Chapter 11
Routing through Efficient Channel Assignment in Cognitive Radio Networks

Yasir Saleem
Sunway University, Malaysia

Farrukh Salim
Technische Universität Ilmenau, Germany
& NED University of Engineering and Technology, Pakistan

Mubashir Husain Rehmani
COMSATS Institute of Information Technology, Wah Cantt, Pakistan

Bushra Rashid
COMSATS Institute of Information Technology, Wah Cantt, Pakistan

ABSTRACT

In Cognitive Radio Networks (CRNs) there is much dynamicity due to the activities of primary users which results in instability of routes. Therefore, an efficient routing protocol based on good channel assignment strategy is required in CRNs. A good channel selection strategy makes route stable by selecting channels having larger capacity and greater availability time. Therefore, the focus of this chapter is joint channel assignment and routing in CRNs, which provides a comprehensive survey on routing and channel assignment in CRNs. First, the importance of joint channel assignment and routing for successful communication in cognitive radio networks is discussed. Then classification and challenges related to channel assignment and routing are discussed in detail. In order to establish reliable routes in CRNs, some factors are discussed that further enhance the communication in CRNs. Finally, guidelines for the development of efficient routing protocols are discussed.

1. INTRODUCTION

Federal Communications Commission (FCC, 2004), USA and Ofcom, UK have found that most of the radio spectrum is under-utilized due to the fact that in traditional network, e.g., paging and military bands, spectrum allocation is fixed and spectrum cannot be re-used even when it is not occupied by licensed user (Akyildiz et al., 2009). Cognitive Radio Networks (CRNs) aim to intelligently utilize the licensed band when it is unoccupied without causing interference to licensed users. Federal Communications Commission (FCC) (FCC, 2004) has approved the usage of licensed spectrum band by unlicensed de-
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vices subject to the condition that communication of licensed users should not be interfered/interrupted. There are two types of users in CRNs, one is Primary User (PU or licensed user) which operates on a licensed spectrum band and other is Secondary User (SU or unlicensed user), which operates either on unlicensed spectrum band or on licensed spectrum band whenever PU is not utilizing its spectrum band. When licensed spectrum band is in use of SU, SU has to vacate this spectrum band whenever PU needs to occupy the said spectrum band at any time and switch to another one by selecting spectrum from spectrum pool (Weiss et al., 2004) so that PU should not be interfered. This is known as spectrum handoff (Akyildiz et al., 2009).

Packet is a basic unit of information in computer networks, and routing is the fundamental function that allows successful and timely reception of data packets for any wireless network. Routing is used for information exchange by transferring packets from one host to another across the network. Significant amount of work has been carried out for routing in different wireless networks. These networks include Wireless Sensor Networks (WSNs), Wireless Mesh Networks (WMNs), Mobile Ad-Hoc Networks (MANETs), Vehicular Ad-Hoc Networks (VANETs) etc. But in CRNs, routing is much more complex due to the dynamic nature of the available frequency bands. This dynamicity is due to various factors such as PU activity, diversity in available channels, heterogeneous channels etc.

Channel assignment plays an important role in the performance and stability of routing protocols. In CRNs, if channel assignment strategy selects channels with low PU activity, high channel availability and high connectivity with neighbors, then routing will be very efficient, stable and CR user can stay on the same channel for longer time interval. Therefore, channel assignment should be properly investigated with reference to its effect on routing in CRNs so that routing can be performed effectively and efficiently.

The importance of CRNs can be seen by examining its various applications in the world. These applications include military applications (Leschhorn & Buchin, 2004), vehicular networks (Maldonado et al., 2005), Delay Tolerant Networks (DTNs) (Van der Schaar & Fu, 2009), etc. CRNs enable communication and restore network connectivity in situations when existing infrastructure is destroyed or disabled by natural calamities in disaster response (Rehmani et al., 2010), emergency and public safety networks by using existing spectrum without needing any infrastructure. The most crucial point in all these applications is timely and reliable data transfer which can only be accomplished through a robust routing protocol. Robustness of routing protocol, in turn, hinges on the selection of channels that are available for transmission for long time periods and cause very little transmission losses commonly known as channel assignment strategy.

Therefore in this chapter, joint channel assignment and routing in CRNs and role of channel assignment in improving network performance is extensively discussed. A lot of work in the form of surveys has been done on channel assignment and routing in CRNs individually (Abdelaziza et al., 2012; Al-Rawi et al., 2012; Tragos et al., 2013; Masonta et al., 2013; Youssef et al., 2013; Xu et al., 2013). But none of them focused on joint channel assignment and routing in CRNs. Therefore, the focus of this chapter is to present a survey on joint effects of routing and channel assignment in CRNs.

Main Contribution

The main points discussed in this chapter are summarized as follows:

- A comprehensive survey on routing; its classification and challenges.
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