OVSF 碼的配置對峰均比(PAR)所造成的效應
The Effect of OVSF Code Assignment on PAR

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摘要

在此篇論文中，第三代無線行動通訊標準(3GPP)的通道碼將被介紹，垂直可變延展因子(OVSF)碼的配置法亦會被提及。對於峰均比(PAR)及垂直可變延展因子(OVSF)碼派置的關係將被討論，而針對寬頻碼分多重接取(W-CDMA)，一種簡單的初始化垂直可變延展因子(OVSF)碼的派置法將被加以研究。此方法之目的乃在於減低峰均比(PAR)，且其精神在於平均分佈，模擬的結果顯示此方法既簡易亦能有效的派置垂直可變延展因子(OVSF)碼。

關鍵詞：補償累積分佈函數，垂直通道雜訊模擬器，垂直可變延展因子，峰均比，寬頻碼分多重接取

Abstract

In this paper, the channelization code for 3GPP is introduced, and some methods to assign OVSF code will be mentioned. The relationship between PAR and OVSF code assignment will be discussed, and a simple method for initial OVSF code assignment in W-CDMA is studied. The assignment method is for the purpose of reducing PAR and it is based on the concept of "even distribution". The simulation shows that it is a useful and simple method to assign OVSF codes.

keyword：**CCDF, OCNS, OVSF code assignment, PAR, W-CDMA**

I. Introduction

Wideband code division multiple access (W-CDMA) is one of the wideband digital cellular technologies that are used for the third generation wireless communication. For W-CDMA, spread spectrum is used to transmit multiple channels over a common bandwidth, and the capacity of the W-CDMA system is limited by the interference from other channels. In the 3GPP technical specification, orthogonal variable spreading factor (OVSF) codes are selected to be the channelization codes which are used for spreading. OVSF codes haves the property of preserving the orthogonality between different physical channels. Because the number of the OVSF codes is finite, it is a valuable resource and should be utilized properly. In [1], a code channel assignment method to support as many users as possible with less complexity is found. In [2], an optimal dynamic code assignment scheme is used to enhance statistical multiplexing and spectral efficiency of W-CDMA systems supporting variable user data rates. Besides, the OVSF code assignment has significant effect on the value of peak-to-average ratio (PAR), and it is important to assign OVSF codes properly. In [3], it is found that PAR of the signal depends on the Walsh code assignment for IS-95 and CDMA2000. Moreover, a method to control PAR by selective Walsh code mapping is proposed. In [4], it is found that the RF characteristics of a W-CDMA signal, particularly the PAR or the complementary cumulative distribution function (CCDF) of the envelope, varies significantly with OVSF code assignment. Generally, consecutive codes generate more severe PAR than the codes that are evenly distributed in the OVSF code space. In addition, low data rate channels produce more severe PAR than high data rate channels.

In this paper, the purpose is to study the OVSF codes assignment's effort on PAR, especially for the 3GPP model. In Section 2, the channelization codes of 3GPP specification will be introduced. Moreover, the PAR definition will be explained, and PAR's effect on 3GPP's specification will be described. Then the suggested OVSF codes assignment will be introduced. In Section 3, the simulation for the OVSF codes assignment's effect on PAR will be shown. This simulation focuses on the test models of 3GPP specification [5]. The simulation results will indicate the suggested method is a proper way to assign OVSF codes based on reducing PAR. In Section 5, some conclusions will be made about OVSF code assignment.

II. The relationship between OVSF code and PAR

A. Channelization Code in 3GPP Specification

The channelization codes adopted in figure 1 and figure 2 are OVSF codes that preserve the orthogonality between different physical channels. The OVSF codes can be defined using the code tree of figure 3 [7].

In figure 3, the channelization codes are uniquely described as $C_{ch,SF,k}$, where spreading factor (SF) is the spreading factor of the code and k is the code number, $0 \leq k \leq$ SF-1. Each level in the code tree defines channelization codes of length SF, corresponding to a spreading factor of SF in figure 3. The total number of possible OVSF codes is equal to SF, but not all of the OVSF codes can be used. In the 3GPP specification, any daughter code in the code tree can't be used if the mother code is already being used.

