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Enhancing optical network Capacity using DWDM system and Dispersion compensating Technique

Babita Singh [1], Shweta Verma [2]
[1 2] Electronics & Communication Engineering Department , Rajarshi Rananjay Sinh Institute of Management &Technology Amethi (U. P.) India-227405

Abstract - From each technical and economic scan, the plasticity to turn out in all chance unlimited transmission capability is that the foremost blatant advantage of DWDM technology. This investment in fiber plant can't entirely be preserved, but optimized by a part of a minimum of thirty 2. so as to cut back dispersion in optical networks numerous dispersion compensating techniques square measure used. Dispersion are often controlled by choosing correct modulation format for the input audiotape. This paper including capability of optical network would be incremented using DWDM system with dispersion compensating technique. The performance of NRZ modulated pulse is evaluated for Dense WDM systems having symmetrical dispersion compensating technique.The pulse breadth i.e FWHM of NRZ modulated mathematician pulse was varied from 5ps to 15ps to judge the performance at eighty Gb/s. This experiment shows that Dense WDM systems square measure most effective as a result of BER is extremely less as compared to the standard WDM systems used antecedently.

Keywords- Optical laser, MUX/DEMUX, DWDM ,NRZ Modulated Gaussian Pulse, Dispersion Compensating Fiber(DCF),Single Mode Fiber(SMF)

1. INTRODUCTION

WDM began within the late Nineteen Eighties mistreatment the two wide spaced wavelengths within the 1310 nm and 1550 nm (or 850 nm and 1310 nm) regions, typically known as broadband WDM. Wave Division Multiplexing is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths of laser light. Early.Figure-1 shows associate degree example of this easy kind of WDM. These systems not only enable bidirectional communications over a single strand of optical fiber but also increase the capacity. The WDM system having the channel spacing of 200 GHz to 100 GHz, called Coarse or Conventional WDM system were developed firstly[1] and later the channel spacing is reduced about 50 GHz, called Dense WDM system were developed. A lot of research is going on to further reduce the channel spacing in order to increase the channel capacity and reducing the requirement of bandwidth[3]. There are some basic problems when transmitting the signal via WDM system are as follow:

1. As the transmission distance increases ,the quality of signal degrades after travelling certain distance depending on the channel spacing and optical fiber characteristics.
2. Transmission bit rate increases, dispersion problem increases.

There is a need of Dispersion Management for higher bit rate WDM systems[2]. Microchip compensation, middle span spectral inversion, optical section conjugation, initial pre chip, completely different delay ways and dispersion compensating fibers square measure some varied techniques that square measure accustomed compensate the losses occurring because of dispersion whereas transmission. In this paper Dispersion Compensating Fibers are used to compensate the losses. The Negative dispersion co-efficient of Dispersion Compensation Fiber when connected to the positive dispersion coefficient of standard single mode fibers the overall dispersion is reduced. This is the basic concepts behind the design of dispersion management for loss free transmission of optical signal to a longer distance.

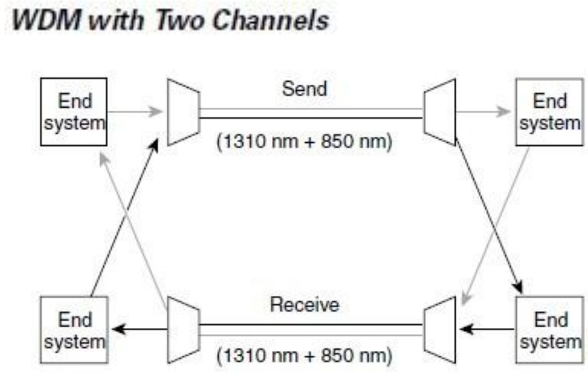

Figure-1 Schematic Diagram of WDM with 2 channel

DWDM systems had evolved to the aim where they were capable of sixty four to 100 and sixty parallel channels, densely packed at fifty or maybe twenty 5 Gc per second intervals.

