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4-Channel Wavelength Division Multiplexing (WDM)

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Abstract—Optical communication, in particular, wavelength-division-multiplexing (WDM) technique, has become a promising networking choice to meet ever-increasing demands on bandwidth from emerging bandwidth-intensive computing/communication applications, such as data browsing in the World Wide Web, multimedia conferencing, e-commerce, and video-on-demand services.

As optics becomes a major networking media in all communications needs, optical interconnects will inevitably play an important role in network. This paper demonstrates the working of WDM using simulation software optisystem.

Index Terms— Wavelength Division Multiplexing (WDM), Multiplexer, Demultiplexer, Transmitter, Receiver, EDFA, Optic fibre link, Adaptive white Gaussian noise(AWG), Non return to zero(NRZ), QPSK Modulation, Spectrum Analyzer

I. INTRODUCTION

Wavelength-division multiplexing (**WDM**) is a method of combining multiple signals on laser beams at various infrared (IR) wavelengths for transmission along fiber optic media. Each laser is modulated by an independent set of signals.

The use of WDM can multiply the effective bandwidth of a fiber optic communications system by a large factor, but its cost must be weighed against the alternative of using multiple fibers bundled into a cable. A fiber optic repeater device called the erbium amplifier can make WDM a cost-effective long-term solution.

In wavelength division multiplexing, we transmit the signals of different wavelengths through a multiplexer and the channel used is an optical fibre so that the bandwidth and transmission efficiency increases. At the receiving side, a demultiplexer a used to demultiplex the signal received we can also use amplifiers to amplify the weak signal received and the photodetector will detect the signal and hence the transmitted signal is received through WDM.

In fiber-optic communications, **wavelength-division multiplexing (WDM)** is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (i.e., colors) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity.

In early WDM systems, there were two IR channels per fiber. At the destination, the IR channels were demultiplexed by a dichroic (two-wavelength) filter with a cutoff wavelength approximately midway between the wavelengths of the two channels. It soon became clear that more than two multiplexed IR channels could be demultiplexed using cascaded dichroic filters, giving rise to coarse wavelength-division multiplexing (CWDM) and dense wavelength-division multiplexing (DWDM). In CWDM, there are usually eight different IR channels, but there can be up to 18. In DWDM, there can be dozens.

II. BLOCK DIAGRAM

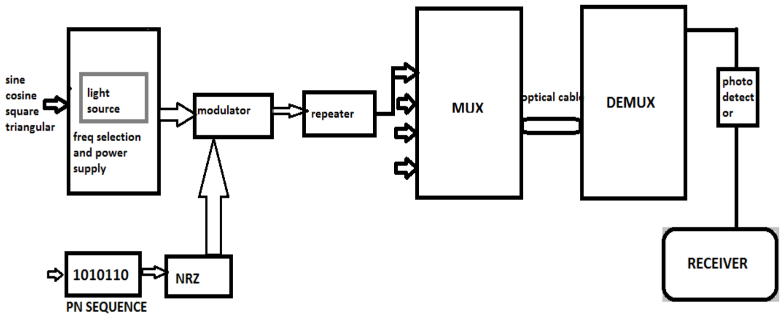
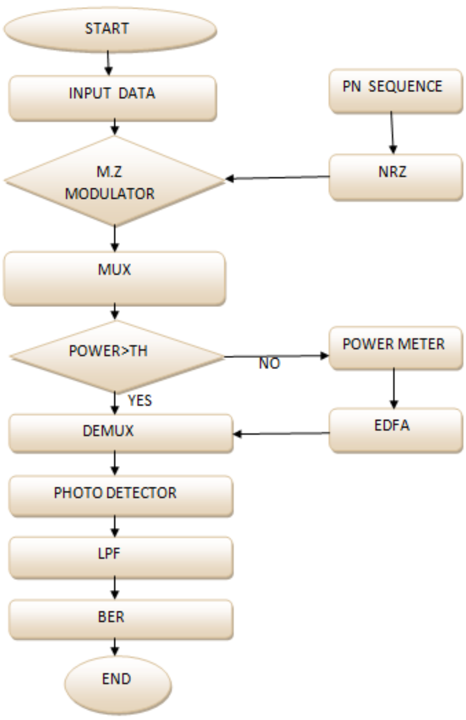


Fig1: Generalized block diagram of WDM

Fig 1 shows the generalized block diagram of WDM systems. It consists of 4 section of sources, each of them comprises of a data input which is then converted into light form by a laser source which converts the electrical input to optical form in order to be transmitted on a fibre optic cable. This optical data signal is modulated along with a locally generated PN sequence signal in NRZ form. Four such transmitter sections are built and then are multiplexed using an optical MUX. This 4:1 multiplexed signal is then transmitted through the fibre optic link. Repeaters are used at regular interval to boost the signal strength; usually Eridium Doped Fibre Amplifier (EDFA) is used. At the receiver end a demultiplexer divides the signal and supplies it to respective photo detector of corresponding wavelengths which is then followed by a spectrum analyzer.

