Performance Analysis of different modulation techniques and Its Impact on Oadm Ring Network

Abhay Bhandari
School of Electronics and Electrical Engineering
Lovely Professional University. Phagwara, Punjab, India.
Email: abhay.13658@lpu.co.in

Abstract: With the recent expansion in internet the demand of internet and services offered by internet is rapidly growing. Therefore, with this growth the bandwidth requirement is also growing so it is the major mission of the engineers to meet these high capacity requirements at minimum cost. Optical fibres are proved as best solution to these increasing demands and future network services[1]. They have low weight than the traditional electrical cables and the signal transmitted is in the form of light which is immune to electrical interferences and hence can travel long distances with minimum attenuation.

Keywords: Wavelength division multiplexing, OADM, EDFA, DWDM OADM ring network

I. INTRODUCTION

WDM mergesmany signalscoming on laser beams at infrared (IR) wavelengths for transmission along opticalfiber.Each laser is modulated by an autonomous set of signals[2]. WDMboosts the data carrying capacity of an optical fiber by passing an incoming light signals on light frequenciesin a certain frequency band. WDM carries each signal autonomously. In this work, a multi-channel long haul high speed DWDM OADM ring network hasbeen designed with 6 OADM nodes and 16 WDM channels with a channel spacing of 0.4nm.Each channel can carry 60Gbps of data rate. Performance optimization of the modelledDWDM OADM ring using different modulation formats has been obtained. Five modulationformats have been taken into consideration i.e., RZ, NRZ, CRZ, CSRZ and PM-QPSK forcomparison. The BER, Q-factor and eye diagrams of different modulation formats have beenanalysed and compared. It has been reported that the PM-QPSK yielded better performanceas compared to other four modulation formats i.e., RZ, NRZ, CRZ, CSRZ. Also, the PMDeffect has been estimated forall the given modulation formats. Again the PM-QPSK has beenfound to be the best format among all. At last, the transient effect has been measured on thedesigned system. It has been observed that the system is affected with transients and itsresponse degrades with the effect of transients. With the use of ring laser technique tomitigate the transients, the effect of transients has been suppressed.

II. LITERATURE REVIEW

Hosung Yoon et al. [3]A special way of monitoring the flatness of gain of again flattened EDFA multichannel is demonstrated here. The reference level dependant on gain isn't required. Regardless of the relentless increase of EDFA, levelling, gain levelness observing and transient addition concealment can be achieved utilizing the distinction of enhanced unconstrained outflow blackmailed from the edges of the addition smoothed transfer speed.

June-Koo Rhee et al. [4] An optical ring network use ring a wavelength blocker used in metro-area and dependent on OADM design is proposed. AOADMwith ability of optical channel that have a dedicated protection in case of a twofiberring system having DWDM traffic capacity of 24 x 10 Gb/s is demonstrated experimentally.The network's optical protection that is done channel-by-channel, is enabled using awavelength-selective switch based on liquid crystal and used as a protection switch andEDFAs with fast transient-gain control.

A. Tzanakaki et al. [5] The simulation studyrevealed the presence of OADMs and specifically the optical filtering related with them. Theoverall performance of the system is improved, which is suffering by nonlinear effectsbecause the optical filtering supports in reducing the enlargement of spectrumimposed by the Kerr nonlinearity and ultimately reduces the penalty.

A. Richter, H. Louchet, I. Koltchanov et al. [6] We present an agenda for imitating dynamicevents of network. We investigated the subsequent impact on performance with a two-stepmethod. It consists of parametric modelling of detailed simulations at bit-level and effectsthat vary slowly.

Emma Lazzeri et al. [7] A recent concept for all the OADM nodes is presented here. Thenode acts as a gateway between the segments of optical network (it exhibits various featuresin terms of modulation format, granularity and multiplexing systems). A commonarchitectureof the OADM node mentioned here shows that the node can behave like a“language translator”between different segments of network on the basis of diverse OTDMand WDM systems.They exploit diverse modulation formats for transporting data streams.

Diego E. Crivelli et al. [8] The design of a dual-polarization QPSK/BPSK single-chip50Gb/s transceiver i.e., DSP-based used for synchronous optical communication is offered. Ina standard single-mode fiber, the CD i.e., chromatic dispersion of more than 3,500 km iscompensated by receiver with the help of frequency-domain equalizer. The main DSP functions of the receiver are; automatic gain control, channeldiagnostics, carrier and timing recovery etc. A novel carrier recovery implementation of lowlatencyparallel-processing which is vigorous in the presence of frequency jitter and laserphase noise is projected.

