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CWDM Network Design 8 channel using Hybrid Amplifier SOA-EDFA

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Abstract
In this experiment we propose and demonstrate a CWDM transmission system using hybrid amplifiers SOA-EDFA. A new hybrid two-stage in the system of optical fiber amplifier for coarse wavelength division multiplexing (CWDM) network is studied. The hybrid amplifier is a cascaded semiconductor optical amplifier (SOA) and erbium- doped fiber amplifiers (EDFA) which provide a nearly flat gain over 80 nm. The hybrid amplifier has been modeled using a OptiSystem version 9 by Optiwave modeling tool on a CWDM transmission system w h i c h consisting of two spans of 100 km.

Keywords: *Coarse wavelength division multiplexing (CWDM); Semiconductor optical amplifier (SOA); Erbium doped fiber amplifier (EDFA); Optical fiber (Accepted July 27th,2015., Published August 10th, 2015).*

1. Introduction

The system experience losses after travelling a long distance such as 100 km or more. In, order to transmit signals over long distances (>100km) it is necessary to compensate the attenuation losses in the fiber [1]. Usually, in the telecommunication system the drop of the signal will affect the operation of the system, optical amplifier [2,3] is one of the elements needed for increasing capacity, long span and multiply connected optical communications networks. Previously, this problem is solved by using an electronic repeater for every 30 to 50 km, the electric repeater is a device used to increase or boost the signal by converting the light signal to an electrical signal and subsequently re-clocking and re-transmitting the signal by converting the signal from electronic from back into optical again.

Coarse Wavelength Division Multiplexing (CWDM) is a multiplexing scheme where multiple wavelengths signals are combined into a single fiber optic cable without any interference [4]. By using the CWDM technology, the optical fiber is a simple transport and cost-effective solution to add more services over a single exiting without interrupting other services to existing customers. The CWDM operates at higher bandwidth than Wavelength Division Multiplexing (WDM) where the operation wavelength span from 1271 nm up to 1611nm which covers 18 CWDM channels with channel spacing of 20 nm [5]. In this experiments, the basic CWDM system is an 8-channel system with wavelengths spaced by 20 nm and ranging from 1470 nm to 1610 nm is investigated [6] and transmission distances at 80 km and the bit rate of 100 Mb/s using SMF fiber optic, and we use only two amplifiers EDFA and SOA to amplify the system, thus avoiding the complexities of hybrid EDFA/SOA amplifiers.

2. Experimental set-up and results.

The commercial amplifier SOA is used to compare with EDFA amplifier performance which is used for CWDM system applications. SOA and EDFA used together for hybrid amplifiers suitable to presenting an amplification spectrum covering the s, c, and l band [8]. However, Semiconductor optical amplifier (SOA) is suitable for CWDM system due to wide bandwidths and cost-effective multi-channel and also suitable for metro space that is well-suited for some CWDM system [9,10].

Standard using EDFA amplification band ranging approximately from 1530 nm to 1560 nm or C-band which is extensively used in the system long-haul fiber optical communications because of the given gain is more than 20 dB [4]. According to function of amplifier is one of the elements for increasing performance in the system, three major requirements for amplifier are (i) high gain (ii) low noise and (iii) flat amplification profile [7].

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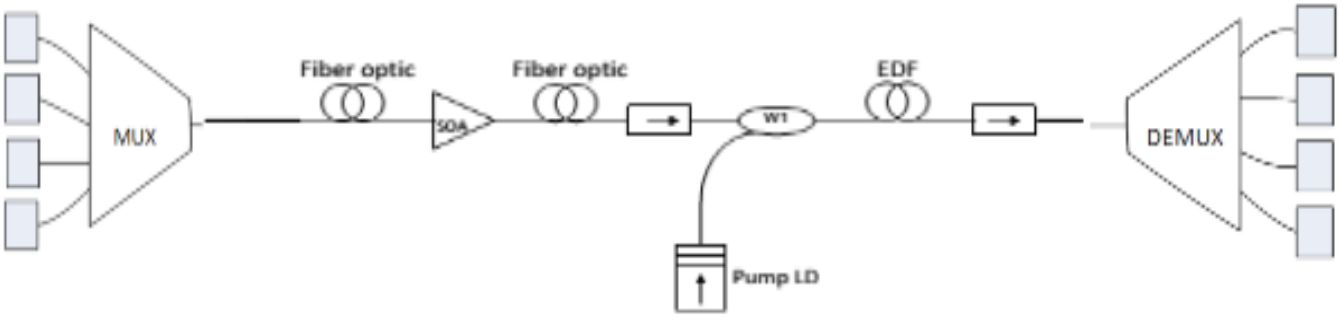

