Performance Enhancement of WDM-ROF Networks With SOA-MZI

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***Abstract*—we present, simulation and experimental results to show the enhancement in the performance of WDM-RoF networks using SOA-MZI-based multiwavelength converter (MWC) of NRZ data form. We analyze performance of WDM-RoF networks by considering the impairments caused by Non-linear effects like four-wave mixing interference, Stimulated Raman Scattering and Stimulated Brillouin Scattering, Group velocity dispersion and chromatic dispersion. Our simulation results indicate the promising enhancement in performance as clear, open converted eye diagram is obtained.**

***Keywords*— All-optical, multicast, multiwavelength conversion (MWC), semiconductor optical amplifier-Mach–Zehnder interferometer (SOA-MZI), wavelength division multiplexing (WDM).**

I. INTRODUCTION

The radio-on-fiber (RoF) system has been regarded as a promising system that can meet the increasing and varied demands of broadband multimedia services for wireless users. RoF systems offer an effective means of supplying various multimedia services both in indoor environments, such as an airport terminal, and in outdoor surroundings, such as a freeway. It is very important to have a wide service-coverage area for this type of wireless system to be efficient and competitive. Therefore, a RoF system should have many base stations (BSs) connected with a central station (CS) and large bandwidth. To meet these requirements, the wavelength-division multiplexing (WDM) technique should be supported.

When WDM technique is implanted on RoF system the network obtain is called as wavelength division multiplexed Radio over Fiber (WDM-RoF) network. In WDM multiple optical signals from different receivers are multiplexed and this composite signal is transmitted over the channel which is an optical fiber. In the channel different process on the signal are performed like amplification and different compensation techniques of non-linear effects.

In WDM-RoF networks as WDM is used for RoF networks; each BS will have a single wavelength. As a result each radio cell covered by BS will have access on the full bandwidth which is available with each wavelength.

All the internet and multimedia applications like Emerging voice-over-Internet protocol, video streaming, high-definition TV, and peer-to-peer file transfer services requires handling of large data traffic. To handle with the problem of large amount data transportation efficiently more network functions have to be transferred in optical layer those are currently performed in electrical domain. Switching, routing and multicasting are examples of these crucial network operations.

II. WAVELENGTH CONVERSION

Wavelength conversion techniques can be classified in two types:

- O/E wavelength converter
- All optical wavelength converter

In O/E wavelength conversion: the optical signal is firstly converted into electrical signal and this translated electrical signal is applied as input to the tunable laser which is tuned to desired frequency. Hence the required optical signal at desired wavelength is produced.

In all optical wavelength conversion: the signal will remain in the optical form during the process of conversion. This type of wavelength conversion technique uses the process like cross phase modulation, cross gain modulation and four wave mixing.

All Optical Wavelength Conversion is the technique which can be used to route and switch wavelengths, resolve contention, reduce node blocking probabilities, increase optical transparency, and enable dynamic network wavelength assignments and allocation capability. All optical Multi-wavelength converter can be realized using a single integrated device SOA-MZI.

A. SEMICONDUCTOR OPTICAL AMPLIFIER- MACH-ZEHNDER INTERFEROMETER.

SOA-MZI (Semiconductor Optical Amplifier Mach-Zehnder Interferometer) is an optical device that can be used for a wide range of operations on both amplitude and phase modulation. It has two input ports and one output port.SOA can be operated bi-directionally. In SOA when the gain changes the refractive index of the material also changes. This change in refractive index is used to achieve optical switching when placed with MZI. The output of the MZI then depends both on the gain saturation and on the phase shift, due to self-phase modulation, in the SOA.