III. SIMULATION SETUP

The investigation for the system has been carried out at 60Gbps for each modulation formatfor given number of channels in a DWDM OADM ring network. The data formats used inthis system are RZ, NRZ, CRZ, CSRZ and PMQPSK. The system performance has beenmeasured on the basis of eye diagram, BER and Q2 db. Figure1 shows the simulationsetupfor the comparison of different modulation formats. The bit sequence generated by thePRBS generator is provided to various modulation formats used in the system but not in thesame system and not at the same time. Then the processed output is fed to the next parts ofthesystem.

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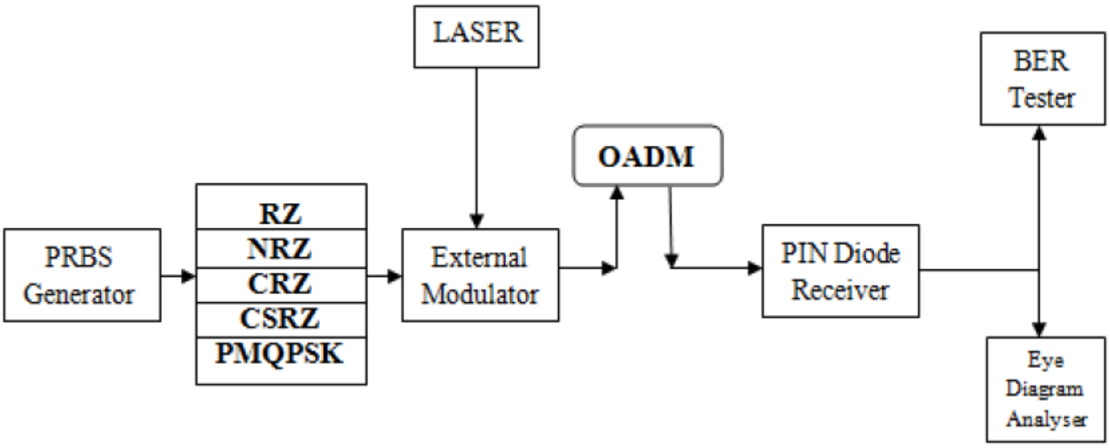

Figure1: Simulation setup for the assessment of various modulation schemes

IV. RESULTS AND DISCUSSIONS

1. RZ (Return to Zero)

The results for the RZ modulation format has been reported on the basis of the selection ofthe extreme lower (λ1), extreme upper (λ16) and the middle (λ8) wavelengths. The bandwidthof6nm ranging from 1547.2nm to 1553.2nm has been used. Three different parameters i.e.,BER, Q2 dB and eye diagrams have been considered for evaluating the performance of thesystem. The performance is taken at three wavelengths i.e., lambda 1 (1547.2nm), lambda 8(1550nm) and lambda 16 (1553.2nm).

The results are displayed in table1 and figure 2-5 below:

Table 1 Performance of NRZ

Wavelength	BER	Q^2 dB
λ_1 (1547.2nm)	10^{-17}	18.5
λ_8 (1550nm)	10^{-17}	18.6
λ_{16} (1553.2nm)	10^{-15}	18.2

Figure2 shows the eye diagram of the RZ modulation format at different wavelengths

