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Comparison of 3D OCDMA Models at Variable Received Power For High Speed Applications

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Abstract: ***For any spread spectrum technology, the number of active users at a given data rate with acceptable level of BER and quality factor are highly dependent on type of sequence selected for spreading and de spreading. In this paper 3D temporal/ spectral / spatial codes based on optical orthogonal codes and different operators from algebra theory are considered at data rate up to 10 Gb/s per user with variable received power till -36dBm for 3D OCDMA. The different models thus designed are compared in terms of eye diagram, signal strength, BER and quality factor. Performance of designed 3D OCDMA system is higher and is compared with the simulated results from other researchers available in terms of number of active users, BER and data rate.***

Keywords: ***Optical Code Division Multiple access, Optical orthogonal codes, linear congruent operator, cubic congruent operator, quadratic congruent operator, hyperbolic congruent operator, Galois field (5), 3 Dimensional, Bit Error Rate.***

1. INTRODUCTION

Coding possess an important challenge for OCDMA technology, as the performance of the system depends on the type of code employed. In this paper, we compare the simulated results of designed models named Model A (LC), Model A (CC), Model B (LC, CC) and Model B (QC, HC) by author [1,4] with each other and other available results in literature. Through (LC), (CC), (LC, CC) and (QC, HC) we mean linear congruent, cubic congruent, quadratic congruent and hyperbolic congruent operators from algebra theory based on Galois field GF (5). Here we employ (13, 4, 1) optical orthogonal [5] code for spreading in temporal domain and above said operators from algebra to spread in spectral and spatial domain.

This paper is organized as follows. Section 2 briefly described Novel 3D codeset and OCDMA system. In section 3 compared results are presented. Finally conclusion is drawn in section 4.

2. 3D CODESET AND OCDMA SYSTEM

The 3 dimensional coding scheme used for various Models is filed.Here, S denotes the spatial channel and λ denotes the spectral channel. For Model A (LC):The spreading sequences based on linear congruent operator used in this simulation for fifteen users in spectral and spatial domain are user 1: $S_0\ \lambda_0S_1\ \lambda_1S_2\lambda_2S_3\lambda_3$, user 2 is $S_0\ \lambda_1S_1\ \lambda_2S_2\lambda_3S_3\lambda_4$, user 3 is $S_0\ \lambda_2S_1\ \lambda_3S_2\lambda_4S_3\lambda_0$, user 4 is $S_0\ \lambda_3S_1\ \lambda_4S_2\lambda_0S_3\lambda_1$, user 5 is $S_0\ \lambda_4S_1\ \lambda_0S_2\lambda_1S_3\lambda_2$, user 6 is $S_1\ \lambda_0S3_2\ \lambda_2S_0\lambda_4S_2\ \lambda_1$, user 7 is $S_1\lambda_1S3_2\lambda_3S_0\lambda_0S_2\ \lambda_2$, user 8 is $S_1\ \lambda_2S3_2\ \lambda_4S_0\lambda_1S_2\ \lambda_3$, user 9 is$S_1\ \lambda_3S_2\ \lambda_0S_0\lambda_2S_2\ \lambda_4$, user 10 is$S_1\ \lambda_4S_2\ \lambda_1S_0\lambda_3S_2\ \lambda_0$, user 11 is $S_2\ \lambda_0S_0\ \lambda_3S_3\lambda_1S_1\lambda_4$, user 12 is$S_2\ \lambda_1S_0\ \lambda_4S_3\lambda_2S_1\lambda_0$, user 13 is $S_2\ \lambda_2S_0\ \lambda_0S_3\lambda_3S_1\lambda_1$, user 14 is $S_2\ \lambda_3S_0\ \lambda_1S_3\lambda_4S_1\lambda_2$and user 15 is $S_2\ \lambda_4S_0\ \lambda_2S_3\lambda_0S_1\lambda_3$ .similarly , the sequences for Model A (CC),for Model B (LC, CC) and for Model A (QC, HC) can be calculated.

The 3 D system thus build is shown in Fig 1. Here, each bit is divided into time periods, wavelengths and spatial channels. Each user on the OCDMA system is assigned a unique signature sequence (as per the address sequences given above). Data or information to be transmitted is encoded in the encoder. The encoder of each transmitter transmits one signature sequence for each bit 1 and 0 for binary0 and is represented using an all zero sequence. Signature sequence comprising 1 shows the presence of one at corresponding wavelength, time slot and spatial channel. After encoding signal is propagated to decoders through star coupler that reversesthe sequences to place them at desired positions. Then the signal is passed to the receiver in the data recovery unit.

