ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 11, November 2015

Advanced Technology Review of Cognitive Radio Networks

P.Satyanarayana Goud,M.Tech.,
Assistant Professor,
Department of ECE
Anurag Group of Institutions,

Abstract:In this paper **the deployment of a commercial CR network is yet to emerge. A large portion of the existing literature does not build on real world scenarios, hence, neglecting various important aspects of commercial telecommunication networks. For instance, a lot of attention has been paid to spectrum sensing as the front line functionality that needs to be completed in an efficient and accurate manner to enable an opportunistic CR network architecture. While on the one hand it is necessary to detect the existence of spectrum holes, on the other hand, simply sensing (cooperatively or not) the energy emitted from a primary transmitter cannot enable correct dynamic spectrum access. The set of assumptions that these schemes are built upon do not always hold in realistic, wireless environments. Specific settings are assumed, which differ signifi- cantly from how existing telecommunication networks work. In this paper, we challenge the basic premises of the proposed schemes. We further argue that addressing the technical challenges we face in deploying robust CR networks can only be achieved if we radically change the way we design their basic functionalities. In support of our argument, we present a set of real-world scenarios, inspired by realistic settings in commercial telecommunications networks, namely TV and cellular, focusing on spectrum sensing as a basic and critical functionality in the deployment of CRs. We use these scenarios to show why existing DSA paradigms are not amenable to realistic deployment in complex wireless environments. The proposed study extends beyond cognitive radio networks, and further highlights the often existing gap between research and commercialization, paving the way to new thinking about how to accelerate commercialization and adoption of new networking technologies and services.**

I.INTRODUCTION

The increasing demand for wireless connectivity has shifted the attention and efforts of many researchers all over the globe towards the opportunistic dynamic spectrum access paradigm. This concept is not new, and was first introduced by Mitola [1]. In brief, the idea is that licensed spectrum can be made accessible to unlicensed users ("secondary") when the licensed ("primary") entities are absent. This absence of a primary user from a specific frequency band at a given point in time and space is referred to as spectrum hole [2]; a reserved portion of the spectrum that is not in use. In other words, a spectrum hole is a function of frequency, time and location. During the last years there have been significant advancements in hardware technology, enabling engineers to build radios that can understand their environment and dynamically alter their transmission parameters (e.g., transmission frequency, modulation type etc.). One would have expected that such developments would have lead to large scale cognitive radio network deployments. However, this is not the case, and even a prototype large-scale deployment is yet to appear. In this challenge paper, we argue that this is largely due to the specific mindset we have when we consider the research and design of protocols for CR networks. The majority of the work in this area is theoretical and makes a number of assumptions that may not hold in practice. Even though these studies are arguably important and can provide scientific insights, they are not the best avenues to drive practical implementation and eventually commercial adoption and success. As we will elaborate in the following sections, specific assumptions that are prevalent in the literature can either expose the primary receiver to harmful interference or limit the performance of a CR network.

Using two representative examples of primary user technologies, that of television and of a cellular network, we argue that current research proposals fail to address "system" level questions; are the spectrum holes we can identify with existing algorithms really useful? Why does the presence of a primary signal necessarily render the frequency unusable? How can we identify the regions where passive receptions of a broadcast system exist? How can we take advantage of the different uplink and downlink

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 11, November 2015

frequencies in asymmetric systems? Similar questions are many times ignored, regardless of their importance towards the realization of commercial CR networks. The answers to some of these questions might be simpler than we think (e.g., the database solution presented above) and/or require research directions that are substantially different from the current literature. We argue through our Many distributed real-time applications, such as audio- and video-conferencing, collaborative environments and distributed interactive simulation require simultaneous communication between groups of computers with quality of service guarantee; these applications involve a source in sending messages to a selected group of receptors. Classic unicast and broadcast network communication is not optimal; therefore,[1] Deering proposed a technique called IP multicast routing for one-to-multiple and multiple to multiple communication, which entrusts the task of data duplication to the network applications can send one copy

2. RELATED STUDIES

Despite the fact that efficient spectrum sensing has been identified as key to the success of cognitive radio networks very early [6], we still lack a satisfactory approach to perform this task. Existing literature can be broadly categorized into three classes: (i) non-cooperative transmitter detection, (ii) co-operative transmitter detection and (iii) interference-based detection.

