Enhancing Optical Network Capacity using DWDM System and Dispersion Compansating Technique

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Abstract: From every technical and economic read, the flexibleness to produce in all probability unlimited transmission capability is that the foremost blatant advantage of dense wavelength division multiplexing technology. This investment in fiber plant can't solely be preserved, however optimized by an element of a minimum of thirty two. In order to reduce dispersion in optical networks various dispersion compensating techniques are used. Dispersion can be co ntrolled by selecting proper modulation format for the input dat. In this paper capability of optical network would be incremented utilizing dense wavelength division multiplexing system by the assistance of dispersion compensating technique. The performance of non-return to zero modulated pulse is evaluated for dense wave division multiplexing systems having symmetrical dispersion compensating technique. The pulse width full width at half maximum of n o n - r e t u r n t o z e r o modulated Gaussian pulse was varied from 5 ps to 15 ps to evaluate the performance at 80 GB/s. This experiment s h o w s t h a t dense wavelength division multiplexing systems are most efficient because bit error rate is very less as compared to the conventional dense wavelength division multiplexing systems used previously.

Keywords: Optical laser; Multiplexer; Demultiplexer; Dense wavelength division multiplexing; Non return to zero; Modulated gaussian pulse; Dispersion compensating fiber; Single mode fiber; Wave division multiplexing

I. INTRODUCTION

Wave Division Multiplexing (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. 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 100GHz, called Coarse or Conventional WDM system were developed firstly and later the channel spacing is reduced about 50 GHz, called Dense WDM system were developed [1]. 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 [2,3]. There are some basic problems when transmitting the signal via WDM system is as follows:

    a.   As the transmission distance increases, the quality of signal degrades after travelling certain distance depending on the channel spacing and optical fiber characteristics.

    b.   Transmission bit r a t e i n c r e a s e s , d i s p e r s i o n problem increases.

There is a need of Dispersion Management for higher bit rate WDM systems. Microchip compensation, mid span spectral inversion, optical phase conjugation, initial pre chip, different delay methods and dispersion compensating fibers are some various techniques which are used to compensate the losses occurring due to dispersion while transmission. In this paper dispersion compensating fibers (DCF) 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 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.
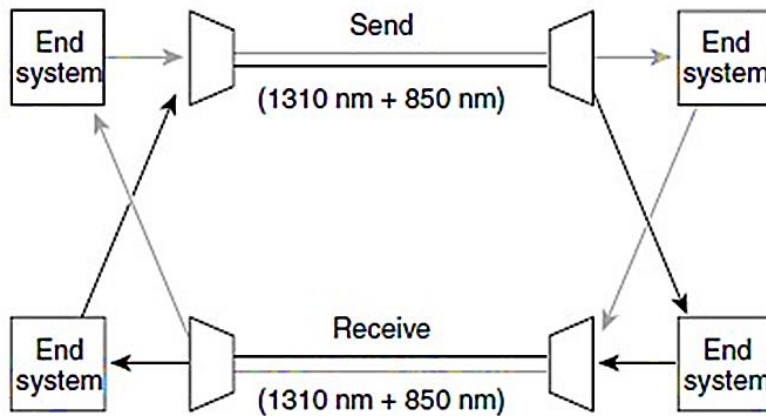

Figure 1: Schematic diagram of WDM with 2 channels.

Dense wavelength division multiplexing (DWDM) systems had evolved to the purpose wherever they were capable of sixty four to a hundred and sixty parallel channels, densely packed at fifty or perhaps twenty five gigacycle 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.
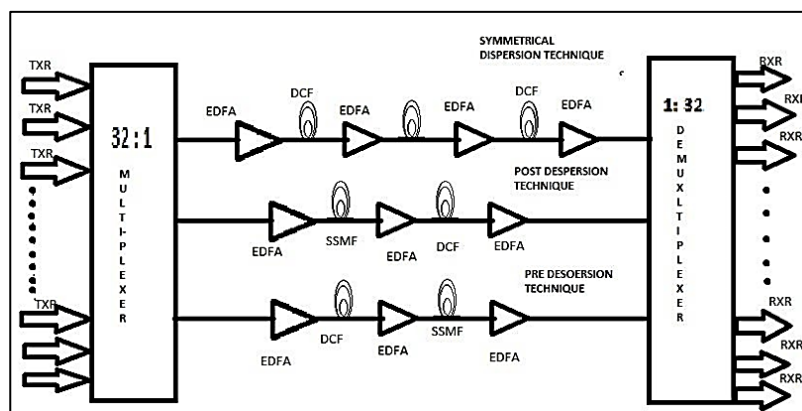

Figure 2: Block diagrame of 32 channel DWDM system using despersion compensating fiber techniques (pre, post and symmetrical).

