Extending the reach of 160 Gbps WDM link using dispersion compensation

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Abstract- **Optical Fiber cable offers very high bandwidth. For making the efficient utilization of available bandwidth many signals should be transmitted through the same cable. WDM Network allows several channels to be routed through the same fiber cable on different Wavelength. Dispersion is the major limiting factor in High speed optical WDM Network. Dispersion causes pulse broadening and pulse distortion. In this paper, Analysis of WDM Network has been done with Non-Return to Zero modulation formats. The system has been analyzed using pre, post and mix dispersion compensation schemes. I simulated 160 GB/s WDM Network supporting sixteen users. From All these two schemes are compared in terms of Q-factor and Bit Error Rate. From the simulation result I extend the reach of 160 Gbps WDM link using dispersion compensation**.

Key word- Dispersion, WDM, Dispersion Compensating Fiber, Q-Factor and BER.

INTRODUCTION

WDM optical network has bring a performance improvement in data transmission because of high speed, high bandwidth and high capacity. So a lot of research is going on in this field. In WDM networks optical fibers are used to transmit information between the transmitter and the receiver. WDM systems have the capability to transmit multiple signals simultaneously. In WDM Network, different signals from different users are multiplexed. But the light signals degrade in intensity when they travel inside the fiber. Fibers suffer from dispersion other nonlinearities due to fiber material nonlinearities and distance the signal travels inside the fiber. In WDM network, dispersion, Group velocity dispersion (GVD) and nonlinear effects, like self phase modulation, cross phase modulation and four-wave mixing is observed at different data rates. So this dispersion and fiber nonlinearities at different data rate must to be minimized by different dispersion compensation techniques like dispersion compensation fiber, fiber Bragg grating, optical phase conjugation and electrical compensation methods.

WHY DISPERSION COMPENSATION ?

In optical Fiber Communication, when light signal is propagated through the fiber, due to the dispersion system performance is degraded. In dispersion, different modes travel with different group Velocity due to the material and waveguide property of the fiber. So ultimately all the modes reached at the different times results in pulse broadening means inter symbol interference occur. The classification of different types of dispersion is
(1)Modal dispersion
(2)Group velocity dispersion
(3)Polarization mode dispersion

Material dispersion is caused by due to the material property of the fiber. Material dispersion is due to the change in refractive index of material with wavelength. Waveguide dispersion is due to the

Physical structure of fiber means because of the refractive index profile of the core and cladding of the fiber. Modal dispersion is Generally observed in multimode fiber due to the multiple mode travel with different group velocity. Polarization mode dispersion is caused by different polarization state of pulse travel with different velocity results in pulse broadening. To avoid the broadening of the pulse dispersion should be compensated in optical network. There are different techniques possible for dispersion compensation like use of dispersion compensating fiber, use of fiber Bragg grating, use of optical phase conjugation and use of electronic equalizers. Among these, dispersion compensating fiber is efficient way of reducing dispersion in optical fiber communication system.
In this paper to compensate the effect of dispersion and for extend the reach of 160 Gbps WDM link dispersion compensating fiber is used.

SIMULATION SET-UP

The figure 1 show the simple block diagram of 16 channel WDM link

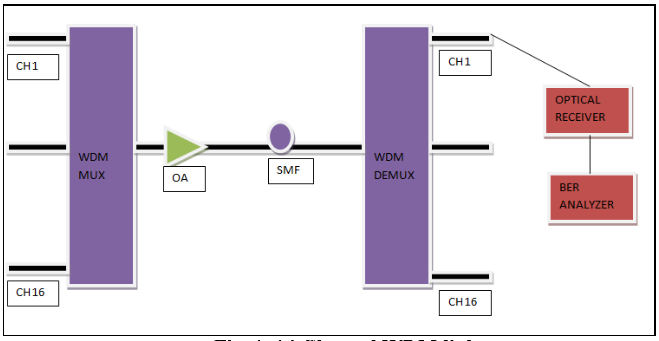

Fig. 1. 16 Channel WDM link

For wavelength-division-multiplexing (WDM) transmission, the embedded standard single-mode fiber (SMF) should be upgraded to compensate the dispersion. For this purpose, some dispersion compensation scheme must be used periodically in the link. There are several different methods that can be used to compensate for dispersion, including dispersion compensating fiber (DCF),fiber Bragg gratings, optical phase conjugation and electrical

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dispersion compensation. we have simulated one Wavelength division multiplexing topology supporting 16 user and operated at data rate of 16×10 Gb/s=160 Gbps. In this topology, to compensate dispersion, dispersion compensation fiber (DCF) technology is used. We have simulated two dcf scheme, the pre compensation and post compensation program. The above techniques are compared in terms of Q-factor and Bit error rate.