Non-cooperative detection: This is the most basic form of spectrum sensing where the secondary transmitter tries to decide whether there is a primary transmitter using the spectrum or not. The detection problem is formulated using hypothesis testing, where the null hypothesis is the absence of the primary transmitter and the alternate hypothesis indicates its presence [7].

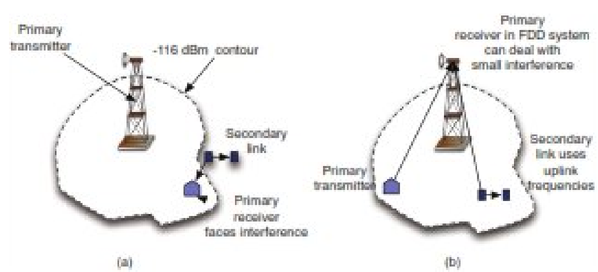
Cooperative detection: Non-cooperative spectrum sensing approaches are subject to high uncertainties due to wireless propagation effects. For instance, fading can cause large degradations at the received signal strength from a single radio. Obtaining more measurements from a larger number of co-located radios can provide us with a more robust decision. This is the goal of a cooperative spectrum sensing scheme. There are two basic approaches followed in cooperative detection, namely (a) soft combining and (b) hard combining (e.g., [15] [16] [17]).

Interference-based detection: Both cooperative and non-cooperative detection do not take into consideration the presence of a primary receiver. However, since interference takes place at the receiver, identifying its presence and/or position is important. The idea of examples that if we change our mindset and align our thinking more with the way commercial telecommunication networks operate and less in terms of mathematical modeling and protocol design, some of these questions may be answered leading to more rapid development of CR systems.

Interference temperature (IT) has been proposed by the FCC [21], to capture the additional interference (above the noise floor) that a primary receiver can tolerate. This means, that using the interference temperature model, we can have simultaneous transmissions from a primary and secondary user, as long as the interference from the latter is beyond the IT of the primary receiver. Even though as a concept this is appealing, there are many practical issues related with this approach. For instance, how is it possible to measure the interference at the primary receiver without prior knowledge of its position relative to the secondary transmitter [22]? An interesting approach was presented by Wild and Ramchandran [23]. Low cost sensor nodes are mounted on primary receivers to detect the local oscillator leakage power emitted by the RF front-end of the primary receiver. This can essentially detect the presence of the latter. This information is consequently sent as feedback to the secondary users. However, such approaches have received low attention from the community and have been practically abandoned as unrealistic. The main argument against such proposals is that they require large scale infrastructural upgrades. Nevertheless, as we will argue in Section 4, if we want to have a real-world cognitive radio network deployment, this is a promising direction that needs revisiting.

2.2 TOPOLOGIES FOR CR NETWORKS

In this paper, we will use two specific topologies and corresponding scenarios to illustrate the problems with existing approaches and the need for a completely new thinking for the success of CR networks. These topologies are shown in Figure 1



ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 11, November 2015

Figure 1: Topologies and Scenarios for Investigating Challenges with CR Networks

TV White Spaces As our first example, we consider the most widely discussed spectrum for usage in a CR network setting which is that of broadcast television white spaces. The corresponding topology and scenario is shown in Figure 1(a). The IEEE 802.22 standard states that any sensing algorithm used should be able to detect digital television signals at -116 dBm, with probabilities of false alarm and mis-detection, both equal to 0.1. Based on this requirement, if no signal is detected the spectrum is declared as free and secondary transmissions can be scheduled.

