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Contents

I. Introduction

There has been advancement in technology and growth in demand for the data rate in access network [1], [2]. Residential subscribers demand high speed network for services such as IPTV, HDTV, video conferencing, etc. Similarly, corporate subscribers demand high speed network so that they can extend their local-area networks to the backbone network. This demands the network of higher capacity. Many brilliant inventions and discoveries have been done over the past few decades in order to meet ever increasing demand for bandwidth, progressing from the copper wire to Asymmetric Digital Subscriber Line (ADSL) which is now replaced by fiber optics. Optical fibers offer almost limitless bandwidth capabilities, has excellent reliability, provides longer transmission distance from central office to the subscriber and is becoming increasingly economical to install. Consequently a fiber seems to be unsuppressed in its superiority over the other broadband technologies.

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Figures

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Keywords

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I. Simulation of bi-directional WDM-TDM PON with 5 Gb/s downstream and 2.5 Gb/s Upstream re-modulated Data based on RSOA

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Abstract*—Paper present a simulation of bi-directional WDM-TDM PON with upstream re-modulation based on RSOA for 64 ONUs at 60 Km reach with 5 Gb/s downstream and 2.5 Gb/s upstream bit rate. A 1:16 splitter is used as a PON element which creates communication between central office and different users. The effectiveness of this design depends on the ability of the RSOA to re-modulate the received downstream signal with the new upstream signal. This architecture is investigated for different RSOA power, downstream receiver power and extinction ratio in terms of BER. The result shows that as the RSOA input power decreases and the device operating regime becomes increasingly linear, the BER performance of the upstream signal deteriorates and that of downstream signal improves. Also it is observed that greater the extinction ratio the harder is for the RSOA to overwrite the downstream signal

Keywords*— Passive optical network (PON), Reflective semiconductor optical amplifier (RSOA), optical network unit(ONU), Wavelength division multiplexing(WDM), time-division multiplexing (TDM)

I. INTRODUCTION

There has been advancement in technology and growth in demand for the data rate in access network [1], [2]. Residential subscribers demand high speed network for services such as IPTV, HDTV, video conferencing, etc. Similarly, corporate subscribers demand high speed network so that they can extend their local-area networks to the backbone network. This demands the network of higher capacity. Many brilliant inventions and discoveries have been done over the past few decades in order to meet ever increasing demand for bandwidth, progressing from the copper wire to Asymmetric Digital Subscriber Line (ADSL) which is now replaced by fiber optics. Optical fibers offer almost limitless bandwidth capabilities, has excellent reliability, provides longer trans- mission distance from central office to the subscriber and is becoming increasingly economical to install. Consequently a fiber seems to be unsuppressed in its superiority over the other broadband technologies.

Passive optical network (PON) is one of the most promising optical access architecture because of the absence of active components between Central office (CO) and customers [3], [4], [5]. For the optical access networks, WDM PON is consid- ered as a promising solution for the next generation of FTTx because of it offers almost-unlimited bandwidth, security, and protocol transparency [6], [7]. But this requires expensive wavelength specified optical sources therefore, it is not largely deployed. For this reason, an access network architecture utilizing a centralized light source at central office (CO) and data re-modulation using the downstream wavelength is an attractive solution for low cost implementation of the upstream transmitter as it requires no wavelength management and needs no expensive wavelength specified light source.

Recently, several schemes have been proposed based on semiconductor optical amplifier (SOA), and reflective semi- conductor optical amplifier (RSOA) because it can reuse the downstream signal received at the ONU for the upstream transmission. A. Singh et al. [10] investigated higher data rate carrying architecture using upstream re-modulation technique. For re-modulation RSOA was used and also feed-forward cancellation circuitry was adapted to an RSOA to improve transmission performance. The architecture supported asym- metrical 2.5 Gbps / 1.25 Gbps and symmetrical 10 Gbps/10 Gbps data rate

In this paper, we have proposed a bidirectional WDM-TDM PON where the downstream signal is amplified and re- modulated with upstream signal by the RSOA and sent back to the CO. Thus, this technique does not require any additional broadband light sources at the CO and can provide sufficient power budgets for the upstream signals. The organization of the paper is as follows: Section II describes the working of simulated model along with the parameters used in the simulated model. Section III, provides the results and finally section IV draws the main conclusion of the paper.