The system performs the following main functions:

a. Generating the signal: The source, a solid-state optical device, should give stable ethical motive a particular, slender information measure that carries the digital knowledge, modulated as an analog signal.

b. Combining the signals: Modern DWDM systems use multiplexers to mix the signals. There's some inherent loss related to multiplexing and demultiplexing. This loss relies upon the quantity of channels however are often alleviated with optical amplifiers, that boost all the wavelengths right away while not electrical conversion.

c. Sending the signals: The effects of interference and optical signal degradation or loss should be reckoned with in fiber optic transmission. These effects are 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.

d. 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.

e. Receiving the signals: The demultiplexed signal is received by a photo detector.

III. SINGLE MODE FIBER DESIGNS

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

a. Non-dispersion-shifted fiber (NDSF)
b. Dispersion-shifted fiber (DSF)
c. Non-zero dispersion-shifted fiber (NRZ-DSF)

The major kinds of single-mode fibers and their application are summarized as follows (Table 1):

- Non dispersion shifted fiber (Standard SM fiber): Accounts for larger than ninety 5% 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 10 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 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.

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)	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

Table 1: Different optical fibers with their window sizes.

IV. SYSTEM ESCRIPTION

All the simulations are done using opti system 7.0 software. The thirty-two channel DWDM system i.e., Dense Wavelength Division Multiplexing is designed using post dispersion technique. The block diagram is shown in the Figure 3.
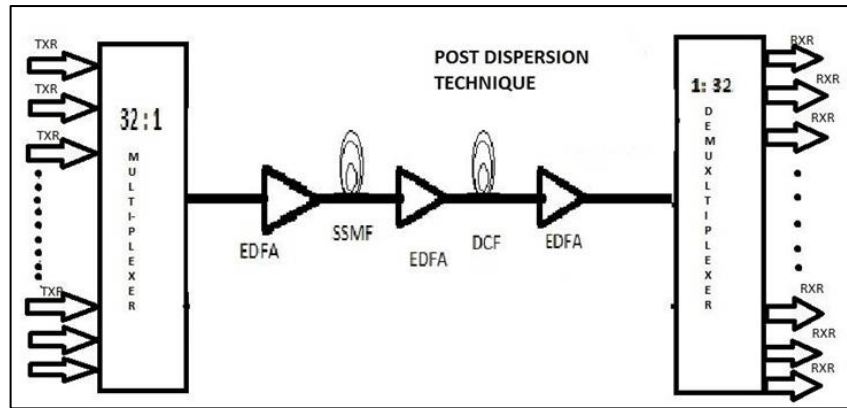
Figure 3: Channel DWDM system with post dispersion technique.

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 Thirty-two channel system, there are 32 laser sources generating optical signals of different wavelengths. Wavelengths are selected depending on the channel spacing between the adjacent channels during transmission through single mode fiber (Table 2).

Channel No.	Wavelength (nm)	Si (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	36.725144
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	49.88112	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: Channel DWDM system with different wave lenghts used.