A Cellular FDD Network As the second example, we consider a cellular network that employs frequency division duplexing (i.e., there are separate frequencies for the uplink and downlink). In the US, the uplink (824-849 MHz) and downlink frequencies (869-894 MHz) are separated by 45 MHz in one commonly used slice of licensed spectrum. In a given cell, on the uplink frequencies, only the base station is the receiver as shown in Figure 1(b). Channels that are 1.25 MHz (5 MHz) wide are employed in 3G systems based on the CDMA200 (UMTS) standard. It is also well known that the load in cells varies significantly over time and day of week (e.g., [25] [26]). Since CDMA systems are interference limited, a secondary transmission that employs only the uplink frequencies may be able to operate without causing any harm to the primary system [27]. Especially if the secondary transmissions are employing low transmit power for short range links, there may be negligible interference or harm. This is further helped by the fact that the path loss for short distances usually has a smaller exponent compared to large distances. Thus, while the signal attenuates significantly and has very small power by the time it reaches the primary receiver (the base station), it is sufficient to perhaps support high data rates at shorter distances. However the cellular spectrum cannot be used for secondary applications as of now. If the spectrum is sensed, it will be discovered to be occupied by the primary users. The transmitters in this case are the mobile phones which will all employ the same frequency in a CDMA system. Thus, a very small number of mobile phones transmitting on the uplink would still tag the spectrum as occupied making it unusable by a secondary system even when it is unlikely to cause any harm at the primary receiver. Of course, in this case the quality of the secondary link might be impacted by the interference from primary transmissions. We further consider this scenario in Section 5.

3.WORKS ON COGNITIVE RADIO NETWORKS

Cognitive (or smart) radio networks like xG's xMaxsystem are an innovative approach to wireless engineering in which radios are designed with an unprecedented level of intelligence and agility. This advanced technology enables radio devices to use spectrum (i.e., radio frequencies) in entirely new and sophisticated ways. Cognitive radios have the ability to monitor, sense, and detect the conditions of their operating environment, and dynamically reconfigure their own characteristics to best match those conditions.

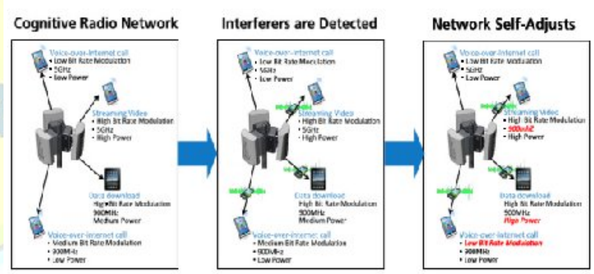


Fig.2. Cognitive Radio Networks Actions

Using complex calculations, xMax cognitive radios can identify potential impairments to communications quality, like interference, path loss, shadowing and multipath fading. They can then adjust their transmitting parameters, such as power output, frequency, and modulation to ensure an optimized communications experience for users.

Conventional, or "dumb" radios, have been designed with the assumption that they were operating in a spectrum band that was free of interference. As a result, there was no requirement to endow these radios with the ability to dynamically change parameters, channels or spectrum bands in response to interference. Not surprisingly, these radios required pristine, dedicated (i.e., licensed) spectrum to operate.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 11, November 2015

By contrast, xMax cognitive radios have been engineered from the ground up to function in challenging conditions. Unlike their traditional counterparts, they can view their environment in great detail to identify spectrum that is not being used, and quickly tune to that frequency to transmit and/or receive signals. They also have the ability to instantly find other spectrum if interference is detected on the frequencies being used. In the case of xMax, it samples, detects and determines if interference has reached unacceptable levels up to 33 times a second.

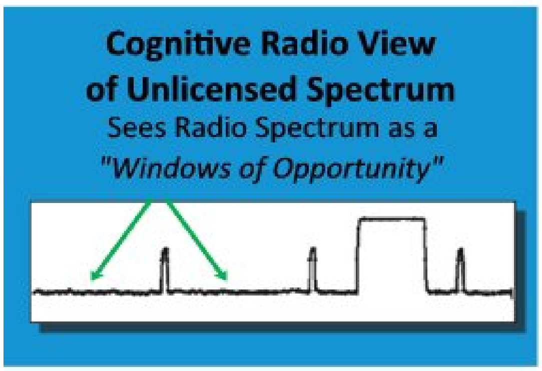


Fig.3.Sample Preformation of Cognitive Radio Networks

The following image illustrates how xMax cognitive radios operate differently from conventional radios. It shows screen captures of spectrum analyzer readings taken from an xMax network tower in Ft Lauderdale, FL. The frequencies being measured are in the unlicensed 900 MHz ISM band. Because this spectrum is unlicensed (i.e., free of charge for anyone to use) it is used by hundreds, if not thousands of radios in the local area for applications like cordless phones, baby monitors, commercial video security systems, etc.

xMax divides the 900 MHz spectrum block shown into 18 channels—giving it 18 opportunities (windows) every 33 milliseconds to find available spectrum.

