SIMULATION AND ANALYSIS OF FLEXIBLE CROSS CORRELATION CODE ON RADIO OVER FIBER (ROF) SYSTEM WITH OPTICAL INTERLEAVER

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*Abstract :*The design of flexible cross correlation code on Radio over fiber with optical interleaver is proposed in this paper. Radio over fiber (ROF) refers to an analog transmission over fiber technology whereby light is amplitude modulated by a radio signal and transmitted over an optical fiber link to facilitate wireless access. ROF technology entails the use of optical fiber links to distribute RF signals from a central location (headend) to Remote Antenna Units (RAUs). In this paper, two data carrying RF signals (odd and even) with a high frequency (usually greater than 10 GHz) is imposed on a lightwave signal for 20 km through single mode fiber which offers low signal loss (0.3dB/km for 1550nm and 0.5 dB/km for 1310nm wavelengths) using optical ineterleaver. Interleaver is frequently used in digital communication. It can expand the number of channels per fiber and devices or networks can be upgraded without requiring that all devices be upgraded.it based on multiple beam interference. As the demand of faster speed and reliable telecommunication going stronger, the challenge of designing of high capacity network to handle the diversity and bulky data traffic has become more crucial task for researchers and network providers. We demonstrate that it is possible to achieve high speed communication by using Radio over fiber communication with flexible cross correlation chip sequence(FCC). The well known advantage of fiber such as low loss, light weight, large bandwidth, low cable cost are very useful in optical communication.

Index Terms - **Central station, Opti-system software, Radio over fiber, Remote Antenna Units, flexible cross correlation.**

I. INTRODUCTION

Fiber optic communication is a method of transmitting information(voice,video,data) from one place to another place by Sending pulses of light through an optical fiber.first developed in the 1970s,fiber optic have revolutionized the telecommunications industry and have played a major role in the advent of the information age.[1]because of its advantages over electrical transmission, optical fibers have largely replaced copper wire communication in core networks in the developed world. Radio transmission over fiber is used for multiple purposes,such as in cable television(CATV) networks and in satellite base stations,the term ROF is usually applied when this is done for wireless access.[2]

II. RADIO OVER FIBER SYSTEM

Radio-over-Fibre (RoF) refers to an analog transmission over fiber technology where by light is amplitude modulated by a radio signals and transmitted over an optical fiber link to facilitate wireless access. This technology entails the use of optical fiber links to distributeRF signals from a central location (headend) to Remote Antenna Units (RAUs). Innarrowband communication systems and WLANs, RF signal processing functionssuch as frequency up-conversion, carrier modulation, and multiplexing, are performedat the BS or the RAP, and immediately fed into the antenna. RoF makes it possible to centralize the RF signal processing functions in one shared location (headend), andthen to use optical fiber, which offers low signal loss to distribute the RF signals to the RAUsas shownin Figure 1.1
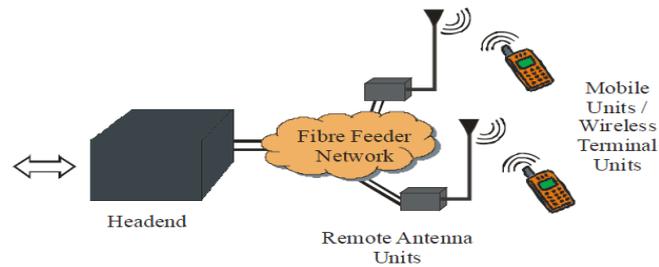
figure 1.1: The radio over fiber system concept

By so doing, RAUs are simplified significantly, as they only need toperform opto-electronic conversion and amplification functions. Thecentralisation ofRF signal processing functions enables equipment sharing, dynamic allocation ofresources, and simplified system operation and maintenance. These benefits cantranslate into major system installation and operational savings, especially inwide-coverage broadband wireless communication systems, where a high density ofBS/RAPs is necessary.[2]

