OBSERVATION AND EVALUATION OF POWER TRANSIENTS IN 45 CHANNEL SSDWDM OPTICAL NETWORK

Vikrant Sharma, Dalveer Kaur

[1,2] Department of ECE,IKG PTU, Jalandhar, India

Abstract: Erbium doped fiber amplifiers (EDFA) are most commonly used in optical networks for the most assorted applications. The fast power transient effect of the cascaded erbium-doped fiber amplifiers (EDFA) in 45 channels optical ring network areinvestigated. The result shows, the power transient effect of EDFAs when channels are added and dropped.It is shown that, for low channel-adding/dropping frequency closed to EDFA transient rate, the transmission performances of the surviving channels are impaired severely.And also ring laser configuration technique has been reported to mitigate the effect of power transients.

Keywords: SDWDM, EDFA, OADM, Power transients.

1.*INTRODUCTION*

Wavelength division multiplexing technique [WDM] uses EDFA's for increasing transmission capacity [1-3]. This technique is also attractive for use in optical network for its high capacity, flexibility, reliability and cost effectiveness [4]. Multiwavelength optical networks use EDFA's to decrease the effects of fiber attenuation andsplitting of signal powers .Large changes in the input output power to an EDFA produce optical power transients at the output that affect the performance of the optical network.It is also noted that the value of transients increases with the number of amplifiers in a chain which is due to the characteristics of depletion, saturation, state lifetime [5-10]. Large changes in the input optical power to an EDFA can adversely effect optical network performance. The transient speed in a cascade of EDFA's is directly proportional to the number of EDFA's in a cascade [11]. The transients caused by channel dropping is more as compare to channel adding [10]. These transients have effect on all over network performance. The power variation of EDFA input will lead to undesirable fast power transients in the surviving channels by dynamic cross-gain saturation effect [11]. In an optical network with ring configuration, the lasing power plays reservoir of excited Erbium ions and surrounds in opposite direction to input signal variation. When channels are added or dropped because of network reconfiguration the power of the surviving channel decreases or increases due to cross saturation in the amplifier[11]. This paper is organized as follows section 2 provides a experimental setup for measuring transients. Section 3 provides simulation results.

2.*SIMULATION SET UP*

Fig 1 shows the schematic diagram to study power transients and the BER degradation of channels in a routed optical network having data rate of 10 Gbps. It consists six OADM network as shown in figure 1 connected by non linear single mode fiber.

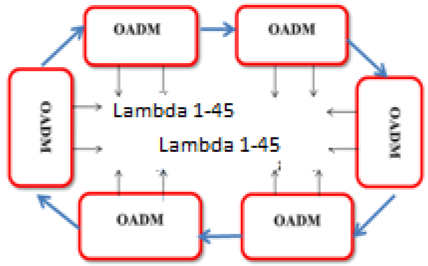

Fig.1 six nodes, 45 channel SDWDM OADM ring

Each node is converting the electronic data into optical signal and transmitting optical link of SDWDM ring. Each node has the ability to add/drop any wavelength of each data channel EDFA is inserted after each fiber span to compensate any fiber losses. LFAF fiber viz., Large effective area is used to compensate the non linearties of multichannel system. The power per channel at transmitters is used is 9db. 45wavelengths are used at 0.4 nm channel spacing at 45Ghz and wavelength ranging from 1545 nm to 1556 nm wavelength.Total 6 EDFA are used.Time delay block is used to connect signal from last node back to first node for performing ring simulations with multiple iterations.The simulation setup for observing transients in optical ring network has been shown in fig.2.For simplicity, only two wavelengths i.e.1545 and 1556 nm is used for the observation of power transients.1545nm wavelength is used as switching wavelength and 1556nm wavelength is used as surviving wavelength .Surviving wavelength is the wavelength, which excursion power transients when 1545nm wavelength is added or dropped. Rest other 45 wavelengths should be applied with null signal to make it inactive.

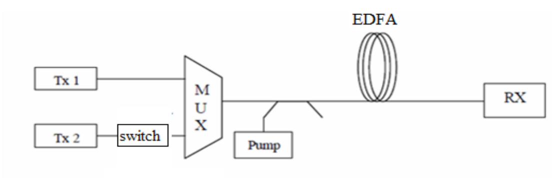

Fig 2 Block diagram of simulation setup

The system is co-pumped at 980 nm with 55 mw of pump power and the Tx1 signal is at 1556 nm and TX2 is at 1545nm. After first EDFA transient plotter is attached to plot the transient effect. It must be noted that lambda 16 is the surviving channel and lambda 1 can be switched on and off with the help of switch. 1545nm channel is connected through switch so that it can be on off or add drop and 1556nm channel is directly attached and the third input is 980nm pump laser.Fig.3 shows practical simulation set up for observing transient .Figure shows OADM first input is at 1545nm, which is to be added or dropped. Signals at 1556nm and 980nm are connected internally to OADM block

