Unified KS–Code

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INTRODUCTION

Many codes have been proposed for optical CDMA system as discussed in Svetislav, Mari, Zoran, Kosti, and Titlebaum (1993), Salehi (1989), Liu and Tsao (2002), Maric, Moreno, and Corrada (1996), Wei and Ghafouri-Shiraz (2002), and Prucnal, Santoro, and Ting (1986). Optical code division multiple access (OCDMA) has been recognized as one of the most important technologies for supporting many users in shared media simultaneous, and in some cases can increase the transmission capacity of an optical fiber. OCDMA is an exciting developments in short haul optical networking because it can support both wide and narrow bandwidth applications on the same network, it connects large number of asynchronous users with low latency and jitter, and permits quality of service guarantees to be managed at the physical layer, offers robust signal security and has simplified network topologies. However, for improperly designed codes, the maximum number of simultaneous users and the performance of the system can be seriously limited by the multiple access interference (MAI) or crosstalk from other users.

Another issue in OCDMA is how the coding is implemented. The beginning idea of OCDMA was restricted in time domain, in which the encoding/decoding could not been fully utilized in optical domain. Therefore a new coding in OCDMA has been introduced based on spectral encoding (Kavehrad & Zaccarin, 1995; Pearce & Aazhang, 1994; Smith, Blaikie, & Taylor, 1998; Wei & Ghafouri-Shiraz, 2002). The system, called Optical Spectrum CDMA, or OS-CDMA, has the advantage of using inexpensive optical sources, and simple direct detection receivers. In this article with an emphasis on the Spectral Amplitude Coding scheme, a new code known as Khazani-Syed (KS) code is introduced.

BACKGROUND

The unique concept of KS-codes is due to the arrangement of two subcodes in their code family, in a way that the resulting cross-correlation among two users is always less or equal to one (Al Junid, Ali, Ramli, & Abdullah, 2004; Aljunid, Zan, Anas, & Abdullah, 2004; Aljunid, Samad, Othman, Hisham, Kasiman, & Abdullah, 2005). Before probing any further, let us define the

Figure 1. Venn diagram: KS-Code, C

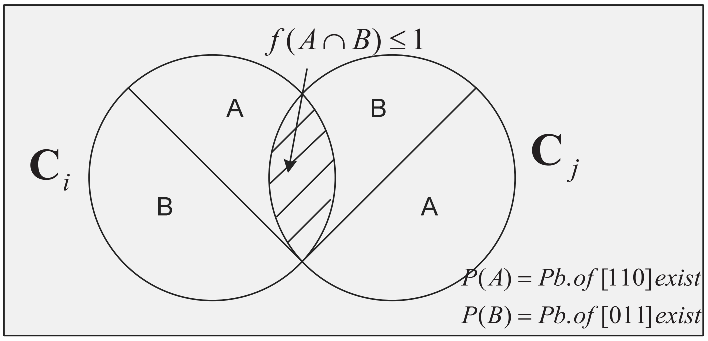
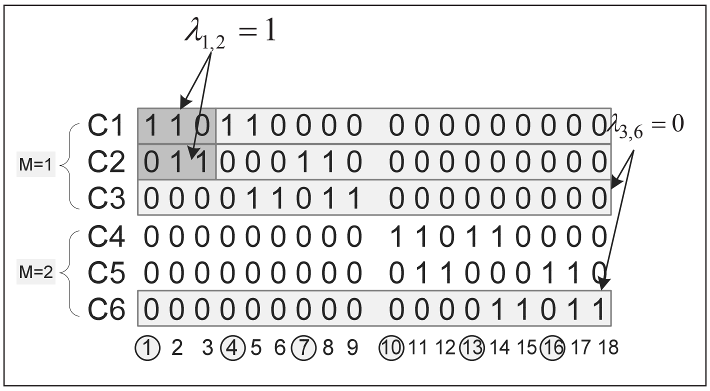


Figure 2. KS-Code, W=4, M=2



four important parameters used to characterize the KS-code. They are code weight, W, number of mapping, M, number of users, K, and code length, N.

The properties of KS-code can be best depicted in a Venn diagram, as shown in Figure 1. Let C_i and C_j, be two different codes which belong to two different users, with $i \neq j$. Both codes are from the same family of KS-code, **C**. $P(A)$ and $P(B)$ are defined as the probability of existence of subcodes A and B, respectively. Both codes, C_i and C_j would have one of three subcodes combination probabilities; either (1) $P(A) > 0$ *and* $P(B) > 0$ or (2) $P(A) > 0$ *and* $P(B) = 0$ or (3) $P(A) = 0$ *and* $P(B) > 0$. From Figure 1, it is stated that in KS-code, the event of $A \cap B$ is defined as in-phase CC, where the frequency of $f(A \cap B)$ occurs at most one. In another word, the maximum CC, $\lambda = 1$ (i.e., the in-phase CC of [1 1 0] and [0 1 1] is equal to one).

The relationship between these events and the three probabilities of C_i or C_j is explained by example in Figure 2. Let a family code **C** consist of C_u codes, u=1,2,..,6, and M be the number of mapping, M=1,2. Code C_1 and C_4 are arranged in such a way that $P(A) > 0$ *and* $P(B) = 0$, while in contrast, both code C_3 and C_6 have $P(A) = 0$ *and* $P(B) > 0$. There is also probability that $P(A) > 0$ *and* $P(B) > 0$, as in code C_2 and C_5. It can be seen that any of the two codes within the same mapping would have resulting an in-phase CC, $\lambda = 1$, for example between C_1 and C_2. Meanwhile, any code's spectrum would not affect the other's spectrum from different mapping, thus $\lambda = 0$ (e.g., between C_3 (from M=1) and C_6 (M=2)).

CONSTRUCTION OF KS-CODE

As stated earlier, the construction of KS-code family is influenced by the arrangement of two subcodes A = [110] and B = [011]. It is therefore important to define the position of each subcode in each user, while the remaining subcodes are filled with [000]. For example, by referring to Figure 2, each subcode can be initialized by the position of 1, 4, 7, 10, 13, or 16 (as in circle). At this point, the application of matrix is valuable for the code construction. Let the basic code be defined