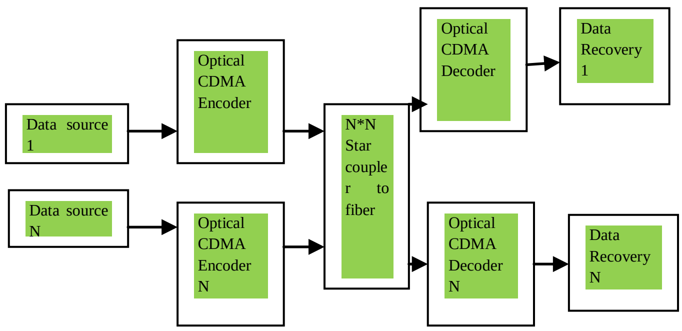

Fig 1: OCDMA Block Diagram

The parameters that were taken while simulating the proposed 3D codeset using temporal/wavelength/spatial codes with GF (5) has 5 Operating wavelengths in C band i.e. λ_1= 1550.0e-9m, λ_2= 1550.8e-9m, λ_3= 1551.6e-9m, λ_4= 1552.4e-9m and λ_5= 1553.2e-9m with repetition rate=variable and peak power= 1.0e-3 w and Delta =.8e-9 (i.e. spacing between the wavelength) is based on Dense Wavelength Division Multiplexing. Fig 2 shows the snapshots of 3D OCDMA in OPTSIM Simulation Software. This schematic evaluates the 3D OCDMA link with encoding/ decoding with different users and coding based on Galois field GF (5) with operators from algebra theory along with optical orthogonal codes as explained above.

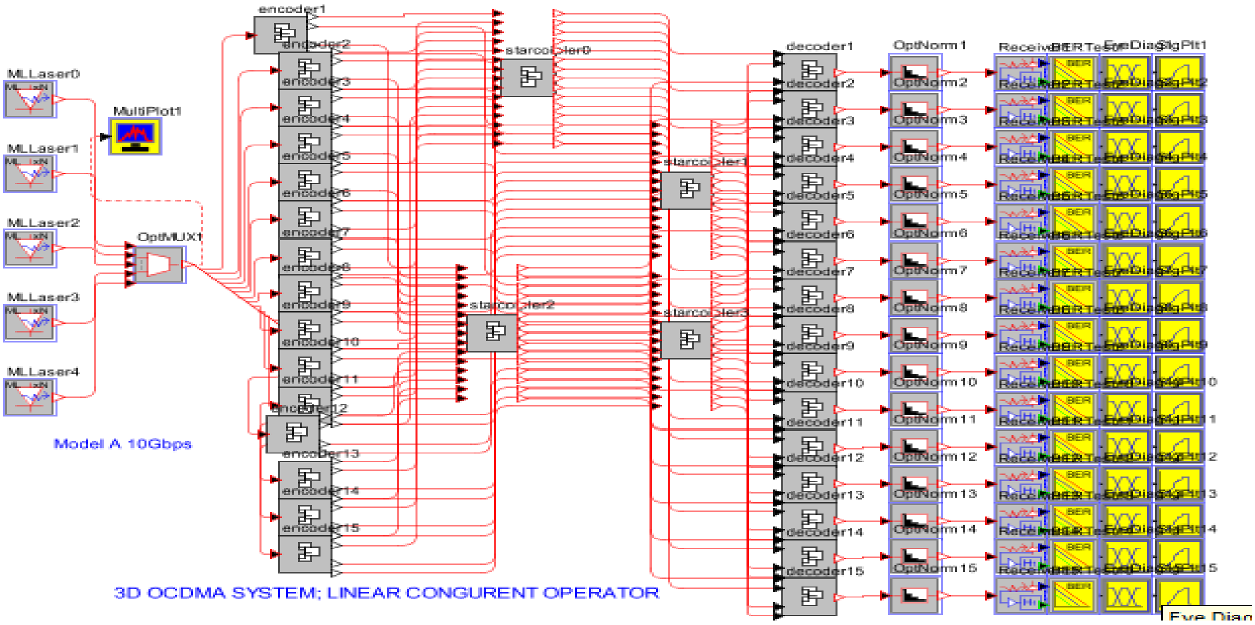

Fig 2: Technology Demonstator for 15 users 3D OCDMA system using Model A(Linear Congurent).[6]

