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A NOTE ON: COGNITIVE RADIO ISSUES, CHALLENGES AND APPLICATIONS

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ABSTRACT

A cognitive radio wireless sensor networks is one of the candidate areas where cognitive techniques can be used for spectrum access. Current research in this area is still in its early stage, but now it is evolving rapidly. The aim of this research study is to classify the pros of the fast emerging appliance area of cognitive radio networks and to highlights the key research that has already been undertaken and indicates the open problems. This paper describes the benefits of cognitive radio wireless sensor networks, application areas of cognitive radio wireless sensor networks and current research trends in cognitive radio wireless sensor network. The CRS need for the resource utilization in the leased networks, Military, CR Mesh Networks, Multimedia networks, Cellular Networks and Emergency Networks. For the resourceful utilization of the limited spectra, CRS plays an important role, which has a capability to adapt its parameter and protocol as per the nearby environment and from its past experience. Grounded on software defined radio technology, its main motive is to provide additional flexibility and improved effectiveness in overall spectrum deployment. But the design and execution part suffers from many issues and challenges. Some key research issues and challenges are pointed out in this research article. Especially achievement challenges in Cognitive Radio (CR) focusing on RF front-end, transceiver, A/D and D/A interfaces which still act as blockade in CRS development.

KEYWORDS: Cognitive Radio, Issues and Challenges, Spectrum Sensing, Spectrum Management, Security.

1. INTRODUCTION

Cognitive radio is a type of wireless communication in which a transceiver can cleverly detect which communication channels are in use and which are not and right away move into vacant channels by avoiding occupied ones. This optimizes the use of available Radio-Frequency range while minimize the interference to other users. In its basic form, CR is a hybrid technology concerning Software Defined Radio as applied to spread spectrum communications and probable functions of cognitive radio include the capability of a transceiver to resolve its geographic location, identify and authorize its user encrypt or decrypt signals, sense nearby wireless devices in operation and change output power and modulation characteristics. Cognitive radio is the enabling technology for supporting [1] DSA: the policy that addresses the spectrum scarcity problem that come across many countries. Thus CR is regarded as one of the most hopeful technologies wireless communications in future. To make radios and wireless network truly cognitive, however, is by no way a simple task, and it requires collaborative effort from different research communities, with network engineering, signal processing, software-hardware design, communications theory, game theory and reconfigurable transmitter and radio-frequency design. In this paper, a logical overview on Cognitive Radio networking and communications by looking at the key functions of the Physical, Medium Access Control, and networking layers involved in a Cognitive Radio design and how these layers are crossly related is provided. In exacting, for the PHY layer, supportive spectrum sensing, [2] spectrum sensing in signal processing and transceiver design for cognitive spectrum access is addressed. For medium access control layer, we analyze sensing scheduling scheme, sensing-access exchange design, spectrum-aware [1] access MAC, and Cognitive Radio MAC protocols. In the network

layer, Cognitive Radio Network tomography, spectrum-aware routing, and QoS control will be directed. Emerging CRNs that are actively developed by various consistency committee and spectrum-sharing economics will also be reviewed. Finally, we point out some open questions and challenges that are related to the Cognitive Radio design.

