MULTIRATE SIGNAL PROCESSING FOR COGNITIVE RADIOS

Upendra Mohan Bhatt,*CMJ University scholar*

ABSTRACT-

One perspective in communication systems is to increase the spectrum utilization using cognitive radios. A cognitive radio is a network of intelligent co-existing radios which senses the environment to find the available frequency slots, white spaces, or the spectrum holes as noted in Akyildiz et al. (2008); Haykin (2005). Then, it modifies its transmission characteristics to use that particular frequency slot. Figure 1 illustrates the overlay spectrum sharing outlined in Cabric et al. (2006), or the opportunistic spectrum access discussed in Zhao & Sadler (2007); Zhao & Swami (2007), or the dynamic spectrum access which is considered in Sherman et al. (2008). Here, secondary users occupy the frequency slots which are not used1 by the primary users.

Keywords: *Spectrum Management, Radio network, Research challenges*

INTRODUCTION

The radio frequency (RF) spectrum is a scarce natural resource, currently regulated by government agencies. Under the current policy, the primary user (PU) of a particular spectral band has exclusive rights to the licensed spectrum. With the proliferation of wireless services, the demands for the RF spectrum are continually increasing. On the other hand, it has been reported that localized temporal and geographic spectrum utilization efficiency is extremely low. For example, it has been reported that the maximal occupancy of the spectrum between 30 MHz and 3 GHz is only 13.1% and its average occupancy is 5.2% in New Delhi. The spectral under-utilization can be addressed by allowing secondary users to access a licensed band when the PU is absent. Cognitive radio (CR) has become one promising solution for realizing this goal , which provides the capability to share the wireless channel with licensed users in an opportunistic manner. CR networks are envisioned to provide high bandwidth to mobile users via heterogeneous wireless architectures and dynamic spectrum access techniques. Wireless communication attracts enormous investments, while at the same time user requirements continuously increase. Moreover, evolution in wireless technologies should keep pace with the aforementioned fields, in order to facilitate the integration of innovative services and applications in everyday communication. Aligned with these thoughts, this white paper constitutes the result of work conducted within the 6th working group of the Wireless World Research Forum with respect to Cognitive Radio and the efficient management of spectrum and radio resources in reconfigurable systems. For this purpose, a technical approach for all anticipated problems related to the management of future systems is initially done, followed in the sequel by an addressing of the impacts of different air interfaces on wireless connectivity. Moreover, the respective regulatory perspectives are also opposed, and promising future research directions are highlighted in the end of this white paper.

TECHNICAL APPROACH

Radio Resource and Spectrum Management Approaches

There is currently much research and investigation by many industrial organizations and national administrations on the closely related topics of dynamic spectrum management, flexible spectrum management, advanced spectrum management, dynamic spectrum allocation, flexible spectrum use, dynamic channel assignment, and opportunistic spectrum management . Cognitive radio and the closely related technologies of policy-based adaptive radio, software defined radio, software controlled radio, and reconfigurable radio are enabling technologies to implement these new spectrum management and usage paradigms. These concepts are equally applicable to a wide variety of mobile communications systems including public protection and disaster relief (PPDR), military, and commercial wireless networks.

More efficient use of the spectrum is one benefit associated with cognitive radios and the closely related technologies such as policy-based adaptive radio. To be able to achieve this benefit, it is necessary for these advanced radios to be controlled in such a way that underutilized portions of the spectrum can be utilized more efficiently. This has been called opportunistic spectrum management. For many scenarios, the method of control needed to achieve opportunistic spectrum management through the use of cognitive radio and policy-based adaptive radio is a network issue as well as a radio issue.

Network control of these advanced radios includes control of the configuration of the radio and the RF operating parameters. Regulatory policies which govern the allowable behavior, i.e., RF operating parameters, are part of this network control. The control policies may, for some scenarios also include network operator and user policies. In general, there are two control models for opportunistic spectrum access or flexible spectrum usage namely the centralized control model and the distributed control model. For each of the control scenarios, spectrum sensing is a critical aspect of the control of cognitive radios and policy-based adaptive radios which employ software defined radio technology.

Frequency Agility: The radio is able to change its operating frequency to optimize its use in adapting to the environment.

Dynamic Frequency Selection (DFS) – The radio senses signals from nearby transmitters to choose an optimal operation environment.

The concept of policy-based adaptive radio potentially provides a new regulatory policy framework, particularly for use in unlicensed bands. For licensed bands, it potentially allows licensed holders a method for improved utilization of the spectrum covered by their license. The concept allows for diversity of privacy sources from different regulatory sources. It also allows for policies that change with time and geographical location. The concept will facilitate regulatory traceability provided the computer-coded policies trace to the original regulatory documents.