II. DWDM System Functions

At its core, DWDM involves a tiny low variety of physical-layer functions. These are delineated in Figure-2 that shows DWDM schematic for thirty two channels. Every optical channel occupies its own wavelength

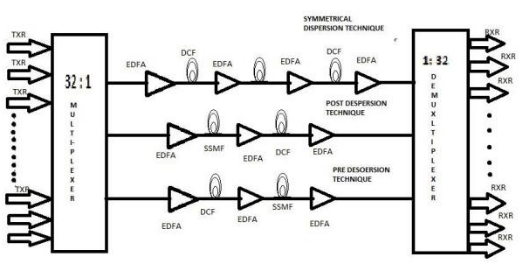

Figure-2 Block diagrame of 32 channel DWDM system using despersion compensating fiber techniques(pre,post & symmetrical)

The system performs the following main functions:

• Generating the signal—The supply, a solid-state device, ought to offer stable ethics a specific, slender metric that carries the digital information, modulated as associate degree analog signal.

• Combining the signals—Modern DWDM systems use multiplexers to combine the signals. There's some inherent loss regarding multiplexing and demultiplexing. This loss depends upon the number of channels but square measure usually eased with optical amplifiers, that boost all the wavelengths at once whereas not electrical conversion.

• Sending the signals— The effects of interference and optical signal degradation or loss ought to be reckoned with in fiber optic transmission.These effects is reduced by dominant variables like channel spacings, wavelength tolerance, and optical maser power levels. Over a transmission link, the signal might have to be optically amplified

• Separating the received signals—At the receiving finish, the multiplexed signals should be separated out. though this task would seem to be merely the other of mixing the signals, it's truly a lot of technically tough

• Receiving the signals—The demultiplexed signal is received by a photo detector.

III Single-Mode Fiber Designs:

Designs of single-mode fiber have evolved over many decades. The 3 principle sorts and their ITU-T specifications are:

• Non-dispersion-shifted fiber (NDSF)

• Dispersion-shifted fiber (DSF)

• Non-zero dispersion-shifted fiber (NZ-DSF)

The major kinds of single-mode fibers and their application are summarized as follows:

• Non-dispersion-shifted fiber (standard SM fiber)—accounts for larger than ninety five % of deployed plant; appropriate for TDM (single-channel) use within the 1310-nm region or DWDM use within the 1550-nm region (with dispersion compensators). this kind of fiber can even support ten Gigabit local area network standard at distances over three hundred meters.

• Dispersion-shifted fiber— suitable for TDM use within the 1550-nm region, however unsuitable for DWDM during this region.

• Non-zero dispersion-shifted fiber—good for each TDM and

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DWDM use within the 1550-nm region.

• Newer generation fibers—includes sorts that enable the energy to travel any into the protective covering, making a tiny low quantity of dispersion to counter four-wave intermixture, and dispersion-flattened fibers, which allow use of wavelengths farther from the optimum wavelength while not pulse spreading

Designs of single-mode fiber have evolved over many decades. The 3 principle sorts and their ITU-T specifications are:

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• Dispersion-shifted fiber (DSF)
• Non-zero dispersion-shifted fiber (NZ-DSF)

Table-1: Different Optical fibers with their window sizes

S.No	Window Range	Name of fibers	Applications
1	1310 nm	Non-dispersion-shifted	appropriate for TDM (single-channel)
2	1550 nm	Non-dispersion-shifted(with dispersion compensators)	appropriate for DWDM
3	1550 nm	Dispersion-shifted fiber	suitable for TDM but unsuitable for DWDM
4	1550 nm	Non-zero dispersion-shifted fiber	Good for each TDM and DWDM use

IV System Description

All the simulations are done using optisystem 7.0 software. The thirty-two channel DWDM system i.e Dense Wavelenght Division Multiplexingis designed using post dispersion technique. The block diagrame is shown in the fig-3

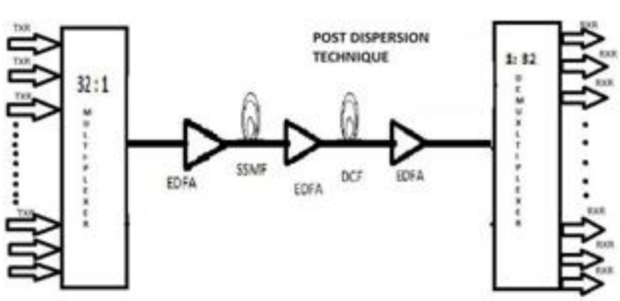

Fig-3 32 channel DWDM system with post dispersion Technique

The data source used is binary pseudorandom data at 80 Gb/s. NRZ pulse generator along with Gaussian pulse generator is used to generate the NRZ pulses which modulates the optical laser signal with the help of Mech-Zehnder Modulator[4] .In this DWDM 32 channel system, there ar thirty two optical device sources generating optical signals of various wavelengths.Wavelengths are selected depending on the channel spacing between the adjacent channels during transmission through single mode fiber as shown in the form of table as follows:

channel No.	Wavelength (nm)	Signal Power (dBm)	Noise Power (dBm)	OSNR (dB)
1st	1550	-13.18345	-49.975978	36.792527
2nd	1548.3989	-13.258156	-49.807033	36.548877
3rd	1546.8011	-13.183413	-49.880418	36.697006
4th	1545.2065	-13.26168	-49.763963	36.502284
5th	1543.6153	-13.184931	-49.903632	36.718701
6th	1542.0273	-13.185488	-49.893318	36.707829
7th	1540.4426	-13.185169	-49.899021	36.713852
8th	1538.8612	-13.260963	-49.764035	36.503073
9th	1537.283	-13.256038	-49.87667	36.620631
10th	1535.708	-13.185441	-50.121322	36.935881
11th	1534.1363	-13.259833	-49.835021	36.575187
12th	1532.5678	-13.255993	-49.858559	36.602566
13th	1531.0024	-13.186575	-49.877125	36.69055
14th	1529.4403	-13.183246	-49.90899	36.725744
15th	1527.8813	-13.251668	-50.04321	36.791542
16th	1526.3256	-13.25436	-49.909118	36.654757
17th	1524.773	-13.251924	-49.81664	36.564716
18th	1523.2235	-13.185147	-49.768304	36.583157
19th	1521.6772	-13.18484	-49.909174	36.724334
20th	1520.134	-13.250825	-50.047657	36.796832
21st	1518.594	-13.254356	-49.873705	36.619348
22nd	1517.0571	-13.251776	-50.050864	36.799089
23rd	1515.5233	-13.25358	-50.04594	36.79236
24th	1513.9925	-13.183462	-49.895665	36.712203
25th	1512.4649	-13.185089	-49.877421	36.692331
26th	1510.9404	-13.25366	-50.056109	36.802449
27th	1509.4189	-13.255577	-49.898328	36.642751
28th	1507.9005	-13.25422	-49.88122	36.627
29th	1506.3851	-13.255127	-49.905913	36.650787
30th	1504.8728	-13.256879	-49.826946	36.570067
31st	1503.3635	-13.184772	-49.91087	36.726097
32nd	1501.8572	-13.248374	-50.132956	36.884582

Table-2 32 channel DWDM System with different wavelenghts used

The power level of input signals is adjusted between 0 dBm to10 dBm depending on DWDM system. Multiplexer combine the 32 input channels and transmit them over a single channel. The transmission channel contains one dispersion compensating fiber of length 10 km with negative dispersion co-efficient of 85 ps/nm/km and two Single mode Fiber of 25 km each with 17 ps/nm/km dispersion coefficient. The number of span is taken to be 2. So the total link length is equal to the 120 km in case of post compensation[5].EDFA is used to amplify the signal. The EDFAs are of gain control type with noise figure of 6 dB and their gain is adjusted between 5 dB to 10 dB[11].At receiving side,1:32 demultiplexer is used to split the signals to 32 different channels. The output of

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demultiplexer is detected by PIN photo detector and passed through Bessel filter.the output is observed on BER analyzer.