3. RESULTS

The results are analysed in terms of eye diagrams , signal strength, at -26dBm received power. For Model A (LC), Fig 3,4 shows the Eye diagrams and signal strength at 1Gbps and 10Gbps respectively.For Model A (CC), Fig 5,6shows the Eye diagrams and signal strength at 1Gbps and 5Gbps respectivelyFor Model B (LC,CC), Fig 7,8shows the Eye diagrams and signal strength at 1Gbps and 5Gbps respectively and For Model A (QC,HC), Fig 9,10shows the Eye diagrams and signal strength at 1Gbps and 10Gbps respectively. The graphs between Bit Error Rate and received power at 1,2 ,5 and 10 Gbps are shown in Fig 11 to 15 respectively.In Fig 16 and 17 comparison is drawn at variable data rates at -26dBm received power in terms of Bit Error Rate and Quality Factor.it is concluded that as the data rate increases , proabability of error increases and proposed codes behave good at very high data rates and can be employed for transfering high end applications.

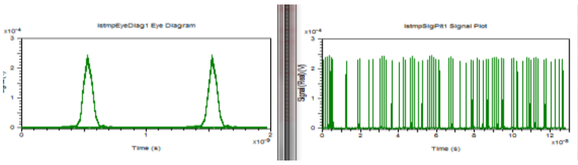

Fig 3: Model A (LC): Eye Diagram and Signal Strength (1Gbps)

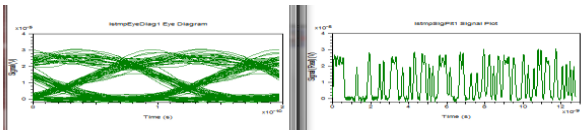

Fig 4: Model A (LC): Eye Diagram and Signal Strength (10Gbps)

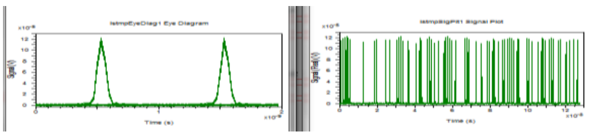

Fig 5: Model A (CC): Eye Diagram and Signal Strength (1Gbps)

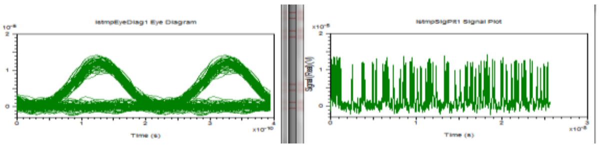

Fig 6: Model A (CC): Eye Diagram and Signal Strength (5Gbps)

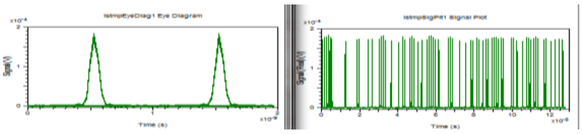

Fig 7: Model B (LC, CC): Eye Diagram and Signal Strength (1Gbps)

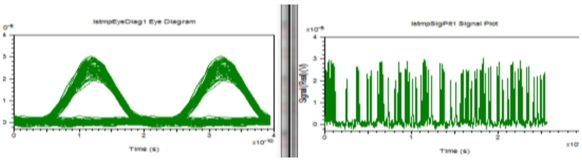

Fig 8: Model B (LC, CC): Eye Diagram and Signal Strength (5Gbps)

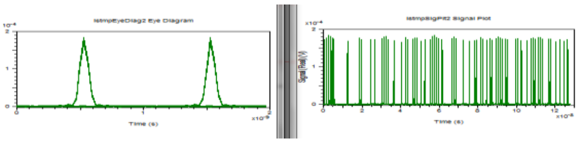

Fig 9: Model B (QC, HC): Eye Diagram and Signal Strength (1Gbps)

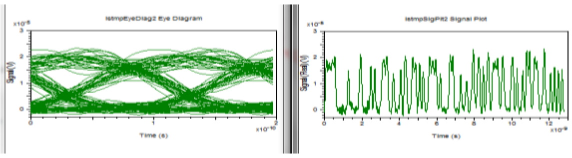

Fig 10: Model B (QC, HC): Eye Diagram and Signal Strength (10Gbps)