Figure 1: Network layout of CWDM system with the hybrid SOA-EDFA amplifiers

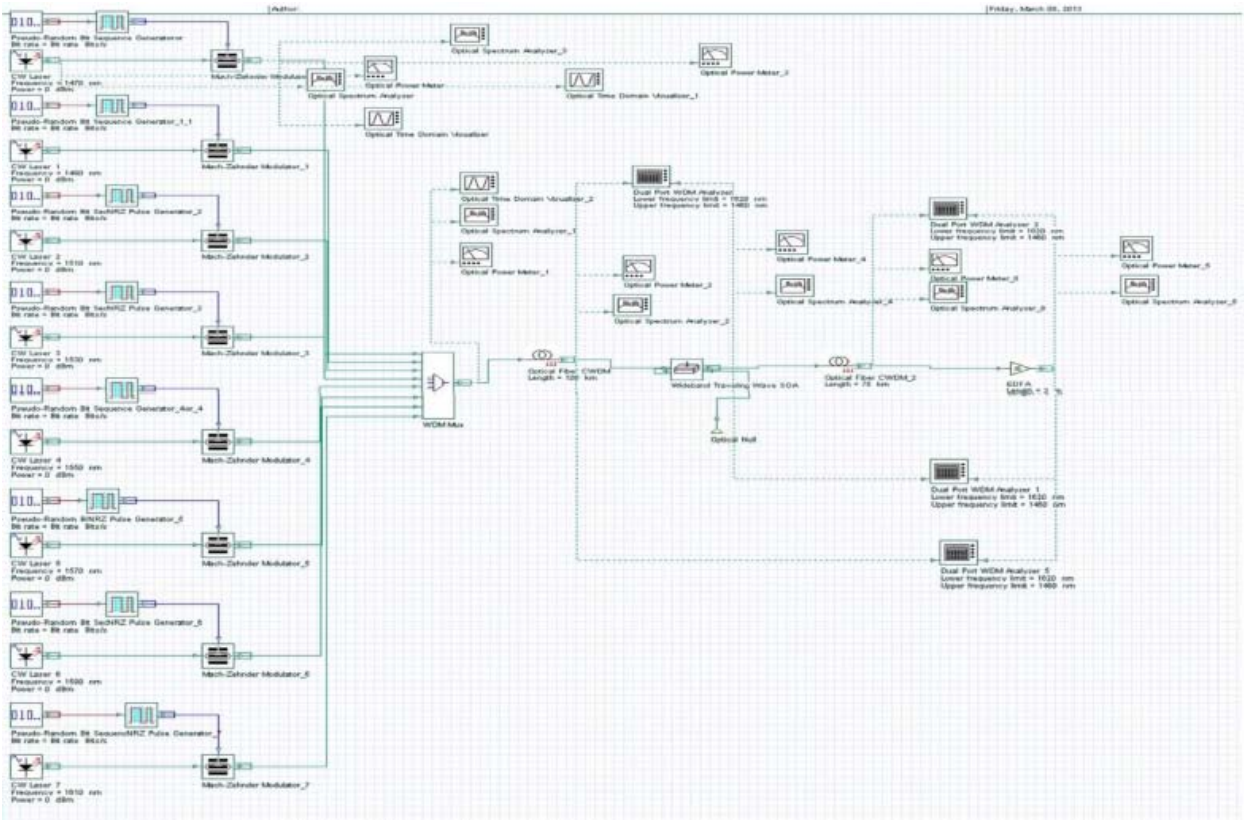

Figure 2: Network layout of CWDM system with hybrid optical amplifiers are designed and modeled using an optical network simulator tool, OptiSystem version 9 by Optiwave

Based on the proposed use of optical fiber amplifier in the hybrid system is from S to C bands using SOA and EDFA amplifier is designed and modelled using optical network simulator tool namely Opti-System version 9 by Opti-Wave.

This experiment was done using 8 channels CWDM system from 1470 to 1610 nm and uses two optical amplifier SOA and hybrid EDFA when conducted the system. Figure 3 shows the set-up of the SOA and EDFA hybrid amplifiers in two phases for CWDM system using opti-system.