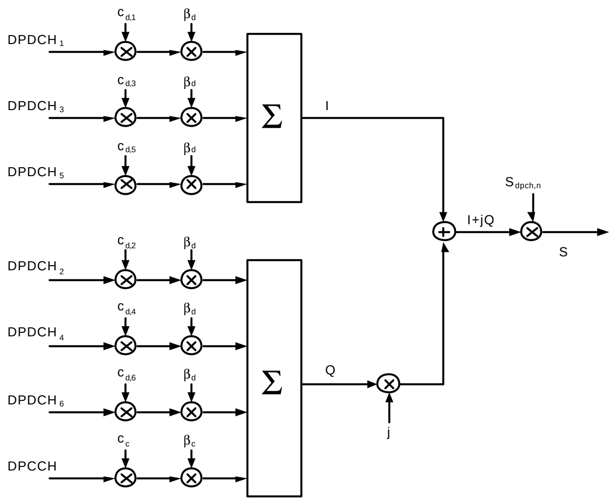

Figure 1. Spreading for uplink DPCCH and DPDCHs

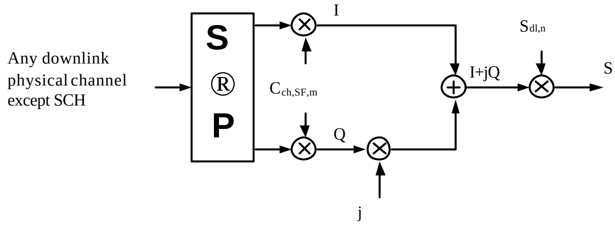

Figure 2. Spreading for all downlink physical channels except SCH

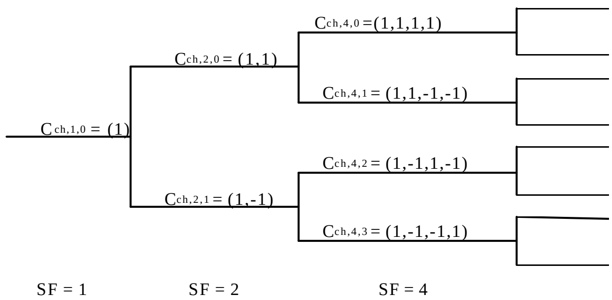

Figure 3. Code-tree for generation of orthogonal variable spreading factor (OVSF) codes

B. PAR's definition and effect

The PAR is the ratio of peak power to average power, and the peak value of a signal x(t) is obtained by the maximum value of its envelope |x(t)| in amplitude. PAR is a significant parameter for the linear amplifier. Operating a power amplifier in its linear range will avoid chipping and hence spectral regrowth. Therefore PAR is a significant issue for basestation design. In order to reduce the required PA linear dynamic range, a low PAR is desirable. PAR is typically shown graphically through the signal's CCDF. The CCDF plot is a histogram that graphs the PAR and is a statistical method to indicate the peak power properties of the signal versus probability. There is a parameter called crest factor and it is the maximum PAR value obtainable if the observation window is significantly large. In other words, the crest factor is the maximum PAR value that occurs at any probability point on the CCDF curve. In order to amplify the signal linearly, the PA has to be operated in the dynamic range that is greater than or equal to the crest factor. Figure 4 shows the CCDF curves for two W-CDMA downlink signals with different channel configurations: a signal with 16 serially distributed DPCHs and a signal configured as test model 1 with 16 DPCHs. For a probability of 0.01 percent, the signal with 16 serially distributed DPCHs has a higher PAR than the signal configured as test model 1[6].

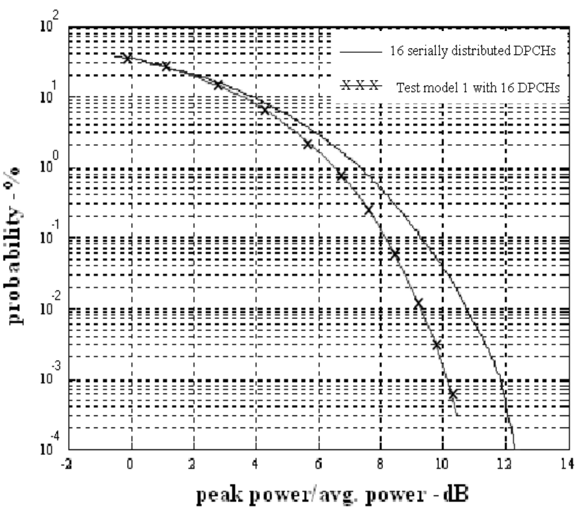

Figure 4. A typical CCDF plot of PAR for 16 W-CDMA downlink channels with SF = 128

