Performance Analysis of WDM and SCM using Available Modulation Techniques

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Abstract—In fiber-optics, transmission mechanism, capacity and the distance plays an important role in deciding the performance of the system. Optical fiber avails the user an enormous bandwidth using systems like multichannel optical communication. This, in todays' world too has left an enormous potential literally untapped. Today, a very few applications involve the use of high bandwidth, giving way to the method of imposing low speed signals over the high speed carrier signals. This makes the higher speed signal, the carrier of various low speed signals. This low speed channels are multiplexed together in time to form a higher-speed channel. Various systems viz. Wavelength Division Multiplexing (WDM), Subcarrier Multiplexing (SCM) have been developed to increase the performance of existing optical communication system. In this project we will be trying to analyze the performance of Wavelength Division Multiplexing (WDM), Subcarrier Multiplexing (SCM). We will use an 8 channel MUX to analyze the performance while in SCM, we use 4 channel SCM system.

The performance analysis of SCM employing OSSB modulation scheme using different modulation schemes like PSK, ASK and FSK have been analyzed and performance comparison between these schemes has been done taking several parameters into consideration using optisystem software.

Keywords: Subcarrier Multiplexing, Wavelength Division Multiplexing, Amplitude shift keying, Frequency shift keying, Phase shift keying

I. INTRODUCTION

The technology of communication in huge bandwidth was the global demand either for industrial field or consumer interest. Basically, drastic demand of high bandwidth on communication was cause of a new communication application which required higher bandwidth such as internet video and audio and others new application. In recent years, optical communications networks are finally feeling the bandwidth constraints already in other type of communication networks such as wireless and satellite communication systems. In fact, service providers are searching a ways to increase their fiber optic network capacity. Optical communication was one of the best ways in term of high bandwidth data communication. Even there a lot of parameters that will affect the performance of optical communication especially in term of dispersion and attenuation, server providers were have full of excitation to use optical fiber as medium. Technology like TDM, FDM, SCM and WDM and their combination are used and improved the performance of the optical communication. The use of subcarrier multiplexing (SCM) transmission using an optical carrier instead of the traditionally used super carrier over optical fibers is very attractive. This technology has found wide spread application because of its simplicity and cost effectiveness. Error correction coding techniques, such a block convolution, and trellis, have advanced, further enhancing the noise immunity of multi state modulation scheme. Thus, the type of modulation mentioned plus coding techniques can be very good candidates for SCM application.

II. SIMULATION SETUP

A. *Wavelength Division Multiplexing*

Wave Length Division Multiplexing combines many Time Division Multiplexing (TDM) channels into the same fiber. TDM combines lower speed signals and produces a resultant higher speed signal where each a bit of lower speed signal is transmitted in its respective time slot (hence the name TDM).This ultimately raises the bit rate that a single optical signal carries. This is where WDM is advantageous over TDM.WDM uses low bit rate and optical power and reaches higher capacity at the same time.

B. *Subcarrier multiplexing*

The Sub Carrier Multiplexing (SCM) is about combining different signals by multiplexing them and transforming it into optical signal for transmission along optical fiber. Modulation of the different signals is done using different frequencies in RF domain and multiplexed by an RF multiplexer and transformed into optical signal using optical source. The whole task is performed by a transmitter.