Principle of operation: The two input signals applied are CW-in and Signal –in the input signals CW-in can propagate in Co-direction and Counter direction with respect to input signal. The optical signal CW-in is applied to both upper and lower SOA. The wavelength of CW-in signal is halved firstly then it is transmitted to two SOAs. Another optical signal having wavelength λ_{sig} Signal-in is coupled to the lower SOA. These two signals having different wavelengths will produce the XPM between two optical signals. At the output port the two output optical signal from two SOA will interface with each other either constructively or destructively results in intensity modulation of input signals. This principle can also be used for the mixing of the optical signals. It can also be used for harmonic conversions. This integrated combination is used for wavelength converter because it saves operational cost and reduces system complexity. Secondly, it provides more independency on bit rate, protocol, modulation format and utilized bandwidth.

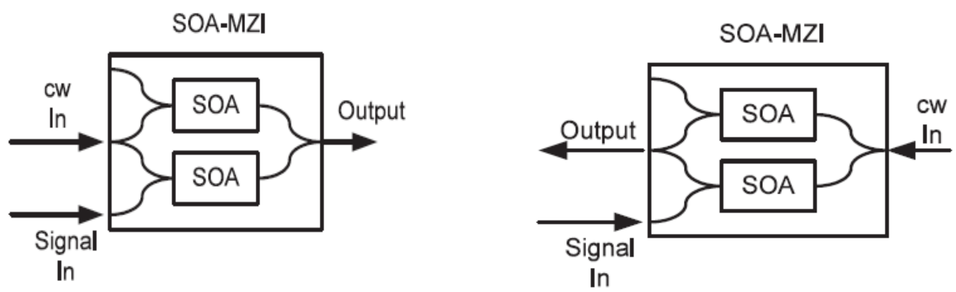

Figure 1: Schematic of SOA-MZI configured in Co- direction (b) Schematic of SOA-MZI configured in Counter- direction

This device has advantages like simultaneous conversion, high conversion efficiency and large bandwidth.

B. SOA-MZI AS WAVELENGTH CONVERTER

The wavelength converter is important as it helps in avoidance of wavelength blocking in optical cross-connect in WDM networks. The wavelength converter will change the input wavelength to a new wavelength without modifying the data content of the signal. In packet switching network the wavelength converter can be used to change the wavelength of certain signal so as to avoid packet contention and reduce the need for optical buffering.

Principle of operation of SOA-MZI as a wavelength converter: A data signal at the wavelength is coupled into port #1 of the MZI. As the signal propagates through the upper SOA, it modulates the carrier density, causing a change in the refractive index, and thereby a phase modulation. CW-light at the wavelength is coupled into port #3, and is subsequently split equally to the two interferometer arms. In the lower arm the CW-light will experience a constant phase change according to the biasing of the lower SOA. However, in the upper arm the CW-light will experience a phase change depending on the bit pattern of the input data signal. Thus, the CW-light will combine constructively or destructively at the interferometer output depending on the modulation of the input data signal. In this way, the bit pattern is transferred to the CW-light, which is selected at the output using a filter. This means that the converted outputs signal can either be inverted or non-inverted compared to the input data signal, simply by operating on the negative or positive slope, respectively. The All optical wavelength converter is shown in the following figure.

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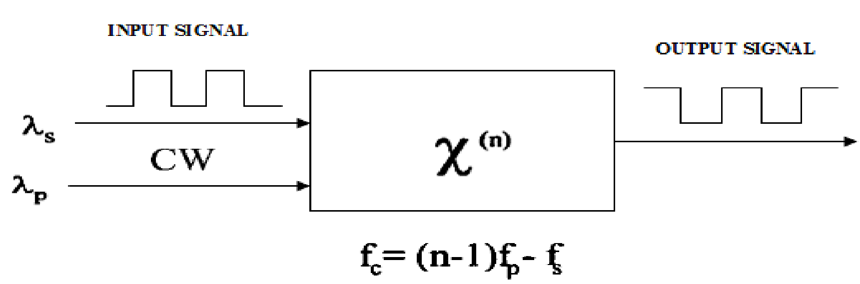


Figure 2: SOA-MZI as a wavelength converter

C. SIMULATION SETUP AND PARAMETERS

The model described as below is used for the generation of ODSB signals and device all optical wavelength. In WDM RoF systems the transmission takes place between Remote Antenna Unit (RAUs) to the central base station (CBS). The RoF transmitter can be defined as a device which includes N numbers of RAUs having optical modulator. In this system eight channels are multiplexed to form the WDM- RoF system. It means for the RoF transmitter each RAU can work at a single wavelength. All the eight channels are transmitted using single mode fiber after multiplexing to the CBS. At CBS each base signal is de-multiplexed using WDM de-multiplexer. Then the respective base station detects the signal using RoF receiver. the transmitter and receiver sections are also shown.