The power level of input signals is adjusted between 0 dBm to 10 dBm depending on DWDM system. Multiplexer (MUX) combine the 32 input channels and transmit them over a single channel. The transmission channel contains one dispersion compensating fiber (DCF) 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 [6-8].At receiving side, 1:32 demultiplexer (DEMUX) is used to split the signals to 32 different channels. The output of demultiplexer is detected by PIN photo detector and passed through Bessel filter. The output is observed on bit error rate (BER) analyzer (Figures 4-9).
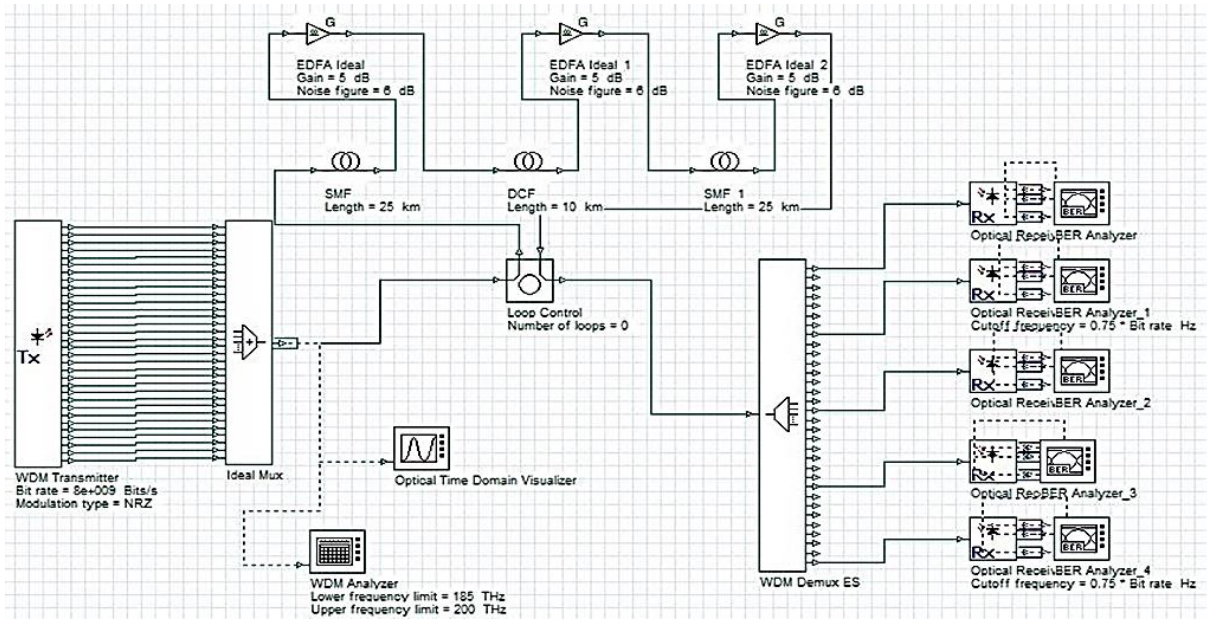
V. RESULTS AND SIMULATION

A. Simulation Diagram

Figure 4: Dispersion compensated circuit design of DWDM on optiwave software.
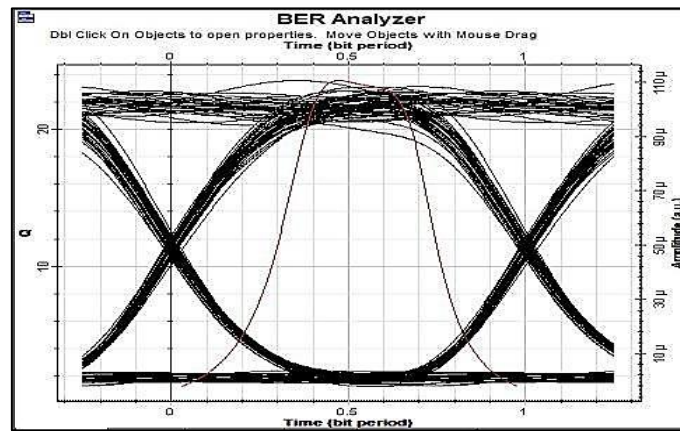
B. Different BER Analysis
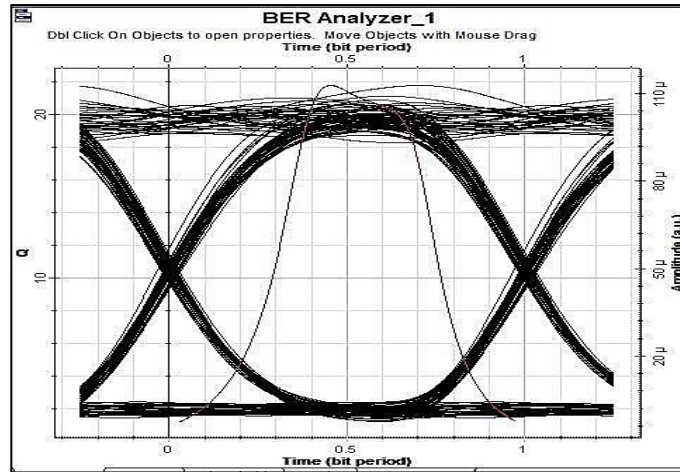