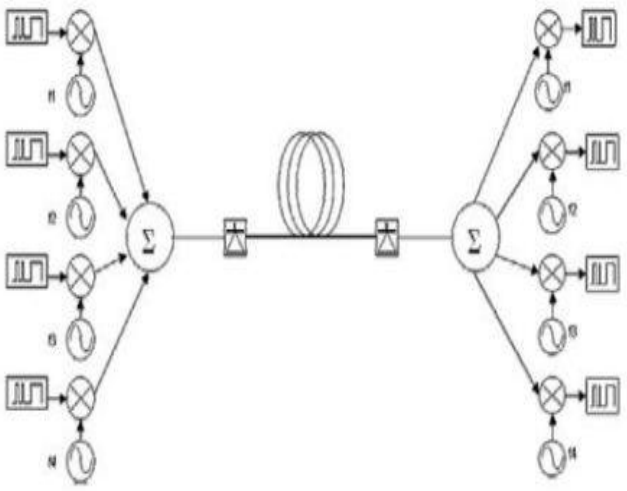

Fig. 1 : SCM Configuration

The optical data transmission with SCM technique is widely appreciated and researched by researchers since this is simple compared to other standard old techniques as well as cost effective. The fact that SCM uses optical carrier unlike the traditional carrier adds to this advantage. This technique basically joins different optical carriers together. There will be a number of transmitters in a transmission medium

performing the RF modulation process and successive conversion into o optical signal. SCM has a better bandwidth utilization than that of WDM owing to the fact that RF modulation process in the initial stages of SCM process. This is because the maturity, frequency selectivity stability of microwave and RF devices are better than pure optical devices. So, SCM is basically a two-step modulation process. The first step modulation involves RF frequency modulation of simple signals and multiplexing them. This multiplexed signal is modulated onto higher frequency microwave carrier. Second step modulation is the one that occurs in optical domain. First, the modulate signal is transformed into optical domain using laser diode optical modulator.

C. SCM using OSSB Modulation

In this paper, our main focus is placed on the SCM [4] system employing OSSB modulation. This paper is to set up a simulation implementation of SCM system employing OSSB modulation and BPSK, FSK, ASK modulation techniques using OptiSystem. The objective of this project is to analyze the performance and design guidelines of the BPSK, FSK, ASK using OSSB SCM transmission system.

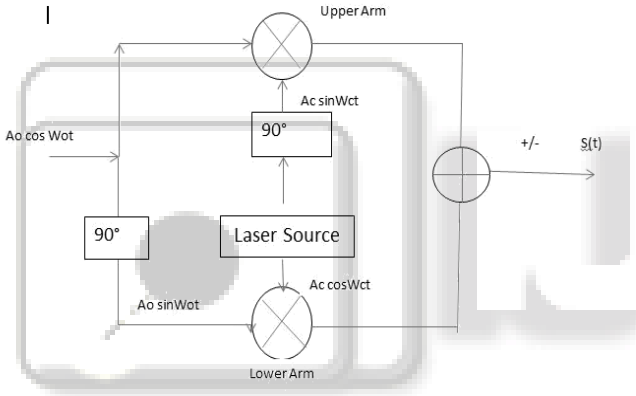

Fig. 2: Basic illustration of OSSB using Phase shift mechanism

Some selections of the performance parameters are done based on the quality of the detected baseband signal. SCM using OSSB can be done using different modulation techniques like PSK, FSK and ASK by changing the necessary block in the above diagram.

Basically, there is a phase shift method applied inside the dual-electrode MZ modulator [1]
We let the output of the BPSK modulator as:

$$m(t) = \pm Ac \cos \omega c\, t$$

The positive and negative polarity signs correspond to a1 and a0 baseband binary data stream which is transmitted from the digital source. By first considering a 1 baseband binary data is transmitted, thus

$$m_1(t) = Ac \cos \omega c\, t$$

This signal is the microwave modulating signal and is applied onto the upper arm of the MZ modulator, whereas another modulating signal with the same amplitude and 90 degree out of phase as compared to modulating signal, m1(t) is applied onto the lower arm of the MZ modulator,

$$= AcAo[\cos(\omega c + \omega o)t]$$

Or

$$AcAo[\cos(\omega c + \omega o)t]$$

Hence the spectrum of the OSSB signal is:

$$s(f)LSB = \frac{AcAo}{2}\{\delta[\omega - (\omega o - \omega c)] + \delta[\omega + (\omega o - \omega c)]\}$$

And

$$s(f)USB = \frac{AcAo}{2}\{\delta[\omega - (\omega o + \omega c)] + \delta[\omega + (\omega o + \omega c)]\}$$

