Performance analysis of Wave Length Division and Sub Carrier Multiplexing using different modulation techniques

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ABSTRACT

In fiber-optic transmission system, transmission capacity and distance of optical signal are always an important consideration factor to improve the performance of the fiber-optic transmission system. The driving force motivating the use of multichannel optical systems is the enormous bandwidth available in optical fiber. A higher speed signals will be a combination of many lower-speed signals, since very few individual applications today utilize this high bandwidth. These lower-speed channels are multiplexed together in time to form a higher-speed channel. Several systems like Wavelength Division Multiplexing (WDM), Subcarrier Multiplexing (SCM) have been developed in order to increase the performance of transmission systems. In this project, we investigate the performance analysis of WDM and SCM methods. In WDM system, we have investigated the performance of the system using an 8 channel multiplexer. In SCM system, we have investigated the performance of the system using a 4 channel SCM system. The performance analysis of SCM employing OSSB modulation scheme using different modulation schemes like PSK, ASK and FSK have been analysed 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**

1. 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.

2.0 SIMULATION SETUP

2.1 WAVELENGTH DIVISION MULTIPLEXING

The time-division multiplexing (TDM) can be accomplished in the electrical or optical domain, with each lower-speed channel transmitting a bit in a given time slot and waiting for its turn to transmit another bit after all the other channels have had their opportunity to transmit. The TDM strategy is to increase the bit rate carried by a single optical wavelength. These systems use very short pulses to achieve very high bit rate and thus they are subject to the influence of dispersion and nonlinearities. Later, as technology advanced, WDM came along to make better use of optical fiber bandwidth by stacking many TDM channels into the same fiber. The advantage of WDM over TDM is that WDM usually use much lower bit rates and optical power in each channel while achieving a higher total capacity.

2.2 SUBCARRIER MULTIPLEXING

The basic configuration of SCM system is illustrated in figure 1. Generally, n numbers of signals were modulated individually with different frequency in RF domain. Then the modulated RF signal will be added up by a RF multiplexer (or by an adder) before transform the RF signal into Optical signal through optical source and optical modulator on a single wavelength. All the operation above was perform by a single transmitter[6].

Practically, in one link of transmission medium, there will be several numbers of transmitters in the system. Each transmitter was tempted to sending data and other types of information. Therefore an optical multiplexer was required facility the system in order to sharing the same fiber link[3]. As be mentioned before, because of its simple and low-cost implementation, high-speed optical data transmission using SCM technology attracted the attention of many researchers. The most significant advantage of SCM in optical communications is its ability to place different optical carriers together closely. This is because microwave and RF devices are much more mature than optical devices: the stability of a microwave oscillator is much better than an optical oscillator (laser diode) and the frequency selectivity of a microwave filter is much better than an optical filter. Therefore, the efficiency of bandwidth utilization of SCM is expected to be much better than conventional optical WDM.

The main idea of SCM is combining two step of modulation which is operating at different domain. First modulation was occupied at RF part such that several low bandwidth RF channel carrying analogue or digital signal add up together by using multiplexer. Thus the signal will be very close to each other in the frequency domain depending to local oscillator frequency that applied in the modulation part. This combined signal actually modulated onto higher frequency microwave carrier. The up-converted signals are in different frequency bands and can therefore be combined by a microwave power combiner forming a microwave subcarrier multiplexed composite signal. Second modulation was occupied at optical domain, the modulated signal then convert to optical domain by using laser diode and optical modulator.

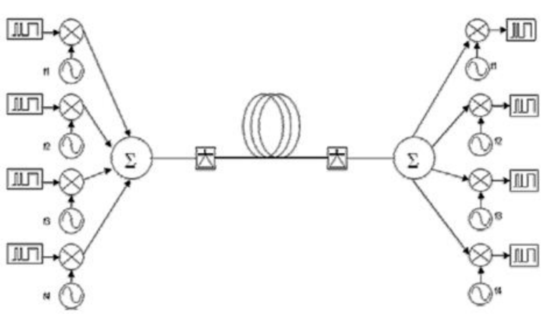

Fig .1 Basic configuration of SCM

2.3 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. 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.