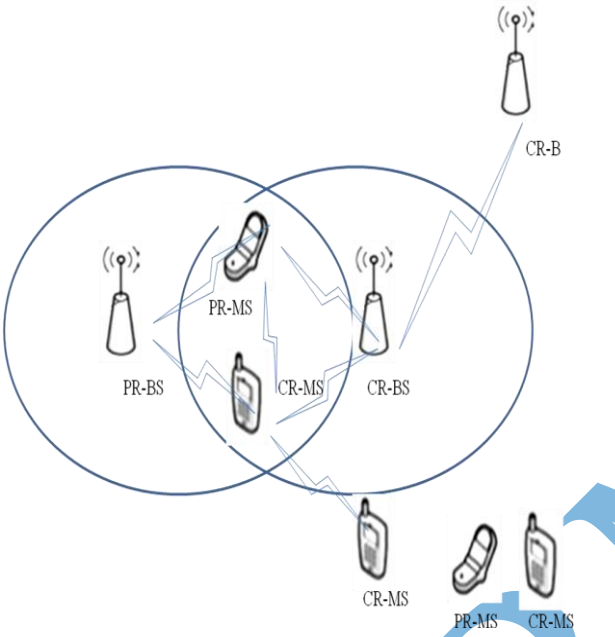

Fig. 1 Cognitive Radio Network

2. MOTIVATION

Significant underutilization [1] of the radio spectrum, in essence Cognitive Radio solves the spectrum underutilization problems in a tightly inter-coupled pair of way and senses the radio surroundings to detect spectrum holes in terms of both occasions. Control employment of the spectrum holes by secondary users will efficiently, focus to the constraint. The total power in each spectrum hole does not surpass a prescribed limit. Advanced wireless communication systems have been evolved extensively over the last two decades. Still, there are limits for expansion, but wireless communications of the wireless spectrum is a limited resource. In most countries, the government agencies control the usage of the frequency spectrum like the Telecom Regulatory Authority of India (TRAI) in India. TRAI coordinated allocating frequency bands and issuing exclusive licenses to [1] systems within a geological area while forbidding or at least adaptable other systems with respect to these bands. The Federal Communication Commission (FCC) in [4] USA report on spectrum utilization confirms that licensed ranges from 15% to 85% in the bands below 3 GHz, which indicates that there is a plenty of scope for improving spectrum efficiency. Hence, Cognitive Radio and Dynamic Spectrum Access are proposing an opportunistic spectrum usage approach. The vital idea of DSA is in which frequency bands that is not being utilized by their licensed users or primary users are utilized by CRs or secondary users as long as they do not interfere with the working of primary users. Hence, [4] cognitive radio is an important technology in DSA.

3. ISSUES

3.1 SPECTRUM SENSING

Spectrum sensing has been recognized as a key to enable cognitive radio to not interface with primary users and detect reliable primary user signals. So, sensing requirements are based on primary user modulation type, power, frequency and temporal parameter. It is often considered as a problem to be solved. Many techniques were developed in order to detect the hole in the spectrum band. Focusing on each narrow band, [3] the existing spectrum sensing technique is widely categorized into energy detection and feature detection. The performance of the energy detector is susceptible to unidentified or changed noise levels and edge. With cognitive Radio being used in a number of applications, the area of spectrum sensing has become increasingly important. As CR technology is being used to provide a method for using the spectrum [3] more powerfully, the application used here is spectrum sensing. The ability of Cognitive Radio systems to access spare sections of the radio spectrum and to keep monitoring the spectrum to ensure that the CR system does not cause any undue interface relies totally on the spectrum sensing elements of the system.

3.2 SPECTRUM MANAGEMENT

Cognitive radios have a great possibility to improve spectrum utilization by enabling users to access the spectrum dynamically without disturbing certified primary radios. A key challenge in operating these radios as a network is how to implement an efficient MAC mechanism

that can adaptively and efficiently allocate transmission powers and spectrum among Cognitive Radios [4] according to the neighbouring environment. Most existing works address these issues via suboptimal heuristic approaches or centralized solutions. An efficient spectrum management framework is primarily required to realize the cognitive radio sensor networks. In this section, some major challenges and major issues regarding such dynamic spectrum management framework is discussed. Among these, spectrum sensing is one of the key functionalities distinguishing CRSN from traditional WSN. Matched filter, energy detection, feature detection, interference temperature are the most common spectrum sensing techniques. Available channels are assigned to cognitive users opportunistically by source distribution. There may be various cognitive users trying to access the spectrum. SUs should coordinate their access to the available spectrum channel.

3.3 COMPLEXITY ISSUE

CR is a future glide path of tackling the difficulty of the increasing radio spectrum. To achieve this, it postulates that the connection nodes themselves are capable of feeling, and dynamically selecting, and allocating the suitable spectral resources [4] without causing much interference to other users. To achieve this, researchers are recommending a variety of composite methods for implementing cognitive radio, which include software defined radio (SDR), [4] intelligence and dynamic spectrum management. The challenge is to see whether such complexity is justified, and to check its possible outcomes to overcome the present regulatory constrain for spectral task process. It is anticipated that it should be promising to develop reduced complexity strategy that will be much of the functionality of projected systems, enable rapid acceptance, and wider use in systems where cognitive radio is presently not being debated due to prohibitive complexity.

4. CHALLENGES

In this section, the various core challenges like decision making, learning process, cross layers and security are discussed and explained.

4.1 DECISION MAKING

As Cognitive Radio is determined by a decision making, the first relevant research challenge is to determine where and how the decision making should happen. The first issue is directly related to whether the cognitive process should be executed in a centralized or distributed way. This feature is more critical not only for cognitive networks, where intelligence is more possible to be distributed, but also for cognitive radios, as decision making could be influenced by collaboration between them and other devices. The second issue is the choice of the decision algorithms e.g., neural networks, genetic algorithms, ant-colony optimization, which should be customized to fulfil the CR requirements.

4.2 LEARNING PROCESS

Research in learning process has grown dramatically recently, with significant amount of progress. One of the important aspects of the learning mechanism is whether the learning performed is supervised or unsupervised. In the context of a Cognitive Radio either technique may be applied. The first challenge of learning is to avoid wrong choices before a possible decision, particularly in autonomous or unsupervised learning process. The second issue is to concretely define learning process in the context of Cognitive Radio its objectives and contributions. In terms of implementation and algorithm design, the cognitive functionalities, which are linked to enabling devices or networks to learn from past decisions to advance their behaviour, are too much complex. The design of the learning algorithm represents by itself a challenge, and capacity which should be employed by learning open new issues related to which measurements to use and how to perform them.