SIMULATION RESULTS

In this section we show the simulation of 160 Gbps WDM link without dispersion compensating fiber and with dispersion compensating fiber.This section consist of Simulation of how we extend the reach of 160 Gbps WDM link using DCF.It also consist of the eye diagram and BER-link length plot.I Simulate the 160 Gbps WDM link and I Extend the reach of 160Gbps WDM link with BER<10^-9 (recommended by ITU) in all 16 channels.

Simulation consist of following part

[1] WDM Transmitter
[2] WDM Mux-WDM Demux
[3] SMF (Single mode fiber)
[4] DCF (Dispersion compensating fiber)
[5] Optical Amplifier
[6] Optical Receiver
[7] BER Analyzer

For simulation we take following parameter shown in table 1

TABLE 1

PARAMETER	VALUE
POWER	2 dbm
NO OF CHANNEL	16 (SPACING 100 GHZ)
EACH CHANNEL BITRATE	10 Gbps
MODULATION TYPE	NRZ
INSERTION LOSS	3 db
OA GAIN	11.4 db
SMF DISP. COEFF.	17 ps/nm/km
DCF DISP. COEFF.	-80 ps/nm/km

SIMULATION 1

The 160 Gbps WDM link without using dispersion compensating fiber shown in figure 2

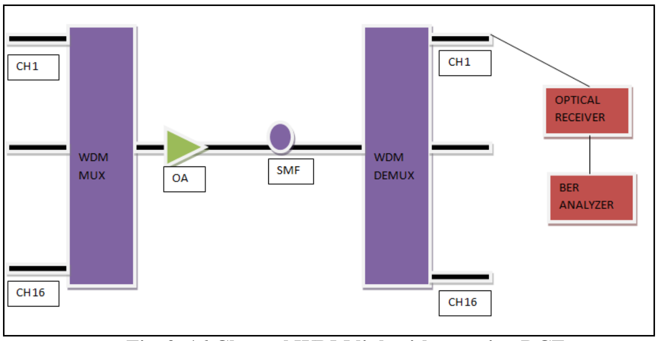

Fig. 2. 16 Channel WDM link without using DCF

In 160 Gbps WDM link without using dispersion compensating fiber I reach up to 69 km.As shown in figure 2 this simulation provide Q-factor of 6.6480 and BER of 1.36×10^-11 and reach up to 69 km. For this simulation the log10(BER)-link length graph is shown in figure 3

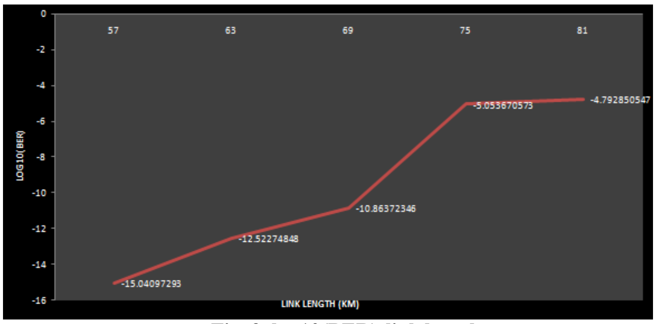

Fig. 3. log10(BER)-link length

SIMULATION 2

The 160 Gbps WDM link with using pre-dispersion compensating fiber of length of 7 km shown in figure 4

