

Chapter 6

Modeling of Software Defined Radio Architecture and Cognitive Radio: The Next Generation Dynamic and Smart Spectrum Access Technology

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ABSTRACT

Today's wireless networks are characterized by fixed spectrum assignment policy. The spectral scarcity and the inefficiency in the spectrum usage necessitate new communication paradigms to exploit the existing wireless spectrum, opportunistically. Software Defined Radio (SDR) and Cognitive Radio (CR) are the very paradigms 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. When the radio link features are extended to the network layer, the cognitive radios form the cognitive radio network. This chapter is focused on software defined radio, its architecture, its limitations, evolution to cognitive radio network, architecture of the CR, and its relevance in wireless and mobile ad-hoc networks.

INTRODUCTION

Now a days we must be heard of the terms cell phones, cordless phones, garage door openers, car door openers, wireless Internet cards, satellite,

paggers, radars, etc which all belong to the family of Radios. Obviously the question arises – what this Radio actually is? Well, it may be defined as device that intentionally transmits or receives radio frequency signals (part of electromagnetic

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spectrum) (FCC, 2003) in a wireless manner to facilitate the transfer of information. Over the last few years, analog radio systems have been replaced by the modern digital radio systems in different radio application areas, like – military, civilian, commercial spaces, etc. Additionally, programmable hardware modules are increasingly being adopted in digital radio systems at different functional levels making radios more dynamic and more versatile. The technology which aims to take advantage of these programmable hardware modules in order to build an open-architecture based software radio system is recognized as Software-Defined Radio (SDR). 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. 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.

SOFTWARE DEFINED RADIO (SDR)

A number of definitions can be found to describe Software Defined Radio (SDR), also known as Software Radio. The SDR Forum, working in

collaboration with the Institute of Electrical and Electronic Engineers (IEEE) P1900.1 group, has worked to establish a definition of SDR that provides consistency and a clear overview of the technology and its associated benefits. Therefore, SDR is defined as:

Radio in which some or all of the physical layer functions are software defined.

Another definition that seems to encompass the essence of the SDR is that it has a generic hardware platform on which software runs to provide functions including modulation and demodulation, filtering (including bandwidth changes), and other functions such as frequency selection and if required frequency hopping. By reconfiguring the software or simply by downloading a new program, SDR is able to inter operate with different wireless protocols, incorporate new services, and upgrade to new standards.

Levels of SDR

It is not always feasible or practicable to develop a radio that incorporates all the features of a fully software defined radio. Some radios may only support a number of features associated with SDRs, whereas others may be fully software defined. In order to give a broad appreciation of the level at which a radio may sit, the SDR Forum (now called the Wireless Innovation Forum, WINNF) has defined a number of tiers. These tiers can be explained in terms of what is configurable.

Tier 0: A non-configurable hardware radio i.e. the radio that cannot be changed by software.

Tier 1: A software controlled radio where limited functions are controllable. These may be power levels, interconnections, etc. but not mode or frequency.

Tier 2: In this tier of SDR, there is significant proportion of the radio is software configurable. Often the term software controlled

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