GEO Satellite Communication System

Ms. K. Abirami
Assistant Professor
Dept of ECE
Parisutham institute of Technology and Science-Thanjavur

Mr. S. Kamaraj
UG Scholar
Dept of Aeronautical
Parisutham institute of Technology and Science-Thanjavur

Mr. L. Mariya Sharvin Jeffrey
UG Scholar
Dept of Aeronautical
Parisutham institute of Technology and Science-Thanjavur

Abstract **:A three-layer inter leaver scheme, which is added into TO-SCOMA specification for the compatibility with satellite environment, is proposed for 3G mobile satellite communication systems. Simulation results for satellite channel are presented, which demonstrate that the third interleaver can improve the system performance significantly and satisfy the demands. The proposed interleaver design also provides the theory basis for researching upper layer protocol and transplanting TO-SCOMA specification to satellite environment.**

Keywords: GEO satellite, satellite communication,

I. INTRODUCTION

As a for of mobile communication system, mobile satellite communication system is not only a significant way for realizing seamless coverage of wireless communication, but also an important guarantee for economic and social development. With the worldwide application of 3rd Generation (3G) network, 3G mobile satellite communication system implementation in China is still a blank field. Though the research on3G satellite system is emerging quickly, most of the results are based onFrequency Division Duplex (FOO) mode. Analyses of the compatibility between WCOMA and satellite communication system from aspects of air interface,random access, network architecture.

Apart from WCOMA standard which is based onFOO, the TOO-based TO-SCOMA standard is also an important option of 3GPP UMTS. But so far, Iridium system is the only one TOO satellite communication system which leads to few studies about compatibility between TO-SCOMA standard and mobile satellite communication system. Compared to FOO, TOO-based mobile satellite communication system has the benefits such as more flexible spectrum allocation, easier to use smart antennas and beam fonning methods to achieve perfonnance optimization.

However, in contrast with the terrestrial mobile communication systems, satellite system suffers from many restrictions such as lacking of resources and deterioration of channel conditions, which will result in compatibility issues for directly transplanting TO-SCOMA standard to satellite system. Among them, the most obvious change in the satellite system is channel conditions, especially at the aspect of larger.This work is supported by the National Science Foundation of China (Grant No. NFSC #61071083).Ying Si, Xi Luan, Shubo Ren, Satellite and Wireless Communication Lab, School of Electronics Engineering and Computer Science, Peking University, Beijing 100871, China(e-mail: renshubo@pku.edu.cn). Jianjun Wu, Satellite and Wireless Communication Lab, School of Electronics Engineering and Computer Science, Peking University, Beijing 100871, transmission delay and longer coherence time For satellite systems, worse channel conditions will cause system BER perfonnance degradation, which cannot meet the requirements of high-BER business. give a method to overcome the perfonnance deterioration in mobile satellite communication system. Nevertheless, the compatibility with 3G standard is not taken into account.

In this paper, we set out from terrestrial TO-SCOMA specification, focus on the design of interleaver to overcome the channel fading and propose a 3rd layer interleaving scheme. The proposed configurable interleaver, whose major parameters and methods are discussed here, is inserted into the mobile satellite communication system compatible with TO-SCOMA specification. Simulation results preliminarily show that the proposed scheme is satisfactory and feasible in mobile satellite communication system.

The remainder of this paper is organized as follow. Section 2 briefly reviews the features of mobile satellite communication system based on TO-SCOMA standard and the compatibility problems. Section3 proposes a three layers interleavers design and the properties of the structure are analyzed in detail. Section 4 presents the perfonnance evaluation of the scheme by simulation results. Section 5 draws some conclusions.

II. SYSTEM DESCRIPTION

As one of the 3G standards, TO-SCOMA has entered the stage of widespread use. In contrast with WCOMA, TO-SCDMA system has the advantages of higher spectrum efficiency, lower power control requirements, more suitable to use smart antenna and joint detection techniques to improve system perfonnance. Applying TO-SCOMA standard to mobile satellite communication system can partly inherit these merits to obtain better system perfonnance.

Typical mobile satellite communication system consists of three parts: user tenninal, satellite and gateway station, as shown in Fig. 1. The air interface of satellite system can be referred to terrestrial system.

