Chapter 6
The State of the Art in Cognitive Radio Networks in 5G Hetergeneous Networks

Tarek M. Salem
https://orcid.org/0000-0002-3465-7065
Systems and Computers Department, Electronics Research Institute, Giza, Egypt

ABSTRACT

This chapter addresses cognitive radio systems (CRSs) in the 5G network and presents the existing, emerging, and potential applications employing CRS capabilities and the related enabling technologies, including the impacts of CRS technology on the use of spectrum from a technical perspective. The description of such technologies, operational elements, and their challenges are also presented. Furthermore, this chapter provides high level characteristics, operational and technical requirements related to CRS technology, their performances, and potential benefits. Finally, factors related to the introduction of CRS technologies and corresponding migration issues are discussed.

INTRODUCTION

One of the most important technology used in the 5G mobile network is Cognitive radio systems (CRSs) are expected to be a driver of innovation and development of future wireless systems. CRSs would be one of the foreseen technical solutions to address the growing traffic demand in the future. CRSs could allow more efficient use of radio resources including limited spectrum resources, compared with conventional radio communication systems.

The key technical features and capabilities of a CRS as identified in

- The capability to obtain knowledge of its radio operational and geographical environment, its Internal state and established policies, as well as to monitor usage patterns and users' preferences;
- The capability to dynamically and autonomously adjust its operational parameters and protocols according to the knowledge in order to achieve predefined objectives; and

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- The capability to learn from the results of its actions to further improve its performance.

Due to rapidly increasing wireless traffic and the need for a larger amount of spectrum, studies in 5G networkhave identified important aspects related to the use of CRS technologies. CRS technologies could be an enabler for spectrum sharing and radio resource management on a more dynamic basis, thus providing increased spectral efficiency and mitigating the problem of congestion, e.g., through enhancing capacity.

As described in (FCC et al., 2002), CRSs may provide several benefits to both system operators and end users, however, the extent of the benefits and suitability of CRS technologies depends on the deployment scenarios and use cases for these systems as well as the technical conditions of CRS operation.

In principle, the introduction and deployment of CRS can take place without the need for any changes to the Radio Regulations. In addition to that, as stated in (Salem et al., 2014) - (Haykin et al., 2005), it should be noted that any system of a radiocommunication service that uses CRS technology in a given frequency band will operate in accordance with the provisions of the Radio Regulations governing the use of that band. A CRS is not a radiocommunication service, but a set of technologies that in the future may be implemented in a wide range of applications in the 5G network. However the deployment of CRSs in the 5G networkmay require identification of unique and detailed characteristics such as security mechanisms to ensure appropriate operation which can be achieved by future studies and further technical analysis.

This chapter provides a detailed description of CRS capabilities and enabling technologies as well as the relationship between them. It describes also the key technical features related to these technologies as enablers for enhanced sharing and coexistence as well as more efficient use of resources. It also discusses the impact of CRSs on the use of spectrum from a technical perspective. The report describes the high level characteristics, operational and technical requirements of a CRS. As well general performance criteria and metrics are presented in this report to help the performance evaluation of 5G networkradio system employing CRS technology. In this report the initial set of potential benefits introduced in (Lee et al., 2011), are further expanded. Furthermore, factors related to the introduction of CRS technologies are discussed in addition to related migration issues.

DEFINITIONS AND TERMINOLOGY

The following definition and terms are used in the chapter.

Definitions

Cognitive radio system (CRS): A radio system employing technology that allows the system to obtain knowledge of its operational and geographical environment, established policies and its internal state; to dynamically and autonomously adjust its operational parameters and protocols according to its obtained knowledge in order to achieve predefined objectives; and to learn from the results obtained.

Software-Defined Radio (SDR): A radio transmitter and/or receiver employing a technology that allows the RF operating parameters including, but not limited to, frequency range, modulation type, or output power to be set or altered by software, excluding changes to operating parameters which occur