4.3 CROSS-LAYERS

While the aspect of inter protocol interaction is included in the concept of cognitive network as means to support user and applications requirement, no applicable and complete analysis is available to address the performance. In general, the behaviour of applications and network based on Cognitive Radio technology is also considered. The design of cognitive or self-organized network [5] is itself a challenging task, however, the outer and inner loops coordination, the networking middleware for information exchange, and intersystem networking for sharing

and cooperation retaining its significance. Challenge also lies in the design of high layers including [5] MAC sub layer, network layer, spectrum management functions integrated at the different layers of the network protocol, cognitive radio resource management and its coordination, various protocols and routings. As a result, challenges in interoperability, include coexistence, collaboration for devices and network signalling with cross-layer interfaces and interlayer signalling are to be resolved.

4.4 SECURITY

The challenges of employing Cognitive Radio include ensuring secure devices operations. Security in this framework includes enforcement of rules. Enforcement for static system is already a challenge due to the amount of resources for equipment authorization, the requirement of obtaining proof that violations have occurred, and the determination of the violator identity. As the systems are more dynamic, there is rapid growth in potential interaction that leads to violation. This leads to a decrease in time and special scales of these interactions. The first issue is on equipment approval, especially on estimation criteria and security certification. It becomes even more difficult with the employment of self-learning mechanisms.

5. APPLICATION AREAS OF COGNITIVE RADIO NETWORKS

Cognitive Radio networks may have a wide range of application domains. Indeed, CR can be deployed anywhere in place of Wireless Sensor Networks. Some examples of prospective areas where CR-WSNs [6] can be deployed in areas such as: facility management, machine surveillance, defensive maintenance, precision agriculture, Medicine, [6] logistics, telemetries, object tracking, intelligent road side, safety, actuation and maintenance of complex systems, monitoring of indoor and outdoor environment.

5.1 LEASED NETWORK / EMERGENCY NETWORK

Leased Lines are symmetric dedicated point-to-point connections. By linking leased lines together it is possible to create a Wide Area Network (WAN) [14] that links multiple sites together. This topology allows traffic to flow from any two locations. If there is a failure on the head office, it is possible for other sites to communicate with each other. The [14] Emergency services network provides the next generation communication system for the three emergency services for ambulance, fire, police and rescue.

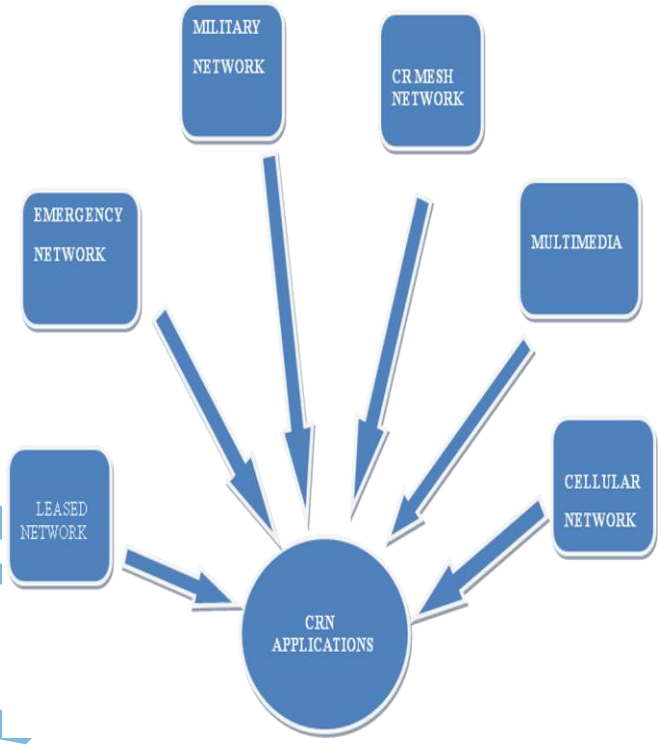

Fig.2 Application Areas of CRN

5.2 CR MESH NETWORK /MILITARY APPLICATIONS

The basic needs for a mobile, like interference-resistance, scalability, frequency agile, cost-efficient wireless system are to be satisfied. Convention Wireless Sensor Networks are used in many military and public security applications, chemical biological radiological and nuclear (CBRN), investigation, command control, gather the information of battle damage evaluation, battlefield surveillance, intelligence assistant, targeting.

5.3 MULTIMEDIA AND CELLULAR NETWORK

For the purpose of quick estimation of queuing delay in the multimedia[4] over CRN applications without exchanging traffic information among secondary users, the Cellular

networks [5] are used with multiple low-power transmitters (100w or less),by dividing the area into cells each served by its individual antenna. Transmitter, receiver and control unit are served by base station. Band of frequencies allocated.

6. CONCLUSION

This paper presents the needs of Cognitive Radio Network techniques which can overcome the challenges faced by present techniques used for wireless communication systems. This paper discusses the motivation of Cognitive Radio Network, technical issues, research trends and challenges. Cognitive radio has a very useful techniques and it have several advantages like, CR Networks, Issues, Challenges, Spectrum Sensing, Spectrum Management and Security.

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