3G Commercial Deployment

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INTRODUCTION

Currently, five terrestrial radio interfaces, which can be categorized as frequency division duplex (FDD) and time division duplex (TDD) modes, have been approved as the IMT-2000 radio interfaces. CDMA in TDD (TDD-CDMA) mode will be based on the harmonization between UTRA (UMTS terrestrial radio access) TDD and TD-SCDMA (time division-synchronous CDMA). Compared to UTRA TDD, which is 3.84Mcps in 5MHz bandwidth, TD-SCDMA, is also called low chip rate (LCR) TDD or Narrowband (NB) TDD for its 1.28Mcps in 1.6MHz bandwidth. TDD uses a combined time division and code division multiple access scheme. Hence the signals of different users are separated in both time and code domains (Chen, Fan, & Lu, 2002).

Jointly developed by the China Academy of Telecommunications Technology (CATT) and Siemens, TD-SCDMA is one of the five IMT-2000 standards accepted by the ITU. The main benefits of TD-SCDMA are that it can be implemented less expensively than comparable 3G systems since it is much more spectrum efficient and is compatible with the current deployment of GSM network elements in China, allowing 3G asymmetric services without installation of completely new infrastructure.

Compared with WCDMA and CDMA, TD-SCDMA (Peng et al., 2005) adopts TDD duplex mode, uses the same frequency band for the uplink and downlink, and makes full use of the asymmetrical frequency resource. Meanwhile, the TDD mode has the adjustable switch point between uplink and downlink, which can adapt to the asymmetrical service in uplink and downlink and makes full use of the spectrum. Furthermore, the symmetrical channel feature of TDD systems makes it very flexible and convenient for TD-SCDMA to adopt the advanced technologies such as joint transmission, smart antenna, and so on, which can improve the system capacity and spectrum efficiency. Because the uplink and downlink of TD-SCDMA use the same carrier frequency, the channel propagation features and channel impulse response in downlink and uplink have strong correlation when the interval between uplink reception and downlink transmit is less than the channel coherent time. So the channel information estimated in uplink can be directly used for downlink transmission, and this provides a good condition for implementation of smart antenna. Therefore, compared with the FDD system, channel estimation, power control, and smart antenna in the TD-SCDMA system become more simple and feasible.

As the CDMA system is a self-interfering system, interference among users is the key factor that limits the system capacity (Klein, Irwin, & Roberto, 1991). Using joint detection (JD), inter-symbol interference (ISI), and multiple access interference (MAI) can be effectively eliminated, and as a result, the system capacity is improved (Peng et al., 2004). With the spatial location information, smart antenna can focus the transmit signal power in the direction of the target user, through which users will receive more useful signal power, and interference is highly compressed. This is another way to increase system capacity. However, what is the difference of the radio network planning between TD-SCDMA and WCDMA/cdma2000? Based on the TDD mode, TD-SCDMA covers all application scenarios: voice and data services, packet and circuit-switched transmissions for symmetric and asymmetric traffic, pico, and micro and macro coverage for pedestrian and high mobility users. However, the adopted key techniques, such as time division duplex, smart antenna, multi-user joint detection (MUD), dynamic channel distribution, uplink synchronization, and baton handover, make the network design in TD-SCDMA have a significant different from WCDMA and cdma2000 (Peng et al., 2005). Unfortunately, to the best of our knowledge, there are still no papers investigating and proposing network design solutions for TD-SCDMA in which the impacts of key techniques have been considered. In this article, the key techniques impacting on the radio network design of TD-SCDMA are introduced. Meanwhile, some special radio network design issues for TD-SCDMA are presented.

