Gain Enhancement through Cascadeing Stages of Optical Network

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Abstract— This paper explores the usability of passive optical network and the significance of parameters of the optical network. It explains the different stages of optical networks and its uses for the present as well as the next generation communication. Passive optical networks provide the huge bandwidth for the data transmission for triple play (video-voice-data) simultaneously. Requirement for the high speed communication networks is the high bandwidth for the data transmission without interruption. Passive optical networks provide this facility very effectively. It is often not important to consider the optical parameters, however as the bit rate and transmission length increases, these optical parameters have the capability of playing truant in the network. In this paper a novel optical network design is proposed which shows the improved results as compared to the previous stages where results shows the gain v/s bandwidth, bandwidth v/s noise and the gain flatness from peak to peak point variation's with the quantum conversion efficiency and power conversion efficiency. Simulations results are used to verify the proposed approach.

***Keywords**: PON, APON, BPON, EPON, GPON, NGPON.*

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I. INTRODUCTION

Optical fiber Raman amplifiers exhibit various merits such as wider amplification bandwidth, flexible center wavelength, and larger amplification capacity [1], [2]. as the optical power of the commercially available pump diodes is limited within 200–300 mw, several pumps are needed to provide enough power for amplifying all the channels. In order to get wide and flat gain bandwidth, the power and wavelength of each pump diode should be carefully chosen [3], [4]. The pioneer research of fiber Raman amplifiers (FRAs) [5] faded out right after the invention of erbium-doped fiber amplifiers (OPTICAL NETWORKs) over 15 years ago. However, it has recently made a successful comeback [6], [7]. The renewed interest on FRA is mainly due to the availability of high power compact pump lasers [8] and the superior performance of Raman amplification, such as wide bandwidth, low noise, and suppressed nonlinearities performance in transmission systems.

Nonlinear effects within optical fiber provide optical amplification, this achieved by stimulated Raman scattering, stimulated Brillion scattering or stimulated four photon mixing by injecting a high power laser beam into undoped or doped optical fiber. Raman amplification exhibits advantage of self phase matching between the pump and signal together with a broad gain- bandwidth or high speed response in comparison with the other nonlinear processes[9].There are two types of Raman amplifier discrete (lumped) and distributed Raman amplifier .Distributed type Raman amplifier (DRA) utilizing transmission optical fiber as an active medium[10] if the amplifier is contained in a box at the transmitter or receiver end of the system it is called a discrete Raman amplifier.

A network planner needs to optimize the various electrical and optical parameters to ensure smooth operations of a wavelength division multiplexing (WDM) network. Whether the network topology is that of a point-to-point link, a ring, or a mesh, system design inherently can be considered to be of two separate parts: optical system design and electrical or higher layer system design. To the networking world, the optical layer (WDM layer) appears as a barren physical layer whose function is to transport raw bits at a high bit rate with negligible loss. Most conventional network layer planners do not care about the heuristics of the optical layer. However, such lapses can often be catastrophic. Until the bit rate and the transmission distance is under some bounded constraint (for example, small networks), it is often not important to consider the optical parameters. However, as the bit rate increases and transmission length increases, these optical parameters have the capability of playing truant in the network. A network planner must consider the affecting parameters and build a network that accommodates the impairments caused by the optical parameters. Optical network.