3G mobile satellite communication system compatible with TO-SCOMA standard, which makes some appropriate modifications on air interface and core network of UMTS3G standards, needs to employ modified versions of TO-SCOMA standard to fulfill the two-way link. Because the physical layer is more likely to be affected by the satellite channel environment, we pay close attention to the applicability of TO-SCOMA physical layer specification in the 3G mobile satellite communication system. The physical process such as slot structure, transport and physical channel division and mapping, channel multiplexing and coding process, spread spectrum and modulation are grounded on TO-SCOMA criterion with proper update. In this paper, we mainly focus on the interleaver design and implementation.

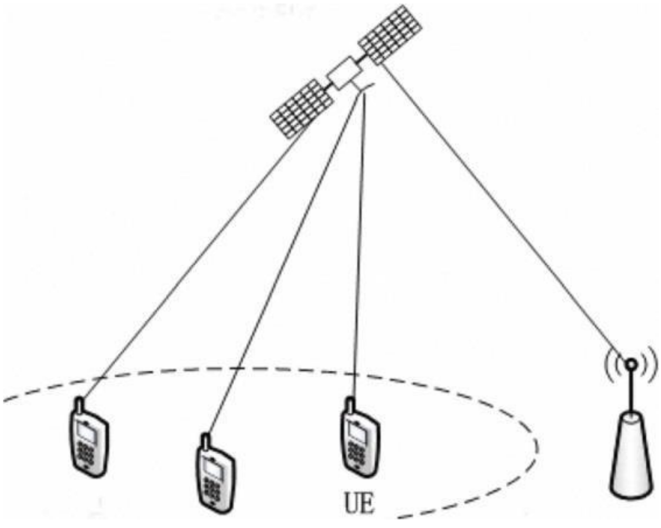


Fig. I. Typical mobile satellite communication system structure

III. INTERLEAVER SCHEME

In TO-SCOMA system, fading that occurs on small time scale can be mitigated using interleaving, but fading that takes place on large time scale can only be reduced by power control. Corresponding to the mobile satellite communication system, fading that happens on a time scale larger than system interleave depth cannot be overcame due to the larger channel propagation delay and longer power control period. Moreover, owing to the longer coherent time, mixed performance improvement on the interleaving and fading has also declined. Taken together, satellite system which directly uses TO-SCOMA specification cannot completely overcome the channel fading; the system BER performance degradation is too serious to meet the requirements of data services. In order to enhance the BER results, we modify the original TO-SCOMA standard interleaver structure and propose a3rd layer interleave strategy.

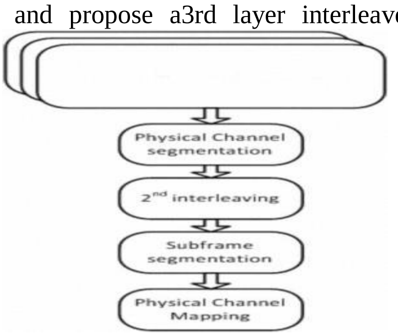


Fig. 2. TD-SCDMA standard transport channel processing

The transport channel process in TO-SCOMA is shown as Fig. 2. Two layers of interleaver are used in the specification: 1st interleaver is specific to each CCTrCH, including four interleaving depth selections: 10ms, 20ms, 40ms, 80ms; 2nd interleaver focus on transport channel after multiplexing, two options, frame related and timeslot related interleaving, are included. Thus, in existing TO-SCOMA standard, only fading which occurs on a time scale slower than 80ms can be mitigated by interleaving. We improve the large time scale fading by power control. Nevertheless, power control period in satellite system is about 600ms, which greatly exceeds the maximum interleaving depth and leads to system performance degradation.

According to the discussion above, we propose a3rd layer interleaver in the 3G mobile satellite communication system. The proposed interleaver is a configurable one which is inserted between two physical sub-layers, as shown inFig. 3. Interleaving depth is a key parameter for the 3rd layer interleaver, its selection should be compromised among several factors: firstly, the 3rd layer interleaver should compensate for the fading which cannot be overcame and result in an interleaving span larger than 600ms due to the increasing of power control period; Secondly, considering the processing difficulty, interleaving depth ought to be an integer multiple of max TTl which equals to 80ms; And finally, since the system performance is positively related to interleaving depth, the interleaving depth of3rd layer interleaver should be selected as long as possible. However, with the interleaving depth increase, the system complexity and processing delay are also rising. Furthermore, when interleaving depth reaches the 4-5 multiples of channel coherent time, increasing interleaving depth does not significantly improve the system BER performance. Hence, we should minimize the depth to satisfy the requirement of the two previous demands.