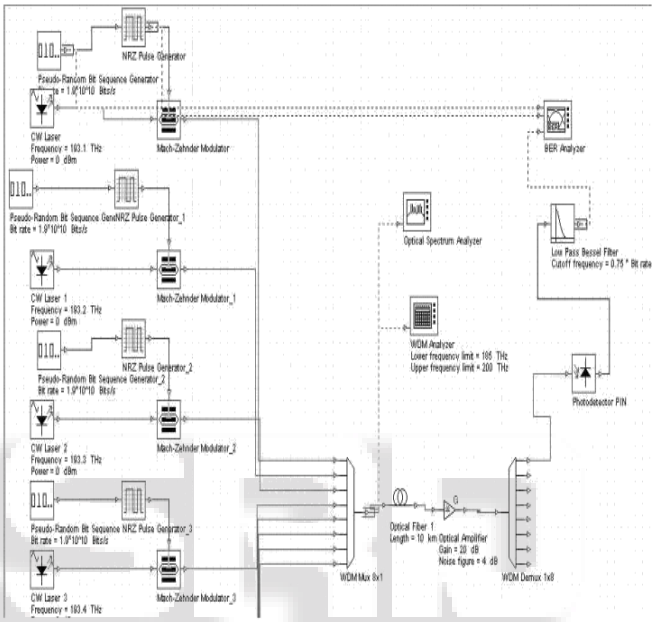

Fig .3: Simulation Setup of WDM

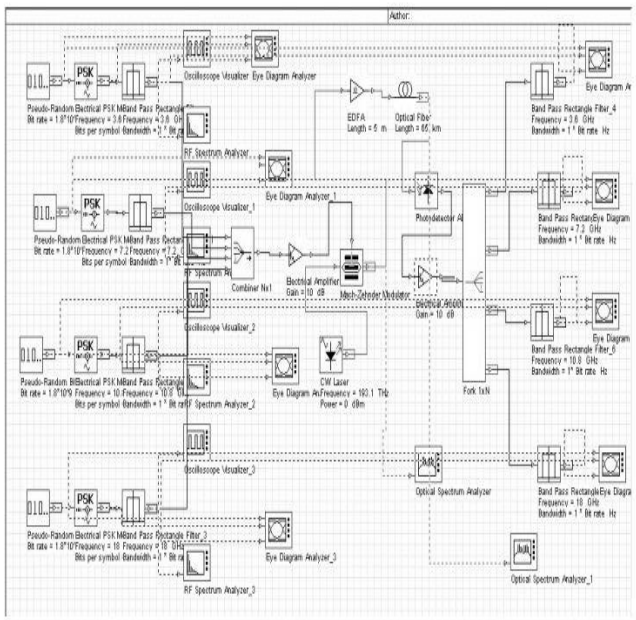

Fig. 4: Simulation Setup of SCM

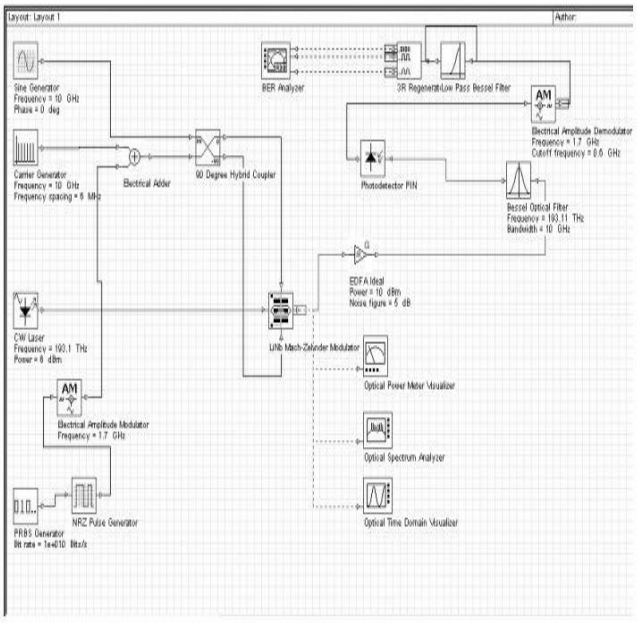

Fig. 5: Simulation setup of SCM employing OSSB modulation

III. Simulation Results and Findings

The SCM model has been successfully simulated and analyzed by a commercial optical system simulator, OptiSystem. The results from these analysis shows that BER performance is linearly increases for the transmission link from 1 km until 18 km fiber link. The BER performance constantly high once reaches 118 km length of the fiber. The BER is 5.871*10^-4 at 65km fiber length. The below figure shows the BER plots of all the four channels

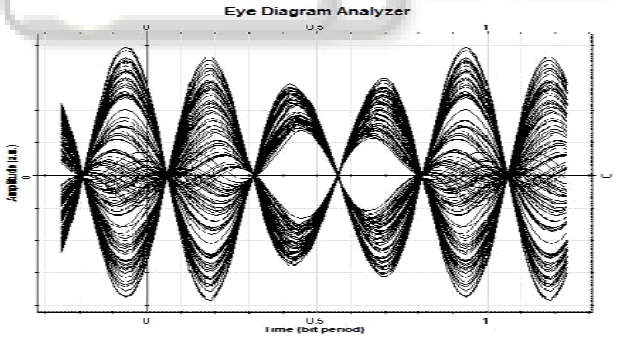

Fig .6: Eye Diagram for SCM channel 1

IV. Conclusion