Optical network

An optical network is a device that amplifies an optical signal directly, without the need to first convert it to an electrical signal. An optical network may be thought of as a laser without an optical cavity, or one in which feedback from the cavity is suppressed. Stimulated emission in the amplifier's gain medium causes amplification of incoming light. Optical networks are important in optical communication and Traditionally,when setting up an optical link,one formulates a power budget & repeaters when path loss exceedes the available power margin. To amplify an optical signal with a conventional repeters,one performs photon to electron conversion,Electrical Amplification ,Retiming,Pulse Shaping, & the electron to photon conversion.althuogh this process works well for moderate speed single wavelength operation,it can be fairly complex & expensive for high speed multiple wavelength systems.Thus a greate deal of effort has been expended to develop all optial amplifiers. These devices completely operate in the optical domain to boost the power levels of the multiple lightwave signals over spectral bands of 30 nm & more. Optical networks have found widespread use in diverse applications ranging from ultra wide long undersea links to short links in acess networks.in long distance undersea & terristial point –to-point links the traffic pattren relatively stable, so that the input power levels to an optical network do not very significantly.However, since many closely spaced wavelength channel are being transported over these link.The amplifier must have a wide spectral response range & be highly reliable.Usually fewer wavelength are carried on metro & acess network links.But the traffic patterns can be bursty & wavelengths an often be added or dropped depending upon the customers demand for services.

II. Erbium Doped Fiber optical network

The invention of the OPTICAL NETWORK in the late eighties was one of the major events in the history of optical communications systems. It is provided new life research of technologies that allow high bit rate transmission over long distances. Higher bit rates are also possible using various dispersion compensations techniques. In general, OPTICAL NETWORK has a narrow high gain peak at 1532 nm and a broad peak with a lower gain centered at 1550 nm. In order to take the advantage of the whole amplification band provided by OPTICAL NETWORK gain spectrum, equalization techniques have to be applied [39]. The use of increasing number of channels in the present day DWDM optical networks requires a flat gain spectrum requires a flat gain spectrum across the whole usable bandwidth.
Fluorozirconate glasses doped with Pr or Nd are used for operation in the 1300 nm window, since neither of these ions can amplify 1300 nm signals when embedded in silica glass. The most popular material for long haul telecommunication applications is a silica fiber doped with Erbium, which is known as a OPTICAL NETWORK. In some cases, Yb is added to increase the pumping effiency and the amplifier gain .the operation of an OPTICAL NETWORK by itself normally is limited to the l530-1560 nm region. The active medium in an optical fiber amlifier consists of a nominally 10-30-m lenght of optical fiber that has been lightly doped with a rare earth lement ,such as erbium(Er),ytterbium (Yb),thulium (tm).the host fiber material can be standerd silica,a fluoride-based glass,or a tellurite glass.

III. SOFTWARE USED

In the desiging of the optical network required software are .
1.FOSP(Fiber Optical Simulation Program)
2.Gain Master

IV. Optical network design

We design the OPTICAL NETWORK optical network with help of WDM using the Fiber Optical Simulation Program & the Gain Master.

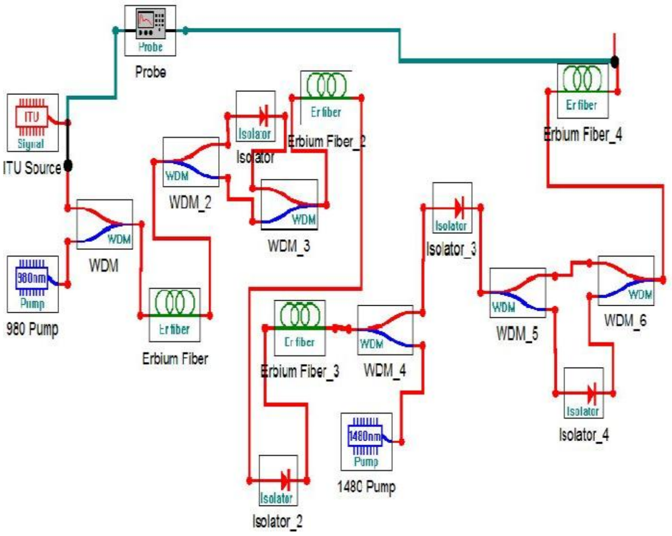

Figure:1 Fourth stage of optical network design.

In this design we show that the optical network gives all the parameter of the erbium fiber & that gives the idea how the signal is to be transfer from one location to the other location.
In this design we find the gain,wavelength & noise parameter.

