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# Performance Evaluation of Hybrid amplifiers for 16 × 20 and 32 × 20 Gbps DWDM System

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***Abstract***

*In this paper, the 16 channel and 32 channel DWDM systems at 20 Gbps have been investigated for hybrid amplifiers. The performance has been analyzed on the basis of transmission distance. The comparison of BER and Q-factor for two hybrid amplifiers EDFA+RAMAN and RAMAN+EDFA at different transmission distance is done. It is observed that for 16 × 20 Gbps and 32×20Gbps DWDM system using EDFA+RAMAN provides better results than the DWDM system using RAMAN+EDFA. The analysis is done using OptiSystem 7.0 simulator.*

***Keywords****: DWDM, BER, EDFA, RAMAN, Q Factor, OptiSystem 7.0*

## 1. Introduction

DWDM technology uses multiple wavelengths to transmit information over a single fiber. Dense WDM is WDM utilizing closely spaced channels. Today the demand of network capacity increases. So to increase the information carrying capacity of the network the DWDM system is the most useful technique. In DWDM system with the increase in distance there occurs degradation of signal, so to decrease this degradation of signal hybrid amplifiers are used to boost up the signal. Basically an optical amplifier is a device which amplifies the optical signal directly without ever changing it to electricity. DWDM system uses a multiplexer at the transmitter end, which multiplexes more than one optical signal onto a single fibre and demultiplexer at the receiver to split them apart. Figure 1 is showing a basic DWDM Technology

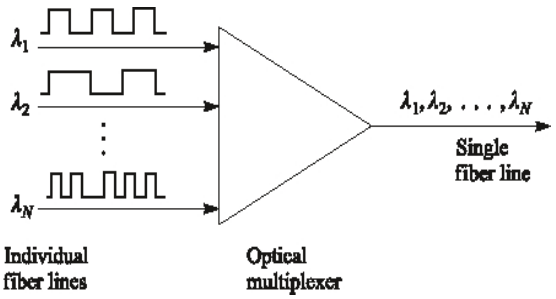


**Figure 1. DWDM System**

For long distance communication loss of signal strength is the major problem which can be overcome by the optoelectronic repeaters in this optoelectronic repeater the signal is first converted into electric current and then regenerated with the help of transmitter but these regenerators are very complex and expensive for the DWDM systems so these days optical amplifiers are used which directly amplify the transmitter signal without any conversion of optical signal to electric signal .basically optical amplifiers amplifies the signal and reduce the attenuation. EDFA is basically used to boost up the signal by using

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this can transmit data up to several kilometers .There is other type of amplifier which is RAMAN amplifier and this is basically used to improve the noise figure and reduce the nonlinearities. When EDFA cascaded with RAMAN and vice versa then it is called hybrid amplifiers.

## 2. System Design

In this model, 16 and 32 channels are transmitted at 20 Gbps speed with channel spacing from 200Hz. Each input signal is modulated in NRZ format and pre-amplified by a booster. A DWDM transmitter having16 and 32 transmitters are used. In DWDM transmitter each transmitter section consists of the data source, electrical driver, laser source and external Mach–Zehnder modulator. The data source is generating signal of 20 Gbps with pseudo random sequence. The electrical driver converts the logical input signal into an electrical signal. The CW laser sources generate the 16 and 32 laser beams at 190THz .The signals from data source and laser are fed to the external Mach–Zehnder modulator and then the modulator output signal is fed to the multiplexer then signal is passed through the optical amplifiers and then demultiplexer convert single input to16 and 32 outputs and then at eye analyzer the eye pattern is analyzed.

