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Design and Implementation of a Novel Set of 3D codes for OCDMA LAN System at 5Gbps

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Abstract: This paper designs 3DCodeset to increase users in OCDMA considering orthogonal polarization phenomena of the light. Mathematical model developed to check the performance, Analyses for users at 5gbps and Comparison with 2D have carried . **Keywords: OCDMA** optical code division multiple access, **LAN** local area network, **2D**: 2 Dimensional **3D**: 3 Dimensional, **OOC** optical orthogonal codes, **AM-OPPW**- at most one pulse per wavelength

1. Introduction Spread spectrum (SS) communication systems have the transmission bandwidth much greater than the base band message signal bandwidth. A pseudo-noise code, which is independent of the information *'spreads'* the signal energy over a bandwidth which is greater than the signal information bandwidth and at the receiver, the signal *'despreads'* using a synchronized replica of the pseudo-noise random code to extract the information back. For utilizing the huge potential of optical fiber, signal is multiplexed by TDMA, WDMA, or CDMA. When CDMA is applied in optical domain it is termed as OCDMA [1]. In the work carried out earlier, it has been observed that there were two major problems giving rise to performance degradation of the system in terms of bit rates, which are Multiple Access interference (MAI) i.e. number of active users that can transmit signal asynchronously and range. Hence a need is felt to use OOC codes that provide better cardinality and good correlation property (cross-correlation & autocorrelation) (AM-OPPW codes) for designing a high speed LAN-OCDMA [2] system with reduced MAI to support more users .The analysis that has been carried out till date regarding the performance of codes considered bit rate up-to 1 Gbps for 5 users in 2D. This system contains lower data transmission rate and less number of users. Therefore, the need was felt to design and analyze the performance of OCDMA system for data rates greater than 1 Gbps with more number of users, outcome to which code dimensionality was increased from 2D to 3D considering the fact that light can be transmitted through two orthogonal polarization states. For spreading signal, Signature sequences used can be classified on Dimension basis as 1-D, 2-D or 3-D. Fig 1.1, 1.2 and 1.3 shows the structure.

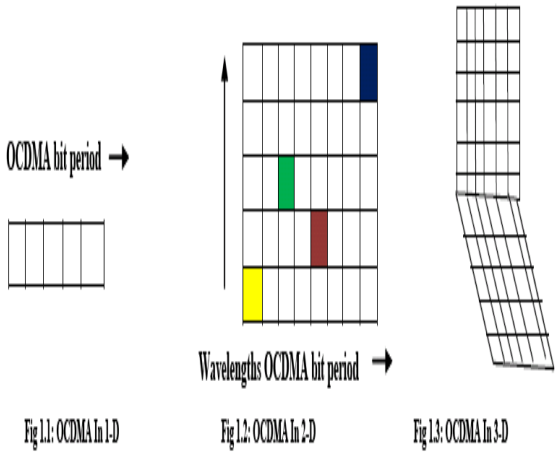


Fig 1.1: OCDMA In 1-D Fig 1.2: OCDMA In 2-D Fig 1.3: OCDMA In 3-D

2. Mathematical Modeling

The codes used in this work are restricted 3D-AM OPPW OOC .Therefore, the Restricted Bound [2] is given as

$$\Phi_{AM\text{-}OPPW}(\Lambda \times T,w,k) \leq [\{(\Lambda/w)\}\{T(\Lambda-1)/(w-1)\}\ldots.\{T(\Lambda-k)/(w-k)\}] \quad (1)$$

Where maximum number of wavelength and T is is maximum time slot number and w is the weight of the code and k is the maximum collision parameter. Table 1.1 shows the parameters employed while simulating OCDMA LAN . These codes are transferred to 3D which results in Codeset as shown in Fig 1.5

Chip Delay (Tc) Calculation: For 5gbps system, the chip time is calculated a**s:**