III. FLOWCHART



IV. EXPERIMETAL SETUP

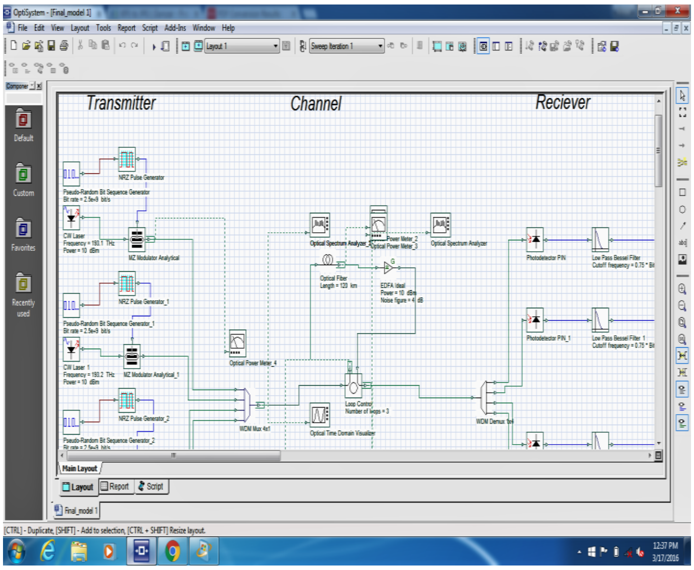


Fig 2 : Simulation diagram

Fig 2 shows the actual simulation window of WDM on optisystem. The working is as follows:

1. A continuous wave laser output is modulated with a locally generated PN sequence in Non Return to Zero(NRZ) format.
2. **Non-return-to-zero (NRZ)** line code is a binary code in which ones are represented by one significant condition, usually a positive voltage, while zeros are represented by some other significant condition, usually a negative voltage, with no other neutral or rest condition.
3. Thee modulation used is Mach Zender modulation
4. A **Mach-Zehnder** modulator is used for controlling the amplitude of an optical wave. The input waveguide is split up into two waveguide interferometer arms. If a voltage is applied across one of the arms, a phase shift is induced for the wave passing through that arm. When the two arms are recombined, the phase difference between the two waves is converted to an amplitude modulation.
5. Four such transmitter sections are built and the outputs are multiplexed using 4x1 WDM Mux.
6. This multiplexed signal is then transmitted through a fibre length of 120km.
7. Optical power meters and spectrum analyzer are used to measure optical signal strength at regular intervals.
8. Eridium Doped Fibre Amplifier’s (EDFA) is used as repeater to boost signal strength.
9. **EDFA** is an optical repeater device that is used to boost the intensity of optical signals being carried through a fiber optic communications system. An optical fiber is doped with the rare earth element erbium so that the glass fiber can absorb light at one frequency and emit light at another frequency.
10. At the receiver side a WDM Demux is used to separate out the signals based on wavelengths to respective photodetectors.
11. The output of photodetectors is fed to a Low Pass Bessel Filter
12. A **Bessel filter** is a type of analog linear filter with a maximally flat group/phase delay, which preserves the wave shape of filtered signals in the passband.
13. This is then followed by a 3-R regenerator the function of which is to obtain a 3R regenerator: re-amplification and reshaping, timing extraction and re-sampling.

14. 3R regeneration preserves data quality and allows for improved transmission distances, thus enhancing transparency, scalability, and flexibility of optical networks.
15. Then th regenerated output is forwarded to the final stage i.e. a BER analyzer.
16. **BER** analyzer is used to estimate the bit error rate based on a Gaussian algorithm with transmission of a short sequence of bits.

