Chapter 2

LITERATURE REVIEW

Various techniques have been proposed for the support of multi-rate services provision in OCDMA networks. Varying the code length [9, 10], adopting optical fast frequency hopping [11], and multi-code [15–19] are the most popular techniques employed to provide multi-rate service in OCDMA networks. Svetislav V. Maric, Oscar Moreno, and Carlos J. Corrada found that in any spread spectrum system there are two ways to vary the data rate. The data rate can be varied either by varying the spreading factor while maintaining a constant spread bandwidth, or by varying the number of codes transmitted in parallel. They choose the former possibility which in fact, in the fiber-optic CDMA, corresponds to varying the length of signature sequences where OOC families have been considered and measured over a wide range of data [20]. Therefore, in order to achieve multi-rate transmission it is necessary to be able to construct quasi orthogonal OOCs with different lengths. In this case a longer sequence corresponds to lower data bit rates and the shorter length sequence corresponds to higher data rates [9].

Although, theoretically the most obvious way for varying the system rate the system has limited applications due to a limited number of sequences for high rate users and their relatively high error probability. Svetislav V. Maric and Vincent K. N. Lau have introduced two schemes for achieving multi-rate transmission in fiber-optic CDMA networks as in [15]. One scheme called parallel mapping [15], more than one codeword is dedicated to users with high bit rate or more than one service. The number of codewords is proportional to user bit rate or number of its services. The second, variable spreading rate or serial mapping [9, 21], codes with variable-length codewords are employed. Codewords with smaller length are dedicated to services with higher bit rates, and codewords with larger length are dedicated to services with lower bit rates. Even though this scheme usually experiences a high bit error rate (BER) for high rate users, in [22], a multilength OOC code for multirate OCDMA is proposed which presents a lower BER for high rate users. The performance analysis shows that both schemes can allow simultaneous transmission of a high number of different rate users. Both schemes are extremely interesting from the practical stand point since they do not require any new optical processing at the receiver, since they use exactly the same OOC sequences used for single rate transmission and hence the same number of incoherent optical matched filters. In the parallel scheme error correction codes (ECC) was applied to improve the number of simultaneous users

in the network. The addition of ECC is again achieved with no loss in the information throughput and with no added complexity in the receiver [15]. In the serial scheme the ECC is not applied. However, because there is only one active address per each active user (no matter of its rate), the interference experienced by all the users is the same. Hence, this scheme can allow a larger number of simultaneous higher rate users in the uncoded case. It is interesting that the serial scheme in a special case of a single rate network solves the problem of small sizes of OOC families and that with the addition of error correction coding and multi-rate capabilities makes the fiber optic networks based on CDMA extremely interesting for practical applications [15]. Previous studies have reported a poor performance for these two conventional schemes because they require large code cardinality, which is not feasible for OOC codes with good correlation properties. In order to obviate the problem of low code cardinality, in [23], a new multi-rate multi-service scheme is proposed, which is a combination of time-hopping CDMA and OOC codes. In this method, the transmission time is divided into slots and, as the data rate or number of active services of the user increases, more time slots are dedicated to the user to transmit its data using its allocated OOC codeword. Also there several works have addressed multi-rate communication using optical direct sequence CDMA (DS-CDMA) [9, 24]. In these works, the strategy has largely been to give priority to the code structure that supports multi-rate traffic.

Using an adaptive overlapping pulse-position modulator (OPPM), multi-rate transmission scheme have been executed where variation of bit rate depends on the number of slots M in the optical OPPM-CDMA systems at the same bandwidth [25]. In [26], Ahmed E. Farghal, Hossam M. H. Shalaby, and Zen Kawasaki have used an OPPM scheme to support multimedia services with different transmission rates and QoS requirements in OCDMA networks by changing the OPPM modulation parameters and using multi-length variable-weight optical orthogonal codes (MLVW-OOCs) as the signature sequences. The multi-code scheme presents high flexibility for supporting MR/MS applications such as simpler coordination protocols, simpler service synchronization, lower implementation complexity and cost, and finally lower link budget [16].

Providentially, multi-coding techniques have been introduced in [12] for optical code-division multiple-access (OCDMA) systems. In these techniques, traffic streams with different transmission rates are integrated into a unified architecture. Users of high rates are assigned a number of codes based on the relation between the rates they are requesting and the basic rate of the system. Adopting multi-coding techniques in OCDMA networks would require a set of large number of signature sequences, which is not available in one-dimensional optical orthogonal codes (1D OOCs). In fact, increasing the cardinality in OOCs means increasing the code length, which is not practical for high bit rate applications where the number of time slots is limited. To overcome the shortcoming of 1D OOC, we adopt two-dimensional optical orthogonal codes, which extends the cardinality to a larger set. Specifically, a 2D one-coincidence frequency hop code (2D OCFHC/OOC) supports very good cardinality and has excellent correlation properties [14].

A lot of researches have been conducted on S-ALOHA and random-access CDMA [27–29]. However, random-access packet switching becomes a challenging issue to overcome with the increasing packet-type demand with large number of users, shorter message delay delivery, and minimum packet-dismissed probability. Protocols for a high-speed fiber-optic LAN using passive star topology were proposed in [30, 31]. New optical CDMA access protocols with and without pretransmission coordination were studied in [3]. Recently, Ahmed E. Farghal use a multi-code variable-weight (MCVW) technique with generalized multiprotocol label switching (GMPLS) optical networks protocol to support multirate and integrated multimedia services [32].