

Chapter 14

Secondary Use of Radio Spectrum by High Altitude Platforms

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ABSTRACT

Traditional spectrum licensing enables guaranteed quality of service but could lead to inefficient use of the spectrum. The quest to achieve higher usage efficiency for the spectrum has been the hottest research topic worldwide recently. More efficient transmission technologies are being developed, but they alone cannot solve problems of spatially and temporally underused spectrum and radio resources. In this chapter, the authors review major challenges in traditional spectrum sharing and mechanisms to optimize the efficiency of spectrum usage. They investigate and assess incentives of a primary terrestrial system and secondary system based on a High-Altitude Platform (HAP) to share spectrum towards common benefits. The primary terrestrial system is defined to have exclusive rights to access the spectrum, which is shared by the secondary HAP system upon request. The Markov chain is presented to model two spectrum-sharing scenarios and evaluate the performance of spectrum sharing between primary terrestrial and secondary HAP systems. Simulation results show that to reserve an amount of spectrum from a primary system could encourage spectrum sharing with a secondary system, which has a frequent demand on requesting spectrum resources.

DOI: 10.4018/978-1-4666-2812-0.ch014

INTRODUCTION

Given the success of mobile communications and broadband Internet, network operators and equipment vendors are changing to focus on various data applications and wireless access to the Internet. With the introduction of packet data switching services in cellular systems, connection can be provided for broadband services. Due to the influence and preferences by fixed broadband services, it is believed that data rates will also be increased in mobile communication systems.

To support high data rates with wide area coverage with an accepted cost would require substantial technological advances to increase efficiently usage of radio network resources, e.g. core radio network, base station, radio spectrum. Different approaches have been introduced and applied to increase the efficiency:

- Advanced antenna systems and radio spectrum in lower frequency bands are the two main ways to improve link budgets in macro cellular systems, which are the dominant architecture for second and third generation of mobile networks.
- Relaying techniques could also be used to increase coverage area for high data rates.
- Dynamic Radio Resource Management (RRM) can be improved to efficiently exploit spectrum usage via different strategies, e.g. channel assignment techniques, cognitive radio spectrum sharing.

Regardless of types of wireless services and technologies, a critical component common to all wireless deployments is the access to radio spectrum, which is generally agreed to be a limited and scarce resource. However, there are several measurement campaigns on the spectrum occupancy over time, space and frequency showing that spectrum is sporadically used, which creates motivations to develop new mechanisms to better utilize the spectrum (Peha & Panichpapiboon,

2004). The 2002 report of the Federal Communications Commission (FCC)'s spectrum Policy Task Force (SPTF) represents a seminal document, which shows FCC is moving away from a traditional "command-and-control" spectrum management to a more market-oriented, dynamic approach enabled by rapid innovations in radio communications technology. Consequently, these activities show that it is possible for a spectrum sharing between different operators (or radio access techniques). Approaches to improve the efficiency of spectrum usage have been motivated by its space-time varying spectrum usage. The improvement can be achieved with collaborative mechanisms between different actors using the spectrum. These actors are typically end user terminals, base stations (or the operators owning base stations and users). Therefore, a dynamic spectrum allocation can be regarded as a multi-actor system where actors can share spectrum. Then it is possible to apply knowledge of economics (e.g., game theory) aided mechanism to manage spectrum sharing.

Secondary Access to Limited Spectrum Based on Cognitive Radio

Secondary access means a secondary device is allowed to transmit if and only if it does not interfere with the primary license-holder. In this scheme, spectrum is licensed. A secondary device gain the right to transmit by explicitly requesting permission from the license-holder as needed. A license-holder can grant the permission to access to the spectrum only if a secondary device does not interfere with the primary license-holder, which is serving other calls simultaneously. The primary license-holder will grant the permission if the requirement of Quality of Service (QoS) which is already underway can be met. The license-holder can charge a fee for the secondary access, which provides an incentive to share the spectrum.

Wireless network is characterized by a fixed spectrum assignment policy. In U.S., more than

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