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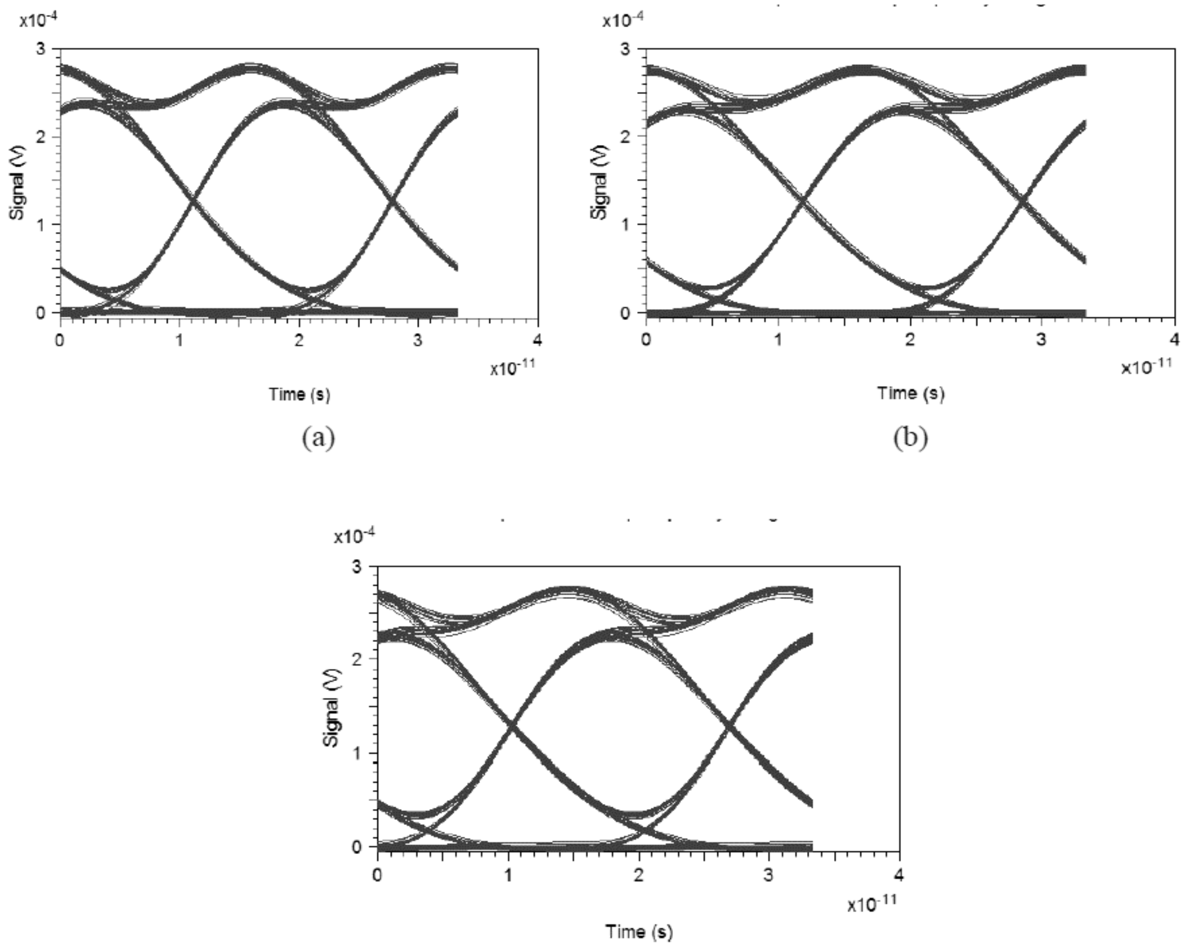

(c)

Figure2: Eye diagram at wavelength (a) 1547.2nm, (b) 1550nm and (c) 1553.2nm

2. Non Return to Zero (NRZ)

Table 2 Performance of NRZ

Wavelength	BER	Q^2 dB
λ_1 (1547.2nm)	10^{-16}	18.2
λ_8 (1550nm)	10^{-16}	18.0
λ_{16} (1553.2nm)	10^{-15}	17.8