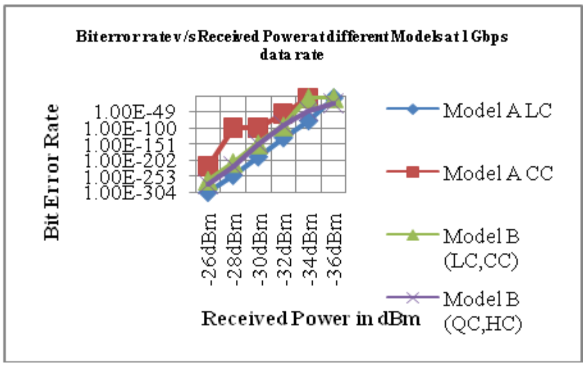

Fig 11: Bit error rate v/s Received Power at different Models at 1Gbps data rate

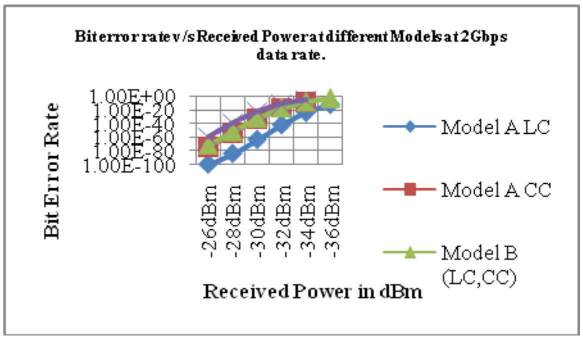

Fig 12: Bit error rate v/s Received Power at 2Gbps

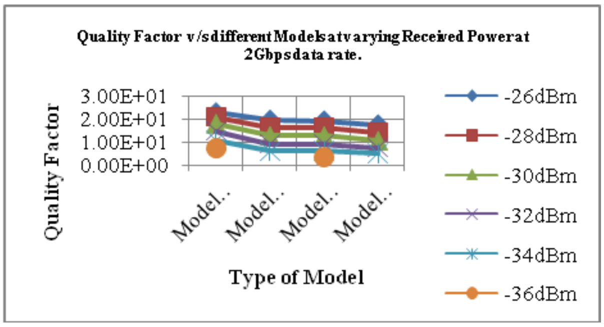

Fig 13: Quality Factor v/s different Models at varying Received Power at 2Gbps data rate.

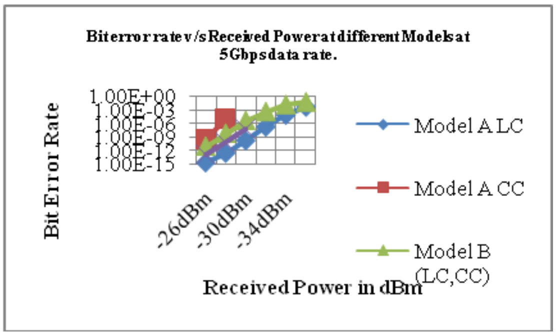

Fig 14: Bit error rate v/s Received Power at different Models at 5Gbps data rate

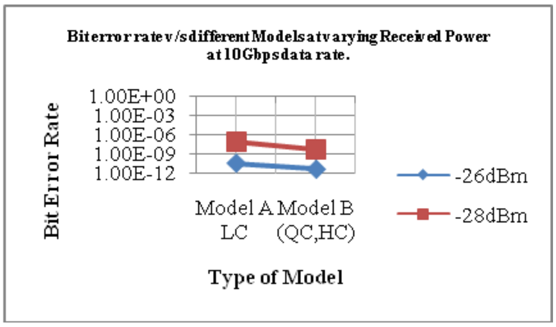

Fig 15: Bit error rate v/s Received Power at different Models at 10 Gbps data rate