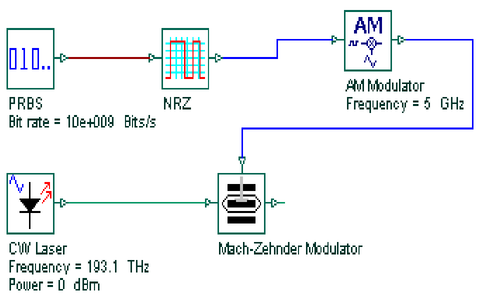


Figure 3: RoF Transmitter

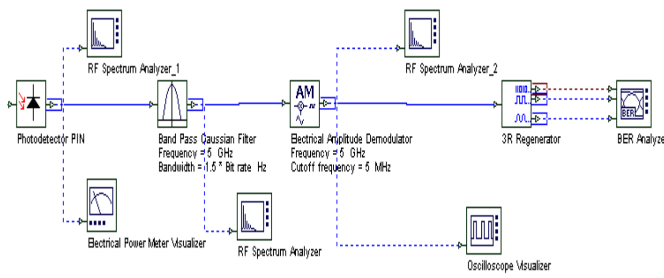


Figure 4: RoF Receiver

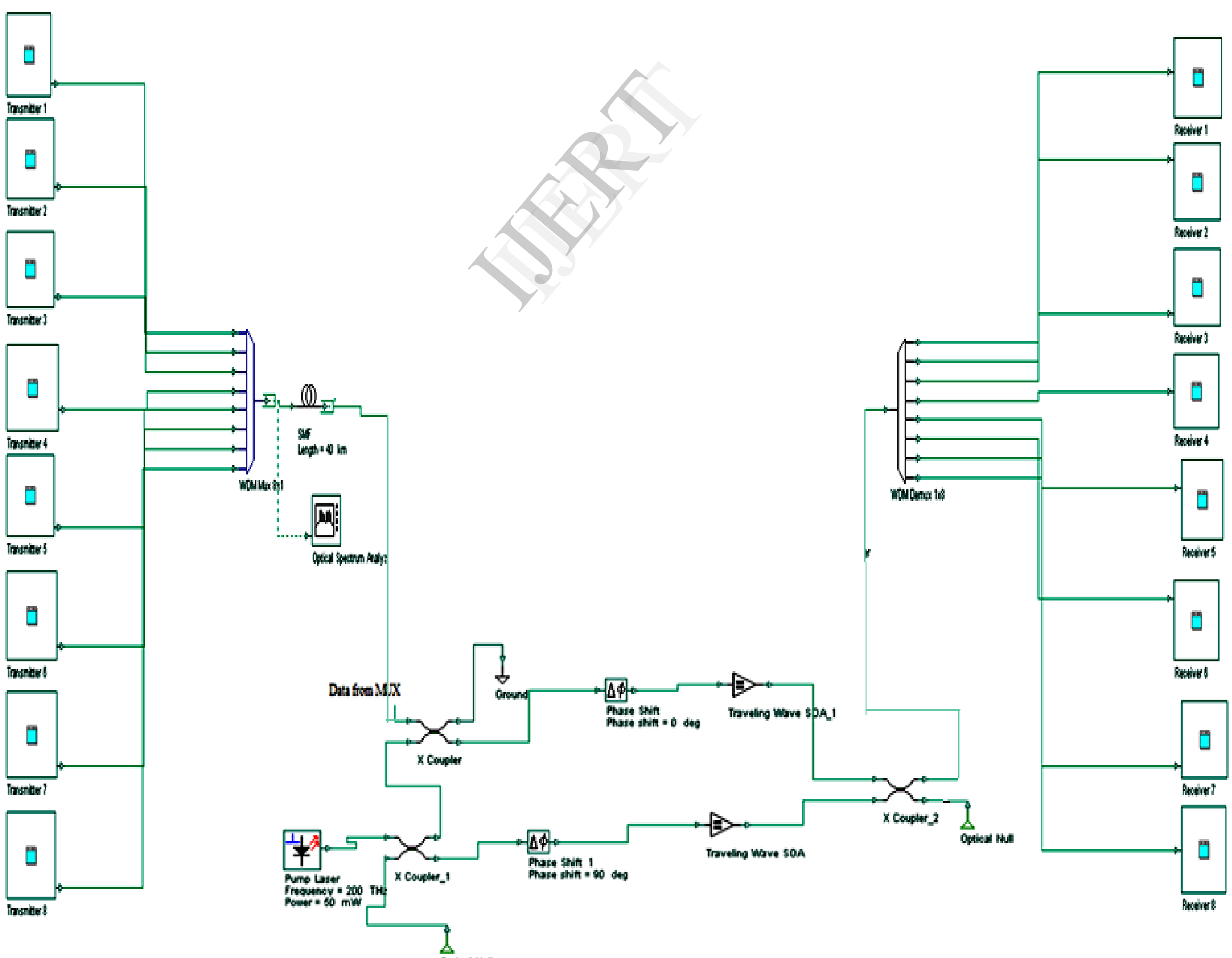


Figure 5 : Simulation System for WDM- RoF system with SOA-MZI

PARAMETERS FOR WAVELENGTH CONVERTER

Parameter	Value
Frequency of Pump Laser	200 THz
Power of Pump Laser	50 mW
Injection Current for SOA	0.15 A

PARAMETERS FOR ROF TRANSMITTER

Parameter	Value
Number of RAUs	8
Modulation	AM
RF carrier frequency	5 GHz
Optical power of CW Laser	0 dB
Injection current to SOA	300 mA

PARAMETER FOR RoF RECEIVER

Parameter	Value
Photo--detector Type	PIN
Responsivity	1A/W
Dark current	10 nA
Electric Filter Type	Gaussian Band Pass
Bandwidth of Electric Filter	1.5* bit rate Hz

D. EXPERIMENTAL RESULTS:

Here the simulation is performed for the eight input signal having different frequency ranging from193.1 THz to 193.8THz. These signals are multiplexed and then transmitted over the optical fiber. In the channel SOA-MZI is placed which will perform the operation of wavelength converter. The simulations are performed at different fiber lengths, different input powers and different bit rates.

