WCDMA시스템에서 고속전송을 위한 다중 전송률 구조

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A Hybrid Multi-rate Schemes for High-speed Transmission in WCDMA Systems

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요 약

본 논문에서는 WCDMA시스템에서 세가지 서로 다른 다중 데이터율(multi-rate) 전송구조의 성능을 비교하고 고속데이터 전송에 적합한 구조를 제안한다. 세가지 다중 데이터율 전송구조의 성능을 분석하기 위해 백색 가우시안(AWGN) 채널과 주파수 선택적 페이딩 채널(frequency selective fading channel)하에서 모의실험 하였다. 다중코드와 다중 처리 이득 코드를 이용한 시스템을 Hybrid하게 사용한 시스템이 WCDMA시스템의 고속전송에 적합하다는 것을 볼 수 있었다.

ABSTRACT

Different kinds of Multi-rate communication systems are considered for accommodating information sources with different data rates. Direct-sequence code-division multiple access(DS/CDMA) techniques have attracted many attentions to be employed in such a system. In this paper, three multi-rate transmission schemes in a W-CDMA system are compared. Both AWGN and multipath Rayleigh fading channels are considered. It is shown that for high data rates the spreading factor in the variable spreading factor scheme will be very small and thus the performance will be significantly degraded due to intersymbol interference. Thus Variable spreading factors are used for the low and medium high data rates, and combined with multicode transmission for the highest data rates. Simulation result shows that hybrid multirate transmission scheme is suitable for WCDMA.

Ⅰ. 서 론

IMT-2000 systems are required to deal with multimedia communication services that transmit various kinds of data with bit rates being from low rate to much higher rate[1]. As direct sequence W-CDMA is recognized as one of the most promising technologies for IMT-2000 systems, so that there are lots of studies on this technologies[2]. Obtaining high bit rates at low error rates over wireless channels is a difficult task. The increase of data rate in a W-CDMA can be implemented by two schemes: Orthogonal multi-SF(spreading factor) code[3] and multicode [4].

An orthogonal multi-SF forward link using orthogonal multi-SF code allows flexible offering of different multi-rate services to users without loss of orthogonality. The spreading code does not need to be changed according to the data rate. However, the spreading ratio is reduced as the data rate increases[13].

In the multicode scheme, the bit stream to be transmitted is split into several parallel streams. Each stream is then spread by a code out of a

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set of orthogonal codes, and then transmitted in parallel.

The drawback of the multicode scheme is that it requires as many RAKE receivers as there are codes. So the complexity of the receiver can be quite high.

Here we assume that the channel consists of a fixed number of paths. The multiple access interference is Gaussian. We will also assume that the multipath Rayleigh fading channel is a slowly fading channel, so that the channel random parameters do not change over several consecutive symbol intervals.

In this paper, we consider different kinds of multirates schemes and then compare their performance. In extremely high rate transmission, we proposed to introduce the hybrid use of orthogonal multi-SF(Spreading Factor) code transmission and multi-code transmission in high-speed wireless Data Transmission.

The organization of this paper is as follows. we describe three multirate schemes in Section Ⅱ, Section Ⅲ presents simulation result, Finally, Section Ⅳ is the concluding sections.

Ⅱ. Multi-rate Schemes

A. Multicode transmission schemes

Fig.1 illustrates the multicode(MC) transmission schemes. In this system, an incoming high-rate data stream with duration T_b is serial-to-parallel (S/P) converted into M low-rate bit streams with symbol duration $T=KT_b$. The M data streams are spread by different orthogonal codes A_k, $k=1,\cdots m$, and add together. The use of orthogonal spreading codes will be given zero interference between the two subchannels .

To describe the multicode transmission system shown in Fig.1, let $\{b_m\}$, $b_i \in \{\pm 1\}$ be the input bit sequence to be transmitted. The bit period of each sub-stream is now $T^* = MT$. The M post-spreading waveforms transmitted on the channel are now given as

$$s^{*(j)}(t) = \left(\sum_m \sqrt{2P} b^{(j)}{}_m \left[\sum_{n=0}^{G^*-1} c_{m+n} q_n^j \cdot h(t - mT_1^* - nT_c) \right] \right) \times \times \cos(2\pi f_c t),\ j = 1, \ldots, M \quad (1)$$

where, h(t) is rectangular pulse of unit amplitude on [0, T_c] with T_c being the chip rate and $G^* = \frac{T*}{T_c}$ is the processing gain for each sub-stream in this case[5].

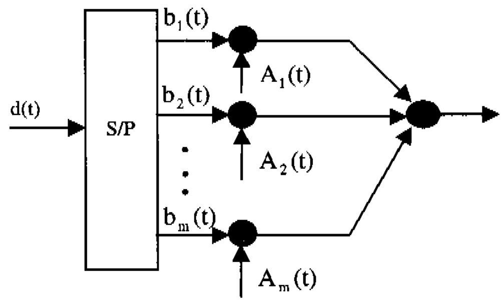

Fig. 1 Multicode transmission scheme.

The resultant transmitted waveform can be written as

$$s^* = \sum_{j=1}^{M} s^{*(j)}(t) \quad (2)$$

B. single code transmission scheme

For high rates the spreading factor may be very low and for variable-rate services the spreading factor will vary during the call. A drawback of the variable spreading factor scheme is that a very short code duration leads to intersymbol interference(ISI). A method to obtain variable-length orthogonal codes that preserve orthogonality between different rates and SFs based on a modified Hadmard transformation is presented in [3]. In a single-code transmission, the chip rate is constant, and each user transmits data on only one CDMA channel with a spreading factor(SF) that varies inversely with the rate R, SF =

Orthogonality between the different spreading factors can be achieved by tree-structured orthogonal codes whose construction is illustrated in Fig. 2..

