath on-demand routing protocol for multi-hop CRANs. They have studied the impact of number of flows and number of PUs activities on the operation of the proposed routing protocol. The proposed EOMR protocol combines the integration of spectrum and route discovery to establish communications across areas of spectrum heterogeneity. The dynamical traffic assignment is performed according to the traffic arrival rate, and spectrum availability to minimize the end-to-end overall delay performance in multipath CRANs. In addition, the EOMR scheme can efficiently increase the data transmission rate and thus improve the average network throughput. [4] In this Paper they provide a comprehensive survey of network coding schemes in cognitive radio networks, highlighting the motivations for and the applications of network coding in CRNs. They provide typical case studies of network coding schemes in CRNs, as well as the taxonomy of network coding schemes in CRNs. Finally, they present open issues, challenges, and future research directions related with network coding in cognitive radio networks. Compared to previous survey articles, their survey presents a comprehensive overview of network coding schemes in cognitive radio networks. Despite the existence of extensive survey literature, that literature has either been focused on separate investigations on cognitive radio networks or on network coding. [5] In this paper they propose Undercover: a multi-hop routing protocol for cognitive radio networks in which we integrate the collaborative beamforming technique with layer 3 routing. Specifically, their protocol revisits a fundamental assumption taken by the state of the art routing protocols designed for overlay cognitive radio networks; this assumption is that secondary users cannot use the spectrum when primary users are using it. In Undercover, they allow a group of secondary users, each with a single antenna, to collaborate together and transmit in the regions of primary users activity. This is done through nulling out transmission at primary receivers via beamforming. Moreover, Undercover is designed to enhance the transmission quality at

the secondary destinations whenever possible. To account for the excessive levels of interference typically incurred due to cooperative transmissions, they allow their protocol to be interference-aware. [6] In this article, spectrum aware and cognitive sensor networks (SCSNs) are proposed to overcome spatio-temporally varying spectrum characteristics and harsh environmental conditions for WSN based smart grid applications. Specifically, potential advantages, application areas, and protocol design principles of SCSN are introduced. The existing communication protocols and algorithms devised for dynamic spectrum management networks and WSNs are discussed along with the open research issues for the fulfillment of SCSNs. A case study is also presented to reveal the reliable transport performance in SCSNs for different smart grid environments. Lastly, different energy harvesting techniques for SCSN-based smart grid applications are reviewed. [7] In this paper, they present a comprehensive survey of WMCRNs. Various multimedia applications supported by CRNs, and various CR based wireless networks are surveyed. They highlight the routing and link layer protocols used for WMCRNs. They cover the quality-of-experience (QoE) design and security requirements for transmitting multimedia content over CRNs. They provide an in-depth study of white space, TV white space, and cross-layer designs that have been used for WMCRNs. They also survey the major spectrum sensing approaches used for the communications of bandwidth hungry and time-critical data over CRNs. [8] In this paper, they propose a clustering-based approach to deal with channel allocation ((CA)) problem among SUs considering practical constraints in SG environment. They first present a simple CR based SG communication network architecture by dividing the service area into groups of SUs called neighborhood area network clusters, depending upon the distance of Smart Meters from data concentrator unit. Then we formulate a multiple constraint NP-hard CA problem using interference avoidance strategy by considering two practical scenarios: fairness-based allocation and priority-based allocation. They then propose our CA algorithm based on cat swarm optimization to eliminate the severe integer constraints of the problem under consideration. They simulate the two above-mentioned practical scenarios to measure a number of allocations per SU, Jain's Fairness Index and per user average rewards. [11] This research work aims to propose a bio-inspired routing protocol inspired from characteristics from wolves to reduce the overall end-to-end delay which results in reducing the consumption of energy and extends the lifetime of the network. This research work utilizes M/G/1 queueing model to avoid network congestion, where the requests from nodes are markovian and service times regarding the requests have general distribution time. With benchmark performance metrics NS2 simulations are carried out to check the performance of the proposed protocols. Results conclude that the proposed protocol significantly outperforms than other protocols with better packet delivery ratio, reduced end-to-end latency and energy consumption.

