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Reduction of cochannel interference in WCDMA cellular systems

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Abstract

In this paper, a novel cochannel interference reduction technique is proposed for wideband code division multiple access (WCDMA) cellular systems. Cochannel interference for the proposed cellular architecture is considered and analyzed. An analytic expression for the proposed method is derived. Simulation results demonstrate that the proposed method provides better signal-to-noise (S/N) ratio than the existing cochannel interference reduction methods. A significant reduction of cochannel interference is achieved compared to sectoring and omnidirectional architectures in the proposed microzoning architecture. In particular, it is shown here that the proposed architecture exhibits a larger number of users per cell while maintaining an adequate S/N ratio in comparison with other architectures.

Keywords: Spread spectrum; Wideband code division multiple access (WCDMA); Cochannel interference; Microzoning; Omnidirectional antenna

1. Introduction

Wideband code division multiple access schemes play a crucial role in the third-generation (3G) cellular systems. WCDMA is a digital cellular wireless technology that uses spread spectrum

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techniques to scatter a digital radio signal across a wide range of frequencies [1,2]. Code division multiple access (CDMA) appears to be the most popular civilian applications that uses spread spectrum communications. In a code division multiple access system, users share time and frequency resources simultaneously. This occurs through assigning each user a distinct digital code. This code is added to the information data and modulated onto the carrier, using spread spectrum techniques. Since each user has a uniquely addressable code, privacy is inherent. WCDMA provides high data rate transmission over wireless and mobile channels [6]. In this paper, the effect of cochannel interference of WCDMA wireless systems, that utilizes microzoning architecture is examined and compared to sectoring and omnidirectional architectures. The proposed system can be generalized to other cellular CDMA systems.

2. Interferences in cellular radio systems

Interference is the major limiting factor in the performance of wireless communication systems. In cellular radio systems, sources of interference include mobile units in the same cell, a call in progress in a neighboring cell, other base stations operating in the same frequency band, or any noncellular system which inadvertently leaks energy into the cellular frequency band [5]. Cochannel interference (CCI) arises from cellular frequency reuse and thus limits the quality and capacity (number of users) of wireless networks. CCI can be reduced by the use of microzoning or sectoring architectures. The smart antenna systems that utilize an array of antenna elements are also used to reduce the cochannel interference [9,10]. In this paper, the research is focused on the reduction of cochannel interference by utilizing the proposed cellular microzoning architecture.

3. Cochannel interference

Frequency division multiple access and time division multiple access cellular systems rely on spatial attenuation to control intercell interference. As a result, neighboring cells need to be assigned different frequencies to protect against cochannel interference. In contrast, CDMA cellular system can apply a universal one-cell frequency reuse pattern [7]. Frequency reuse implies that in a given coverage of area there are several cells that use the same set of frequencies. These cells are called cochannel cells and the cochannel interference refers to the interference caused between two cells transmitting on the same frequency within a network. Since cochannel interference is caused by another cell transmitting the same frequency, we cannot simply filter out the interference by increasing the carrier power of the transmitter. This is because an increase in carrier transmit power increases the interference to neighboring cochannel cells. To reduce cochannel interference, cochannel cells need to be physically separated by a minimum distance to provide sufficient isolation due to propagation [5]. We can minimize the cochannel interference through the proposed architecture designed for cellular network. A cellular network must be designed to maximize the signal-to-interference (S/I) ratio. Here the S/I ratio is the signal-to-cochannel interference ratio. One of the ways to maximize the S/I ratio is to increase the frequency re-use distance, i.e. increase the distance between cells using the same set of transmission frequencies. The S/I ratio in part