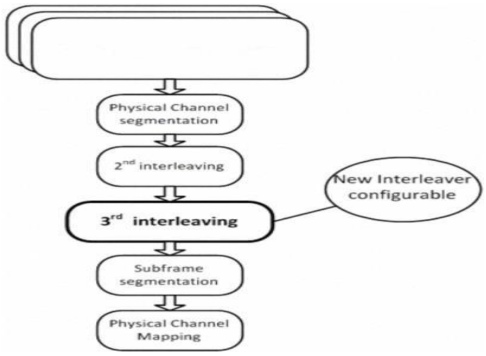
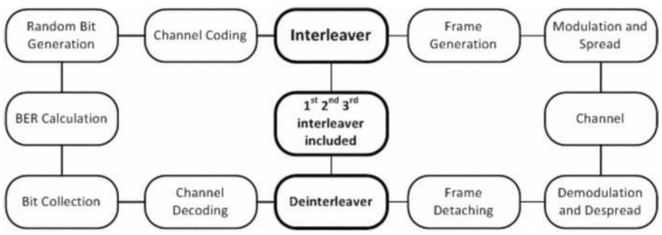


Fig. **3.** Modified and optimized transport channel processing

In the mean time, for adaptability, versatility and consistency, we use block interleaver with inter-column permutations as the 3rd layer interleaving method, similar to the 1st and 2nd interleaver in TO-SCOMA standard. Specific steps are as follows: calculate the interleaver matrix parameters and inter-column permutation pattern; Write the data bits into the matrix row by row and fill the empty position by dummy bits if it is necessary; Perform the inter-column permutation for the matrix based on the pattern; Read output bit column by column, and the output is pruned by deleting dummy bits.

For delay-sensitive and BER-insensitive voice services, the3rd layer interleaver, which brings a significant increase in system processing delay, is unbearable. We can promote the system performance by increasing transmitter power. On the contrary, for BER-sensitive and delay-insensitive data services, 3rd layer interleaver is an available scheme to improve the system performance. In the mobile satellite communication system, whether to use3rd layer interleaver is instructed by higher layer though services QoS, which need to combine with higher control signal and algorithm. In this paper, since we just focus on physical level, these issues are not considered.



In order to verify the correctness and feasibility of above changes, we design a simulation system, the transmitter and receiver block diagrams of the simulation model described in this paper are shown in Fig. 4. The processing details are based on TO-SCOMA standard with some appropriate changes. Frame structure, channel coding and decoding, spread spectrum and modulation, 1st and 2nd interleaver are consistent with the TO-SCOMA specification.

IV. PERFORMANCE ANALYSIS

System simulation parameters are as follows: single antenna, single cell and single user system; 112 convolution code and QPSK modulation; The satellite environment channel model is given by ITU-R.M. 1225, which is modeled as **a** flat fading channel with a strong line-of-sight component; The diffuse fading process is modeled as a complex-valued, zero-mean Gaussian random process with Jakes autocorrelation