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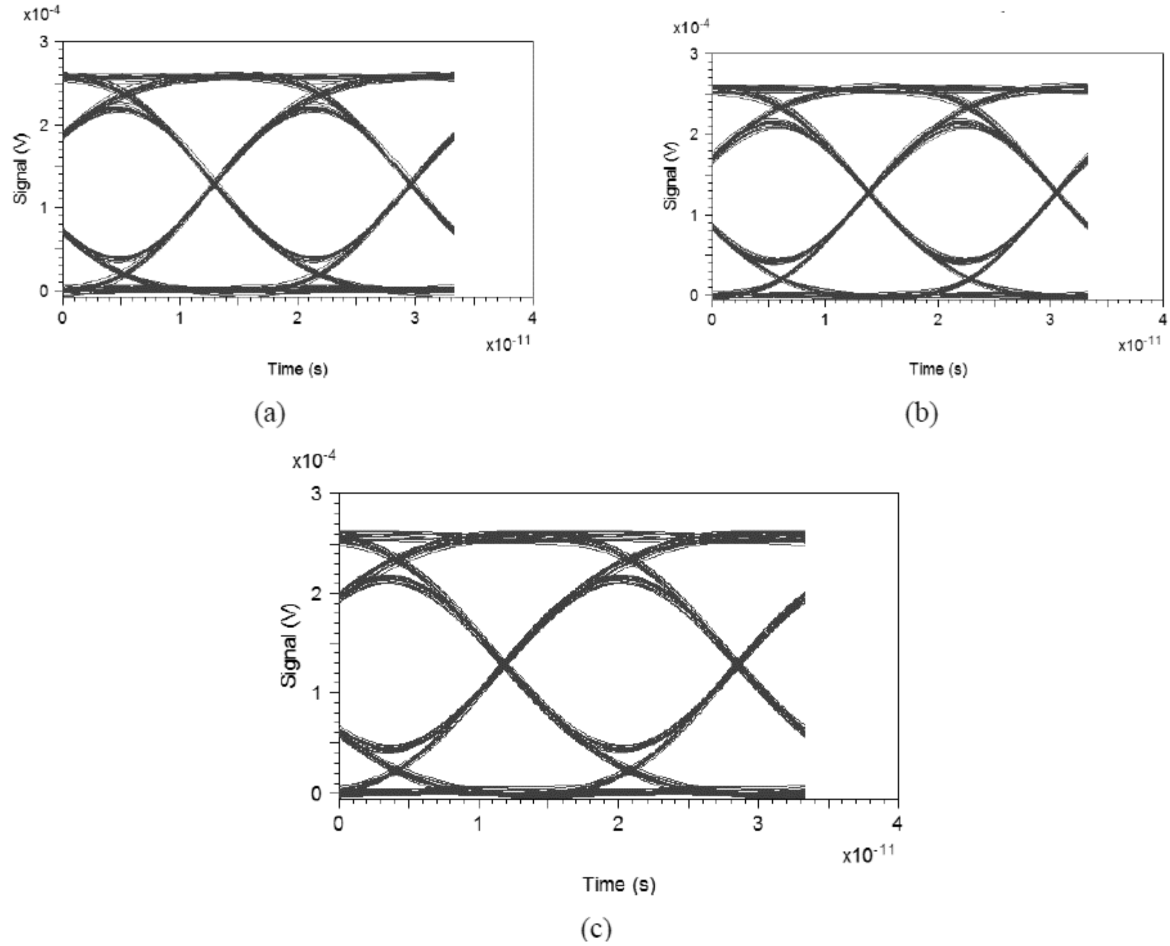


Figure 3: Eye diagram at wavelength (a) 1547.2nm, (b) 1550nm and (c) 1553.2nm

3. Carrier Suppressed Return to Zero (CSRZ)

Table 3:Performance of CSRZ

Wavelength	BER	Q^2 dB
λ_1 (1547.2nm)	10^{-17}	18.4
λ_8 (1550nm)	10^{-17}	18.4
λ_{16} (1553.2nm)	10^{-17}	18.3