A. Benefits of Radio over FiberTechnology

1)   low attenuation loss

2)   Large bandwidth

3)   Immunity to radio frequency interference

4)   Easy installation and maintenance

5)   Reduced power consumption

6)   Multi-operator- multi-service operation

7)   Dynamic resource allocation

III. OPTICAL INTERLEAVER

In an optical communication system using wavelength division multiplexing (WDM), information is transmitted over several "channels", each at a different optical wavelength λi (or optical carrier frequency fi). An optical interleaver is a 3-port passive fiber-optic device that is used to combine two sets of dense wavelength-division multiplexing (DWDM) channels (odd and even channels) into a composite signal stream in an interleaving way. For example, optical interleaver takes two multiplexed signals with 100 GHz spacing and interleaves them, creating a denser DWDM signal with channels spaced 50 GHz apart. The process can be repeated, creating even denser composite signals with 25 GHz or 12.5 GHz spacing.The device can be used in a reverse direction, forming an optical deinterleaver that separates a denser DWDM signal into odd channels and even channels.[3]

IV. DESCRIPTION OF FLEXIBLE CROSS CORRELATION CODE

In a communication system, each user transmits an assigned code whenever a bit of "1" is to be transmitted and does not transmit anything whenever a bit of "0" is to be transmitted. In any type of communication the most important consideration is the code design; improperly code designed and higher number of simultaneous users can be badly degraded the system performance due to existing of Multi User Interference (MUI) .The proposed coding systems utilizing FCCcode has been analyzed with the presence of different noises.   It has been assumed that the in phase cross-correlation value can be flexible which ensures that each codeword can be easily distinguished from every other address sequence. The code is optimum in the sense that the code length is shorter for a given in phase cross-correlation function. The FCC code can be constructed with simple Tri diagonal matrix property, given any number of users and weights.[4]

A.   Algorithm for FCC code design:

Optical codes are family of K (for K users) binary [0, 1] sequences of length N, code weight W (the number of "1" in each codeword) and the maximum cross-correlation, ∂max. For better communication and to distinguish each of the possible users, to

reduce channel interference and to accommodate large number of users, optical codes should have large values of W and the size K.

Step 1:

The set optical code consists of (N, W, ∂max) FCC code for K users. The KxN code matrix $A_K{}^w$ is here called the Tridiagonal Code Matrix. These sets of codes are then represented by;

$$A_K{}^W = \begin{matrix} a11 & a12 & a13 & 0 & 0 & \dots & 0 & A1 \\ a21 & a22 & a23 & a24 & 0 & \dots & \vdots & = A2 \\ 0 & a32 & a33 & a34 & a35 & 0 & \vdots & A3 \\ 0 & 0 & a43 & a44 & a45 & a46 & \vdots & \vdots \\ \vdots & \ddots & \ddots & \ddots & \ddots & \ddots & \vdots & \vdots \\ 0 & 0 & \dots & \dots & \dots & & \dots & aKNAK \end{matrix} \qquad (4.1)$$

Where

$$A_1 = a_{11}, a_{12}, a_{13}\dots\dots\dots\dots a_{1N}$$
$$A_2 = a_{21}, a_{22}, a_{23}, a_{24}\dots\dots\dots a_{2N}$$
$$A_3 = a_{31}, a_{32}, a_{33}, a_{34}, a_{35}\dots a_{3N}$$
$$\vdots$$
$$A_K = a_{k1}, a_{k2}, a_{k3}\dots\dots\dots\dots a_{KN}$$

The rows of A1, A2 and Ak represent the K codeword and it is assumed that, the code weight ofeach of the K codeword is to be W.

Step 2:

After the K codes represented by the K rows of the KxN code matrix in equation (4.1), are to represent a valid set of K codeword with in phase cross correlations $A_K{}^W$ max and code weight W; it must satisfy the following conditions:

1. The elements {aij} of $A_K{}^W$ must have values "0" or"1"

aij="0"or"1"

for i=1,2,..K,

j=1,2,…..N (4.2)

2. The in phase cross-correlation λmax, between any of the K code words (K rows of the matrix, $A_K{}^W$) should not exceed code weight W.

That is,

$$XiXj^T = \begin{cases} \leq \lambda\max & for\ i \neq j \\ = W & for\ i = j \end{cases} \quad (4.3)$$

3. The code weight of each codeword should be equal to W where,

$$\sum_{j=1}^{N} a_{ij} = W, i=1,2,\dots.K \qquad (4.4)$$

4. From equation (4.3), it is seen that the $W = Xi\ Xi^T$ is the in phase auto-correlation function of codes. $Xi\ Yj^T$ is the out of phase cross-correlation between the ith and the jth codes. It follows that $Xi\ Xi^T$ should be greater than $Xi\ Yj^T$. In other words, $W > \lambda max$.

