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Title	マルチメディア通信に適したDS/CDMA方式における通信速度割り当てに関する研究
Author(s)	長岡，貴光
Citation	
Issue Date	2000-03
Type	Thesis or Dissertation
Text version	author
URL	http://hdl.handle.net/10119/1345
Rights	
Description	Supervisor:日比野 靖，情報科学研究科，修士

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A Study on Transfer Rate Assignation for Multimedia Communications in DS/CDMA Systems

Takamitsu Nagaoka

School of Information Science,
Japan Advanced Institute of Science and Technology

February 15, 2000

Keywords: Multimedia Communication, Multi-rate, DS/CDMA, Spread Spectrum, Variable-length orthogonal code, Multi-Code.

Abstract

A variable-length orthogonal code system and a multi-code system has been proposed communications with multiple transfer rate(multi rate) in the Direct Sequence Code Division Multiple Access(DS/CDMA) system. However, fine transfer rate can not be set up in variable-length orthogonal code system, because transfer rate in this system is varied in a power of 2. On the other hand, the multi-code system requires a lot of receivers in order to cope with various transfer rates. As a result, receiver circuits in the system are complicated.

Therefore, the author proposes a Variable-length Multi-Code DS/CDMA System in this paper. In this proposal system, a variable-length orthogonal code system and a multi-code system are combined, which is simply able to set up transfer rate more flexible and frequency bandwidth more simply. The latter half of this paper imposes various conditions of treated media, and show the proposed system flexible against transfer rate and bit error rate(BER) characteristic by computer simulation.

However, this system can not satisfy the required conditions imposed in previous discussions. There, we introduce error correction codes(Hamming code) and show characteristics of effect of this. Finally, we evaluate this proposal system and compare the result of computer simulations with theoretical calculation.

1 Introduction

Recently, the tightness of frequency band in mobile communications and its capability towards multimedia communication become serious problems[1]-[3]. Therefore, it is an

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important factor how to assign transfer rate(bandwidth) for each medias under each radio conditions in multiple access technics[4]. For multi rate communications, a variable-length orthogonal code system and a multi-code system[1],[8] have been proposed in Direct Sequence Code Division Multiple Access (DS/CDMA) system[5]-[7]. However, fine transfer rate can not be set up in a variable-length orthogonal code system, because transfer rate in this system is varied in a power of 2. Also, the multi-code system requires a lot of receivers in order to serve various transfer rates. As a result, receiver circuits in this system are complicated. Therefore, the author proposes Variable-length Multi-Code DS/CDMA System in this paper. In this proposal system, a variable-length orthogonal code system and a multi-code system are combined, which is able to set up transfer rate more flexible and frequency bandwidth more simply.

The rest of this paper is organized as follows. In chapter 2, the CDMA system is introduced. In addition, we show that variable-length orthogonal code system can generate little channels, and the multi-code system requires a lot of receivers in order to cope with various communication rates. In chapter 3, we propose a new variable-length multi-code DS/CDMA system and describe it. And then, we impose various conditions to treat various medias in this paper. In chapter 4, we evaluate the characteristics of the proposal system by computer simulations. In chapter 5, Hamming code, an error correction code, is described. Also, we analyze BER characteristic in theoretical method and computer simulation to confirm how BER characteristic is reduced by Hamming code. And then, we simulate BER characteristic by computer, and show it. In chapter 6, considerations by comparing results obtained by computer simulations and theoretical calculations in the system proposed are described. Finally, conclusions are given in chapter 7.

2 CDMA Communication Systems

In mobile communications, it is necessary to effectively utilize limited frequency resources by enabling multiple users to share radio communications channels to simultaneously conduct communications. The technology that is used for this purpose is called multiple access. Three systems are adopted to realize multiple access depending on way in which radio channels are separated: Frequency Division Multiple Access(FDMA) that divides by frequency, Time Division Multiple Access(TDMA) that divides by time, and CDMA that divides by spread codes using the spectrum spread.

This chapter mainly describes a principle of CDMA(DS/CDMA). And then, we explain reason why CDMA are received much attention, and describe that CDMA is suitable for multiple rate communications as multiple access system, too. Now, proposed method as this techniques, variable-length orthogonal code system and multi-code system are described. However, the authors found weak points that it is impossible for variable-length orthogonal code system to vary flexible rate, and that circuit is complicated in multi-code system because of the increase of the number of receivers.

