Chapter 19

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ABSTRACT
Software Defined Radio (SDR) and Cognitive Radio (CR) are the key enabling technologies to overcome the spectrum scarcity problem a bit, by supporting dynamic spectrum access in which either a network or a wireless node reconfigures its transmission or reception parameters to communicate efficiently, avoiding interference with licensed or unlicensed users. CR senses the environment and enables a secondary system to share the licensed spectrum with the primary system, which usually has exclusive access. The performance of the secondary system could be enhanced by Cooperative Spectrum Sensing (CSS) as it increases the primary detection probability. Again cognitive radio network greatly benefits from a cooperative transmission, employing intermediate nodes as relays. This chapter is focused on software defined radio, its architecture, limitations, then evolution to cognitive radio network, architecture of the CR, and its relevance in the wireless and mobile ad-hoc networks. Additionally, an overview of Cooperative Spectrum Sensing (CSS), its classification, components, challenges, and Cooperative Relay are discussed.

INTRODUCTION
Over the last few years Radio spectrum, which is needed for wireless communication systems, appears to be a limited resource with the proliferation of various wireless applications and services in a noninterfering basis. This policy has traditionally been adopted by spectrum regulators and is known as Fixed Spectrum Access (FSA) policy. By doing so, only the assigned (licensed) users have the right...
to exploit the allocated spectrum, and other users are not allowed to use it, regardless of presence or absence of the licensed users. Eventually recent studies on the actual spectrum utilization measurements have revealed that a large portion of the licensed spectrum experiences low utilization. To maintain sustainable development of the wireless communication industry, novel solutions are to be developed to enhance the utilization efficiency of the radio spectrum. Dynamic spectrum access (DSA) technique has been proposed as an alternative policy to allow the radio spectrum to be used more efficiently and economically. It is no secret that anticipated technologies are often hyped as being “hot”, especially in the rapidly evolving and highly dynamic field of wireless communication. These very same technologies about which everybody has talked so enthusiastically then disappear silently, without leaving any impact on the industry, and remaining merely as just another vocabulary in the glossary of Newton’s Telecom Dictionary. However, this time it seems really different…The emergence of a promising, versatile technology into the commercial world seems to set the entire communication industry into pure excitement. Not only has it definitely become a major focus of attention, but it is also catalyzing enhancement of new standards as the industry is taking its big steps towards the age of “third generation,” 3G communication. Software defined radio (SDR) is receiving enormous recognition as the next evolutionary stage of wireless technology that aims to take advantage of the programmable hardware modules in order to build an open-architecture based software radio system to support DSA policy as well (Banerjee & Chakraborty, 2014). It is a rapidly evolving technology that is generating enormous interest in the telecommunication industry, as it facilitates some of the functional modules of a radio system (such as: signal generation, coding, modulation/ demodulation, link layer protocols) in software. This programmability empowers the radios the ability to change its operating parameters to accommodate new features and capabilities without changing the hardware portion much.

Even after SDR, which is slowly becoming more of a reality, is another intelligent radio, known as Cognitive Radio (CR) which is basically SDR along with cognition and reconfigurable properties. With the development of cognitive radio technologies spectrum sharing in the licensed spectrum has drawn a great attention in the research community, which shows the potential advantage of mitigating spectrum scarcity and improving spectrum utilization efficiency. Further, Cognitive Radio (CR) is that very paradigm for wireless communication, in which either a network or a wireless node reconfigures its transmission or reception parameters to communicate efficiently avoiding interference with licensed or unlicensed users. CR adapts itself to the newer environment on the basis of its intelligent sensing and captures the best available spectrum to meet user communication requirements. Therefore, in this chapter CR has been discussed after SDR. As cognitive radio has a lower priority than the licensed spectrum, it needs to be able to determine independently whether the spectrum is available at a particular time, and adjust its transmission and reception accordingly. Spectrum sensing has therefore become one of the major challenges confronting cognitive radio.

The sensing performance of a single cognitive user is limited because of channel fading and shadowing effects. As a result, cooperative spectrum sensing (CSS), which can enhance sensing performance, has attracted considerable attention.

Still this cooperative spectrum sensing does not improve the secondary transmission or the system throughput to that extent. However, by employing a CR that is located nearby the PU as a “Helper” or “Carrier” or “Relay”, Secondary transmission may be improved. This Relay based CSS scheme, known as Cooperative Relaying scheme is a major breakthrough in the wireless communication domain and demands keen research further.