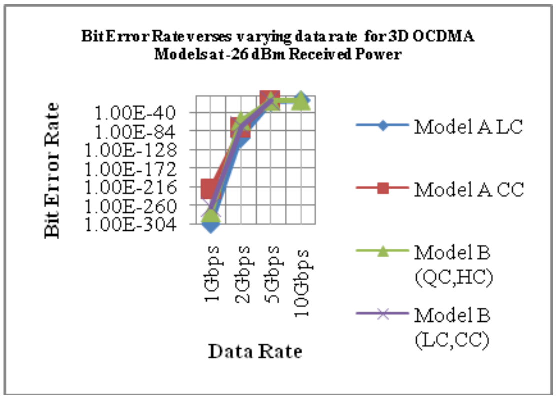

Fig 16: Bit Error Rate verses varying data rate for 3D OCDMA Models at -26 dBm Received Power

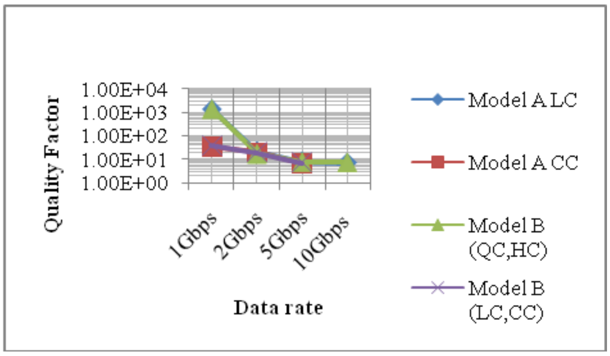

Fig 17: Quality Factor verses varying data rate for 3D OCDMA Models at -26 dBm Received Power

4. CONCLUSION

Proposed codes are compared with available 3D Time / Wavelength/ Space codes given by McGeehan, Kumar et al [2, 3] and found that the cardinality ofthese codes is much higher along with less dimensions in terms of Time / Wavelength/ Space parameters . In this work we were able to transmit maximum 20 active users at 10Gbps data rate with acceptable BER at -26dBm received power level. The results are represented in terms of eye diagram, signal strength at variable data rates with received power ranging from -26dBm to -36dBm. Further, using 2D pseudo orthogonal codes, 4 users were simulatedresulting in BER=3.5503E-045[7] and using same set of 2 D codes 3 users were simulated resulting BER=10e-41 [8].Hence, authors codes behave exceptionally well at higher data rates till 10 Gbps with higher number of users and thus can be employed with the high end applications such as transferring high definition audio and video and suitable for online video conferencing.

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REFERENCES

i. *S Jindal, N Gupta "Exploration of Three Dimensional Codes Based on Model A and Model B Using Algebraic Congruent Operator in OCDMA System" International Journal of Mobile &Adhoc Network, Vol2, issue 3, August 2012. Pg 345-351. ISSN (Online) 2231–6825.*

ii. *John E. McGeehan, S. M. R. Motaghian Nezam, P. Saghari, Alan E. Willner, Reza Omrani, and P. Vijay Kumar "Experimental Demonstration of OCDMA Transmission Using a Three-Dimensional (Time–Wavelength–Polarization) Codeset" Journal of Lightwave Technology, Volume 23, Number 10, October 2005, Pg 3282-3286.*

iii. *M Ravi Kumar ,S SPathak, N B Chakrabarti "Design and analysis of 3D OCDMA code families" Optical Switching and Networking ,Science Direct 6,2009. Pg 243-249.*

iv. *Tao Pu; Yu Quan Li; Shu Wen Yang; "Research of algebra congruent codes used in two-dimensional OCDMA system," Lightwave Technology, Journal of, vol.21, no.11, pg . 2557- 2564, Nov. 2003.*

v. *Jawad A Salehi, "Code Division Multiple-Access Techniques in Optical Fiber Networks-Part I: Fundamental Principles" IEEE Transactions on Communications, Volume 37, Number. 8, August 1989. Pg 824 -833.*

vi. *"Performance Analysis of 3D OCDMA Coding Based on Model A Using GF (5) with Variable Data Rates "International conference on electrical, electronics and computer science on 24th march 2013, Chandigarh. Pg 1-5*

vii. *Bhosale et al "Design and simulation of a novel spectral phase-encoded OCDMA system" World Journal of Science and Technology 2012, ISSN: 2231 – 2587, 2(5):88-90.*

viii. *Chavan et al "QoS improvement in OCDMA systems using Optical Normalizer" in International Journal of Research and Reviews in Signal Acquisition and Processing. Vol 1, No.1, March 2011.Science Academy Publisher, United Kingdom.pg 1-4.*