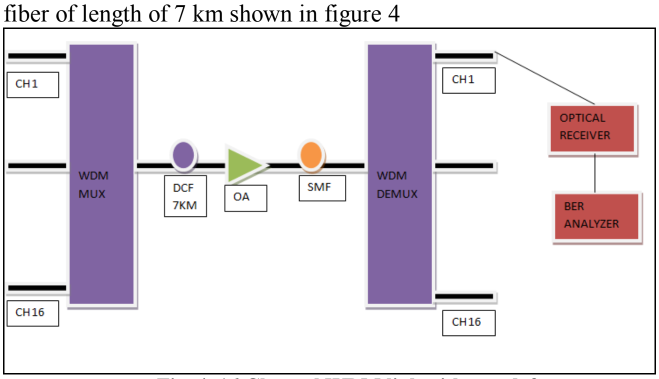

Fig. 4. 16 Channel WDM link with pre-dcf

In 160 Gbps WDM link with using pre-dispersion compensating fiber of length of 7 km I extend reach at 87 km. As shown in figure 4 pre-compensation provide Q-factor of 6.6969 and BER of 9.76×10^-12. For this simulation the log10(BER)-link length graph is shown in figure 5.

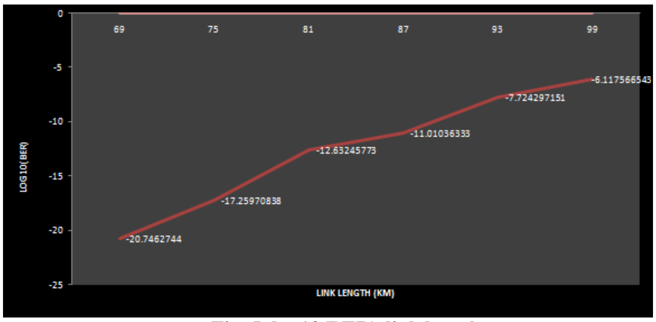

Fig. 5. log10(BER)-link length

SIMULATION 3

The 160 Gbps WDM link with using post-dispersion compensating fiber of length of 2 km shown in figure 6

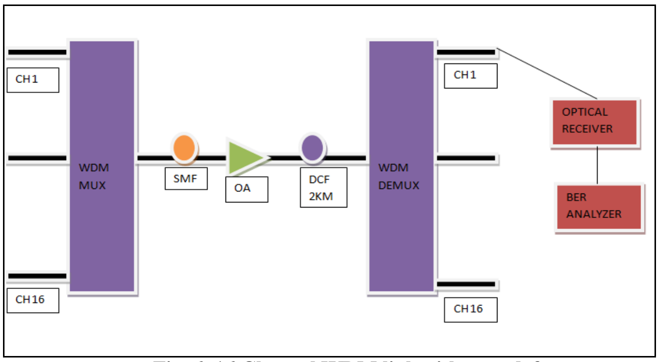

Fig. 6. 16 Channel WDM link with post-dcf

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In 160 Gbps WDM link with using post-dispersion compensating fiber of length of 2 km I extend reach at 81 km As shown in figure 6 post-compensation provide Q-factor of 5.9986 and BER of 9.30×10^-10. For this simulation the log10(BER)-link length graph is shown in figure 7.

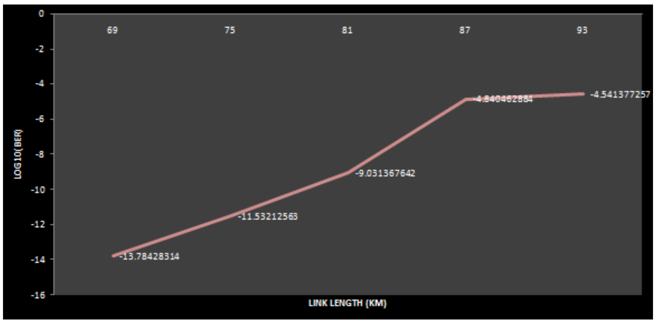

Fig. 7. log10(BER)-link length

CONCLUSION

In this paper, we have simulated one 160 GB/s WDM Network. To compensate dispersion, we have used Dispersion compensating fiber. Two different compensation schemes Pre and post are simulated. These schemes are compared in terms of Q-Factor and BER. After simulation I conclude that I extend the reach of 160Gbps WDM link using Dispersion compensation.

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