C. Proposed OVSF codes assignment scheme

There are many methods to assign OVSF codes for different purposes. The method introduced here is to reduce PAR, and to limit adjacent-channel leakage. High PAR causes serious problem. Signal will be distorted if PA's dynamic range is not wide enough. Using the OVSF code assignment is an alternative method to reduce PAR. The spirit of the proposed method is the concept of "even distribution" and these channels should be evenly distributed in code domain. In the 3GPP specification, the orthogonal channel noise simulator (OCNS) is defined, and it is the mechanism used to simulate the users or control signals on the other orthogonal channels of the downlink. It is also proposed that the 16 dedicated channels of the OCNS signal should be evenly distributed to optimize it. The method opposite to even distribution is to distribute channels serially and the PAR is larger. In addition, the PAR of W-CDMA signals will increase with the number of code channels. Simulation of these conditions will be described in Section III.

III. Performance simulation

In this section, the simulation shows that even assignment of OVSF codes results in smaller PARs than serial assignment of OVSF codes. Moreover, a view of the PAR for W-CDMA signals increasing with the number of code channels is shown.

These simulations are based on the OCNS models in 3GPP specification. The two models can support 16, 32 DPCH channels whose SF = 128 and 256 for variant basestation implementations. Because baseband data can impact PAR significantly, test models have been defined with random data and time offsets [5]. The diagram is shown in figure 5 and these parameters for simulations are shown in Table 1 and Table 2.

The simulation result is shown in figure 6 and the even assignment of OVSF codes has about 2 dB improvement in CCDF at the point of 0.001 percent. Moreover, it is shown that PAR for WCDMA signals increases with the number of code channels for the evenly distributed style.

IV. Conclusion

In this paper, the relationship between PAR and OVSF codes assignment is discussed. Assigning OVSF codes evenly is the suggested method because of its good performance and simple implementation. It has about 2dB improvement in CCDF at the point of 0.001 percent when compared with the method of assigning OVSF codes serially. Besides, it is found that the value of PAR increases with the number of channels.

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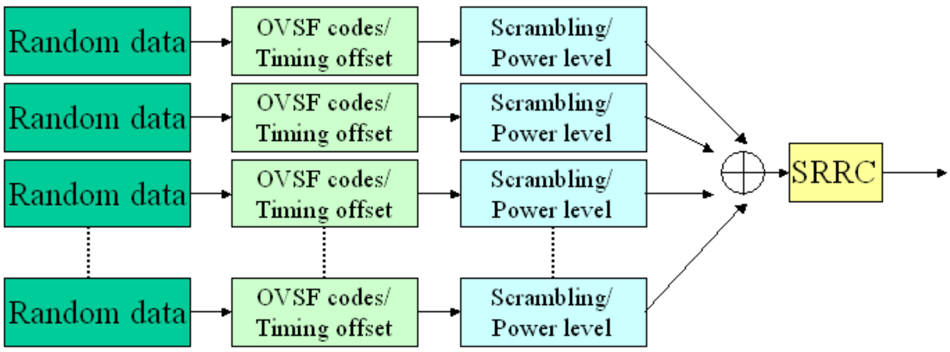

Figure 5. The simulation architecture for OVSF codes allocation

Table 1. The basic parameters for simulations

Chip rate (chip/frame)	38400
Scrambling model	Downlink scrambling
Scrambling seed (x0, …, x17)	1, 0, 0, …, 0

