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New Code design for High Speed Optical Network

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ABSTRACT

A new design of the code is proposed for optical code division multiple access system. This code is based on the in ideal in phase cross correlation method. The code follows the unit cross correlation. The simulation shows that the results are better than the existing methods while all parameters are considered during design. Simulation is performed at high data rates from 10Gbits/s to 20 Gbits/s. The obtained results show better performance than existing techniques RD and MS Code.

Keywords:Multiple Access Interference(MAI), Multiple Service Code (MS), Optical code division multiple access (OCDMA), Random Diagonal Code (RD). Spectral Amplitude Coding(SAC).

1. INTRODUCTION

In optical communication three multiplexing techniques available, define as WDM.TDM and OCDMA. In Optical code division multiple access technique, each user assigns a specific code in term of spectral chips. OCDMA network having the many advantages comparative to WDM,TDM. The OCDMA is a more secure network with easy availability at every corner of the optical network[1-2]. At the receiver end de correlate the code of the corresponding uses. The code of users is such that they posses the ideal in phase cross correlation[3]. There are various codes available on systems such as MDW, RD and MS code[4-6]. These codes are based on the ideal in phase unit cross correlation. The limited factor of these codes are longer length of code. So there is need of a new design of code with less complexity and shorter length. The proposed code having the ability of the shorter length of the code and apply with direct detection technique.The paper divides in four section section I explore the deign of code. Section II explains the mathematical analysis of the design. Section IV discusses the results and paper ends with the conclusion.

2. PROPOSED METHOD

The proposed code is characterized by the (L, W, λC) where the N length of code, W is the weight of code and λC is the ideal in phase cross correlation.

Code construction

The code construction is defined as

(1)W weight is assigned to the first user

(2) The position of the weights of first user is arranged at the $P(W-1)+1$ position.

The P is given as

$$P = \begin{cases} \frac{K}{2} - 1 & K = Even \\ \frac{K+1}{2} - 1 & K = Odd \end{cases} \quad (1)$$

(3) The weight of an even number of user is arranged in the left position from the first weight of first user, is given as $P_{left} = \left(\frac{K}{2} - 1\right)$ Where K is the odd number of users

(4) The weight of an odd number of users is arranged in the right position of the last weight of first user, is given as

$$P_{right} = \left(\frac{K+1}{2} - 1 \right)$$

Length of code L= =W(K-1)+K-1

Where K is the number of users in a network

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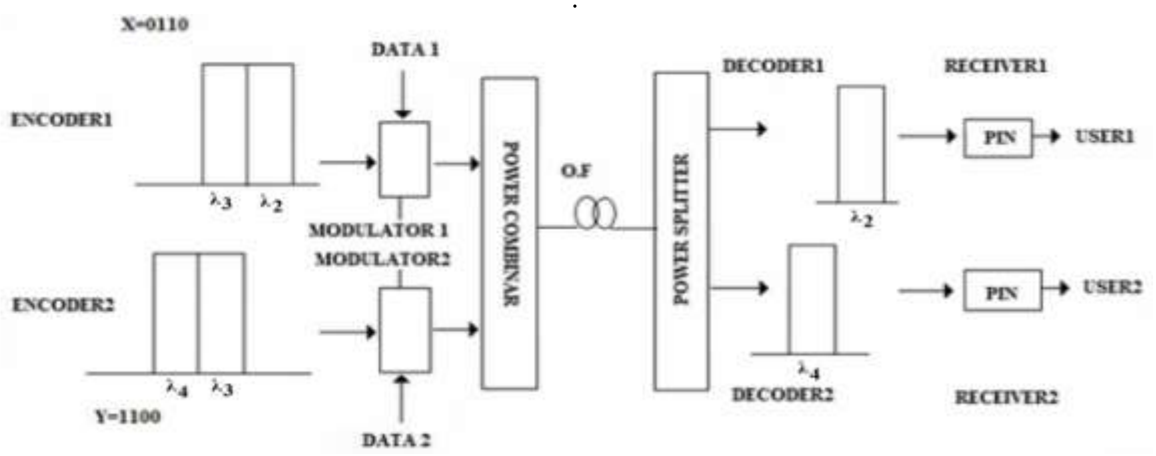

Figure1 Basics design of detection technique]

