Chapter 20


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ABSTRACT

Cognitive Radio (CR) and Software Defined Radio (SDR), concepts which were mere proposals to solve the population of services over the past two decades, are now enabled by novel materials and components to offer fully reconfigurable devices. Thus, a convergence of services can be attained within a reduced, or even single RF (Radio Frequency) signal path in the device. A solid design of reconfigurable frontends, from the RF part to the digital baseband, should consider different criteria to better exploit the available spectrum. Examples of such criteria are scattering parameters and phase linearity of components at a defined carrier frequency, RF signal bandwidth, and signal quality in terms of Error Vector Magnitude and Bit Error Rate. In this chapter, a general perspective to achieve smarter air interfaces is studied and discussed by setting out strategies based on CR and SDR techniques for the implementation and integration of future reconfigurable RF-Frontends.

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INTRODUCTION

With the advent of the Internet of Things, Machine-to-Machine communication, and Cooperative Sensor Networks to enable smart cities, an ever-increasing amount of data across the different parts of the frequency spectrum asks for novel solutions to satisfy the exchange of traffic in a dynamic fashion (Gann, Dodgson, & Bhardwaj, 2011). Yet, current state-of-the-art technologies and devices require a reasonable maturing time to fulfill current and forthcoming communication standards.

Present handheld and portable devices need to reorganize their typical architecture in order to satisfy emerging demands and to face the increased number of services, e.g. LTE, UMTS, GSM, WLAN, RFID, and GNSS, among others. To perform this reorganization, an attractive approach is to reduce the amount of transceiver modules in the RF-Frontend of the architecture while preserving the same functionality. As a consequence, improved energy efficiency as well as a smarter spectrum management can be achieved.

Although the realization of architectures for fully reconfigurable radios are attractive to achieve a smarter frequency spectrum management, the integration of agile components and the required tuning bandwidth of up to 6 GHz to cover all targeted services still involve important challenges to solve.

In this chapter a review of tasks and challenges that enable flexible and agile radios for CR architectures, including SDR implementations, is provided. Beside semiconductive integrated circuits, there are promising implementations by means of a combination of low-cost current and novel reconfigurable tunable components. These implementations are based on microelectromechanical systems MEMS technology and/or on functional materials such as ferroelectrics, e.g. Barium-Strontium-Titanate (BST) for low frequency bands, and liquid crystals for high frequency bands.

RECONFIGURABLE FRONTENDS: A SMARTER AIR INTERFACE BETWEEN COGNITIVE RADIOS

With the steady growth of services and applications for portable devices, dynamic and adaptable communication approaches are strongly required. In that way, an agile reconfiguration should take into account every layer of a typical communication system, i.e. from the application layer down to the physical layer (Tanenbaum, 2003). Nevertheless, while a clear roadmap for protocols and standards has been developed, at the physical layer the RF-Frontend of a device reaches a bottleneck to satisfy forthcoming demands (Nguyen, Villain, & Le Guillou, 2012). In Figure 1, a scenario taking into account a fully-sensed urban area, also known as smart city, shares information in a smart way so that a single user can exploit it by using a single reconfigurable platform. Here, wireless coordination of sensing devices and cooperative computing are enabled to perform different tasks such as tracking, traffic information, monitoring, warning and surveillance. In this way, by means of Cognitive Radio techniques, the aim is to constantly sense the RF environment so that an efficient management of the network resources, namely the wireless spectrum, supported by allocation algorithms can be obtained, either in the baseband or in the RF-Frontend. Thus, an integration of distributed sensors and networks with portable devices like mobile phones, tablets, and PDAs, is required to achieve the convergence of information and its different communication technologies into global service platforms.

An effective interconnection of living areas such as supermarkets, houses, offices, and shopping centers, among others, is becoming an important challenge that allows fulfilling the implementation concept of a smart city (Naphade, Banavar, Harrison, Paraszczak, & Morris, 2011). For this, the interconnection
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