Adaptive 2D Code Assignment for Uplink in 2-Dimensional Block Spread CDMA system

Qiyue Yu
Harbin Institute of Technology, Harbin, China

Fumiyuki Adachi
Tohoku University, Sendai, Japan

1. Introduction

In next generation mobile communications, a flexible support of multi-rate for multimedia services is required. Code division multiple access (CDMA) a promising technique to meet this requirement [1]. The transmission rate can be easily changed by changing the spreading factor of orthogonal spreading code. Recently, 2-dimensional (2D) OVSF spreading that can avoid the multi-access interference (MAI) while allowing the multi-rate uplink transmission was proposed [2]. 2D OVSF spreading has two spreading factors SF_f and SF_t. In OVSF spreading, higher data rates transmission is provided by using lower SF. When one code is used in the OVSF code tree, its descendant and ancestor codes cannot be used. Therefore, the OVSF code tree has a limited number of available codes. Code assignment for 2D OVSF spreading is an important technical problem. In this paper, the code assignment for 2D OVSF spreading is proposed.

2. Multi-rate Uplink CDMA

As users arrive randomly, some of new arrival users have to be refused because of the code limitation. Our purpose is to decrease the blocking probability. There are three methods to support multi-rate transmission. First one is to directly change the spreading factor. Second one is to use multi-code assignment [3]. However, these two methods cannot avoid MAI. For 2D OVSF spreading, if the spreading factor SF_t is chosen such that $SF_t \geq U$ (where U is the number of simultaneous users), the uplink MAI can be avoided while allowing the multi-rate transmission by changing the spreading factor SF_f, where $SF = SF_t \times SF_f$ is the total spreading factor.

3. Uplink adaptive code assignment

The available transmit rate is expressed as $R_i = Q \times R$, where R denotes the lowest rate and Q takes a value from e.g., 8, 4, 2, and 1. The adaptive 2D code assignment algorithm is shown in Fig.1. $SF_{total} = SF_{fmax} \times SF_{tmax}$ is the total spreading factor, where SF_{fmax} and SF_{tmax} are the predetermined maximum spreading factors.

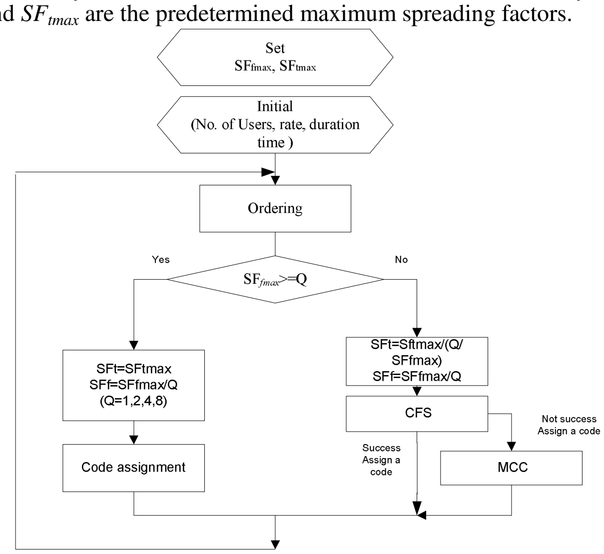

Fig.1 Adaptive 2D code assignment

In Fig.1, CFS stands for the crowed-first-space algorithm [4]. The CFS algorithm picks the candidate code whose ancestor code has the least free capacity (most crowded). If several codes that give the same capacity exist, then the code is chosen which belongs to the ancestor code whose tree is more crowded. MCC stands for multi-code combination to support a higher rate code. It bases on the multi-rates structure theory as described [3].

4. Simulation results and Discussions

In the computer simulation, we set SF_{total}=128 with SF_{fmax}=1 and 2 (two cases are considered). Figure 2 plots the simulated blocking probability as a function of traffic load G. The average packet length is assumed to be 3 slots. It can be seen from Fig.2 that the proposed code assignment algorithm provides lower blocking probability than the random algorithm. The use of SF_{fmax}=2 gives a slightly smaller blocking probability than the use of SF_{fmax}=1.

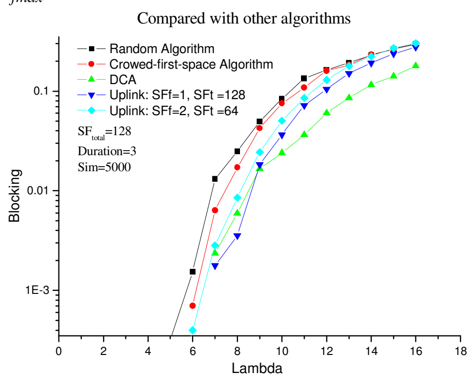

Fig2. Blocking probability.

5. Conclusions

2D OVSF code assignment was proposed. It was shown by the computer simulation that the proposed code assignment algorithm provides the better blocking probability performance than the random algorithm and also the crowed-first-space algorithm.

References

[1] F. Adachi, "Wireless past and future-Evolving mobile communications systems", IEICE Trans. Fundamentals, vol.E84-A, no.1, pp.55-60, Jan. 2001. [2] Le Liu, Fumiyuki Adachi, "2-Dimensional OVSF Spread/Chip-Interleaved CDMA" IEICE Trans. Commun., vol.E89-B, no.12, pp.3363-3375, Dec. 2006. [3] Qiyue Yu, Le Liu, Fumiyuki Adachi, "Adaptive code assignment for a multiuser/multi-rate CDMA system", IEICE Trans. RCS, March. 2008 [4] C. M. Chao, Y. C. Tseng and L. C. Wang, "Reducing Internal and External Fragmentations of OVSF Codes in WCDMA Systems with Multiple codes," IEEE Trans. Wireless Commun., vol.4, pp. 1516-1526, July 2005.