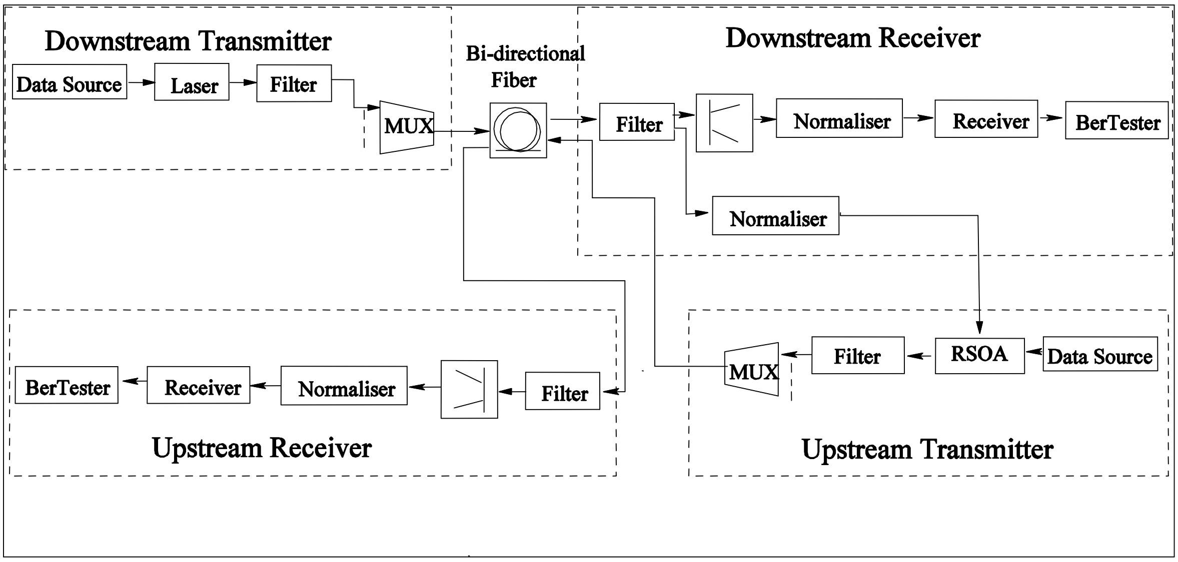

Fig.1. Block Diagram of WDM-TDM PON with RSOA

II. SIMULATION SETUP

The basic block diagram and simulated model of WDM-PON with upstream re-modulation is as shown in Fig.1 and Fig. 2. Two wavelengths 1550 nm and 1549 nm with 100 GHz spacing is used for this simulated model. The transmitter section consists of PBRS block, electric signal generator, laser and modulator. The modulator modulates the light source with incoming data signal to generate optical signal. The generated signals are multiplexed by the multiplexer (MUX) and sent over 60 km bi-directional fiber. The downstream signals are de-multiplexed by de-multiplexer (DEMUX) where various wavelength lights are sent to different ONU. At ONU, optical filters are used to model the filtering effects of AWGs in an optical PON network. Using optical splitter, a portion of the downstream signal is fed to the receiver (whose input power is represented as downRXpwerdBm). For up-link, the other portion of the downstream signal from the splitter is re-modulated using 2.5 Gb/s upstream data by RSOA (whose input power is represented as downRSOApowerdBm) in the ONU. The re-modulated signals are sent back to the CO with another MUX and re-pass through the bi-directional fiber and transmitted to respective ONUs using 1:16 splitter.

The parameters used in simulated model is as shown in Table II.

Fig. 3 shows the transmitted signal and received signal plot at 1550.12 nm wavelength. From this figure we can observe that the output waveform of the detected signal is similar to that of the transmitted signal waveform at that particular wavelength. So we can say that the simulated architecture is able to regenerate the transmitted signal precisely at each decoder.

III. RESULTS AND DISCUSSION

The data are transmitted at two different wavelengths

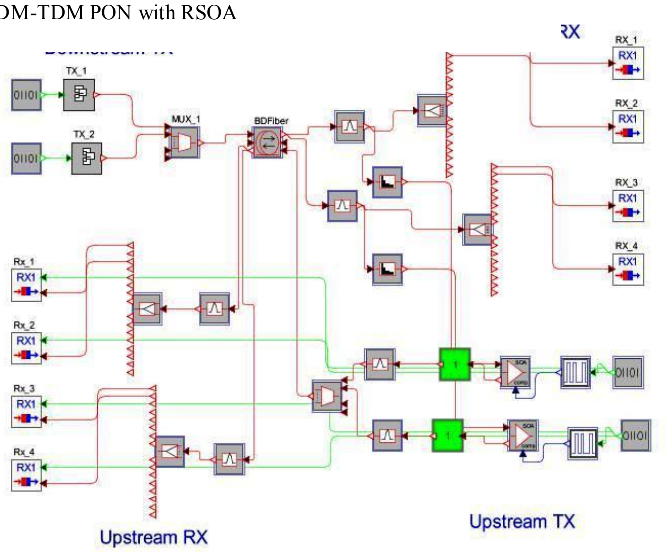

Fig. 2. Simulated model of WDM-TDM PON with RSOA

1550.12 nm and 1549.32 nm with 100 GHz spacing. The result is carried out to study the effect of RSOA power, downstream receiver power and extinction ratio in terms of BER.

