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Spectral Coding System for High Speed Optical Communication Network

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Abstract: This paper shows the development of new code for OCDMA system. The characteristics of code based on the unit cross correlation. The code is such that it follows the minimum cross correlation. The direct detection method is used to recover the information at the receiving end. The result and analysis shows that system has better performance compare to existing method such as MDW, RD Method. Simulation is performed at high data rates from 10Gbits/s to 20 Gbits/s.
Keywords: Communication Network, Optical Network, MS Code, MAI, Signal Processing, Unipolar Code, OCDMA

I. 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 possess 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 is 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 I explore the design of code. Section II explains the mathematical analysis of the design. Section IV discusses the results and paper ends with the conclusion.

II. 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) P weight is assigned to the first user

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

The P is given as

$$q=\begin{cases}\dfrac{K}{2}-1 & K=Even\\ \dfrac{K+1}{2}-1 & K=Odd\end{cases} \tag{1}$$

(3) The weight of an even number of user is arranged in the right position from the last weight of first user, is given as

$q_{right}=\left(\dfrac{K}{2}-1\right)$ Where K is the odd number of users

(4) The weight of an odd number of users is arranged in the left position of the first weight of first user, is given as1111II

$$q_{Left}=\left(\dfrac{K+1}{2}-1\right)$$

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

Where K is the number of users in a network

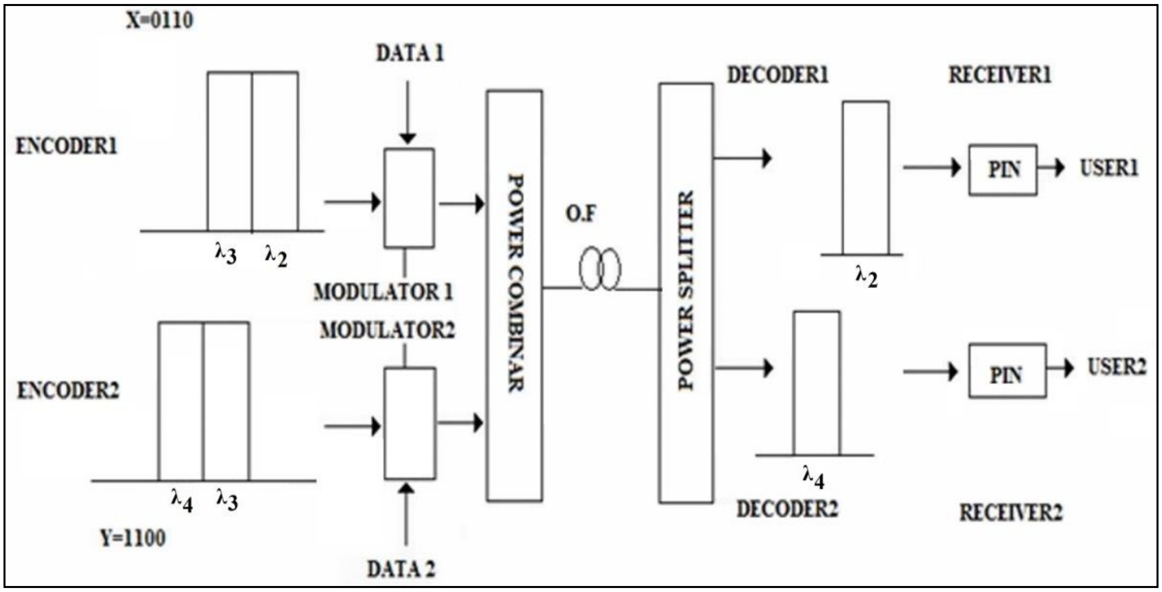

Figure1 Basics design of detection technique

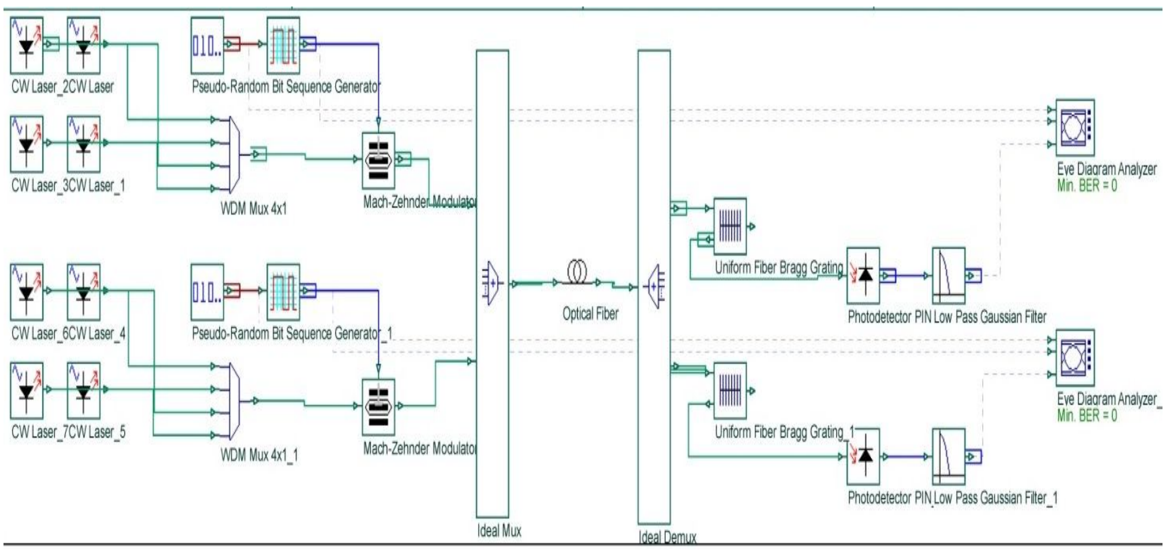

Figure2 Encoder and decoder design of proposed code

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

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III. 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