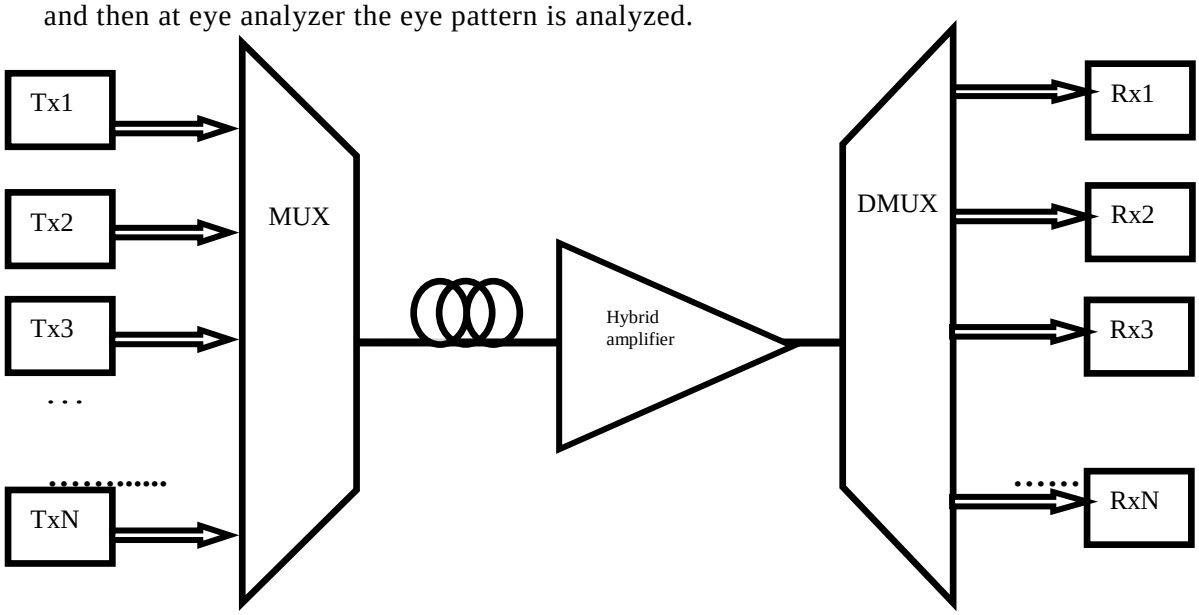


**Figure 2. Block Diagram for Simulation Setup**

The simulations setup of WDM system using 16 and 36 channels at 2ps/nm/km dispersion are shown in Figure 2. The optical signal is transmitted and performance is analyzed for different transmission distance at 2 ps/nm/km dispersion. Optical power meters are used for measuring the signal power at different levels. At the receiver side the modulated signal is converted into original signal with the help of PIN photodiode and electrical filters. 32channel WDM receiver is used to detect all 32 signals and converts these into electrical form. EDFA+RAMAN and RAMAN+EDFA hybrid amplifiers are used in this system. The different transmission distance is taken in this system. The transmission distance is varying from 40-100km. Different components have different operational parameters. Its various parameters are reference frequency is 193.414 THz, attenuation is 0.2dB/km and fiber polarization mode dispersion is 0.2 ps/km. EDFA is used for amplification and its parameters are, EDFA length 5km.RAMAN amplifier parameters are, RAMAN amplifier length 22km ,pump laser 980nm power 300nw.

In Table 1, the parameters used for simulation are tabulated all these values are taken when we are doing simulation of DWDM system in OptiSystem 7.0 simulator

 

**Table 1. Simulation Parameters**

| | |
|---|---|
| WDM transmitter Frequency | 190 THz |
| Frequency spacing | 200 GHz |
| Input Power | 5 dBm |
| Bit rate | 20Gbits/sec |
| Modulation Type | NRZ |
| Fiber length | 40-100 km |
| Attenuation coefficient at cable section | 0.2 db/km |
| EDFA length | 5km |
| Reference wavelength | 1550 nm |
| Dispersion | 2 ps/nm/km |
| RAMAN amplifier length | 22km |
| Pump laser | 980nm |
| Temperature | 300K |
| Power | 300mw |

## 3. Result & Discussion

Performance of DWDM system for 16 and 32 channels with hybrid amplifiers EDFA+RAMAN and RAMAN+EDFA are compared at different transmission distance and the graphs for Q-factor and BER v/s distance at dispersion 2 ps/nm/km are shown below in Figure.3. The graph show that as we increase the transmission distance from 40-100km the Q-factor decreases. The variation in the Q-factor is 19.5391 to 3.74564 for hybrid amplifier EDFA+RAMAN and 18.9054 to 2.7426 for RAMAN+EDFA hybrid amplifier for 16 channels.

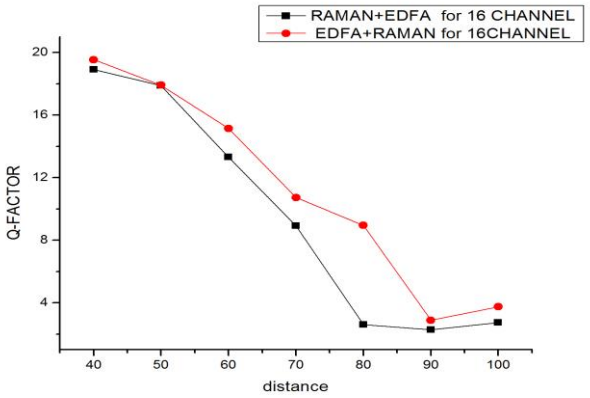


**Figure 3. Q-Factor v/s Distance Graph for 16 Channels**

The BER increases with the increase of distance. For the 16 channels the variations in BER is 2.75956e-75 to 3.93e-3 with EDFA+RAMAN hybrid amplifier and 4.25866e-73to 2.96e-3 with RAMAN+EDFA hybrid amplifier as the distance increases from 40 to 100 km as shown in Figure 4. From this we find that the Q-factor is better if we are using EDFA+RAMAN hybrid amplifier instead of RAMAN+EDFA.