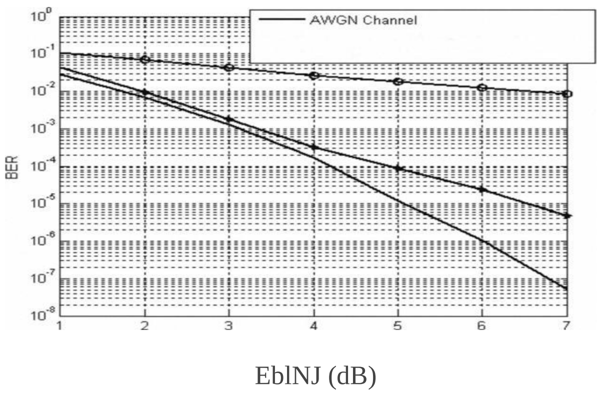


Fig. 5. System BER-EbINO results under different channel models

Fig. 5 presents no-interleaver system BER-EbINO results under the AWGN, satellite channel without Jakes autocorrelation and with Jakes autocorrelation environment. It can be seen that the system has a good performance in AWGN channel. Under the satellite channel without autocorrelation, the deterioration is not serious, particularly when the EblNO is low. However, the system performance results are obvious decline in the Jakes autocorrelation channel. This phenomenon is mainly due to the large relevance of the channel. Under the circumstances that no interleaver is applied, many consecutive errors may occur, which cannot be detected and corrected by the channel coding and decoding scheme, leading to the system performance degradation. The interleaver designed in this paper is mainly used to solve the continuous relevance error problem and improve system BER performance, which ideally should be as close as possible to channel without Jakes autocorrelation**.**

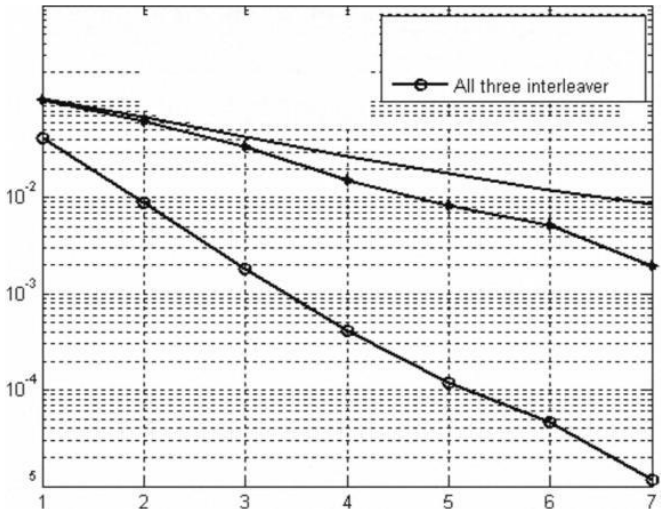


Fig. 6. System BER-EbINO results under different interleaver configurations

From Fig. 6, we can get the system BER-EbINO results under different interleaver configurations: no interleaver, only 1st and 2nd interleavers and three layers interleavers. Consistent with the theoretical analysis, the result without interleaving is worst. The results show that there is not an obvious improvement when 1st and 2nd interleavers are existed because the much longer correlation time compared with terrestrial environment. When three layers interleavers are used, we get a 3-5dB improvement which shows the superiority of the design.

V. SUMMARY

In 3G mobile communication system, interleaving is an importantmean to overcome the channel fading, structure and parameters of the interleaver has a crucial importance for the performance of mobile communication system. The existing autocorrelation and multipath in the satellite channel environment will cause system performance degradation problem. In layer interleaver in the TD-SCDMA standard, which ensure the interoperability andcompatibility.The solution is proven by the simulation that the optimized system performance can nearly reach the non-autocorrelation channel, in line with expected results. These results are not only significant reference for mobile satellite communication system design compatible with TD-SCDMA specification, but also lay a theoretical foundation for further top layers study**.**

REFERENCES

[1] Beatrice MARTIN, N. Chuberre, H.J. Lee, "IMT-2000 Satellite Radio Interface for UMTS Communications over Mobile Satellite Systems[J]", in Advanced Satellite Mobile Systems,2008, Sep,2008, pp.l67-172.

[2] A. U. Quddus, R. Tafazolli, B. G. Evans, "Time Diversity in WCDMA FDD Downlink for Multimedia Broadcast/Multicast Services using Chip Block Interieaving[J]", in Personal, Indoor and Mobile Radio Communications, 2005. PIMRC 2005. July 2006, pp. 311-315.

[3] "Physical channels and mapping oftransport channels onto physical channels (TDD) [S]", 3GPP TS 25.221 V4.8.0, 2005.

[4] Emmons Jr., Thomas Peter, Robert Anthony, "System and method for providing dual satellite communications coverage[P]," US Patent 6,411,609 Bl, Jun. 25, 2002.

[5] Michael Rice, Eric Perrins, "A simple figure of merit for evaluating interleaver depth for the land-mobile satellite channel", IEEE Transaction on Communications, Vo1.49, No.8 , August 2001.

[6] M-l Fernandez-Getino Garica, H.Lou, V.Weerackody, "Channel coding and interleaver design for satellite broadcasting in the S-band", in Vehicular Technology