V CONCLUSIONS

CRNs have the capability to support both real-time and non-real-time traffic. Due to the dynamic nature of CRNs, transmitting multimedia content over CRNs is a challenging task. To support the delay-sensitive and time-critical data transmission in CRNs, various advances in architecture, communications protocols, spectrum sensing techniques, and interference mitigation approaches have been made. The goal of this article to present the case study for the various routing mechanism and their application for the cognitive radio ad-hoc network.

REFERENCES:-

[1] Arsany Guirguis, Fadel Digham, Karim G. Seddik, Mohamed Ibrahim, Khaled A. Harras, Moustafa Youssef, “Primary User-Aware Optimal Discovery Routing for Cognitive Radio Networks”, IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 18, NO. 1, JANUARY 2019, pp 193-206.

[2] Hassan Al-Mahdi, Yasser Fouad, “Design and analysis of routing protocol for cognitive radio ad hoc networks in heterogeneous environment”,

International Journal of Electrical and Computer Engineering, Vol. 9, 2019, pp. 341-351.

[3] S. M. Kamruzzaman, Xavier Fernando, Mohammad Jaseemuddin, "Energy Aware Multipath Routing Protocol for Cognitive Radio Ad Hoc Networks", International Journal of Communication Networks and Information Security, Vol. 8, No. 3, December 2016, pp 187-197.

[4] Ayesha Naeem, Mubashir Husain Rehmani, Yasir Saleem, Imran Rashid, Noel Crespi, "Network Coding in Cognitive Radio Networks: A Comprehensive Survey", IEEE 2016, pp 1-29.

[5] Guirguis, A., Karmoose, M., Habak, K., El-Nainay, M., Youssef, M., "Cooperation-based multi-hop routing protocol for cognitive radio networks", Journal of Network and Computer Applications, 2018, pp 1-19.

[6] A. Ozan Bicen and Ozgur B. Akan, V. Cagri Gungor, "Spectrum-Aware and Cognitive Sensor Networks for Smart Grid Applications", IEEE Communications Magazine, IEEE 2012, pp 158-165.

[7] Muhammad Amjad, Mubashir Husain Rehmani, Shiwen Mao, "Wireless Multimedia Cognitive Radio Networks: A Comprehensive Survey", IEEE, 2017, pp 1-49.

[8] SHERAZ ALAM, AQDAS NAVEED MALIK, IJAZ MANSOOR QURESHI, SAJJAD A. GHAURI, MUBASHAR SARFRAZ, "Clustering-Based Channel Allocation Scheme for Neighborhood Area Network in a Cognitive Radio Based Smart Grid Communication", IEEE access 2018, pp 25773-25784.

[9] Rahat Ali Khan, Al-Sakib Khan Pathan, "The state-of-the-art wireless body area sensor networks: A survey", International Journal of Distributed Sensor Networks 2018, pp 1-23.

[10] Manoj Ramamoorthy, " Sensing in Cognitive Radio Networks: A survey", Technical Report, December 2017, pp 2-12.

[11] Ramkumar Jaganathan, Vadivel Ramasamy, " Performance Modeling of Bio-Inspired Routing Protocols in Cognitive Radio Ad Hoc Network to Reduce End-to-End Delay", International Journal of Intelligent Engineering and Systems, Vol.12, No.1, 2019, pp 221-231.

Devesh Sarathe received his Bachelor`s degree in Electronics & Tele Comunication Engineering from SDIST, Kahndwa, M.P., in 2012. Currently he is pursuing Master of Technology Degree in Electronics & Comunication (Digital communication) from PIES, (RGPV), Bhopal, Madhya Pradesh India. His research area include Wireless Networks.

Mr. Jitendra Kumar Mishra he is Associate Professor and Head of the Department of Electronics and communication in PIES, Bhopal (RGPV). His received Master of Technology and Bachelor's of engineering respectively in Digital communication from BUIT, Bhopal and from RGPV, Bhopal. He has more than 11 years of teaching experience and publish 35+ papers in International journals, conferences etc. His area of Interests are Antenna & Wave Propagation, Digital Signal Processing, Ad-hoc network, Wireless Communication, Image Processing etc.