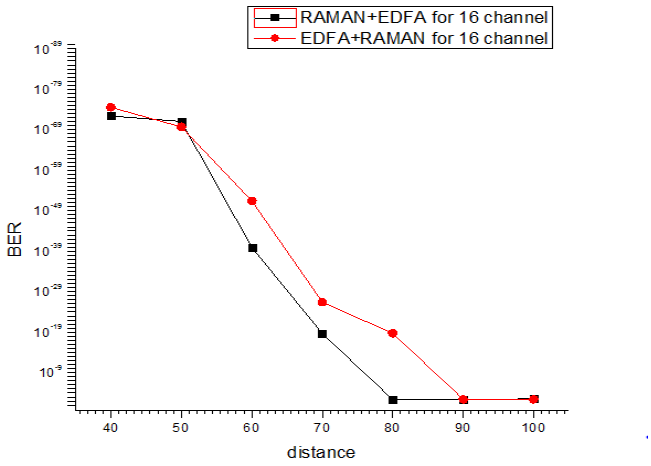


**Figure 4. BER v/s Distance Graph for 16 Channels**

For 32 channels the variations in the Q-factors is 15.4008to 4.15734 for EDFA+RAMAN hybrid amplifier and 14.0089 to 3.12895 for RAMAN+EDFA.from this we find that as we increase the transmission distance the Q-factor decreases .The graph of Q-factor v/s distance shown in Figure.5.shows that the BER is less for the hybrid amplifier EDFA+RAMAN as compared to the RAMAN+EDFA

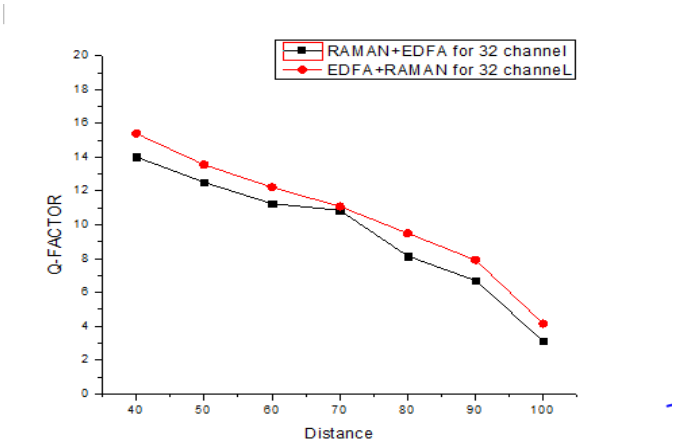


**Figure 5. Q-Factor v/s Distance Graph for 32 Channels**

For 32 channels the variations in BER is 2.55302E-42to 7.52E-5 with EDFA+RAMAN hybrid amplifier and 1.69839E-40 to 8.279E-4with RAMAN+EDFA hybrid amplifier as the distance increases from 40 to 100 km as shown in Figure.6.From this we find that the Q-factor is better if we are using EDFA+RAMAN hybrid amplifier instead of RAMAN+EDFA.

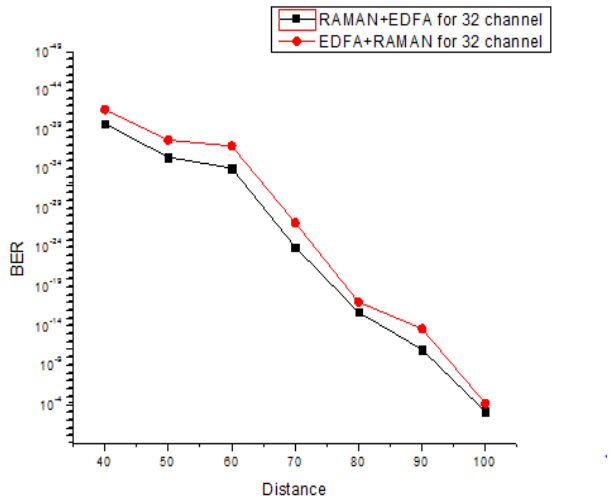


**Figure 6. BER v/s Distance Graph for 32 Channels**

## 4. Conclusion

In this work we have analyzed the 16 and 32 channel DWDM system at 20 Gbps with hybrid amplifiers at different transmission distances. We observed that with increase in transmission distance from 40-100km the Q-factor decreases and BER increases. The system is analyzed with EDFA+RAMAN and RAMAN + EDFA hybrid amplifiers and the results are compared in terms of Q-factor and BER. It is observed that the system with EDFA+RAMAN hybrid amplifier performs better than the RAMAN+EDFA hybrid amplifier. DWDM (DWDM) is today's rapid development, mature technology, it is a kind of technology in a fiber and bolt to send more wavelength signal. The basic structure of DWDM optical network type has star, bus-control (ring) and the tree of, can mix into various complex network structure. Optical networks can be divided into core, transverse metro/between local networks and access.

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