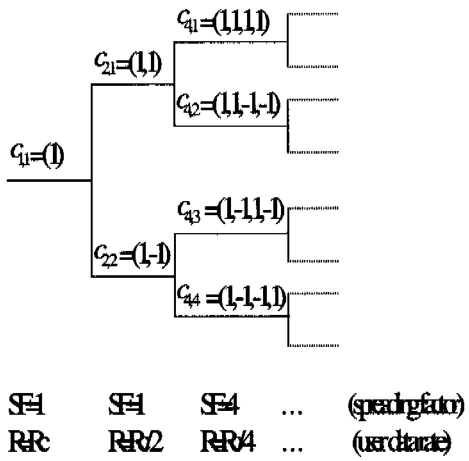

Fig. 2 Construction of orthogonal spreading codes for different spreading factors..

The orthogonal multi-spreading factor codes are generated recursively according to the following equation(3)[3][13].

$$c_{2^m}=\begin{bmatrix} c_{2^m}^{(1)} \\ c_{2^m}^{(2)} \\ \cdots \\ c_{2^m}^{(2^m)} \end{bmatrix}=\begin{bmatrix} \begin{bmatrix} c_{2^{m-1}}^{(1)} & c_{2^{m-1}}^{(1)} \\ c_{2^{m-1}}^{(1)} & -c_{2^{m-1}}^{(1)} \end{bmatrix} \\ \cdots\cdots \\ \begin{bmatrix} c_{2^{m-1}}^{(2^{m-1})} & c_{2^{m-1}}^{(2^{m-1})} \\ c_{2^{m-1}}^{(2^{m-1})} & -c_{2^{m-1}}^{(2^{m-1})} \end{bmatrix} \end{bmatrix} \quad (3)$$

The transmitted spread signal s(t) of the single user can be written as

$$s(t)=\left(\sum_m \sqrt{2P}b_m\left[\sum_{k=0}^{G_c-1} c_{2^m}^{(n)}(k)h(t-mT_1-kT_c)\right]\right)\times \\ \times\cos(2\pi f_c t),\ j=1,\dots,M \quad (4)$$

where $c_{2^m}^{(n)}(k)$ i 2^m $2^m-1)$ c selected from Fig. 3.(note that for spreading modulation, 1 and 0 represent -1 and 1 , respectively).

This system using orthogonal multi-spreading factor code is particularly useful in the situations where the data rate varies during communication. We do not need to change the spreading code according to the data rate, instead we can keep on using the same spreading code with SF corresponding to the data rate.

A single spreading code can be used for a wide range of data rates and thus the mobile receiver can be significantly simplified.

C. Hybrid scheme

We show that variable spreading factors and multicode transmission are used to obtain multiple data rates. In a variable spreading factor scheme, the spreading ratio is reduced as the data rate increases. So the performance will significantly degrade due to intersymbol interference. In a multicode scheme, additional parallel codes are allocated as the data rate increases. Variable spreading factors are used for the low and medium high data rates, and are combined with multicode transmission for the highest data rates. In Fig. 1, A(t) is replaced with orthogonal multi-spreading factor code which is generated from equation(3).

Ⅲ. Simulation Results

In this section, we will show some simulation result for Single-Code, Multi-Code transmission and hybrid transmission under frequency selective Rayleigh fading environments[5].

In Fig.3 we see that the multi processing-gain scheme and the hybrid scheme have almost the same performance. In Fig. 4 the performance of hybrid multirate scheme is better than that of the single code.

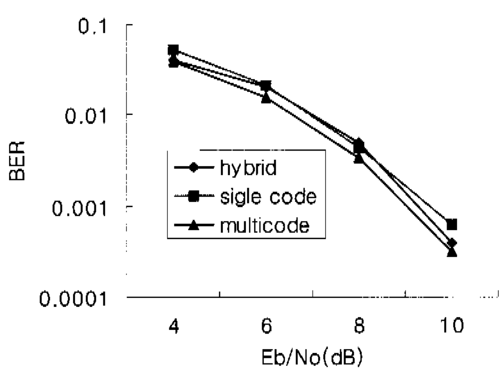

Fig. 3 BER performance with downlink 256kbps

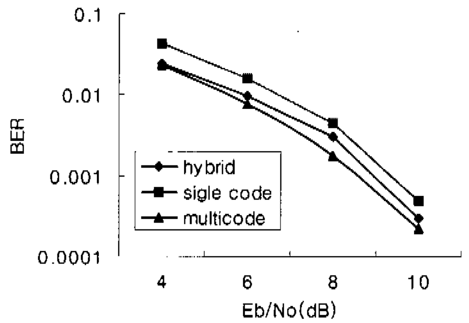

Fig. 4 BER performance with downkink 2Mbps

Ⅳ. CONCLUSION

We have investigated three multi-rate schemes for a WCDMA system and found that the use of multi processing-gain and multi-channel schemes gives almost the same performance, both for AWGN and multipath fading channels.

Simulation results show that the hybrid multi-rate system can support high-rate data transmission with low complexity for WCDMA .

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