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

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

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

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

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

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

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

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

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

The photo current I can be expressed as

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

$$I_{dd} = \Re \frac{P_{sr}[p]}{L} \tag{11}$$

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

$$I^2 = I_1^2 + I_{th}^2 \tag{12}$$

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

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

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

$$I^2 = \frac{P_{sr}eB\Re}{L}\left[(K_B - 1 + p)\right] + \frac{4K_bT_nB}{R_L} \tag{15}$$

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

$$SNR = \langle I_{dd}\rangle^2 / \langle I^2 \rangle \tag{16}$$

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

$$SNR = \frac{\dfrac{R^2 P_{sr}^{\ 2}(p)^2}{L^2}}{\dfrac{P_{sr}eBR}{L}\left((p + K_B - 1)\right) + \dfrac{4K_bT_nB}{R_L}} \tag{17}$$

BER of design-

$$BER = \frac{1}{2}erfc\sqrt{\frac{SNR}{8}} \tag{18}$$

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

IV. RESULT AND DISCUSSION

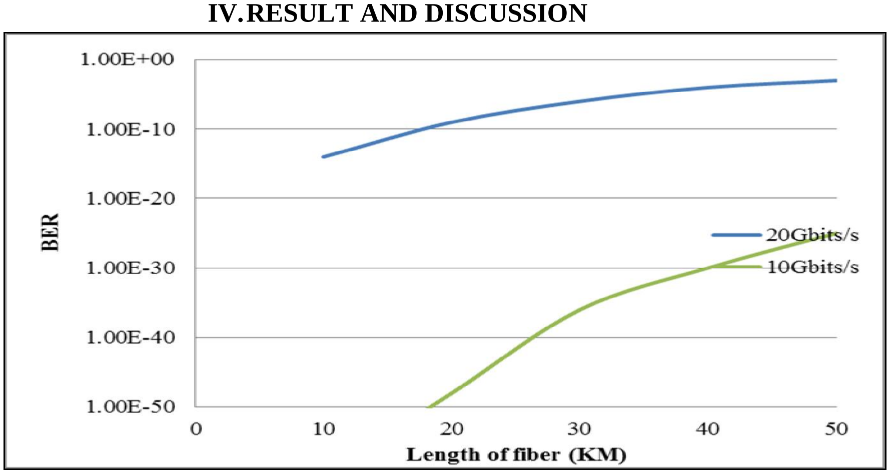

Figure 3: Variation in BER with Length of fiber with 0 dBm received power

Fig.3 shows the various in BER with a length of fiber at 10 Gbits/s and 20Gbits/s at 0dBm reciver power. The simulation is performed for 12 users with weight of W=3. Results show the high data rate response of code. Fig.5 shows the Variation in BER with number of users at 622 Mits/s data rate and -10dBm received power. This is better than the present techniques. Fig.4 shows the Variation in BER with received power for 40 users which shows the better response than the existing MS code at lower received power.