5. All K rows of $A_K{}^W$ should be linearly independent because each codeword must be uniquely different from other codewords. That is to say the rank of the KxN matrix, $A_K{}^W$ should be K. Moreover, for ,$A_K{}^W$ to have rank K, thus codes $N \geq K$.

Step 3:

From the five conditions above in Step 2, one of the matrices binary sequences as shown in equation (4.1) in Step 1, whose the first ith row for the first K user is given by

A$_i$=0…..011….10……0

It can be seen that the length N is minimum under the assumed conditions. Table (1) shows the FCC code for a given number of users K=4, weight W=3 and flexible cross correlation λmax ≤1   .

Table 1 Generation of Fcc Codes

K1	1	1	0	0
K2	1	1	1	0
K3	0	1	1	1
K4	0	0	1	1

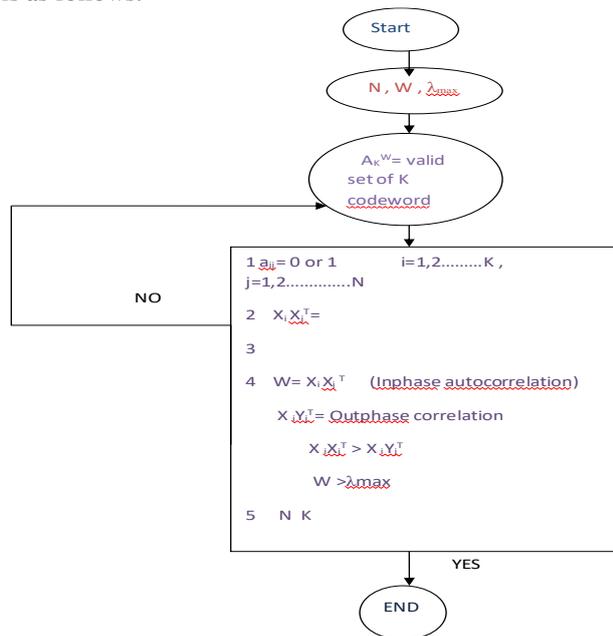Flowchart of these steps is as follows:

fig 4.6 : Flow chart of fcc code

V. SIMULATION SETUP AND DESIGN ANALYSIS

In this proposed method two data signals(odd and even) are generating by user defined bit sequence generater and mixed with NRZ signal and these two signals are optically interleaved and then feeds to the linb Mach-Zender modulator. This is simulated using opti-system 14. Lithium niobate,whose refractive index is a function of the strength of the local electric field. That means if linb is exposed to an electric field ,light will travel more slowly through it. Therefore the phase of the laser light can be controlled by changing the electric field in the lithim niobate. In this linb mach zender modulator, incoming signals are modulated by using laser diode (all operation done at cental station) and then these modulated signals are transmitted to single mode fiber for 20km length. At the receiver side this signal is applied to the delay interferrometer. It based on two beam interference,in which one beam is time delayed to the desired interval. now these two signals feed to the two bessel optical filter,then optical amplifier and PIN photodetector,amplitude demodulator. Shown on different visualizer.
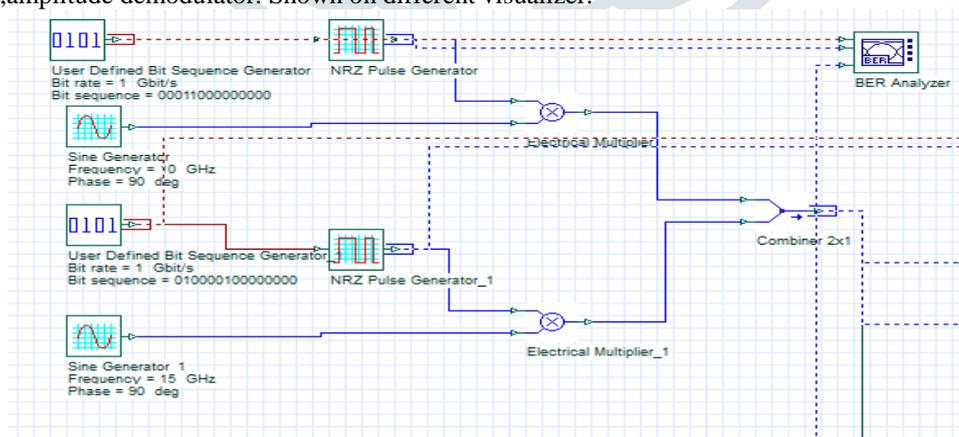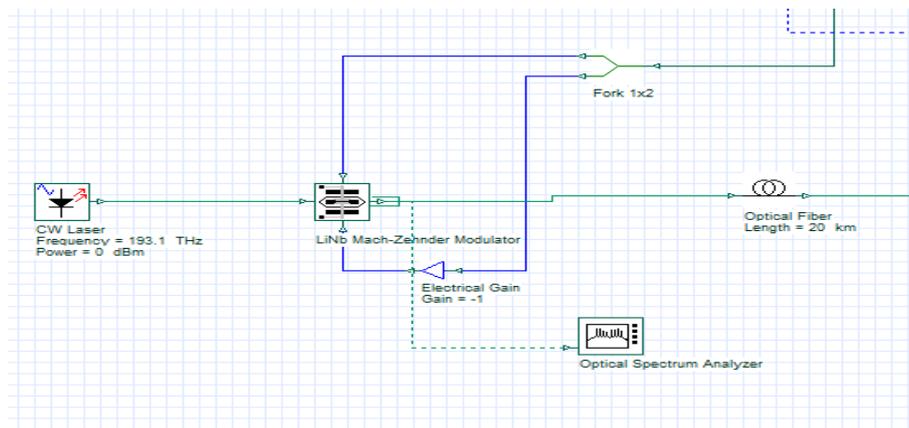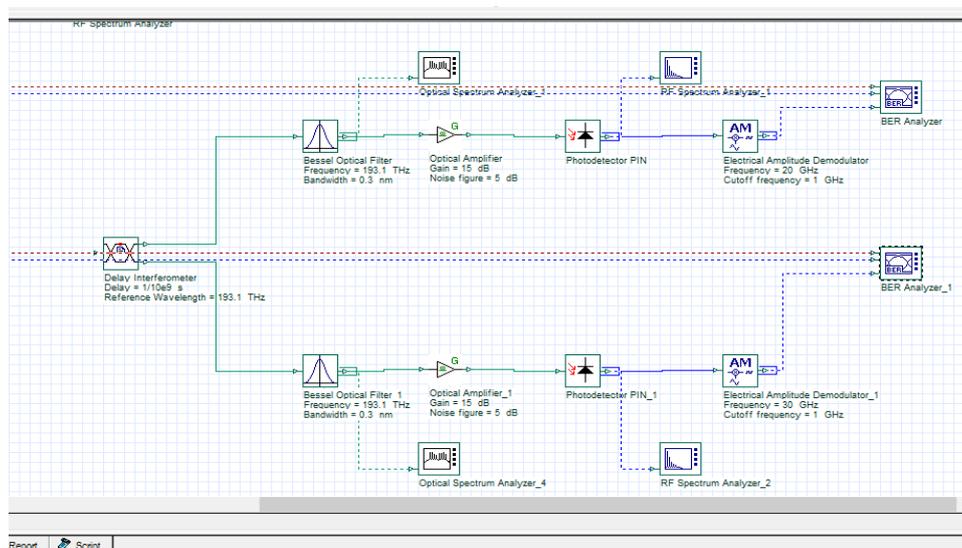
Fig 5.1 Central Station

Fig 5.2 Receiver Station

VI. RESULTS AND CONCLUSION

Transmitted signals are shown in optical spectrum analyzer at the output of linb mach zender modulator in the central station as in fig 6.1. The corresponding results of this simulation setup are achieved at BER analyzer. In this BER analyzer various parameters like Q-factor, Min BER, Threshold value, Eye height etc. can be calculated. Fig. 6.2 shows the BER analyzer of this system ,given input is even sequence of FCC code. It gives the largest Q- factor of 58.40 and least BER to optical fiber link as compared to odd sequence of fcc code.
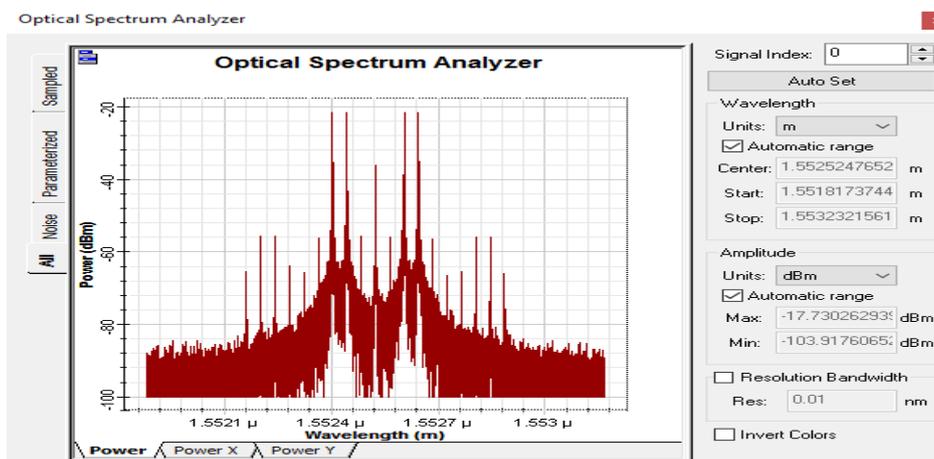