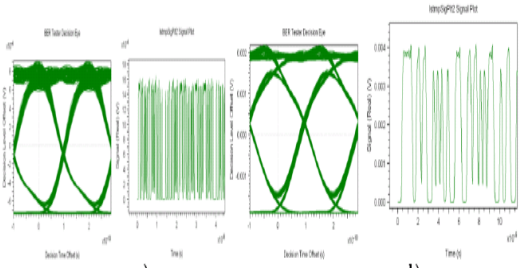
For 5 Gbps system, Bit Rate: 5e9 ; time slot= 6 bits Bit period: 1/Bit rate = 2e-10
Time chip= Bit period / Time Slot = 2e-10 / 6
So, chip time = 3.3 e-11 [4]

3. OCDMA system The block diagram of the system is shown in Fig 1.4; six channel WDM channel utilizing mode locked lasers has been used for generating the carrier signal. This carrier signal is fed to individual encoder, which modulates the signal and encodes it according to the code signature sequence. This carrier signal is used to modulate the PRBS data using external modulator. Signal is divided into two groups, 1st group and 2nd group. After modulating ,the encoder has optical filters and delay line array whose time increments are integral multiple of chip time ,TC=TB/S , where TB is bit period and is given by inverse of bit rate and S is number of time slots. Optical filters transfer single

wavelength, and delay lines provide appropriate time delay. Two 6×1 multiplexer is used to combine signals coming from all encoders, the signal at 2nd group is given polarization shift of 90 degree through polarization rotation in order to transmit the signals at two orthogonal states. A 2×1 multiplexer is used to combine signals. At the receiver side an optical splitter is used to split the two groups separately then inverse polarization and delay lines decode the signal back. A compound optical receiver is used to receive the desired signal back.

4. Results

The performance of an OCDMA system is analyzed using eye diagrams, received signal, BER, Q factor [5] shown in Fig 1.7. The system has been designed for 5Gbps data rate for optical fiber of 1km length,
without using any optical amplifier. The system operates in the 3rd window at 1550nm wavelength & λ1 =1554.8 nm, λ2 = 1555.6 nm, λ3 = 1556.4 nm, λ4 = 1557.2 nm, λ5 = 1558.0 nm and λ6 = 1558.8 nm [6]. The coding technique used for transmission is 3D. The values captured for BER and Qfactor are given in Table 1.3, it shows that in 3D system number of active users supported is fifteen with acceptable BER. Simulations with same 2D codes supported 5 active users as shown in Fig 1.8



a) b)

Fig 1.6 Eye diagram and Received Signal 5Gbps for a) Five Users b) Fifteen Users.

Table 1.3: BER and QFACTOR of 3D codes at 5 Gbps

S.NO	Number of active users	BER	QFACTOR
1	Five	7.6367e-015	1.7594e+001
2	Ten	1.9809e-014	1.7088e+001
3	Fifteen	1.1441e-010	1.5761e+001

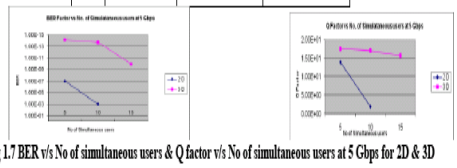


Fig 1.7 BER v/s No of simultaneous users & Q factor v/s No of simultaneous users at 5 Gbps for 2D & 3D

5. Conclusion

In the present work, 3D codes have been designed and to check their practically an OCDMA system has been designed and the codes are implemented, it has been observed that 3D system supports more active (15) and potential users (36). Q Factor verses number of simultaneous users for 2D and 3D coding systems, have been shown in Fig 1.7 .Above results show that 2D codes support 5 simultaneous users and 3D codes support 15 simultaneous users with permissible BER. Fig shows significant improvement in BER and Q factor values for 3D System over 2D system, but, as the number of simultaneous users increases the BER degrades.15 simultaneous users, at 5Gbps can successfully be implemented in 3D. Practically, it also gives minimum acceptable BER i.e. 10e-8. Hence by transmitting data in 3D, The main goal of OCDMA to increase the number of users in network can be achieved with acceptable BER over 2D System.

6. References

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