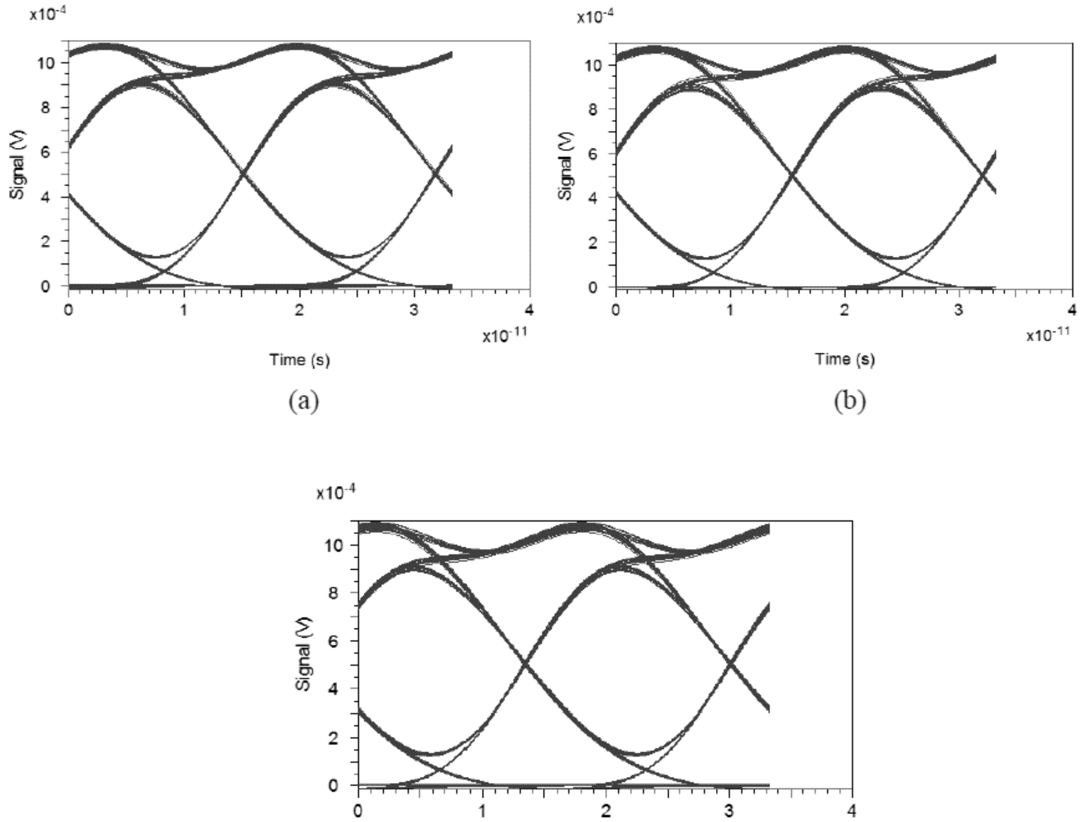
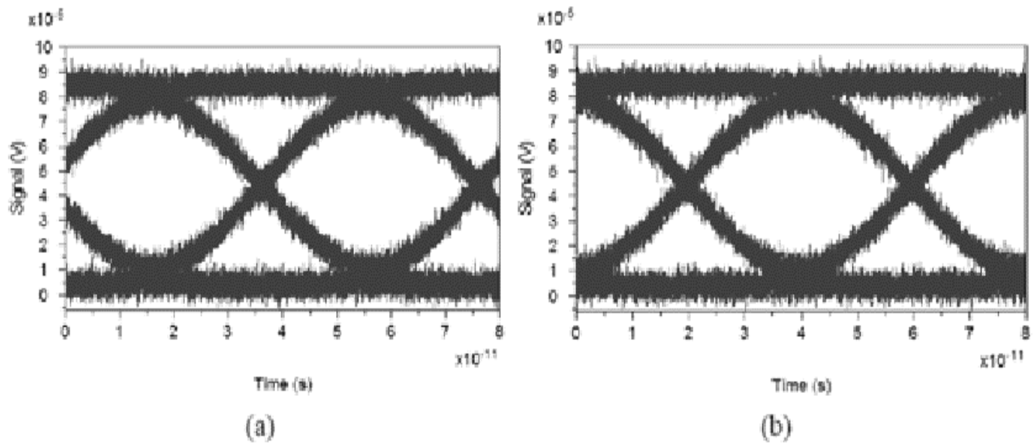


Figure 4 Eye diagram at wavelength (a) 1547.2nm, (b) 1550nm and (c) 1553.2nm

4. PMQPSK

Table 4:Performance of PMQPSK

Wavelength	BER	Q^2 dB
λ_1 (1547.2nm)	10^{-23}	19.9
λ_8 (1550nm)	10^{-22}	19.7
λ_{16} (1553.2nm)	10^{-20}	19.2



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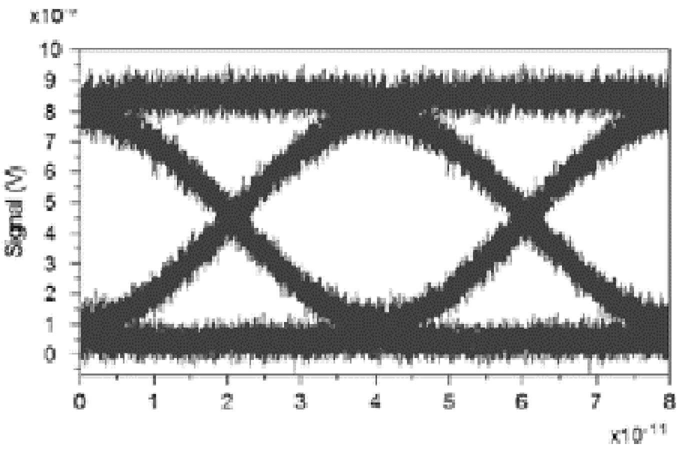

Figure5: Eye diagram at wavelength (a) 1547.2nm, (b) 1550nm and (c) 1553.2nm

Table4: Performance comparison of different modulation formats

Modulation Formats → Lambda ↓	RZ		NRZ		CRZ		PMQPSK	
	BER	Q^2 dB	BER	Q^2 dB	BER	Q^2 dB	BER	Q^2 dB
λ_1(1547.2nm)	10^{-17}	18.5	10^{-16}	18.2	10^{-20}	19.2	10^{-23}	19.9
λ_8(1550nm)	10^{-17}	18.6	10^{-16}	18.0	10^{-20}	19.2	10^{-22}	19.7
λ_{16}(1553.2nm)	10^{-15}	18.2	10^{-15}	17.8	10^{-19}	18.9	10^{-20}	19.2