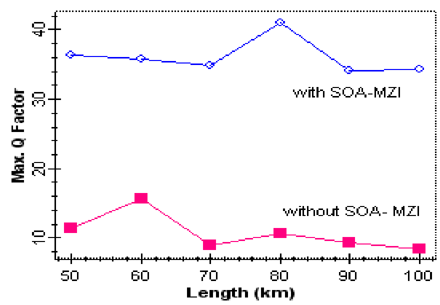


Figure 6: Graph between Q factor and fiber length

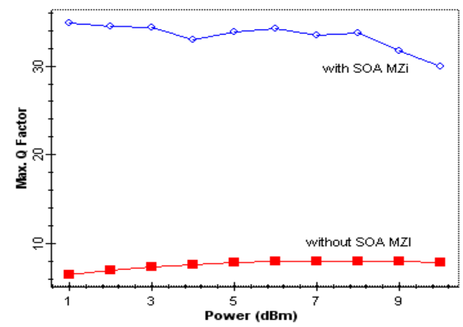
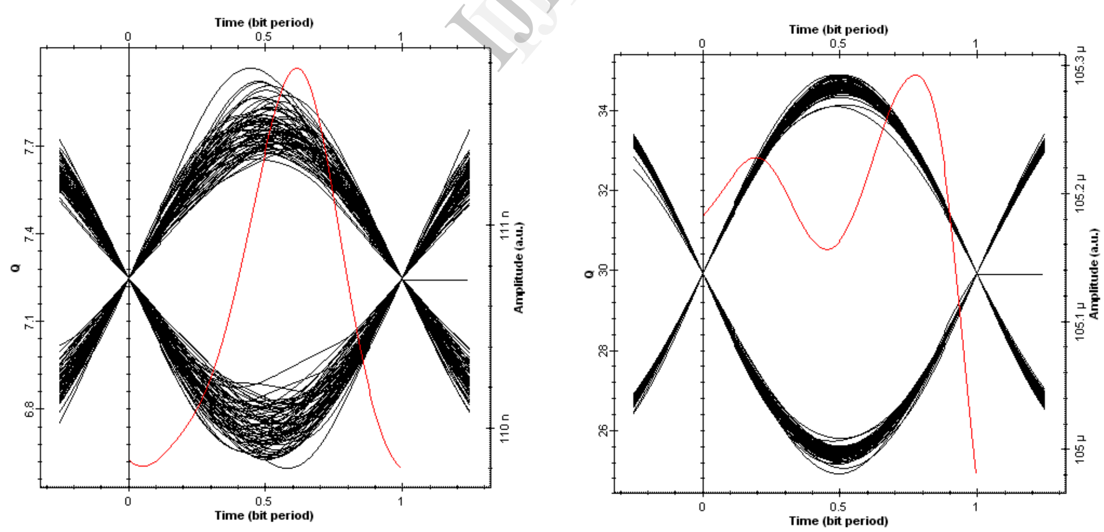


Figure 7: Graph between Q factor and input power

In figure 6 a comparision is shown between the values taken at different fiber lengths for the quality factor. this graph shows that the system integrated with SOA-MZI has better resilience to chromatic dispersion. In figure 7 a comparision is shown between the values taken at different input powers and for the quality factor. this graph shows that the system integrated with SOA-MZI has better resilience to Non-linear effects. In figure 8 a comparision is shown between the values taken at different bit rates and for the quality factor. this graph shows that the system integrated with SOA-MZI has better resilience to GVD.



a) without SOA-MZI b) with SOA-MZI

Figure 8: Eye Diagram for Receiver

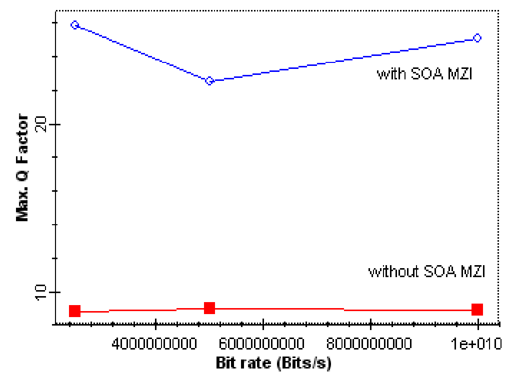


Figure 9: Graph between quality factor and Bit Rate

Figure 9 shows the eye diagram of receiver with and without SOA-MZI. This diagram shows that BER has better value for receiver which receive the input after the wavelength conversion. Hence this receiver has less probability of error.

III. CONCLUSION

RoF is most promising technique for the today's communication system to meet with the requirement of multimedia and high data rate applications. By integrating WDM technique with this RoF network an increase in bandwidth, simplicity in network management can be obtained but use of WDM degrades the performance of the system because of the production of non-linear effects (FWM, SBS, XPM, and SPM). In this paper the simulation results are presented to enhance the performance of WDM-RoF network integrated with wavelength converter based on SOA –MZI. This device will reduce the effects of these non-linear effects. Simulation is performed for the different bit rates, input powers and fiber length. The simulation results show that the system integrated with this device has better performance in respective of resilience to chromatic dispersion, Group velocity dispersion (GVD) and non-linear effects.

IV. REFERENCES

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