Realization Analysis of Incoherent Two-Dimensional Hybrid Code Optical CDMA

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***Abstract*—This paper is forcusing on the optimization simulation analysis of the network structure optical division multiple access (OCDMA) technique is investigated using the 2-D Hybrid OCDMA code. The performance was analyzed using Optisys software. During the simulation process, various parameters, variables such as distance of the fiber, bit rate and number of users are analyzed. The results indicate that with bit rate of 155 Mbps, 4 numbers of user the 2-D Hybrid OCDMA code can achieve maximum transmission of 80 km with bit error rate (BER) 4.99×10^{-9}. At 622 Mbps and 1.1 Gbps both can achieve maximum transmission of 60 km with BER 8.31×10^{-9} and 45 km with BER 6.44×10^{-9} respectively. For 9 users, the 2-D Hybrid OCDMA code of bit rate 155 Mbps, can achieve maximum transmission of 65 km with BER 8.31×10^{-9}. At 622 Mbps and 1.1 Gbps respectively, it can achieve maximum transmission at 40 km and 35 km with BER 1.51×10^{-9} and 5.49×10^{-9}.**

Keywords-multiple access interference, phase induce intensity noise, bit error rate, 2-D Hybrid code.

I. INTRODUCTION

OCDMA is an emerging research area that attracts huge interest due to the demand of OCDMA application in a local area network. OCDMA offers various advantages such as large bandwidth, high security, flexibility of high speed access network, dynamic bandwidth, asynchronous transmission with low latency, soft capacity on demand and enhanced network security. However, in order to improve the performance in term of the number of user results in code length expansion [1]. Another limitation is due to the unipolar characteristic of optical signals where the length of one-dimensional (1-D) optical codes should make large enough to increase the number of simultaneous users [2,3,4].

In order to overcome the drawbacks of 1-D OCDMA codes, the 2-D OCDMA code of OCDMA was proposed [5]. The 2-D OCDMA coding system attracts more and more attention owing to its good correlation properties compared with 1-D OCDMA coding [7-9]. A well designed of 2-D OCDMA code can minimize the interference between users to a lower level and enhance the BER substantially. The two-dimensional codes spread in both time and wavelength simultaneously [5]. The 2-D OCDMA codes provide more flexibility and greater capacity than 1-D OCDMA codes [6]. The wavelength-time schemes provide a lower probability of interception and offers scalability and flexibility. The probability of interception is enhanced because the pulses of each code sequence are transmitted in different wavelengths, making eavesdropping more difficult. In this paper, we will further study on the performance of 2-D OCDMA codes through the simulation setup using 2-D Hybrid OCDMA code. It is because, most of the research into 2-D OCDMA codes before has only discussed the theoretical performance of each 2-D OCDMA code to analyze the bit error rate (BER) performance.

II. CONTRUCTION OF 2-D HYBRID CODE

The 2-D Hybrid OCDMA code evolved from the 1-D Integer Lattice OCDMA code [9] and 1-D Perfect Difference (PD) OCDMA code [10,11]. An example of the 2-D Hybrid OCDMA code with slope, s=1, code size, m_s =3, code weight lattice code, $L_{lattice}$=2, code weight PD code, K_{PD}=2, code length, M=6, a code length of the spectral and spatial code sequence, P=3.

The cross-correlation value of 2-D hybrid OCDMA code is shown in Table 1. From that table, it illustrated the relationship of $R^{(0)}(g,h)$, $R^{(1)}(g,h)$, $R^{(2)}(g,h)$, and $R^{(3)}(g,h)$. It can be observed that $R^{(2)}(g,h)$, and $R^{(3)}(g,h)$ are no used for new correlation function, which effect the MUI elimination process become easier.

The 2-D hybrid OCDMA code signal-to-noise ratio can be expressed as:

$$\text{SNR} = \frac{\left(\frac{RP_{ET}}{m_s}\right)^2}{\frac{B_e R^2 P_{ET}^2}{2m_s \Delta f} + \sigma_T^2 \frac{RP_{ET}}{K_{PD} m_s k_{lattice}} \left(k_{lattice} K_{PD} + \frac{2k_{lattice}(W-1)(P-1)}{(m_s P-1)} \right.}$$

The PIIN can be suppressed and the MAI can be eliminated, by using the new correlation function property of the 2-D Extended-EDW OCDMA.