3 Variable-Length Multi-Code System

In chapter 2, the authors introduce a principle and a feature of CDMA system and show the weak points of a variable-length orthogonal code system and a multi-code system proposed, as method which corresponds to the multi rate communication in DS/CDMA system. In this chapter, we propose Variable-length Multi-code System. In this system, a variable-length orthogonal code system and a multi-code system are both implemented. It is possible to vary communication rate more flexible, more simply. And then, we describe a principle of this system, significancy and a problem about this proposal system. Moreover, we pick up treating medias in this paper, and describe required conditions of these medias.

4 The Evaluation by Computer Simulations

In a variable-length multi-code system, it is possible to provide flexible transfer rate for users more simply, but this system has problem which is the increase of multiple-access-interference(MAI) by code assignation methods.

Therefore, we evaluate proposal system by computer simulations to confirm how this system is made worse by an influence of MAI. Now first, we simulate Direct Sequence Spread Spectrum(DS/SS) single user system and DS/CDMA multi user system are possible to analyze theoretical calculation, to confirm correctly of this simulator. And then, we evaluate the proposal system using three different code assignation methods with this simulator.

5 The Reduction in BER using Forward Error Correction Code

This proposal system can not satisfy the required conditions imposed because of the increase of MAI. Therefore, we devise reducing bit error rate(BER) by using an error correction code in this proposal system.

This chapter describes Hamming code in an error correction code. We analyze BER characteristic in theoretical method and computer simulation to confirm how BER characteristic is reduced by Hamming code.

6 Consideration

This chapter describes considerations by comparing the results obtained by computer simulations and theoretical calculations in the proposed system, in chapter 4 and chapter 5. As a result, we can find out the best code assignation method in a viewpoint of BER characteristic. The proposal system using this method can accommodate up to 4 times number of users compared with the worst case method in this simulation. Also, we show a simple algorithm which is code assignation using the proposal system.

7 Conclusion

The tightness of frequency band in mobile communications and its capability towards multimedia communication become serious problem in recent years. For multi rate communications, a variable-length orthogonal code system and a multi-code system have been proposed in DS/CDMA system. However, fine transfer rate can not be set up in a variable-length orthogonal code system, because transfer rate in this system is varied in a power of 2. Also, the multi-code system requires a lot of receivers in order to serve various transfer rates.

The author proposes Variable-length Multi-code DS/CDMA System in this paper. Here, a variable-length orthogonal code system and a multi-code system are combined, which is able to set up transfer rate more flexible and more simply. However, this system has a problem which is the increase of MAI. Therefore, we evaluate proposal system by computer simulations to confirm how this system is made worse by influence of MAI. As a result, we found out the best code assignation method in a viewpoint of BER characteristic. The proposed system using this method can accommodate up to 4 times number of users compared with the worst case method in this simulation. Finally, we show a simple code assignation algorithm.

References

[1] Sadaatsu OKASAKA, Yukitsuna Furuya, Fumio WATANABE, "A Radio Transmission System for IMT-2000", IEICE Journal, Vol.82, No.2, pp.123-130, 1999.

[2] Minami NAGATSUKA, Yoshihiro ISHIKAWA, Shinji UMEBAYASHI, "Data Traffic Control and Capacity Evaluations for Voice/Data Integrated Transmission in DS-CDMA", IEICE Trans. Commun., Vol.E81-B, No.7, pp.1355-1364, July, 1998.

[3] Young-Woo KIM, Seung Joon LEE, Min Young CHUNG, Jeong Ho KIM, Dan Keun SUNG, "Radio Resource Assignment in Multiple-Chip-Rate DS/CDMA System Supporting Multimedia Services", IEICE Trans.Commun., Vol.E82-B, No.1, pp.145-155, 1999.

[4] P.Mermelstein, A.Jalali, H.Leib, "Integrated Services on Wireless Multiple Access Networks ", Proc. IEEE ICC, pp.863-867, Oct. 1993.

[5] A. J. Viterbi, "CDMA: principle of Spread Spectrum Communications", Addison-Wesley, 1998.

[6] Vijay K. Garg, Kenneth F. Smolik, Joseph E. Wilkes, "Applications of CDMA in Wireless/Personal Communications", Prentice Hall PTR, 1997.

[7] Ramjee Prasad, "CDMA and Wireless Personal Communication", Science and Technology Publishing Company, 1997.

[8] E.H. Dinan and B. Jobbari, "Spreading Codes for Direct Sequence CDMA and Wideband CDMA Cellular Networks", IEEE Commun. Mag., Vol.36, no.9, pp.48-54, Sept. 1998.