Figure 5: Eye pattern obtained at 193.41449 THz

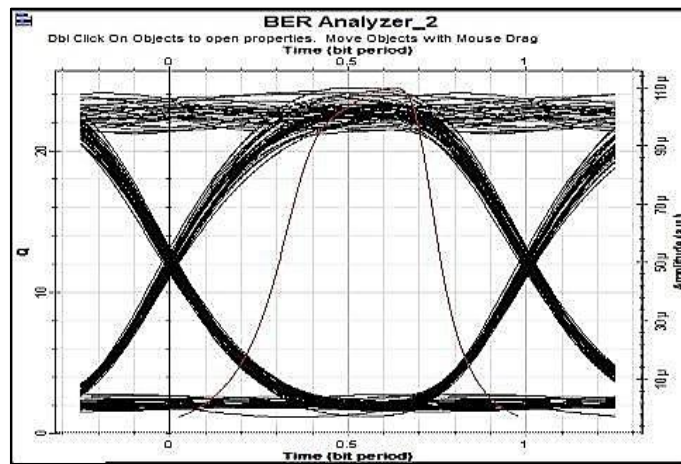**Figure 6: Eye pattern obtained at 196.41449 THz**

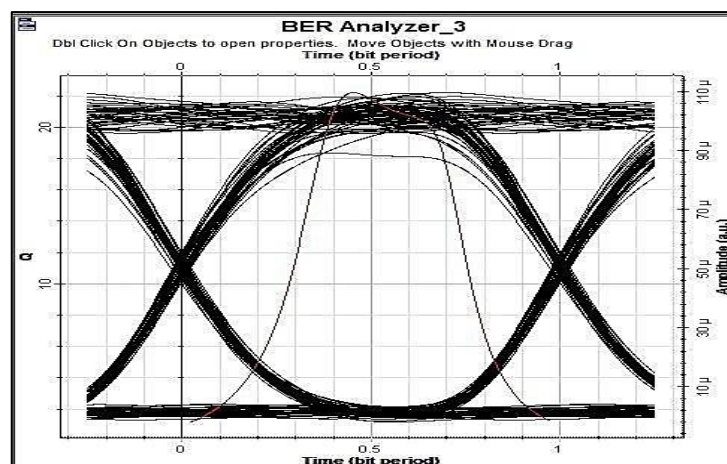**Figure 7: Eye pattern obtained at 194.81449 THz.**

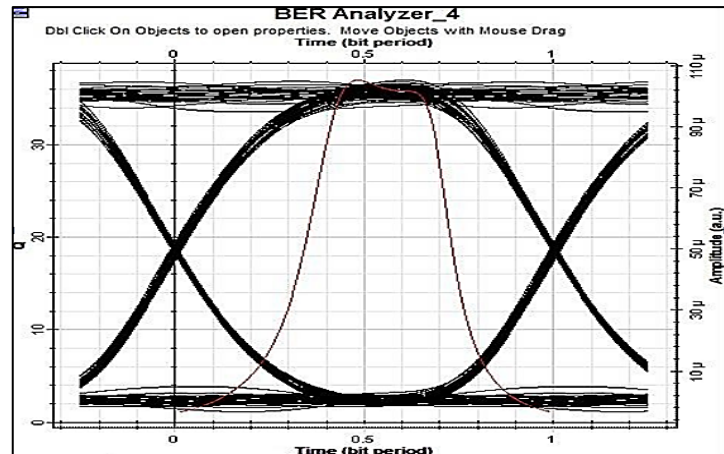**Figure 8: Eye pattern obtained at 198.01449 THz.**

Figure 9: Eye pattern obtained at 199.61449 THz.

V. CONCLUSION

For Dense wavelength division multiplexing the spacing between adjacent channels is reduced to 50 GHz. At receiver all the channels are demodulated and the results are shown for 193.41449 THz, 194.81449 THz, 196.41449 THz, 198.01449 THz and 199.61449 THz channels. The minimum BER is obtained for the pulse width of 5ps and 7.5ps at 199.61449 THz channel and it increases rapidly as pulse width increases to 10ps or beyond. Results shows that the performance of post dispersion compensation is better than pre and symmetrical compensation for 50 GHz channel spacing dense wavelength division multiplexing.

V. REFRENCES

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