Fig. 4 shows measured BER curves of downstream and upstream ONUs after the transmission over 60 km long fiber for various extinction ratio. For downstream, it is observed that, as the extinction ratio increases downstream link performance gets better. However, for the upstream receiver, as the extinction ratio increases, the upstream link performance gets worse. So the extinction ratio plays an important role in determining the effectiveness of the RSOA re-modulation. The extinction ratio for simulated model can be between 3 to 5 dB.

TABLE I. Parameters used in simulated model

Parameter	Value
OLT	
Down-stream Bitrate	5 Gbps
Up-stream Bitrate	2.5 Gbps
Laer Peak Power	1*10-3
Frequency grid spacing	10 Ghz
Laser wavelengths	1550.12 nm , 1549.32 nm
MUX initial frequency	193.4 THz
UprXpower in dBm	-20 dBm
Distribution Link	
Fiber dispersion constant	16.75ps/nm/km
Fiber loss	0.3dB/km
Fiber Length	60 km
RSOA	
RSOA reflectivity	1
DownRXpower in dBm	-17
DownRSOApower in dBm	-10
Extinction Ratio	4

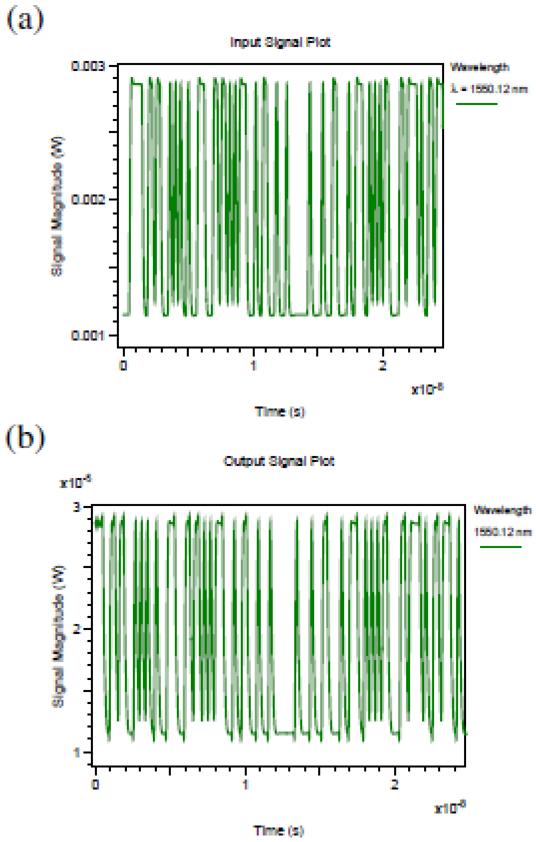

Fig. 3. a) Input Signal Plot b) Detected Signal Plot at 1550.12 nm.

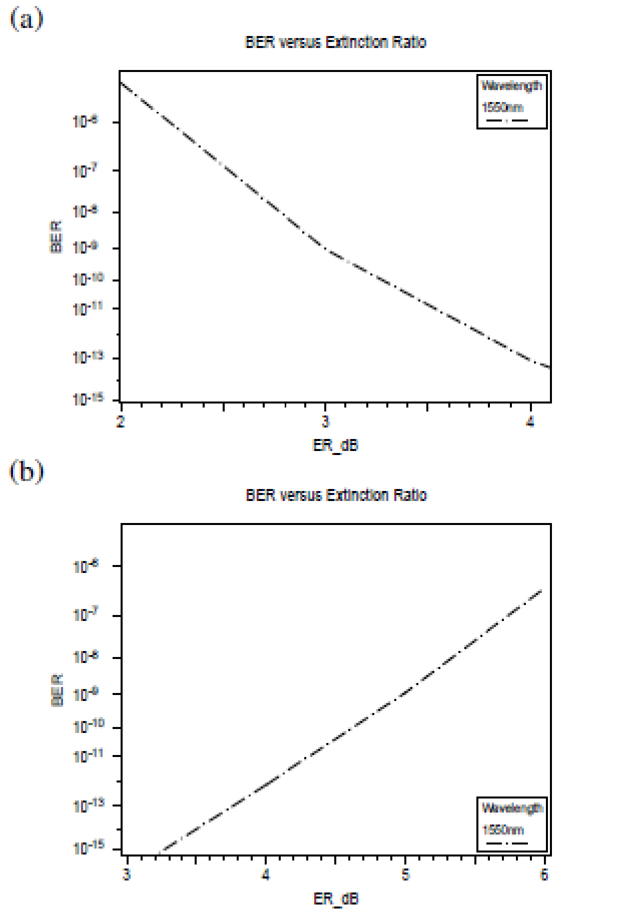

Fig. 4. BER verses Extinction ration for a) Downstream Signal Plot b) Upstream Signal

