Performance Evaluation of Asynchronous CPFSK-CDMA Systems

Kazuyuki Morioka[1] David K. Asano[2]

The Interdisciplinary Graduate School of Science and Technology,
Department of Mathematics and System Development, Shinshu University, Nagano 380-8553, Japan.[1]
Department of Information Engineering, Shinshu University, Nagano 380-8553, Japan.[2]

1 Introduction

In this correspondence, we consider asynchronous Continuous Phase Modulated(CPM) CDMA systems which have better spectral properties than traditional BPSK/QPSK CDMA systems. Asano, *et al.* evaluated the performance of CPM-CDMA systems under the constraint of equal bandwidth after spreading [1]. We extend their research, and evaluate the performance of asynchronous CPFSK-CDMA systems under the same condition for several parameters.

2 System Model

The transmitted signals, $s_k(t), 0 \le k \le K-1$, are described as follows.

$$s_k(t) = A\cos[2\pi f_c t + \phi_k(t, \alpha_{\mathbf{j}}^{(\mathbf{k})})], \qquad (1)$$

where K is the number of system users, A is the amplitude of the transmitted signals, and f_c is the carrier frequency. $\phi_k(t, \alpha_{\mathbf{j}}^{(\mathbf{k})})$ is the phase, which is mapped to the k-th user's j-th spreading sequence $\alpha_{\mathbf{j}}^{(\mathbf{k})}$ and is described as follows.

$$\phi_k(t, \alpha_{\mathbf{j}}^{(\mathbf{k})}) = 2\pi h \sum_{i=-(L-1)}^{N-1} \alpha_{j,i}^{(k)} q(t - iT_c). \qquad (2)$$

Here, h is the modulation index, T_c is the chip interval, and the length of the spreading sequences is given by $N = T/T_c$. The function $q(t)$ in (2) is a continuous phase function described as $q(t) = \int_{-\infty}^{t} g(\tau)d\tau$, where $g(\tau)$ is a pulse shape function.

The signal is called Continuous Phase Frequency Shift Keying (CPFSK), when $L = 1$ and $g(\tau)$ is the rectangular pulse shape. In particular, when $h = 1/2$ the CPFSK signal becomes Minimum Shift Keying (MSK).

3 Simulation Results

Fig.1 shows the average bit error probabilities when the number of system users is five. The values of h used are $0.25, 0.375, 0.5, 0.625, 0.75$ and the corresponding code lengths N are $160, 133, 121, 90, 77$. Here, we choose the code length N so that the bandwidth after spreading is the same. We can see that CPFSK CDMA systems for any parameters outperform the BPSK CDMA systems under the same conditions.

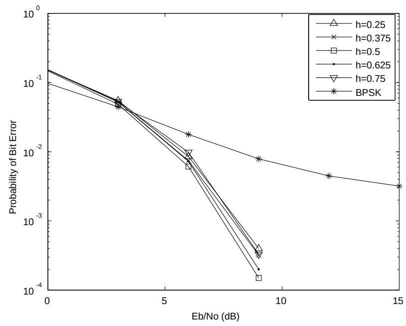

Fig. 1 Average error probabilities for 5 users.

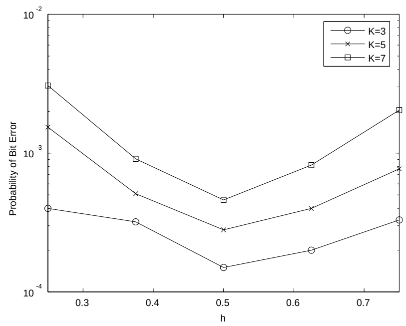

Fig. 2 Average error probabilities at 9 dB.

Fig.2 shows the average bit error probabilities when E_b/N_o is 9 dB. The horizontal axis is the modulation index h. Fig.2 shows that the bit error probability is the best when $h = 0.5$. It means that $h = 0.5$ has the best tradeoff between spreading factor and modulation index.

4 Conclusions

We evaluated asynchronous CPFSK CDMA systems in this correspondence. To evaluate the systems equally, we constrain the bandwidth after spreading. Simulation results show the effectiveness of CPFSK CDMA systems.

References

[1] Asano, D.K. and Hayashi, T. and Kohno, R., 'Modulation and processing gain tradeoffs in DS-CDMA spread spectrum systems', *Spread Spectrum Techniques and Applications, 1998. Proceedings., 1998 IEEE 5th International Symposium on*, vol. 1, pp.9–13, 1998.