In the system, set up of the hybrid amplifier is divided into two parts, strengthening in the area S band and C band that will be obtained from the amplifier SOA and EDFA amplifiers, where in each portion of the band used to have strengthening respectively, like the S band supported by the SOA amplifier and the C band by the EDFA amplifier, while on L band strengthening performed cascade but servicing a given gain cannot reach the whole of the L band. That is meaning, the strengthening gain so weakening much less pronounced in the L band, so the need for reinforcement of the service area L band. The first stage on SOA amplifier operated at bias current of 0.13 A and a energy band gap wavelength with a maximum center wavelength at 1510 nm and center unit frequency noise at 1490 nm where all of them for the setting in SOA in the simulation module. While at the EDFA amplifier, stage EDF has a length of 10m and a wavelength of 980 nm, pump power of 50 mW.

Table 1: Data Simulation according to CWDM system

OLT	Wavelength (nm)	Tx Power (dBm)	Mux Power (dBm)	Fiber Power (dBm)	Rx Power (dBm)
Ch 1	1470	-2.17	1.35	-10.68	-28
Ch 2	1490	0.5			-22
Ch 3	1510	-3.79			-25.42
Ch 4	1530	-3.3			-23.9
Ch 5	1550	-3.3			-24.1
Ch 6	1570	-1			-23.05
Ch 7	1590	-2.3			-23.9
Ch 8	1610	-3.28			-24.8

The use of amplifiers in the telecommunications system that aim to get better results, however, to improve the quality of telecommunications system, it is not only to increase the

power source but also should be added amplifiers in the system to boost in order to get quality results. In Table 1 shows the output power from transmission for every channels are different and the power of the receiver is experiencing a huge reduction that can affect the quality of the results given by the system. In a system that requires an optical amplifier which can improve the quality of results before it is accepted by the user, the signal received by the user can be received well, so that the data or information to avoid mistakes caused by weakness or high noise levels. Adjusted value of the simulator like the real system in the experiments.

From the experiments, it is observed that increased power source or bit rate without the support of network, make saturation point in the system very quick, so that results is not so far away or results generated from the system is not so qualified. So, we try to improve the system by adding amplifiers using a combination of EDFA and SOA where each amplifiers characteristic and way of working are not the same. The receiver can receive input power from system at minimum values -25 dBm. However, in this experiments we try to cover three bands, namely s, c and l bands to provide a good service to the users by increasing the gain and lower noise levels. The use of amplifiers in cascading order is to get improved service gain so that the achievement of service improvement can be done.

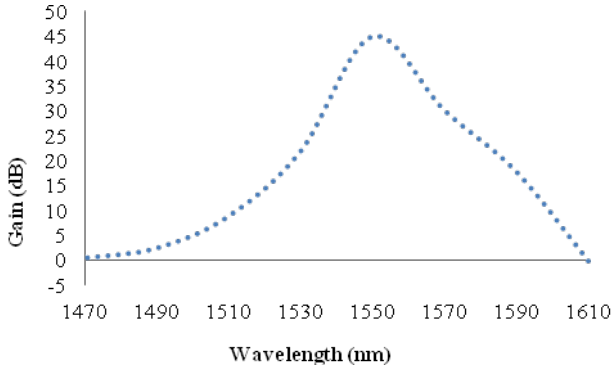

Figure 3: Gain spectra of EDFA amplifier over the bandwidth of 1530 to 1570 nm.

The Figure 3 shows gain spectra from the EDFA amplifiers with input power 1000 mA in the experiment setup. The gain that can be provided by the EDFA amplifiers may reach 45 dB. On the second part of the system sporting by the EDFA amplifiers to amplify gain again after gain workout from SOA amplifiers, it is eligible to add a transmission length of 100 km.

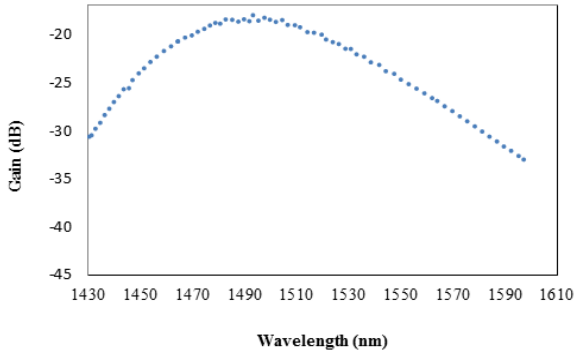

Figure 4: Gain spectra of SOA amplifier with input power 400 mA current level over the bandwidth of 1470 to 1510 nm by real system.