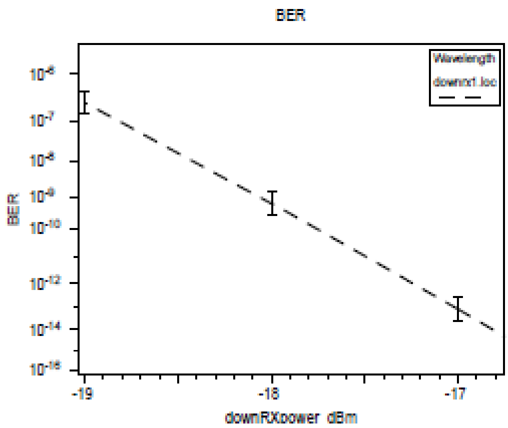

Fig. 5. BER verses downRXpower

Fig. 5 shows the variation in BER with increase in down-stream receiver optical power as downRXpower. As the down-stream receiver optical power increases the performance of downstream signal gets better and the upstream signal performance is not affected by downstr eam receiver optical power variation

Fig. 6 shows the plot of RSOA gain saturation. To demonstrate what happens when RSOA is operated in this regions, the simulation is carried out for upstream transmitter power between -10 dBm and -20 dBm. The result is shown as in Fig. 7.

Fig. 7 shows the variation in BER and Q-factor with increase in upstream transmitter power represented as downR-SOApower. It is observed as RSOA input power decreases and the device operating regime becomes increasingly linear, the BER performance of the upstream signal deteriorates. So we can conclude that as, RSOA input power increases and the device becomes increasingly saturated, the downstream signal is increasingly suppressed, which corresponds directly to improved BER

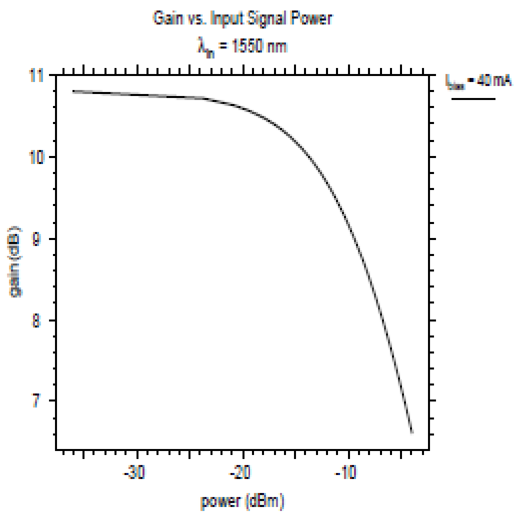

Fig. 6. RSOA gain saturation

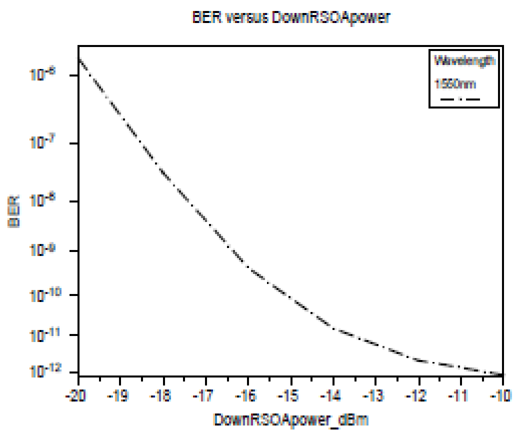

Fig. 7. RSOA gain saturation

IV. . CONCLUSION

We have proposed and demonstrated a cost effective bi-directional WDM-TDM PON with 5 Gb/s Downstream and 2.5 Gb/s upstream re-modulated data based on RSOA. The impact on BER and Q-factor with different downstream receiver power, upstream transmitter power and extinction ratio is studied. We have observed that as extinction ratio increases downstream link performance gets better and upstream link performance gets worse. The impact of downstream receiver optical power on BER shows that as the downstream receiver power increases the performance of downstream signal gets better and the upstream signal is not affected by downstream receiver optical power variation. Also we have observed that as RSOA input power increases and the device becomes increasingly saturated, the downstream signal is increasingly suppressed, which corresponds directly to improved BER

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