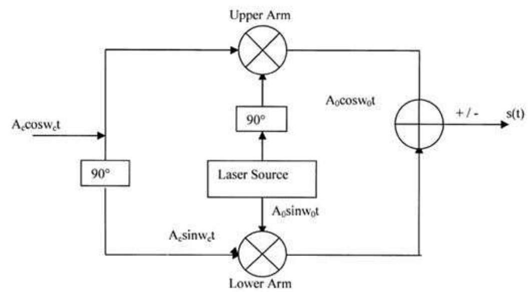

Fig .2 Illustration of OSSB modulation using phase shift method

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

$$m(t) = \pm A_c \cos w_c$$

The positive and negative polarity signs correspond to a 1 and a 0 baseband binary data stream which is transmitted from the digital source. By first considering a 1 baseband binary data is transmitted, thus

$$m_1(t) = A_c \cos w_c t$$

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,

$$m_2(t) = A_c \sin w_c t$$

We let the lightwave signal fronl the laser source into the branches of the modulator as:

$$n(t) = A_0 \sin w_0 t$$

Hence, the lightwave along the upper and lower arms of the modulator will become:

$$n_1(t) = A_0 \cos w_0 t$$
$$n_2(t) = A_0 \sin w_0 t$$

The output of the MZ modulator will be:

$$\begin{aligned} s(t) &= m_1(t)\, n_1(t) \pm m_2(t)\, n_2(t) \\ &= A_c A_0 \cos w_c t \cos w_0 t \\ &\pm A_c A_0 \sin w_c t \sin w_0 t \\ &\frac{A_c A_0}{2}[\cos(w_0 + w_c)t + \cos(w_0 - w_c)t] \\ &\pm \frac{A_c A_0}{2}[\cos(w_0 - w_c)t - \cos(w_0 + w_c)t] \\ &= A_c A_0 \cos(w_0 - w_c)t \\ &Or\ A_c A_0 \cos(w_0 + w_c)t \end{aligned}$$

Hence the spectrum of the OSSB signal is:

$$s(f)LSB = \frac{A_c A_0}{2}\{\delta[w - (w_0 - w_c] + \delta[w + (w_0 - w_c)]\}$$
$$s(f)USB = \frac{A_c A_0}{2}\{\delta[w - (w_0 + w_c] + \delta[w + (w_0 + w_c)]\}$$