Table 2. The parameters for OVSF codes assignment

OVSF code sets	code sequences $C_{ch,128,s}$ or $C_{ch,256,s}$	OVSF codes assignment style
set 1 (spec16)	$C_{ch,128,s}$:{2, 11, ..., 119} OCNS model with 16 DPCHs	Randomly (tend to evenly)
set 2 (series0-15)	$C_{ch,128,s}$:{0, 1, ..., 15} with 16 DPCHs	Serially
set 3 (sf128chs16-even)	$C_{ch,128,s}$:{2, 11, ..., 119} OCNS model with 16 DPCHs	Randomly (tend to evenly)
set 4 (sf128chs32-even)	$C_{ch,128,s}$:{2, 11, ..., 125} OCNS model with 32 DPCHs	Randomly (tend to evenly)
set 5 (sf256chs16-even)	$C_{ch,256,s}$:{2, 11, ..., 119} OCNS model with 16 DPCHs	Randomly (tend to evenly)
set 6 (sf256chs32-even)	$C_{ch,256,s}$:{2, 11, ..., 125} OCNS model with 32 DPCHs	Randomly (tend to evenly)
set 7 (sf256chs32series0-31)	$C_{ch,256,s}$:{0, 1, ..., 31} with 32 DPCHs	Serially
set 8 (sf256ch32series1-32-a)	$C_{ch,256,s}$:{1, 2, ..., 32} with 32 DPCHs	Serially
set 9 (sf256ch32series1-32-b)	$C_{ch,256,s}$:{1, 2, ..., 32} with 32 DPCHs	Serially

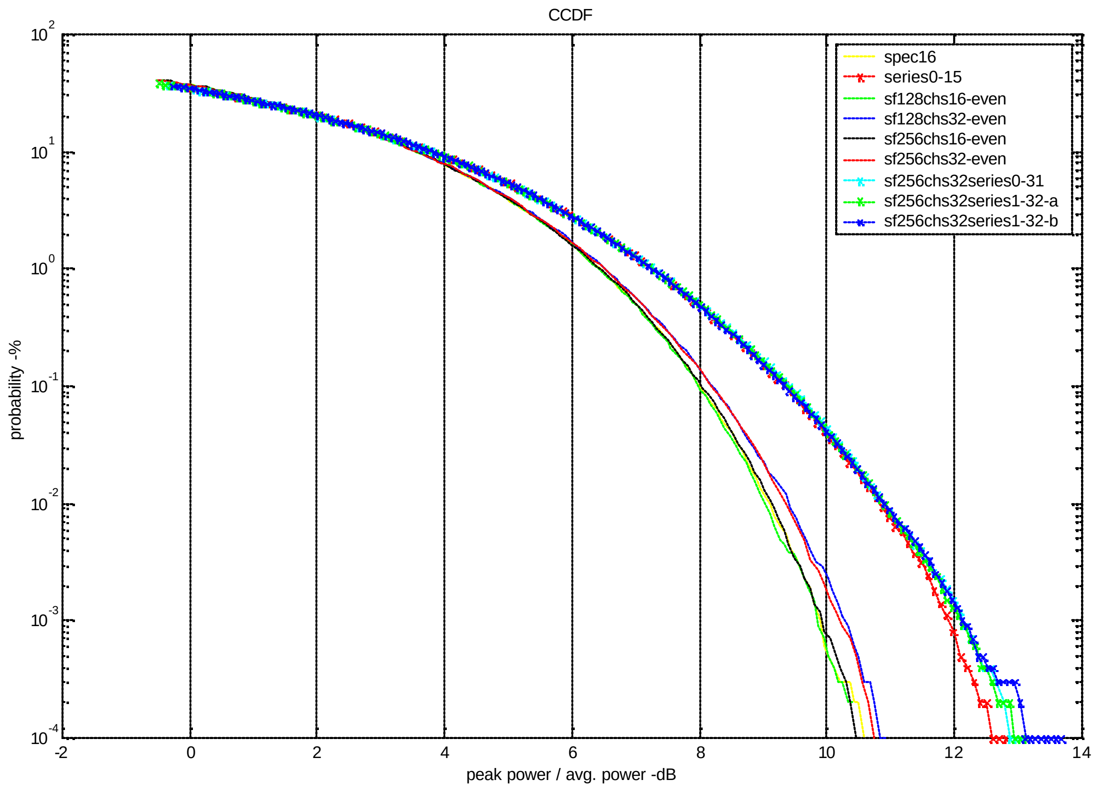

Figure 6. The PAR vs. OVSF codes assignment for SF=128