V. Simulation Of The Optical network

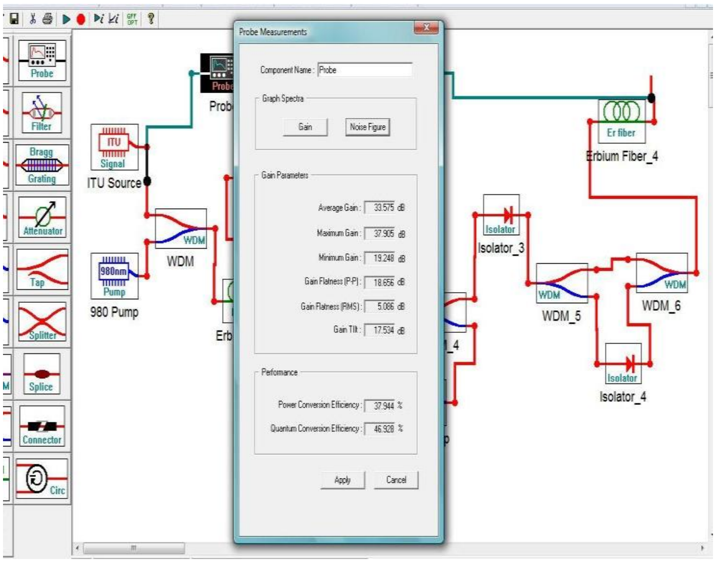

Figure2: Simulation result of fourth stage OPTICAL NETWORK.

The software allows for schematic representations of an optical network to be input via a graphical user interface which mimics the symbolic language often used by engineers to outline a design on paper. The program tracks the optical power through the design, integrating the differential equations to solve the propagation of signal, pump, and amplified spontaneous emission (ASE) bands through all erbium fiber sections. Once a simulation is complete, the user may look inside the design by graphing the power propagating through any fiber in the design, as well as through the length of all erbium fiber sections. . Also, by use of the probe component, the user may make common two-point measurements of interest, such as gain, noise figure,

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Sr.no	Parameter	Range in db(fourth stage)	Range in db(second stage)
1	Average gain	33.575	30.099
2	Maximum gain	37.905	35.085
3	Minimum gain	19.248	24.742
4	Gain flatness(p-p)	18.656	10.343
5	Gain flatness(rms)	5.086	2.972
6	Gain tilt	17.534	10.121

conversion efficiencies, etc. Optical parameters of any component may be changed and the simulation re-run to observe the effects on amplifier performance.

In this paper we have shown the variation of gain & noise with respect to the wavelength for the second stage of optical network. The range consider the 1550 nm-1620nm.the software use is gain master of erbium doped fiber amplifier optical network up to the threshold value the gain increases after that the gain decreases with wavelength & becomes zero at the peak value of wavelength on the similar pattern the noise also 1st increases & then decreases & finally becomes zero at the peak wavelength.

VI. GRAPH MEASUREMENT & SPECTRA

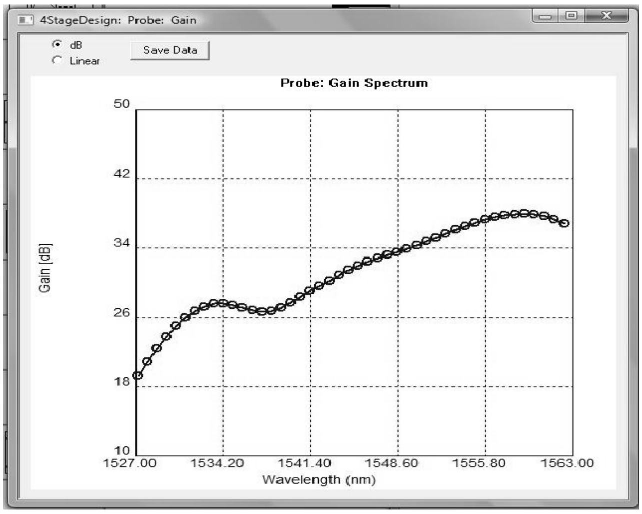

Figure 3: Gain versus Wavelength (fourth stage)