Figure 1. TD-SCDMA frame structure

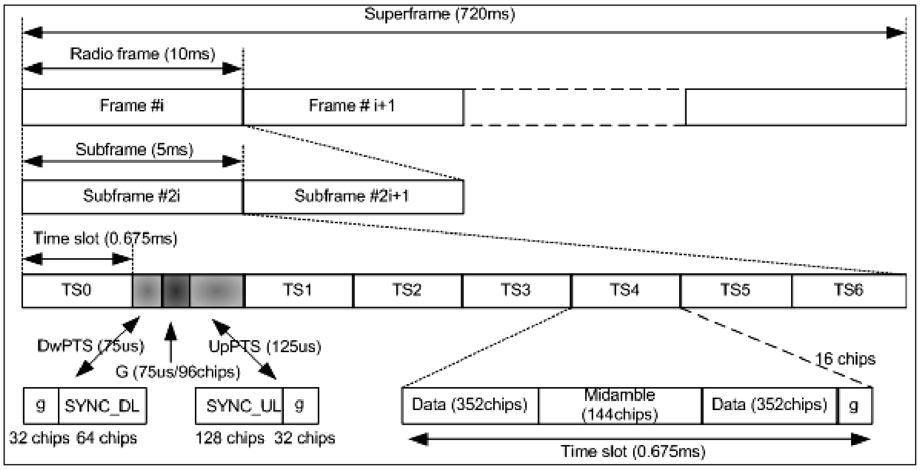
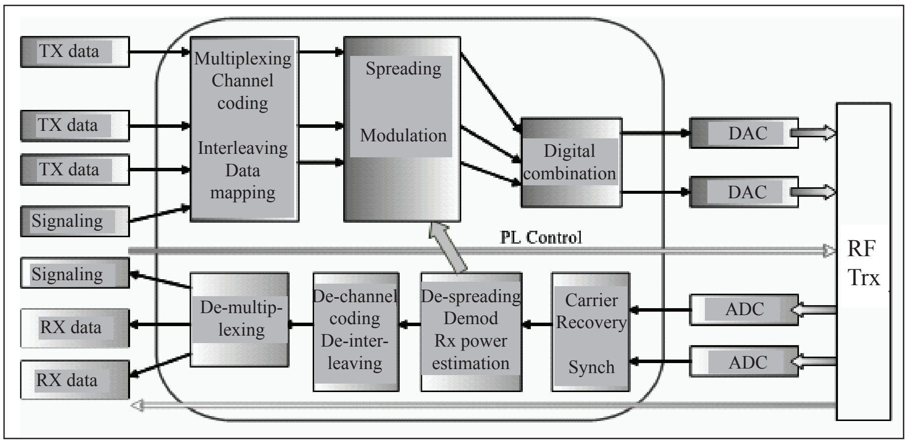


Figure 2. System block of TD-SCDMA base band data processing



SYSTEM BLOCK

TD-SCDMA makes use of both TDMA and CDMA techniques such that channelization in TD-SCDMA is implemented using both time slots and signature codes to differentiate mobile terminals in a cell. The frame structure of TD-SCDMA is shown in Figure 1, where the hierarchy of four different layers—super-frame, radio frame, sub-frame, and time slot—are depicted.

A sub-frame (5 ms) consists of 7 normal time slots and 3 special time slots, where TS0 is reserved for downlink and TS1 for uplink only, whereas the rest (TS2-TS6) should form two groups, the first (whose size can vary from 1 to 4 slots) for uplink and the second (whose size can vary from 4 to 1 slots) for downlink. The slot number ratio of the two groups can take 1/4, 2/3, 3/2, and 4/1 to suit particular traffic requirements. The agility in support of asymmetric traffic is a very attractive feature of TD-SCDMA and of particular importance for Internet services with rich multimedia content in 3G applications. The other three special time slots are downlink pilot (DwPTS), guard period (G), and uplink pilot (UpPTS), respectively. DwPTS and UpPTS are used as a synchronization channel (SCH) for downlink and uplink, respectively, which should be encoded by different pseudo-noise (PN) codes to distinguish different base stations and mobiles. Meanwhile, the subscribers use the midamble part of every burst to estimate the channel impulse response. The subscribers in the same cell are assigned the same basic midamble with different time shift. Using the Steiner estimate principle, the base station can estimate the channel impulse response of all the subscribers simultaneously. The base band data processing is described in Figure 2.

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