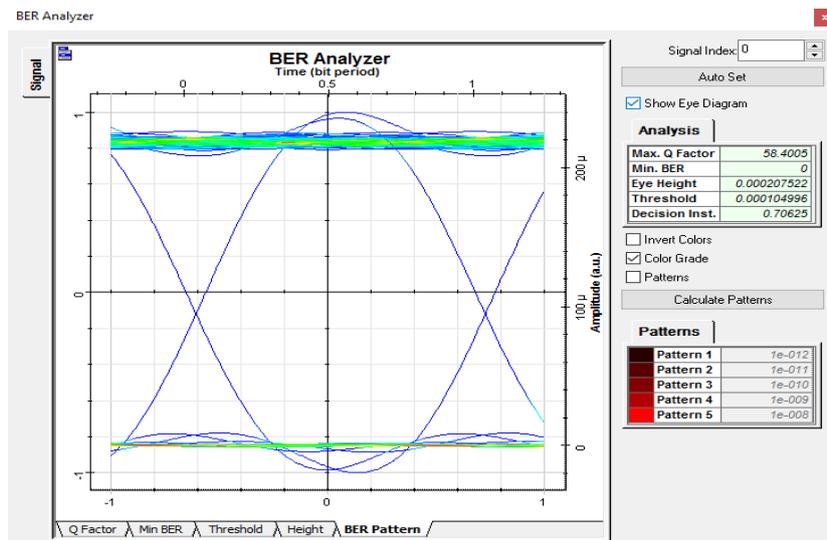Fig 6.1 Transmitted Signals at the Central Station
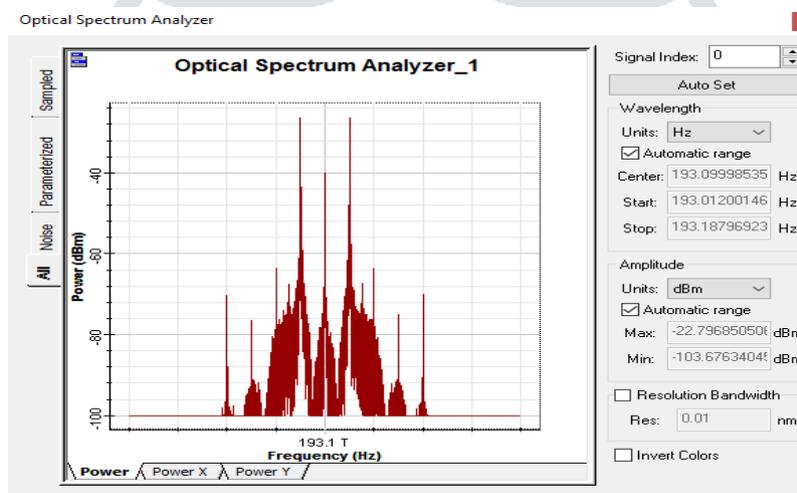
Fig 6.2 Eye diagram at the Receiver

Fig 6.3 Received Signal at the Receiver

In this paper, we disscused about flexible cross correlation code on radio over fiber technolgy with optical interleaver.Here we have analyzed radio over fiber with verity of chip sequence.where it is found that odd and even strength of chip is playing a vital role.flexible cross correlation with even strength is giving better results as compared to odd strength.radio over fiber technology has been used in the implementation of various electronic devices.so there is a scope to use even strength of flexible cross correlation on radio over fiber with optical interleaver for achieving high speed communication.because of using optical interleaver , It can expand the number of channels per fiber and devices or networks can be upgraded without requiring that all devices be upgraded.

VII. ACKNOWLEDGMENT

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