3.*RESULTS AND DISCUSSIONS*

It is found that, for low channel-adding/dropping frequency closed to EDFA transient rate, the transmission performances of the surviving channels are effected severely. This is due to the fact that when channels are added or dropped by network's reconfiguration or failure, the power of the surviving channels decreases or increases due to cross saturation in the amplifiers. Power excursion of surviving channels can cause signal distortion by nonlinear effects or degradation of optical signal to noise ratio (OSNR).Two signals are plotted in the figure; one is 1545 nm nm and another is 1556 nm, It clear from the figure that when 1545nm signal is dropped at node 1, 1556nm signal produce transient and there is shoot in power level.

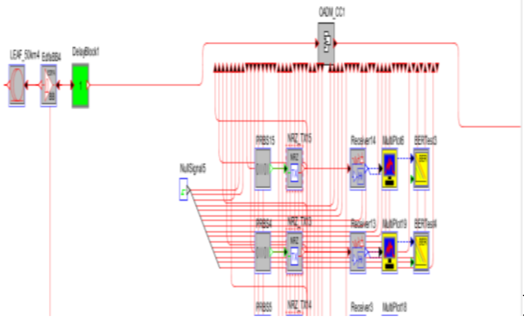

Fig. 3 Practical Simulation set up for transient observation.

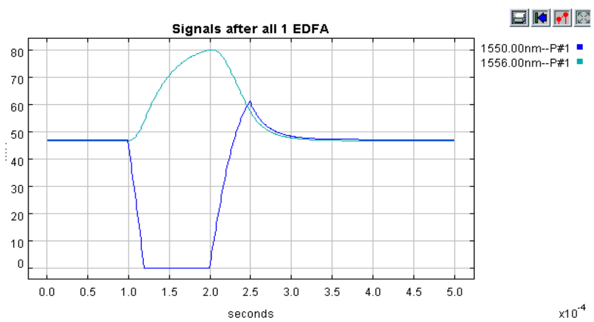

Fig. 4 Signal after first EDFA

Fig.5 shows the simulation setup for two node configuration i.e. after taking results from first EDFA at second node again 1545 nm channel is dropped and again we can see the effect on surviving channel. In this figure output from EDFA1 is connected to next OADM.

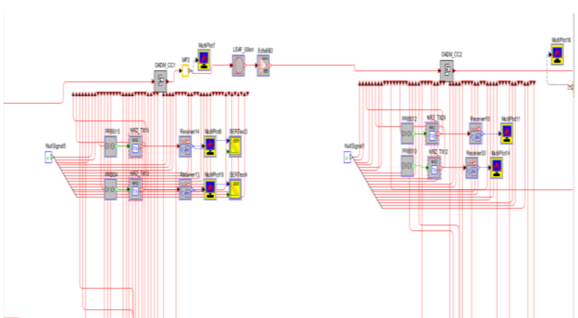

Fig.5 Simulation set up for 2 node configuration

Fig.6 shows the effect of transients after two EDFAs. It is observed that when at second OADM 1545nm signal is again dropped surviving channel i.e.1556nm signal again shoots up .The figure also shows that the power excursions experience faster rise times as the number of EDFAs in the chain increases.

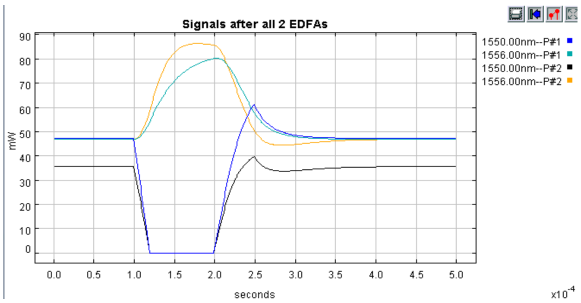

Fig.6 Signals after 2 EDFA

Fig.7 shows the effect of transients after six EDFAs.
It is shown that no transients are fund at 1545 nm wavelength but suppression is much more in 1537nm and 1557nm suppression wavelength even if we take chain of 6 EDFAs.