It has been observed that the performance comparison of different modulation formats showsthat among the 5 given modulation formats, PMQPSK is found to be the best modulationformat in terms of the performance parameters i.e., BER, Q2 dB and eye diagram response.As it generates the BER of the order of e-23 and Q2dB as high as 19.9 dB which is very highas compared to the other 4 formats i.e., RZ, NRZ, CRZ and CSRZ. This proves thatPMQPSK is the best optimal modulation format for the designed multi-channel high speedDWDM OADM system.

V. SIMULATION SET-UP FOR OBSERVING THE POWER TRANSIENTS

The system model is given below in Fig.6.

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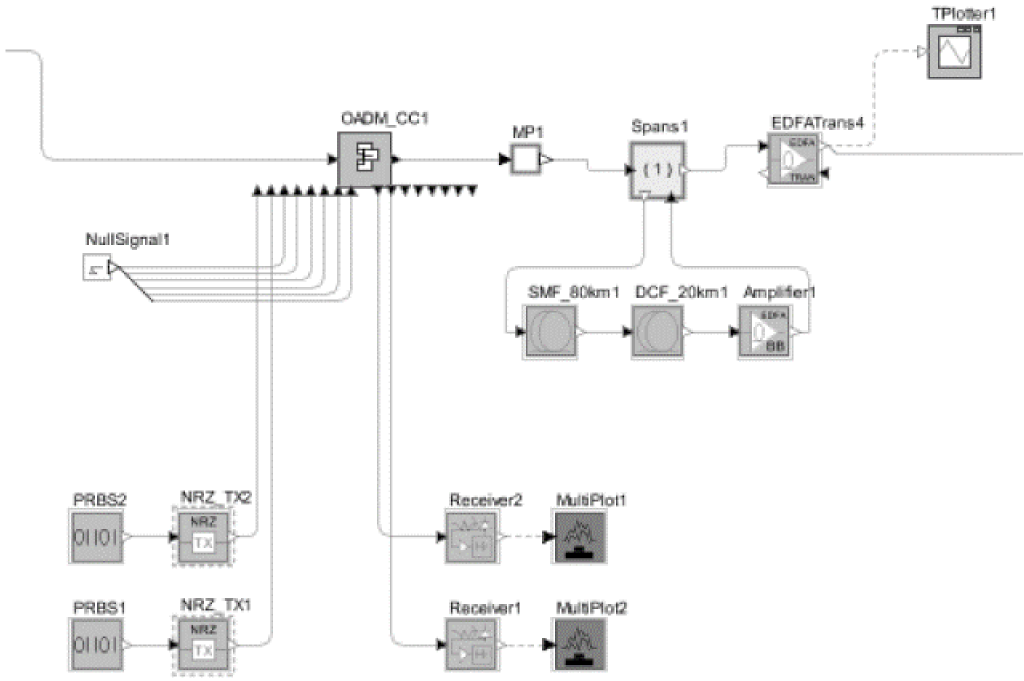

Figure6: System model for transient observation

VI. RESULTS AND DISCUSSIONS

The transient response after 2EDFA's is shown in Fig. 7. Four wavelengths are taken into attention. It is clearly mentionedhere in the figure that the surviving signal power levels experience power excursions whensome of the channels are added or dropped.

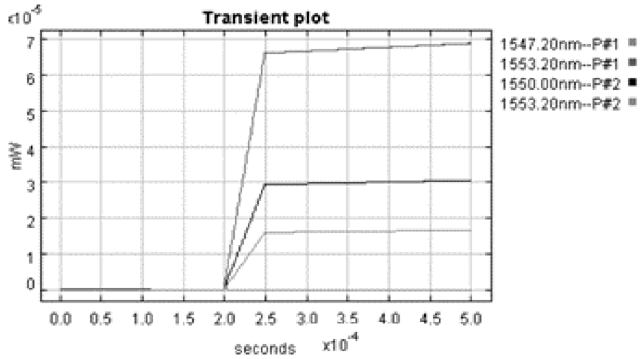

Figure : Transient plot after 2 EDFAs

VII. CONCLUSIONS

The DWDM framework with OADM containing 16 channels, 1000 Km fiber and with 5 distinctive tweak groups has been planned and is working effectively. Execution of PMQPSK tweak design is accounted for to be best among the considered modulation formats

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