V. RESULTS

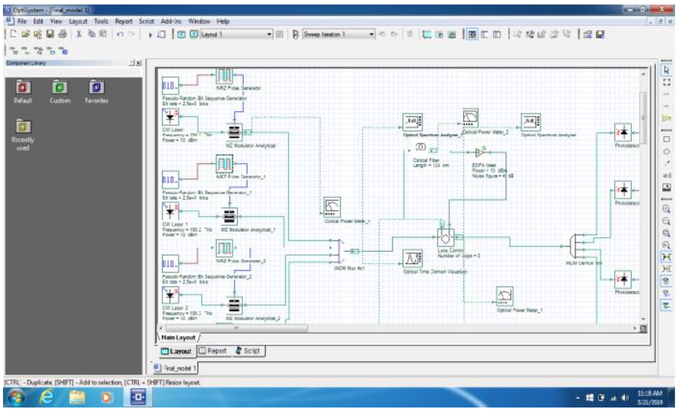


Fig 3: Transmitter channel

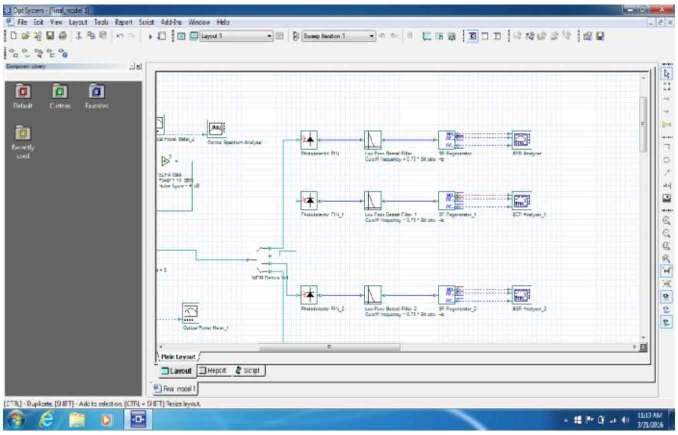


Fig 4: Receiver channel

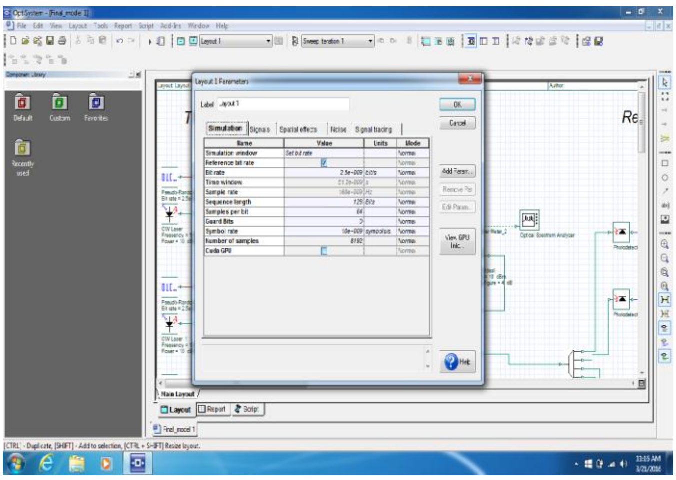


Fig 5 : System Parameters

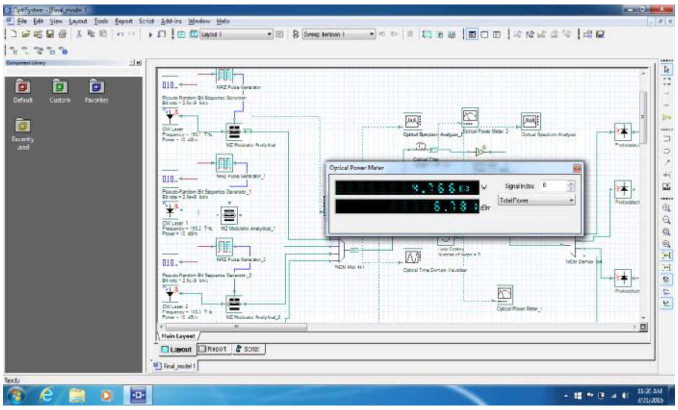


Fig 6: Single channel power

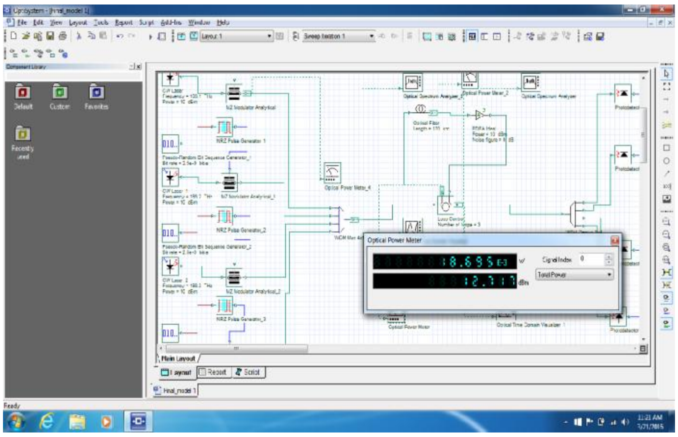


Fig 7: Multiplexed power

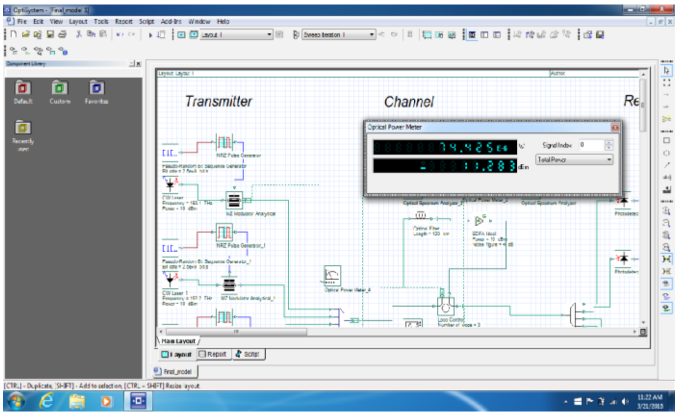


Fig 8: power after channel

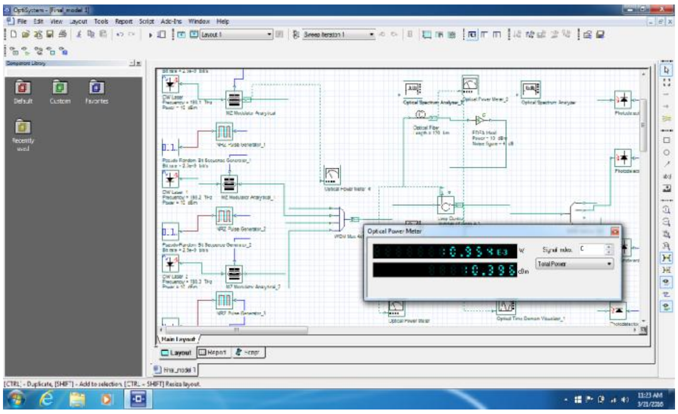


Fig 9: power after amplification

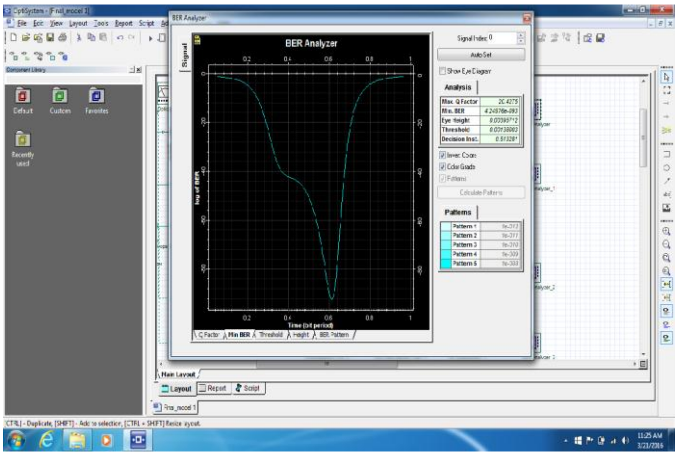


Fig 10: Minimum BER

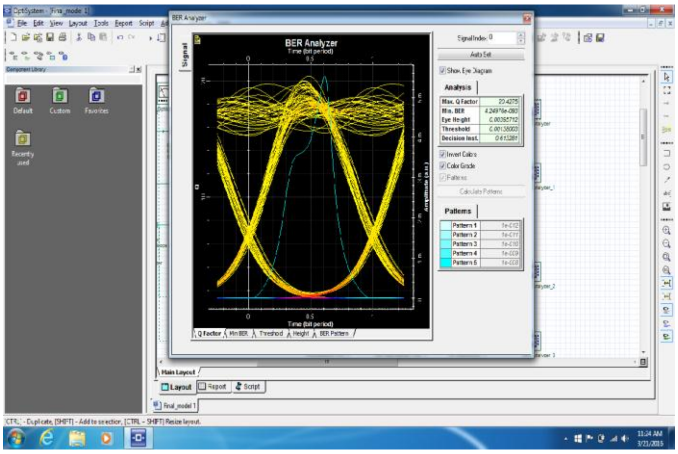


Fig 11: Eye Diagram

VI. ADVANTAGES AND DISADVANTAGES

1. It provide the greater transmission capacity in the system.
2. It has a capability of bidirectional and Duplex data transmission.
3. Easily can handle simultaneous transmission of various signals.
4. Easy system expansion due to this we can use multiple channel at a same time.

5. Faster access the new channels and require minimum time to transmit information from source to destination.
6. Two signals of the same wavelength cannot travel down the same optical fiber (in the same direction).
7. Bandwidth is typically only around 30-40 optical wavelengths.
8. Current optical fibers can only hold 2-20 wavelengths per fiber.
9. A transmitter/receiver cannot modulate a signal (i.e. its wavelength cannot change) .

VII. APPLICATION

1. Video Network Conferencing.
2. Real –Time Medical Imaging.
3. Scientific Visualization.
4. High-Speed Supercomputing & Multiple data sources system.
5. Communication system.
6. Telephone network.

VIII. CONCLUSION

Thus, we have designed 4-channel wavelength division multiplexing (WDM) through optical link successfully using simulation software optisystem and we have observed power on the channel before and after amplification and calculated the minimum BER and observed the EYE diagram.

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