V Result and simulation

a. Simulation Diagram

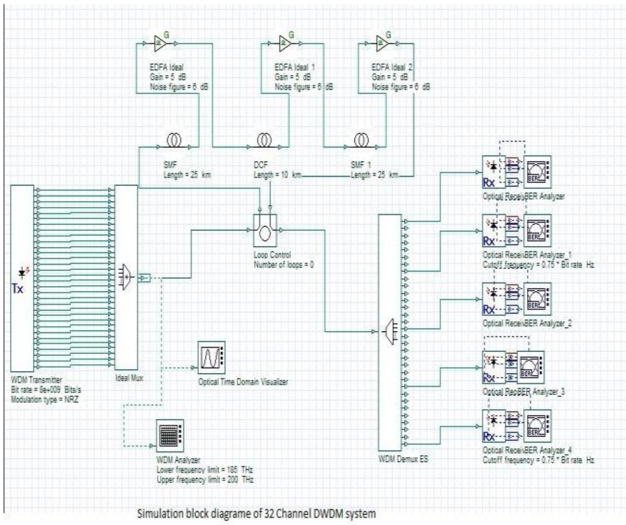

Fig-4 Dispersion Compensated circuit Design Of DWDM on optiwave software

b. Different BER analysis

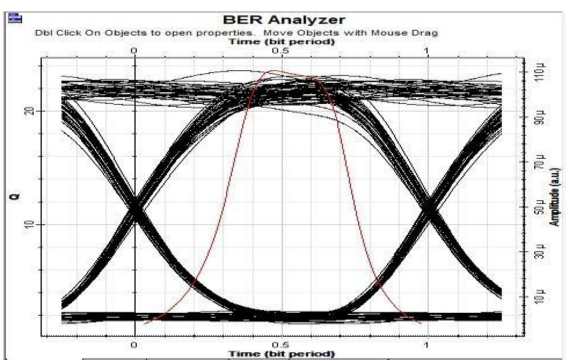

Fig-5 Eye pattern obtained at 193.41449 THz

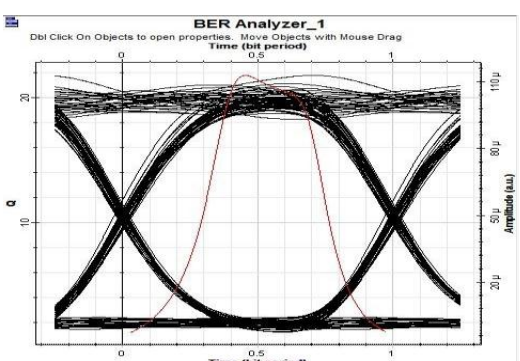

Fig-6 Eye pattern obtained at 196.41449 THz

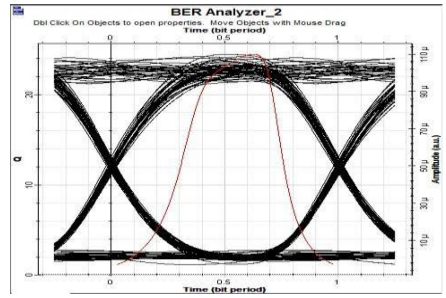

Fig-7 Eye pattern obtained at 194.81449 THz

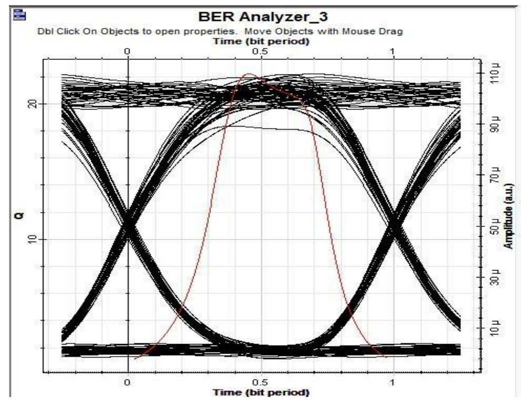

Fig-8 Eye pattern obtained at 198.01449 THz

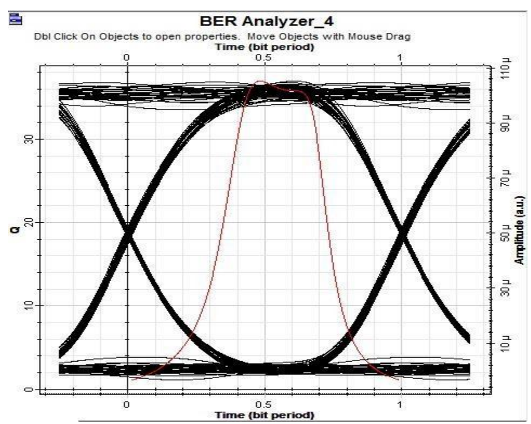

Fig-9 Eye pattern obtained at 199.61449 THz

For Dense wavelength division multiplexing the spacing between adjacent channels is reduced to 50 GHz. At receiver all the channels square measure demodulated and therefore the results square measure shown for 193.41449 THz, 194.81449 THz, 196.41449 THz, 198.01449 rate and 199.61449 rate channels. The minimum BER is obtained for the heartbeat dimension of 5ps and seven.5ps at 199.61449 rate channel and it will increase quickly as pulse dimension will increase to 10ps or on the far side. Results shows that the performance of post dispersion compensat particle is best than pre and

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symmetrical compensation for fifty rate channel spacing Dense wavelength division multiplexing.

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