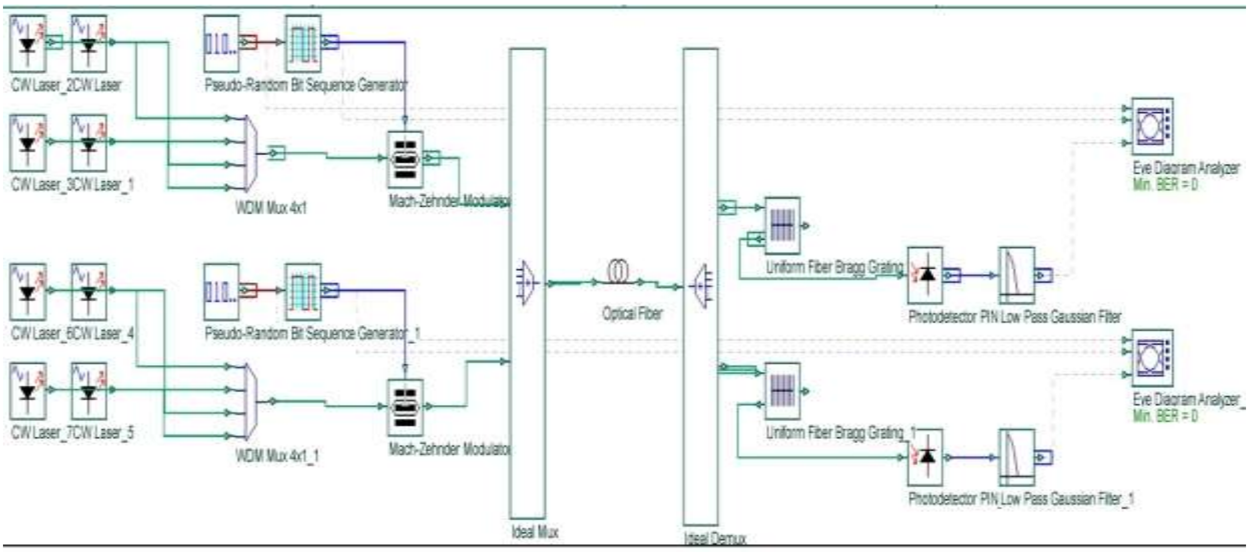

Figure2 Encoder and decoder design of proposed code.

Table 1: Code construction of N users.

	λ_1	λ_2	.	.	.	.	.	.	.	Λ_L
User1	0	0	0	1	1	1	0	0	0	0
User2	0	1	1	1	0	0	0	0	….	….
……	..	0	0	0	0	1	1	1	….	….
'…	…	0	0	0	0	0	,	…	…	…
….	..	0	0	0	0	0	0	,	…	…
UserN	1	….	….	….	….	….	….	1	1	1

Table 2. Code construction of N=3, W=4.

	λ_1	λ_2	λ_3	λ_4	λ_5	λ_6	λ_7	λ_8	λ_9
User1	0	0	0	1	1	1	1	0	0
User2	1	1	1	1	0	0	0	0	0
User3	1	0	0	0	0	0	1	1	1

3. MATHEMATICAL ANALYSIS

Gaussian approximation is used in calculation for analysis of system [6,7]. The Direct detection technique is applied code detection at the receiver end so we only consider the thermal noise (Rth) and shot noise (Rsn) in respect to PIIN. The SNR for electrical signal is the average signal power to noise power. $SNR = [I / R]$ Let CK(i) denotes the ith element of K user in this code. The following assumptions are made each light source spectrum is flat over the bandwidth $[v_o - \Delta v/2,\ v_o - \Delta v/2]$ where v_0 is central frequency and ΔV is the optical source bandwidth in Hertz. Each power spectral component has an identical spectral width. Each user has nearly equal power at the transmitter the power spectral density of the received signals can be given as:

$$r(v) = \frac{P_{sr}}{\nabla v}\sum_{k=1}^{k} d_k \sum_{i=1}^{L} c_k(i)\,rect(i) \quad (2)$$

$$rect(i) = u\left[v - v_0 - \frac{\nabla v}{2L}(-L+2i-2)\right] - u\left[v - v_0 - \frac{\nabla v}{2L}(-L+2i)\right] \quad (3)$$

$$u(v) = \frac{\nabla v}{L} \quad (4)$$

$$u(v) = \begin{cases} 1, v \geq 0 \\ 0, v < 0 \end{cases} \quad (5)$$

$$\int_0^\infty G(v)\,dv = \int_0^\infty \left[\frac{P_{sr}}{\nabla v}\sum_{k=1}^{k-1} d_k \sum_{i=1}^{L} C_k(i)\,C_I(i)\,rect(i)\right] dv \quad (6)$$