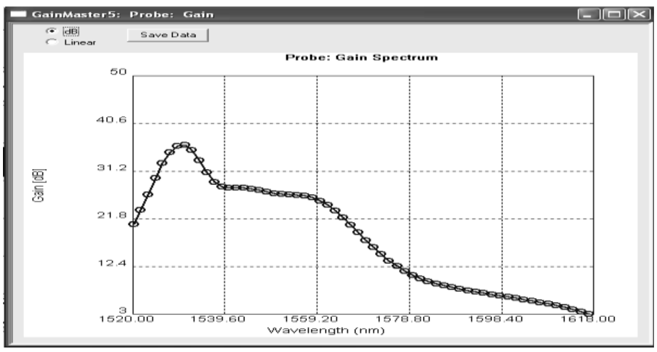

Figure 4: Gain versus Wavelength (second stage)
Noise Measurement & Spectra

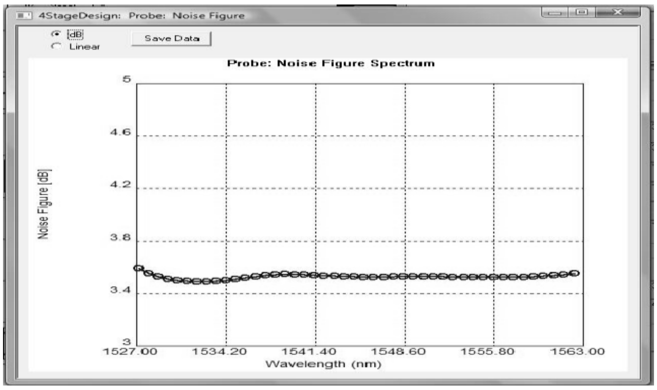

Figure 5: Noise figure versus wavelength (fourth stage)

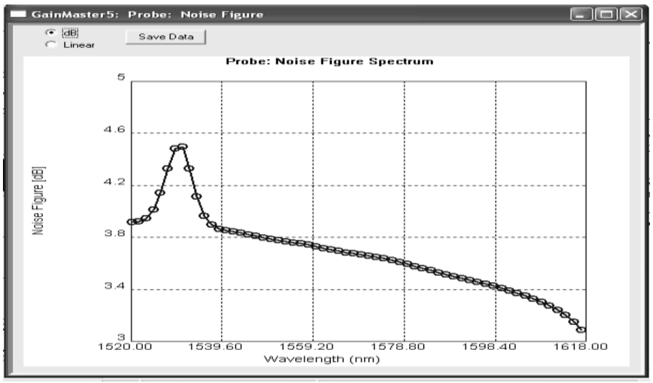

Figure 6: Noise Figure versus Wavelength (second stage)

VII. THE OPTIMUM PARAMETER FOUND FROM THE ANALYSIS ARE :

Performance of the OPTICAL NETWORK :

Sr.no	Parameter	Range in(fourth stage) %	Range in(second stage) %
1	Power conversion efficiency	37.944	28.243
2	Quantum conversion efficiency	46.928	3142

CONCLUSION

This paper shows that the optical network is to be used for amplify the signal and basically designed an optical network to increase the level of the input signal and found that the optimum parameters for the transmission of the data. The input wavelength is taken in between 1520-1617nm. Moreover it also shown the noise spectrum of the erbium doped optical network.

Wavelength division multiplexing (WDM) technique is used for the multiplexing of the signal between the two stage of the optical network. Moreover it is also concluded that the range of the optical network is 1520 -1620 nm. It can be used only up to the 10-30m. It shows the results of the fourth stage of the optical network and the different optimum parameters of the optical networks.

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