OSSB modulation becomes very attractive method for transmitting data to longer distances. In this project, simulation of WDM and SCM systems have been done which proves verification that SCM system gives better results when compared to WDM system. SCM makes better use of available bandwidth and reduces dispersion and cross talk. To achieve much better performance, SCM can be used for employing OSSB modulation which reduces the bandwidth of the signal and thus the obtained signal can be transmitted to longer distances with relatively low amount of dispersion. We have simulated SCM employing OSSB modulation using different schemes like ASK, PSK and FSK. We have analyzed that SCM employing OSSB using PSK gives good results than using ASK and FSK as it has higher spectral efficiency and demodulation of the transmitted signal is simple. Therefore SCM using OSSB modulation becomes very attractive method for transmitting data to longer distances.

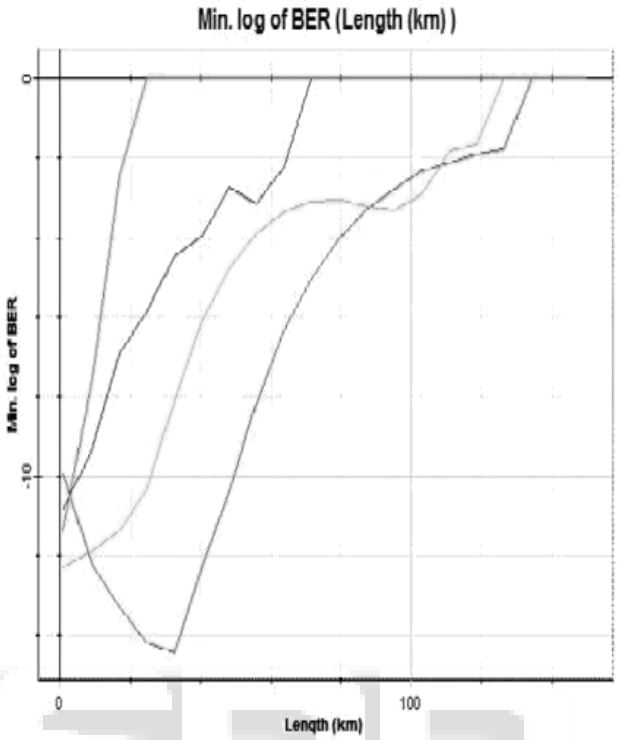

Fig. 7 : BER plots for all the four channels in SCM

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