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Study of fiber optic code division multiple access Code families for Application in Optical Communication based on weight and bit error rate

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ABSTRACT

This paper investigates on fiber optic code division multiple access (FOCDMA) code families using different sets of parameter. The different code families considered here are generalized multi-wavelength Reed-Solomon code (GMWRSC), complete row-wise orthogonal pairs (CRWOP), row-wise orthogonal pairs (RWOP) and Multiwavelength Optical Orthogonal Code (MWOOC). The parameters under investigation in this work chosen to be number of maximum users (Nmax),Bit error rate(BER),Spreading Factor(Sf),Weight(K'),Number of Wavelengths(WI) and number of time chips(T). By using suitable mathematical formula, computation is made for above said parameters using aforementioned methods At the end a healthy comparison was made to identify efficient one among them just by estimating cardinality of each result. The comparison result revealed that row wise orthogonal pairs (RWOP) code family gives high performance.

1. Introduction

Now a day's communication network acts on important issue for the sake of development of society, security and economical growth. Recently the improvement of communication network in the world mostly depends on fiber optic communication with appropriate signals. The intrinsic characteristics of transmitted signal through fiber relies on the concept of fiber optic code division multiple access (FOCDMA), which is based on widely used code division multiple access (CDMA)[1] technology in microwave wireless communications. It is just a code assigned to each user with less cross correlation which is simply known as spreading codes or signature sequences. Fiber optic code division multiple access (FOCDMA) is a common optical communication channel which shared among multiple users [2–5]. The bit error rate (BER) is the majority important presentation factor of any digital communications system. It is a gauge of the probability that any given bit will have been arriving in error. For example a standard greatest bit error rate (BER) for several systems is 10^{-9} [6–10]. This indicates that the recipient is approved to produce an utmost of 1 error in every 10^9 bits of information transmitted or putting it in a different way, the chance that any inward bit is in error of 10^{-9}. The bit error rate (BER) depends chiefly on the signal to noise ratio (SNR) of the arriving signal which in turn is evaluated by the transmitted signal power, the decrease of the link, the link dispersion and the recipient noise [11–15]. Bit error rate (BER) measurement is not an easy process and it requires expen-

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sive and sophisticated apparatus to attain accuracy, particularly at high bit rates. However, the effects of noise and other signal degradation processes can be found qualitatively and perhaps even in a pseudo quantitative and bit error rate (BER) degradation trends which can be enthusiastically calculated due to the effects of signal dispersion and attenuation [16,17]. Though above references dealt with fiber optic code division process, this paper shows a comparative study of performance analysis for different sets of parameters. The different parameters considered are cardinality, spreading factor, number of wavelengths, temporal length and weight. The performance criterion of these code families is bit error rate (BER) due to multiple access interference (MAI) as a function of number of active users. The effect of one parameter to other is analysed by entertaining four type of codes such as generalized multi-wavelength Reed-Solomon code (GMWRSC), row-wise orthogonal pairs (RWOP), complete row-wise orthogonal pairs (CRWOP) and Multiwavelength Orthogonal Optical Code (MWOOC)[18]. The comparisons are designed in the form of tables and figures. In the tables rows are labelled with cardinality (Nmax), bit error rate (BER) due to multiple access interference (MAI), spreading factor (Sf), weight (K'), number of time chips (T) and number of wavelengths (Wl), where as each column is assigned one parameters corresponding to each of the four code families. The objective is to find optimum code family with which maximum number of users should use the spectrum with less bit error rate (BER) due to multiple access interference (MAI)[19]. As number of users increases bit error rate (BER) also increases. The code families which show less increase in bit error rate (BER) are better. For the sake of same comparison, we use generalized bit error rate (BER) form, which given by [20–23]

$$BER^{'} = \frac{1}{2}\sum\nolimits_{i=K'}^{N} N_{C_i}\left(\frac{K'^2}{2WT}\right)^{i}\left(1-\frac{K'^2}{2WT}\right)^{N-i} \tag{1}$$

$$BER^{'} = \frac{1}{2}\sum\nolimits_{i=0}^{K'} (-1)^{i} K'_{C_i}\left(1-\frac{qi}{K'}\right)^{N-1} \tag{2}$$

Where W is the integer number of wavelengths, T is the number of time chips, K' is number of weights, N is number of active users $q = \frac{1}{p}\frac{K'^2(Nmax)p-1}{2ToocNmaxp^2-1} + \frac{p-1(}{p}\frac{K'^2(Nmax)p-1)+\left(K'-1\right)^2}{2ToocNmaxp^2-1}$

Nmax is the cardinality, Tooc is the temporal length.

Eqs (1) and (2) are representing the bit error rate (BER) for GMWRCs and Multiwavelength Optical Orthogonal Code (MWOOC).

The bit error rate (BER) due to multiple access interference (MAI) is quite similar to wavelengths of wi and wj. Since the two 1D OOCs along with wavelengths wi and wj are observed concurrently for any user, Hence the overall response for BER can be evaluated by equation 3 which as follows. an error is occurred due to interference wavelengths wi and wj are bit coinciding (T), so the bit error rate (BER) due to multiple access interference (MAI) for the two dimensional (2D) code families is

$$BER' = \frac{BER(N_{wi}) \times BER(N_{wj})}{T} \tag{3}$$

Eq. (3) represents the bit error rate (BER) for row-wise orthogonal pairs (RWOP) and complete row-wise orthogonal pairs (CRWOP).

Section 2 illustrates performance analysis of different code families(RWOP, CRWOP, MWOOC, GMWRC) with respect to (cardinality (Nmax), bit error rate (BER) due to multiple access interference (MAI), spreading factor (Sf), weight (K'), number of time chips (T) and number of wavelengths (Wl). In addition figures and tables have been suitably placed for proper explanation. Finally conclusions are drawn in section 3.

2. Result and discussion

To get the optimized result, we have focussed to vary two crucial parameter as BER and weights (number of bits) pertaining to all code families. The efficiency each variations were studied deeply, to maximize the number of user with less BER. The detail analysis was available in 2.1 and 2.2, which explains the nobility of this work.

2.1. Analysis of code family based on equivalent bit error rate

The simulation result is available in Fig. 1, where x axis takes independent variable as number of active users, where as bit error rate are plotted in y-axis. To have better comparison we set a fixed bit error rate of 10^{-4}. From the graph we have inferred other parameter like (Nmax), Spreading Factor (Sf), Weight (K'), Number of Wavelengths (WI) and number of time chips (T). Keeping BER range of 10^{-4}, the inferred result suitable placed in Table 1.

We reach to a conclusion that RWOP is showing better performance as compared other code families. If we take GMWRSC alone, it is supporting very large number of active users, which is good prospective for us. By on other hand interference level is quite high, which is not welcome factor. Here K and wi posses high values, which are responsible for causing interference. If we consider RWOP, the cardinality may be less but we are achieving very low interference rate which is our goal. MWOOC