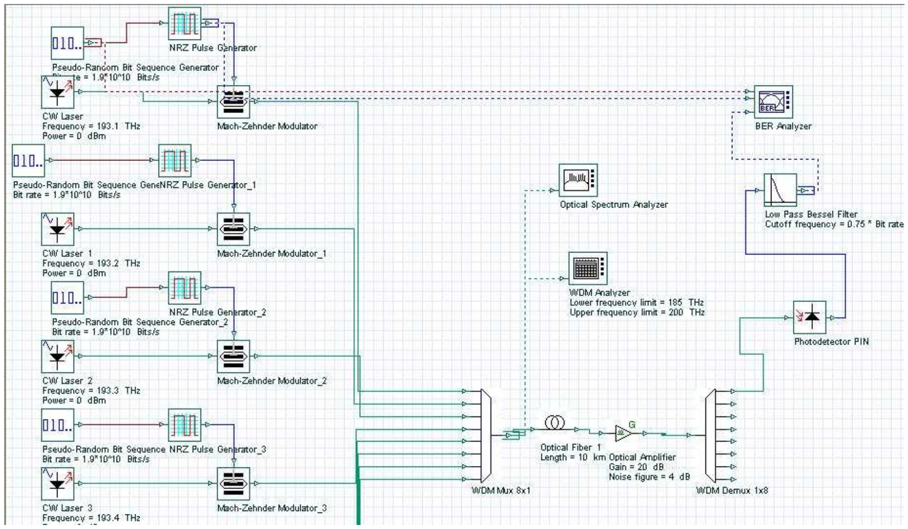

Fig .3 Simulation Setup of WDM

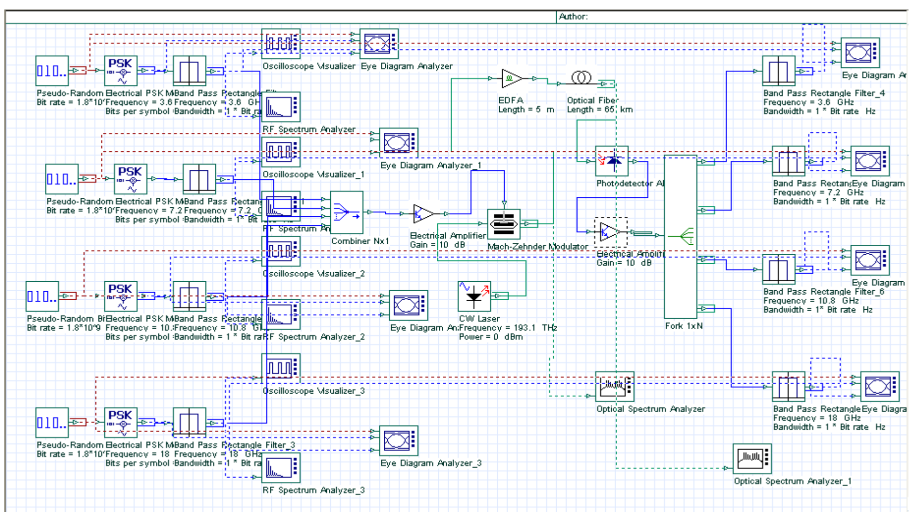

Fig .4 Simulation Setup of SCM

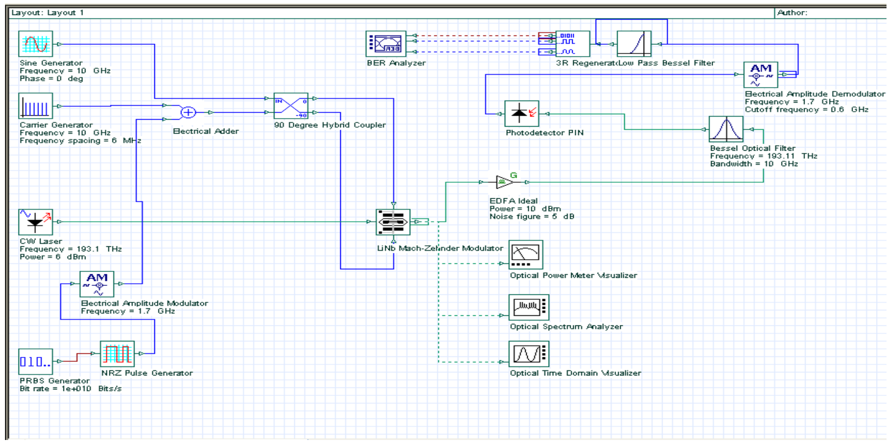

Fig .5 Simulation setup of SCM employing OSSB modulation

3.0 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 for all the four channels.

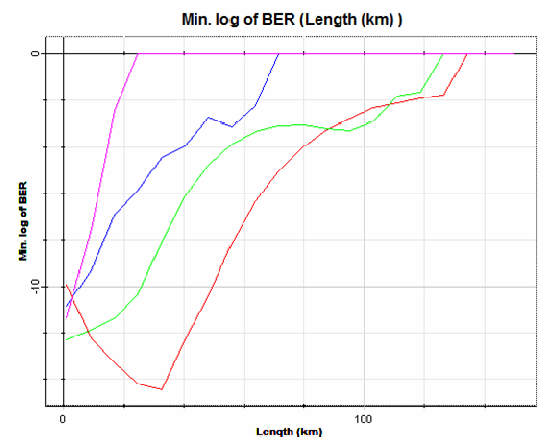

Fig .6 BER plots for all the four channels in SCM

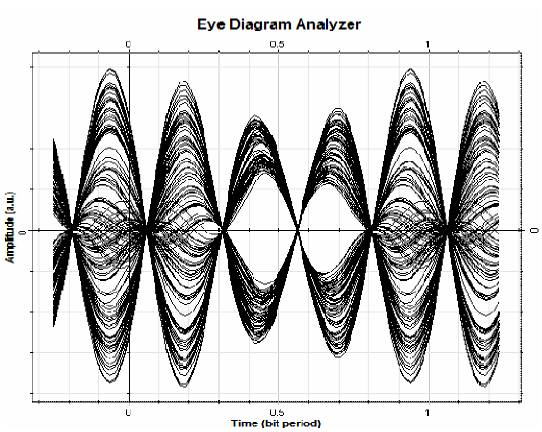

Fig .6 Eye Diagram for SCM channel 1

The below figure shows the BER plots for all the four channels.

4.0 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 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 analysed 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.

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