Table 1: The Cross-Correlation of 2-D Hybrid OCDMA [9]

Correlation A_{gh}	$R^{(0)}(g,h)$	$R^{(1)}(g,h)$	$R^{(2)}(g,h)$	$R^{(3)}(g,h)$
$g=0, h=0$	k_1k_2	0	0	0
$g=0, h\neq0$	k_1	0	$k_1(k_2-1)$	0
$g\neq0, h=0$	k_2	$k_2(k_1-1)$	0	0
$g\neq0, h\neq0$	1	k_1-1	k_2-1	$(k_2-1)(k_1-1)$

III. RESULTS AND DISCUSSION

The result obtained from simulation process was discussed. The simulation was carried out with a number of users equal to four and nine. The performances of the system are illustrated by BER in graph format.

In simulation, the distance range was used is from 10 km to 50 km. Figure 1 shows the BER versus distance at 16 dBm of power. This figure also shows the performance of the system is varied with different bit rate of 155 Mbps, 622 Mbps and 1.1 Gbps. From the graph, it can be seen that the BER increases as the distance increased. This is because a longer fiber will provide a larger dispersion and attenuation.

With bit rate 155 Mbps, 4 numbers of user 2-D Hybrid code can achieve maximum transmission at 80 km with BER $4.99\text{x}10^{-9}$. Then 622 Mbps and 1.1 Gbps both can achieve maximum transmission at 60 km with

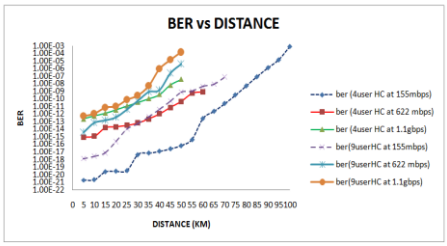

Figure 1: BER versus Distance for 2-D Hybrid OCDMA Code.

Figure 2 shows the eye diagram of the 4 users at bit rate 1.1 Gbps while figure 6 shows the eye diagram of 9 users at bit rate 1.1 Gbps. The distance was fixed at 10 km.

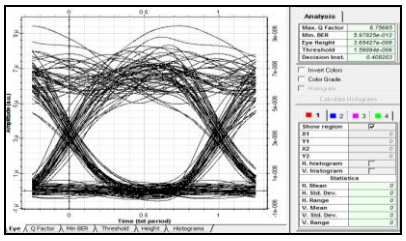

Figure. 2: Eye diagram of 9 users at bit rate 1.1Gbps.

IV. CONCLUSION

In this paper, the analysis on the performance of 2-D Hybrid OCDMA code was investigated. The analysis was carried out through a software simulation. This analysis was carried out to study the performance of the 2-D Hybrid OCDMA code. From the simulation result, it is indicated that with bit rate 155 Mbps, 4 numbers of user 2-D Hybrid OCDMA code can achieve maximum transmission at 80 km with BER $4.99\text{x}10^{-9}$. Then 622 Mbps and 1.1 Gbps both can achieve maximum transmission at 60 km with BER $8.31\text{x}10^{-9}$ and 45 km with BER $6.44\text{x}10^{-9}$ respectively. For 9 users 2-D Hybrid code of bit rate 155 Mbps, it can achieve maximum transmission at 65 km with BER $8.31\text{x}10^{9}$. At 622 Mbps and 1.1 Gbps respectively, it can achieve maximum transmission at 40 km and 35 km with BER $1.51\text{x}10^{-9}$ and $5.49\text{x}10^{-9}$. The 2-D Hybrid OCDMA code also shows a better performance when compared to others 2-D OCDMA code.

V. ACKNOWLEDGEMENT

The author would like to acknowledge the support from the Exploratory Research Grant Scheme (FRGS) under grant number 9010-0037, Department of Higher Education, Ministry of Higher Education Malaysia for the assistance with the grant.

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