Figure 4 shows the spectra gain of SOA with input power of 400 mA and the characteristic of SOA center wavelength is 1490 nm.

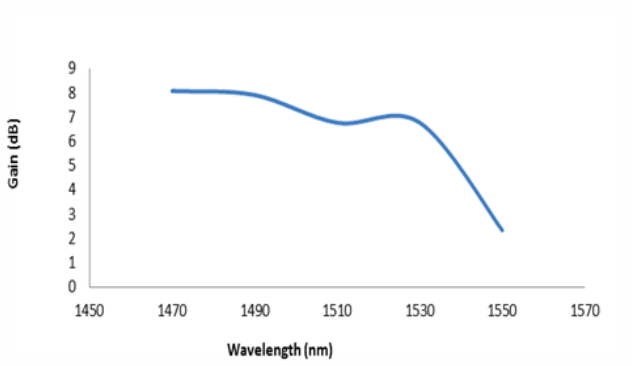

Figure 5: Gain versus wavelength for cascaded SOA-EDFA configuration by simulator.

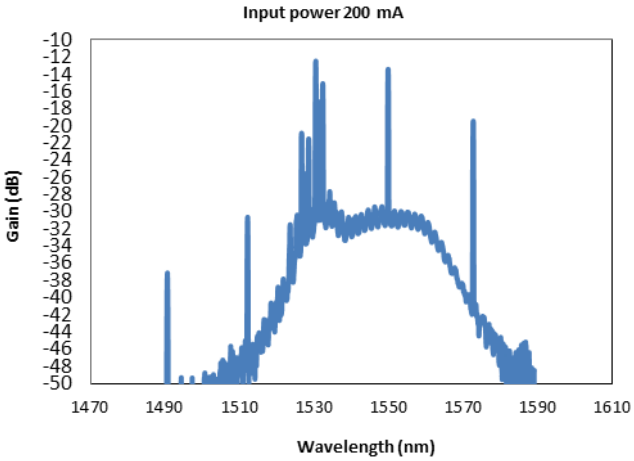

Figure 6: Gain versus wavelength for cascaded SOA-EDFA configuration by simulator.

Hybrid amplifiers already give effective output gain in the system to increase long haul transmission distances. Figure 5 depicts the result from hybrid amplifiers in simulation, the reduction in power gain because of the different optical gain characteristic for each the amplifiers.

Starting gives gain from wavelength of 1470 nm until 1535 nm, according main terms of flattened ness gain, flattening gain occurs at different points from the total gain at the hybrid amplifiers and the area where service gain of EDFA and SOA amplifiers is overlaps, the gain will be drop according nonlinear characteristic of the amplifiers. However, the gain in the system is not uniform but overall optical amplification in hybrid system can increase the performance of the system in particular for operation up to 100 km.

In Figure 6 shows the result from hybrid amplifiers in experiment, uses two amplifiers are cascading in the system is expected to provide services gain of wavelength 1470 nm to 1610 nm, where will occur flattens gain in the system, but services gain at c band is very weak at the wavelength 1470 nm to 1490 nm because the strengthening will weaken after over a distance 40 km but still in the strengthening of signal. In another things, during amplified the signal by the hybrid amplifier is at wavelength 1510 nm to 1570 nm has good signal because the signal from the SOA amplified again by the EDFA amplifier, and in another case during amplified the signal at wavelength 1580 nm to 1610 nm has decreased

after passing the signal reinforced as a whole by EDFA amplifier and a distance of 40 km whose wavelength services on the L band. All output signal issued forwarded to the user.

3. Conclusion

In this experiment we present and demonstrate a CWDM transmission system using hybrid SOA-EDFA amplifiers. The proposed hybrid amplifiers are based on cascaded SOA-EDFA optical amplifier which spans over 100km with uniform performance 0 dBm power penalty in simulation system and 80 km experimental respectively. The proposed of hybrid amplifier enables nearly flat gain over a broad spectrum of the transmission spectrum, with some saturated output power at wavelength of 1550 nm and higher.

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