$$\int_0^\infty G(v)dv = \frac{P_{sr}}{\nabla v}\left[\sum_{k=1}^{k} d_k . W . \frac{\nabla v}{L} + \sum_{k \neq 1}^{k} d_k . \frac{\nabla v}{L}\right] \quad (7)$$

$$\int_0^\infty G^2(v)dv = \frac{P_{sr}^2}{L \nabla v}\sum_{i=1}^{L}\left\{C_l(i)\left[\sum_{k=1}^{k} d_k C_K(i)\right] . \left[\sum_{M=1}^{K} d_m c_m(i)\right]\right\} \quad (8)$$

The value of $\sum_{k=1}^{k} d_k$ is equal to the1 and for above then

$$\int_0^\infty G(v)\,dv = \frac{P_{sr}[w]}{L} \quad (9)$$

The photo current I can be expressed as

$$I_{dd} = \Re \int_0^\infty G(v)\,dv \quad (10)$$

$$I_{dd} = \Re \frac{P_{sr}[w]}{L} \quad (11)$$

The variation of photocurrent due to detection of an ideally un polarized thermal light can be expressed as

$$I^2 = I_1^2 + I_{th}^2 \quad (12)$$

$$I^2 = 2eB(I_{dd}) + \frac{4K_b T_n B}{R_L} \quad (13)$$

$$I^2 = 2eB\Re\left[\int_0^\infty G(v)dv\right] + \frac{4K_b T_n B}{R_L} \quad (14)$$

When all users transmitting 1 than probability of each user sending 1 is ½ then Eq. (13) from Eq.(9) become

$$I^2 = \frac{P_{sr} eB\Re}{L}[(K_B - 1 + W)] + \frac{4K_b T_n B}{R_L} \quad (15)$$

The number of users in basic code (N) is same as the weight (W) of code.

The signal to noise ratio of direct detection technique is given by the following equation

$$SNR = \langle I_{dd} \rangle^2 / \langle I^2 \rangle \qquad (16)$$

When putting Eq.(10) and Eq.(17) in Eq (19) then the new formula for SNR will be

$$SNR = \frac{\dfrac{\mathrm{R}^2 P_{sr}^{\ 2} (W)^2}{L^2}}{\dfrac{P_{sr} e B \mathrm{R}}{L}\left(\left(W + K_B - 1\right)\right) + \dfrac{4 K_b T_n B}{R_L}} \qquad (17)$$

BER of design-

$$BER = \frac{1}{2} erfc \sqrt{\frac{SNR}{8}} \qquad (18)$$

Typical parameters used in the calculation as below:

Photo detector quantum efficiency (η)	0.6
Line-width broadband source (ΔV)	3.75 THz
Operating wavelength (k_0)	1552 nm
Electrical bandwidth (B)	311 MHz
Data bit rate (R_b)	622 Mbps
Receiver noise temperature (T_n)	300 K
Receiver load resistor (R_L)	1030Ω
Responsivity ($\Re$)	0.748