In short, the xMax cognitive radio network sees windows of opportunity where other radios see walls of interference.

To reduce "thrashing" and unnecessary channel switching due to temporary and very short-lived interference phenomenon, or degraded network conditions (that do not cause a noticeable impact to performance or quality), actual channel and handovers decisions are made by trending multiple samples and measurements. The system only switches from its current channel when extreme levels of interference exceed its built-in interference mitigation capabilities. This enables xMax to use frequencies and find available bandwidth where other radios can only see static, yet its real-world tuned algorithms reduce signaling overhead and optimize throughput and quality.

Cognitive Radios Improve Spectrum Efficiency

The ability of xMax cognitive radios to make real-time autonomous decisions and dynamically change frequencies (referred to as dynamic spectrum access, or DSA) allows them to intelligently share spectrum and extract more bandwidth—which improves overall spectrum efficiency. It achieves this by "opportunistic use" of shared frequencies like unlicensed spectrum.

xMax cognitive radio technology was designed to be "frequency agnostic." That is, its cognitive "Identify and Utilize" spectrum sensing technology can be used to power radios in any frequency band. This is beneficial since the FCC and wireless regulatory bodies around the world are in the process of opening up new spectrum, as well as reclassifying existing spectrum, to be made available for opportunistic use by cognitive radios.

This would allow new market entrants, utilities, public safety, enterprise and even existing wireless operators to offer new services, additional bandwidth and higher

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 11, November 2015

capacity without requiring these entities to purchase expensive and scarce wireless spectrum.

Taking Cognitive Radios Further: Interference Mitigation

Most of the research in the cognitive radio field to date has been limited to Dynamic Spectrum Access within the radio device. xG Technology has expanded the application of cognitive techniques beyond DSA in every radio used in the xMax system. xG is leveraging cognitive technology in several other aspects of the radio's operation and across the entire xMax wireless network.

One of the breakthroughs xG has made that takes its xMax solutions beyond competitive cognitive radios is the addition of sophisticated and patent pending interference mitigation. These interference mitigation techniques allow xMax cognitive radios to increase their dwell time on a channel, even in the presence of interference that would cause traditional radios to fail. This increases the total spectrum bandwidth available for use by the xMax system compared to other radio systems, as well as improving the reliability of the xMax network in harsh RF conditions.

xMax cognitive radio networks are also incorporating MIMO antennas and advanced signal processing algorithms to withstand much higher levels of noise, jamming, and general interference than conventional radios and competing cognitive radio solutions.

4.FUTURE WORK & CONCLUSIONS

In this paper we have tried to shed some light on the reasons behind the lack of commercial deployment of a cognitive radio network. In order to do so we focused on a specific functionality, important for the operations of such a network, that of spectrum sensing. However, we would like to emphasize on the fact that similar problems exist with respect to other functionalities, such as spectrum sharing and spectrum access. We emphasize that our work should not be viewed only as a question about the realization of cognitive radio networks. It should be seen more broadly as a challenge to the real world applicability of a large volume of existing research. For example, the research community is used to putting aside, in the majority of the cases, solutions that require large scale infrastructural changes. Without trying to argue in this paper whether this is correct or not, sometimes the only feasible solution(s) is(are) accompanied by this "drawback". Thus, we should be more open to them and less critical of similar proposals. After all this is often the way that the world of commercial network operators functions.