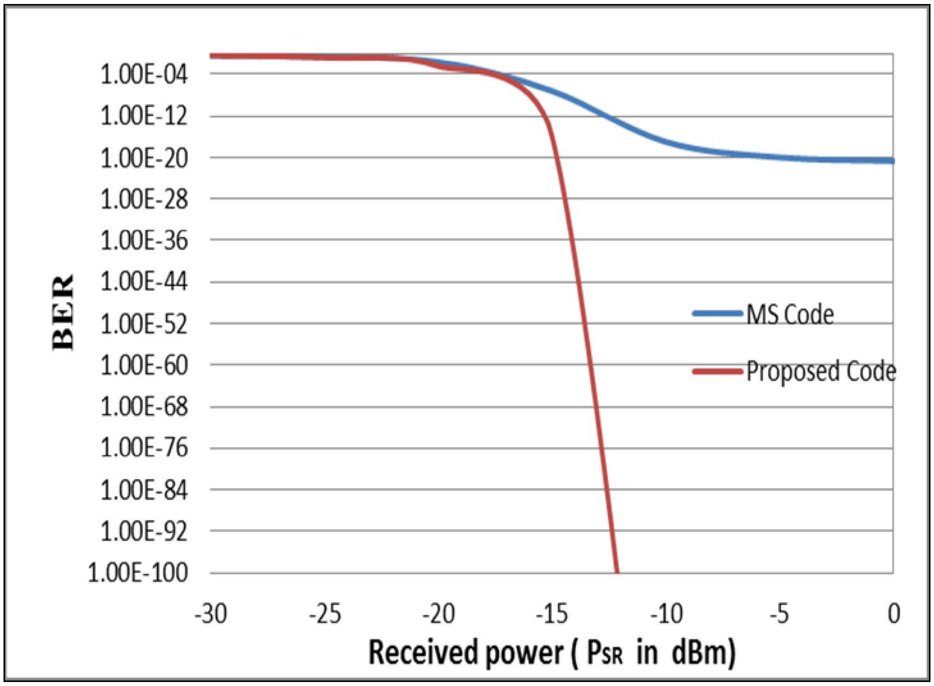

Figure 4: Variation in BER with received power for 30 numbers of users

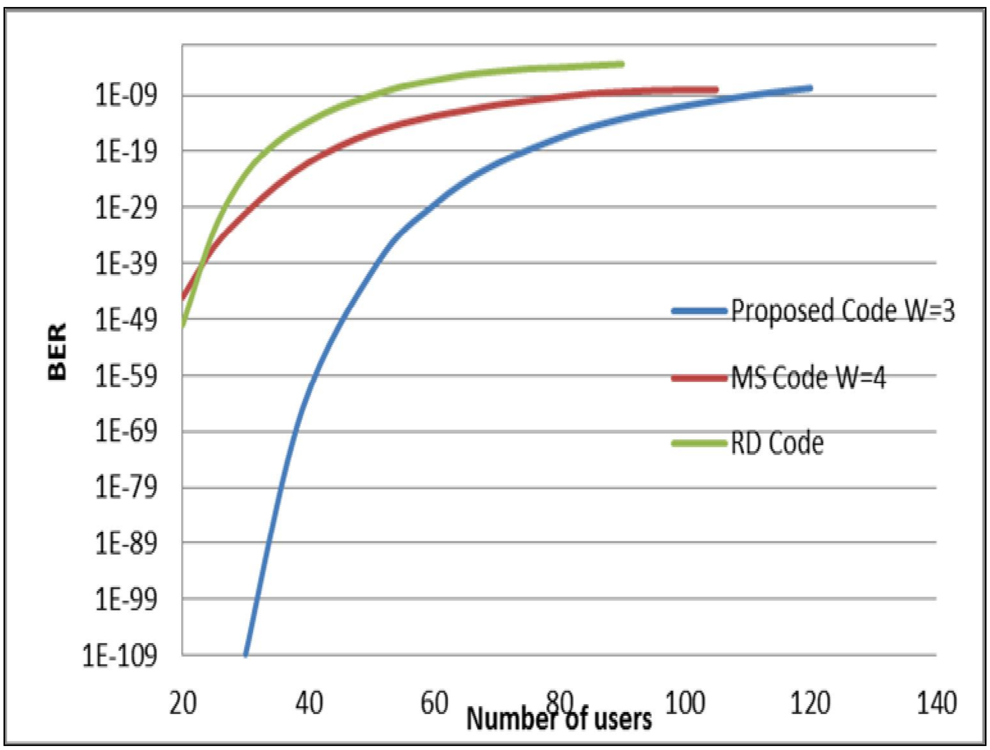

Figure 5: Variation in BER with number of users for 622Mbits/s data rate and -10dBm received power

V. CONCLUSION

The paper discusses a new coding for in phase cross correlation for any number of users and weight for fulfillment of performance of system with enhancement in SNR. The proposed OCDMA coding shows the better performance than the existing method in term of number of power and received power with bit error rate. Present. The design of decoding for the given system shows the less complexity and cost compared to the existing decoding technique. The simulation of the system denotes the high speed response of optical networks. The system stands for the better performZnce in optical network for OCDMA scenario.