4. RESULT AND DISCUSSION

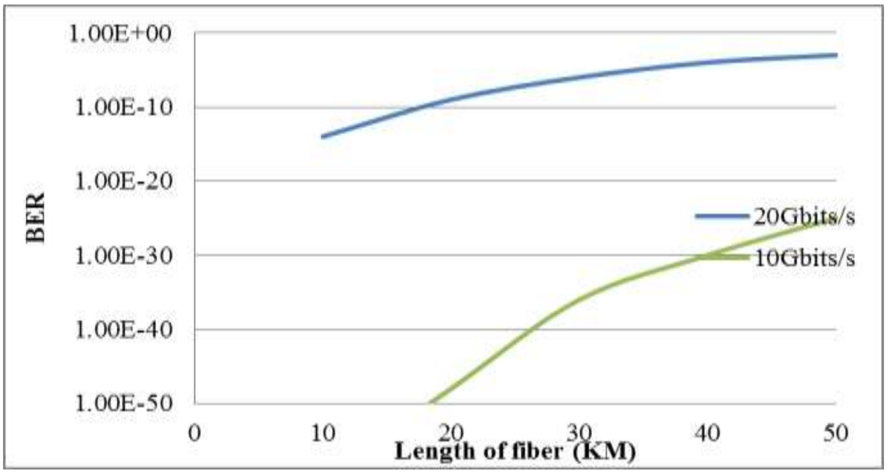

Figure 3: Variation in BER with Length of fiber with 0 dBm received power

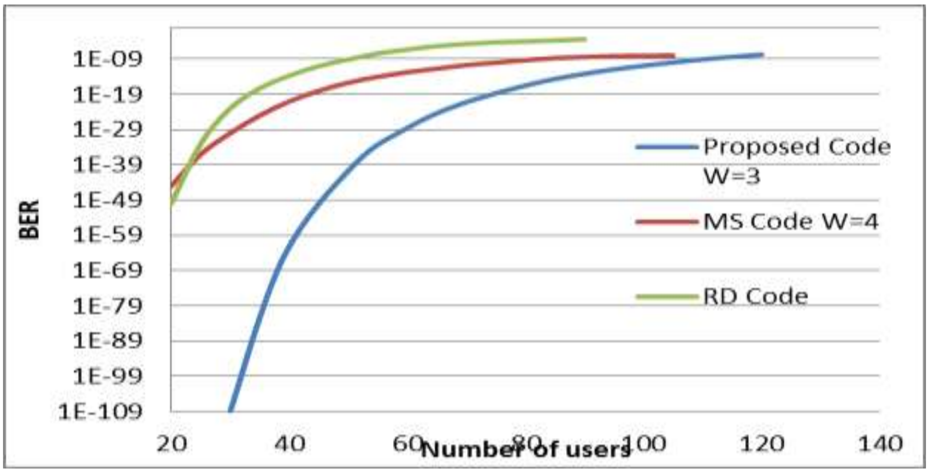

Figure 4: Variation in BER with number of users for 622Mbits/s data rate and -10dBm received power

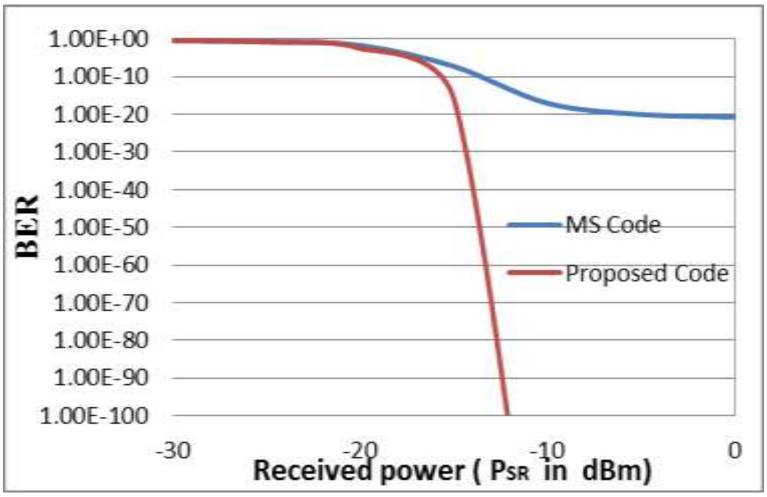

Figure 5: Variation in BER with received power for 30 number of users

Analysis of design of new code is done in a practical environment with considering the all factor and Simulation is performed in ITU standard with single mode fiber and Dispersion compensation fiber. All the attenuation (α= 0.25dB/km), Dispersion of SMF (16.75ps/nm) is maintained. Decoder side after decoding the signal, the signal covert to electrical by passing to the photo detector and 0.75 GHz low pass Bessel filter (LPF) The dark current value was 5 nA, and the thermal noise coefficient was $1.8x10^{-23}$ W/Hz for each of the photo-detectors. Following parameters are considered in the design. Fig.3 shows the variation in BER with the fiber length for 5Gbits/s and 10Gbits/s data rates.Fig.4 shows the variation in BER with number users for 622Mbits/s and compared with the present technique which shows the best performance. Fig.5 shows the variation in BER with received power and comparable with the MS Coding technique with better performance at 622Mbits/s.

5. CONCLUSION

The paper proposed a new coding approach with in phase ideal unit cross correlation. The proposed OCDMA code has better performance than the present schemes. The design of decoding shows the less complexity compared to the existing decoding technique.The simulation of the system shows the high speed response in optical networks.Result of design for input received and number users shows the enhance performance the present techniques.

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