Refrences

[1] J. Mitola III. Cognitive Radio for Flexible Mobile Multimedia Communications. In MoMuC, 1999.
[2] R. Tandra, S.M. Mishra, and A. Sahai. What is a spectrum hole and what does it take to recognize one? In Proceedings of the IEEE, 2009.
[3] M.B.H. Weiss, M. Al-Tamaimi, and L. Cui. Dynamic Geospatial Spectrum Modelling: Taxonomy, Options and Consequences. In elecommunications Policy Research Conference, 2010.
4]The White Space Coalition. http://www.engadget.com/tag/white%20space%20coalition/.
[5] I.F. Akyildiz, W-Y. Lee, M.C. Vuran, and S. Mohanty. NeXt generation/dynamic spectrum access/cognitive radio wireless networks: A survey. In Elsevier Computer Networks, 2006.
[6] A. Sahai, N. Hoven, and R. Tandra. Some fundamental limits on cognitive radio. In 42nd Allerton Conference on Communication, Control and Computing, 2004.
[7] F.F. Digham, M-S. Alouini, and M.K. Simon. On the Energy Detection of Unknown Signals over Fading Channels. In IEEE Transactions on Communications, Vol (55), Issue 1, 2007.
[8] Y. Li. Signal processing issues in Cognitive Radio. In Proceedings of IEEE, 2008.
[9] R. Tandra and A. Sahai. SNR walls for signal detection. In IEEE Journal on Selected Topics in Signal Processing, Vol (2), pp. 4-17, 2008.
[10] D. Cabric, S.M. Mishra, and R.W. Brodersen. Implementation issues in spectrum sensing for cognitive radios. In 38th Asilomar Conference on Signals, Systems and Computers, 2004.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 11, November 2015

[11] A. Fehske, J.D. Gaeddert, and J.H. Reed. A new approach to signal classi_cation using spectral correlation and neural networks. In IEEE DySPAN, 2005.
[12] S. Haykin, J. Reed, and D. Thomson. Spectrum sensing in Cognitive Radio. In Proceedings of the IEEE, 2008.
[13] Y. Zeng and Y.C. Liang. Text on eigenvalue based sensing - For Informative Annex on Sensing Techniques. In IEEE 802.22 Meeting Documents, 2007.
[14] Y. Zeng and Y.C. Liang. Maximum-Minimum Eigenvalue Detection for Cognitive Radios. In IEEE PIMRC, 2007.
[15] G. Ganesan and Y. Li. Agility Improvement through Cooperative Diversity in Cognitive Radio. In IEEE GLOBECOM, 2005.
[16] C. Sun, W. Zhang, and K.B. Letaief. Cluster-Based Cooperative Spectrum Sensing in Cognitive Radio Systems. In IEEE ICC, 2007.
17] E. Visotsky, S. Ku_ner, and R. Peterson. On Collaborative Detection of TV Transmissions in Support of Dynamic Spectrum Sharing. In IEEE
DySPAN, 2005.
[18] S.M. Mishra, A. Sahai, and R.W. Brodersen. Cooperative Sensing among Cognitive Radios. In IEEE ICC, 2006.
[19] G. Ganesan and Y. Li. Cooperative spectrum sensing in cognitive radio, part II: Multiuser networks. In IEEE Transactions on Wireless Communications, pp.
2214-2222, 2007.
[20] J. Ma and Y.G. Li. Soft combining and detection for cooperative spectrum sensing in cognitive radio networks. In IEEE GLOBECOM, 2007.
[21] ET Docket No 03-237 FCC. Notice of inquiry and notice of proposed Rulemaking. In ET Docket No 03-237, 2003.
[22] T.X. Brown. An analysis of unlicensed device operation in licensed broadcast service bands. In IEEE DySPAN, 2005.
[23] B. Wild and K. Ramchandran. Detecting Primary Receivers for Cognitive Radio Applications. In IEEE DySPAN, 2005.
[24] FCC digital TV channels coverage maps. http://transition.fcc.gov/dtv/markets/.
[25] C. Peng, S.-B. Lee, S. Lu, H. Luo, and H. Li. Tra_c-Driven Power Saving in Operational 3G Cellular Networks. In MobiCom, 20011.
[26] D. Tipper, P. Krishnamurthy, A. Rezgui, and P. Pacharintanakul. Dimming cellular networks. IEEE Globecom, 2010.
[27] R. Saruthirathanaworakun and J.M.Peha. Dynamic primary-secondary spectrum sharing with cellular systems. IEEE Crowncom, 2010.
[28] Comcast Digital Box Deployment. https://digitalnow.comcast.com/.
[29] Vijay Garg. Wireless Network Evolution: 2G to 3G. Pearson LLC, 2001.
[30] Arjun Bhupathi Raju. Characterization of uplink transmit power and talk time in wcdma networks. MS Thesis in Electrical Engineering, Virginia Polytrechnic Institute and State University, July 2008.