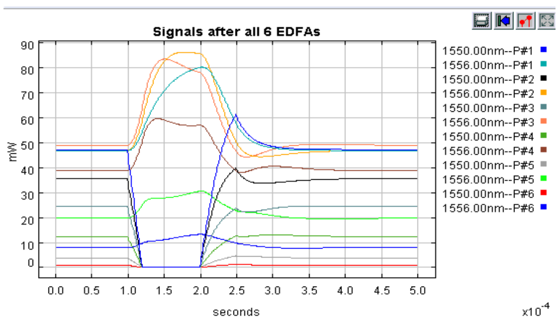

Fig. 7 Signals after six EDFA

Power excursions can be suppressed by using ring laser configurationThe schematic shown in Fig.8 uses a feedback loop to create a ring laser configuration. The EDFA provides the necessary gain. The signal at wavelength 1545 nm is turned on and off by the switch model shown in the schematic. The signal at wavelength 1556 nm is the surviving signal. The lasing signal at 1537 nm clamps the gain of the surviving channel when the signal at 1545 is dropped. The relaxation oscillations of the lasing signal at 1537 nm causes some relatively minor oscillations to be transformed to the surviving channel.
However, these small power excursions are much smaller than those that would be realized without the gain control mechanism. The lasing signal evolves from the ASE noise of the EDFA. The lasing wavelength is selected by the filter in the feedback path. By controlling the amount of loss in the feedback path, we can trade gain stability for EDFA gain.Fig.8 shows power transient's when ring laser technique is implemented.However transient are suppressed by using this technique.

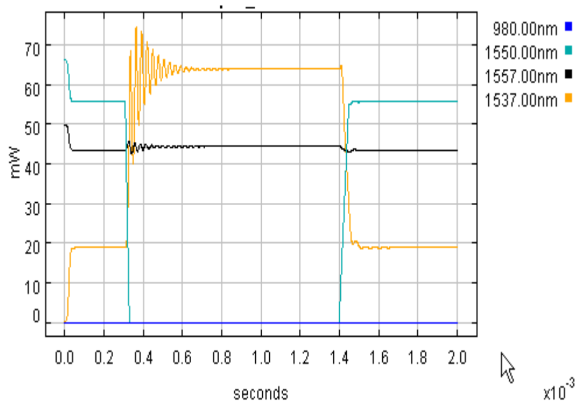

Fig 8: Results after applyingPower transient control technique

REFERENCES

[1]H. Onaka, H. Niyata, G.Ishikawa, K. otsuka, H.oai, Y.Kai, S. Kinoshita, M.Seino, H. Nishimato and T.Chikana, "1.1 Tb/s WDM transmission over a 145 km, 1.34m zero dispersion single-mode fiber." OFC 196, Postdeadline paper PD19, 1996

[2] H.Taga, N. Takeda, K.Imai, S Yamanoto, and S.Akika, "110 Gbit/s (22×5Gbit/s), 9450km transmission experiment using 980 nm pump EDFA1R repeater without forward error correction, OAA 96, Post deadline paper PDS, 1996.

[3] N.Bergano, C.Davidson, D.wilson, F.Kerfoot, M.Tremblay, M.Levonas, J.Morrade, J.Evankow, P.Corbett, M.Mills, G.Ferguson, A. Vengsarkar, J.Pedrazzani,J.Nagel, J.Zyskid, and J.Shloff, "100Gb/s error free transmission over 9100 km using twenty 5Gb/s.

[4] R.S. Vodhanel, F.Shehadeh, J-C chiano, G.K Chang, C.Gibbons and T.Suzaki, Performance of an 8 wavelength 8 node WDM ring network experiment with 80Gb/s capacity, "OFC 96 Postdeadline paper PD28, 1996.

[5] L.Tancevski, A.Bononi, L.A. Rusch, output power and SNR surings in cascades of EDFA for circuit and packed switched optical networks, IEEE. J LightwareTechnom, 19(7)(2001) 933-940.

[6] M.Karasek, M.Menif, L.A. Rusch, output power excursions in a cascade of EDFA's fed by multi channel burst mode packet traffic experimentation and modeling, IEEE J rightwaveTechnol 17(5)(1999) 733-742.

[7] Y.Sun JL Zyskind, A.K. Srivastava, Average Inversion level, modeling and physics of EDFA, IEEE. J Sel. Top. Quant Electron 3(4)(1997).

[8] M.Karasek, A.Bononi, L.A. Rusch, M.Menif, Gain stabilization in gain clamped EDFA cascades feel be WDM burst mode packet traffic, J.LightwaveTechnol 18(3)(2000) 308-313.

[9] C.Tian, S.Kinoshita, Analysis and Control of transist dynamics of EDFA pumped by 1480- and 980 nm lasers, J lightwavetechnol 21(8) (2003) 1728-1733.

[10] Xiadong TANG* Oingji ZEN Yashui JIN and Yiping HAN, Performance penalities due to cascaded EDFA power transients in wavelength routed optical networking, In rare Earth doped materials and devices IV, ShibirJiag, Editor Proceedings of SPIE Vol. 3942,2000. Soo Jin Bal, Chang Hee Lee, Transient control of EDFA using Rectrculating loop for WDM transmission system, CLEO 2000, May 2005, CWK5.

[11] Vikrant Sharma, Anurag Sharma and DalveerKaur, observations and mitigation of power transients in 160Gbps optical Backhave network, in European Scientific Journal, Vol 9, No. 18 June 2013.