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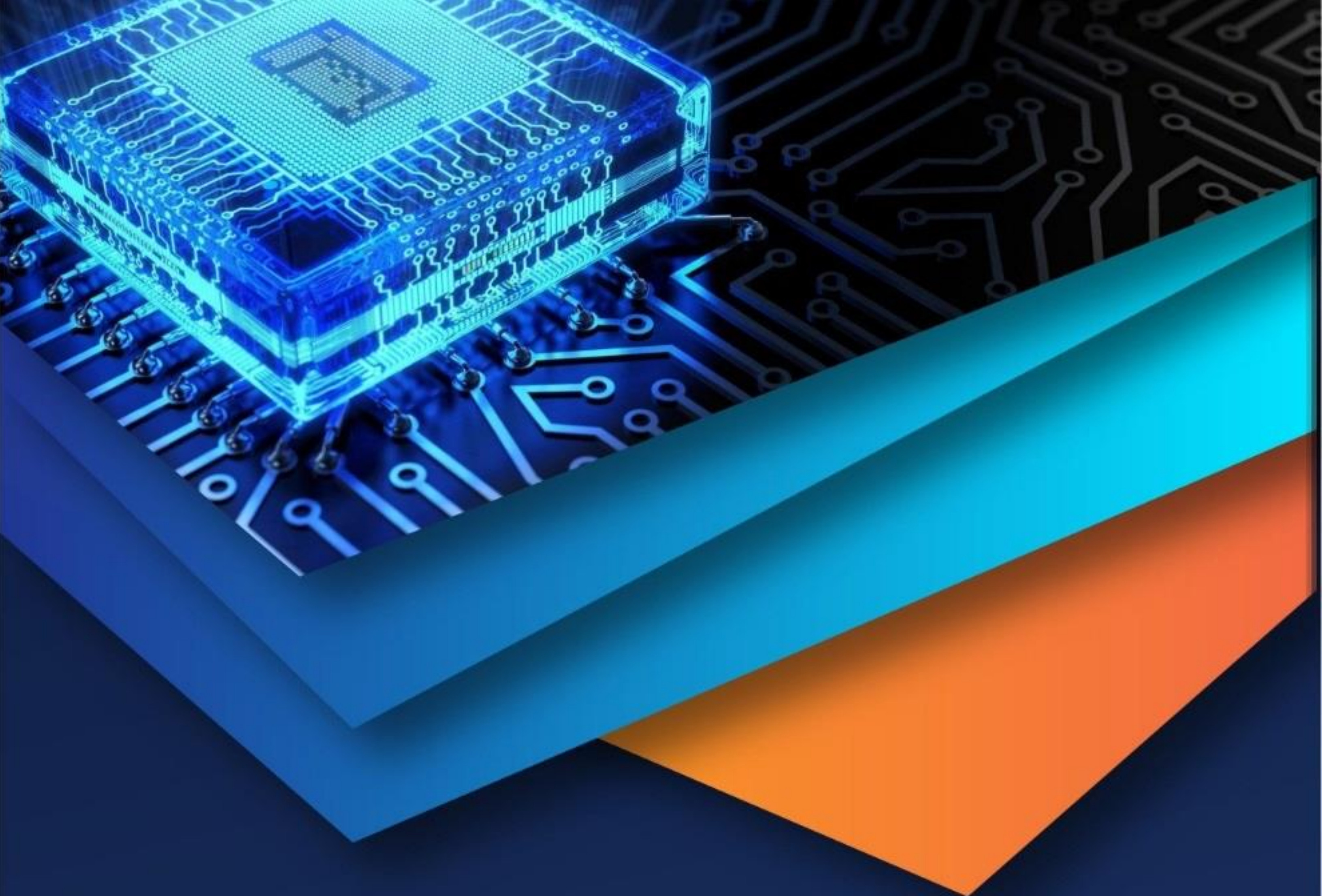

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