Functional Architecture for the Management of Spectrum and Radio Resources in Adaptive/Reconfigurable Systems

Adaptive (cognitive/reconfigurable) systems are aware of their environment as well as their own internal structure. The cognitive radio is, for example, aware of the number of multipaths it sees and can adjust the equalization algorithm accordingly. It can even take hints from the information being exchanged by the user to adapt its detecting strategy and power consumption according to the user's behavior.

The functionalities of DNPM, ASM and ARRM are closely interlocked and coupled. Nevertheless the interworking of these three concepts can be considered as three interlocked loops. Each loop reacts based on the output parameters of the adjacent ones. The more inner a loop is located, the faster is their reaction time. Therefore the entities of the middle and inner-loop should be locally decentralized in order to combat delay through the route to a central entity. The function of the outer-loop can be executed in a central entity at a central place, e.g. for GSM in the core network.

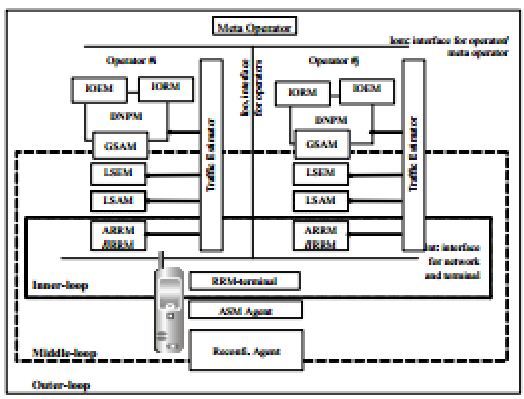

Figure 2: Functional Blocks Overview

CONCLUSION

network matches thereby to the cognitive radio network vision as introduced above. The tables differentiate regulation options into primary and secondary spectrum usage. A QoS guarantee always requires some degree of exclusiveness. If a guarantee is not required, primary systems may share spectrum horizontally. Coexistence is less adequate to support QoS while cooperation increases the level of potential QoS. Regulation authorities can delegate the control of spectrum access to one or multiple private entities to enable spectrum trading at secondary markets. A so-called spectrum manager inherits the role of the regulator in this context. Secondary usage might be allowed for underlay or overlay spectrum sharing, provided that secondary radio systems defer from spectrum utilization whenever the license holding primary radios access their spectrum. Secondary radios can try to coexist with primary radios without interfering them in sharing spectrum vertically. Cooperation between secondary and primary radios enables the secondary radios to support QoS with deterministic interruptions. Secondary radio systems are only able to guarantee QoS if the primary radio systems commit themselves not to interfere. This commitment of the licensee introduces trading of spectrum.

By exploiting the existing wireless spectrum opportunistically, CR networks are being developed to solve current wireless network problems resulting from the limited available spectrum and the inefficiency in spectrum usage. CR networks, equipped with the intrinsic capabilities of cognitive radio, will provide an ultimate spectrum- aware communication paradigm in wireless communications. In particular, we investigate novel spectrum management functionalities such as spectrum sensing, spectrum decision, spectrum sharing, and spectrum mobility. Many researchers are currently engaged in developing the communication technologies and protocols required for CR networks. However, to ensure efficient spectrum aware communication, more research is required along the lines introduced in this survey.

REFERENCES

[1]Won-Yeol Lee and Ian. F. Akyildiz, "Optimal Spectrum Sensing Framework for Cognitive Radio Networks", IEEE Transactions on wireless communications, vol. 7, NO. 10, OCTOBER 2008.

[2]. Joe Evans, U. Kansas Gary Minden, U. Kansas Ed Knightly, Rice, Sep 15 2006, "Technical Document on Cognitive Radio Networks", IEEE.

[3]. K. C. Chen, Y. J. Peng, N. Prasad, Y. C. Liang, S. Sun, "Cognitive Radio Network Architecture: Part I – General Structure" IEEE.

[4]. Ian F. Akyildiz, Won-Yeol Lee, Mehmet C. Vuran, and ShantidevMohanty, "A Survey on Spectrum Management in Cognitive Radio Networks" , IEEE, April. 2008, pp. 41-47.

[5]. Ian F. Akyildiz, Won-Yeol Lee, and Kaushik R. Chowdhury, "Spectrum Management in Cognitive Radio Ad Hoc Networks" , IEEE, July/aug. 2009,pp. 6-11.