Chapter XIII
Code and Time Synchronization of the Cell Search Design Influence on W-CDMA System Performance

Shailendra Mishra
Dehradun Institute of Technology, India

ABSTRACT

The large-scale statistics of an improved cell search design (improved CSD) using cyclic codes is compared with the 3GPP cell search design using comma free codes (3GPP-comma free CSD) in terms of acquisition time for different probabilities of false alarm rates and to achieve faster synchronization at lower hardware complexity is addressed in this chapter. In the chapter we also proposes design improvements in stage 2 of the 3GPP-comma free CSD. The 3GPP-comma free CSD proposed in this chapter uses a Fast Hadamard Transformer (FHT) in stage 2 that achieves lower hardware complexity and faster decoding. Furthermore, masking functions are used in stage 3 of both the improved CSD and the 3GPP-comma free CSD to reduce the number of scrambling code generators required as described in previous work. This results in a reduction in the ROM size required to store the initial phases of the scrambling code generators in stage 3. The Improved CSD proposed in this chapter aims to achieve faster synchronization between the mobile station (MS) and the base station(BS) and thus improves system performance. Our results indicate that for a channel whose signal-to-noise ratio is degraded with additive white Gaussian noise (AWGN), the improved CSD achieves faster synchronization with the base station and has lower hardware utilization when compared with the 3GPP-comma free CSD scheme under the same design constraints.

INTRODUCTION

W-CDMA is one of the leading wideband digital cellular technologies that will be used for the third-generation (3G) cellular market. The earlier Japanese W-CDMA trial system and the European Universal Mobile Telephone System (UMTS) have both served as a foundation for the workings of this harmonized W-CDMA system under the supervision of the Third-Generation Partnership Project (3GPP). The 3GPP organizational partners are the European Telecommunications Standard Institute (ETSI), the Japanese Association of Radio Industries and Businesses (ARIB), the Japanese Telecommunication Technology Committee (TTC), the Korean Telecommunications Technology Association (TTA), and the American Standards Committee on T1 Telecommunications. The harmonized system is sometimes referred to as 3GPP W-CDMA, to distinguish it from earlier wideband CDMA versions. The W-CDMA system will employ wideband CDMA in both frequency division duplex (FDD) and time division duplex (TDD) modes (Ojanperä & Prasad, 1998).

The main difference between W-CDMA and CDMA2000 is that W-CDMA supports asynchronous base stations (BSs) whereas CDMA2000 relies on synchronized BSs. Synchronous CDMA systems need an external time reference. A global positioning system (GPS) clock can be used by all BSs to synchronize their operations. This allows the mobile station (MS) to use different phases of the same scrambling code to distinguish between adjacent BSs. In an *asynchronous* CDMA system, each BS has an independent time reference, and the MS does not have prior knowledge of the relative time difference between various BSs. The advantage of asynchronous operation is that it eliminates the need to synchronize the BSs to an accurate external timing source. However, since there is no external time synchronization between the adjacent BSs, different phases of the same code cannot be used to distinguish adjacent BSs. Thus, in an *asynchronous* CDMA system, adjacent BSs can only be identified by using distinct scrambling codes. Consequently, cell search—which involves the process of achieving code, time, and frequency synchronization of the MS with the BS—takes longer in comparison to a *synchronous* CDMA system. Cell search is complicated in the presence of signals which are intended for other mobile systems within a cell, as well as signals from other BSs (Dahlman et al., 1998). Thus, it is very important to develop algorithms and hardware implementations to perform cell search using lower acquisition time and minimum hardware resources for *asynchronous* CDMA systems. In W-CDMA,

Figure 1(a). Downlink channel multiplexing and spreading