ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 6, June 2014

Features of Bidirectional RoF Based on RSOA

Himanshu Kapoor[1], Poonam Singhal[2], Subodh Bansal[3]

ECE Department, DCRUST Murthal, India[1,2]

ECE Department, NCCE Israna, India[3]

Abstract: The optical and wireless communication systems integration will activate the potential capacity of photonic technology for providing the expected growth in interactive video, voice communication and data traffic services that are cost effective and a green communication service. The last decade growth of the broadband internet projects the number of active users will grow to over 2 billion globally by the end of 2014. Enabling the abandoned capacity of photonic signal processing is the promising solution for seamless transportation of the future consumer traffic demand. Systems based on Radio over fiber have been studied and parameter changes have been investigated resulting into analysis for bidirectional RoF based on RSOA. RSOA works as amplifier and modulator. It utilizes OQPSK for the downlink and OOK for the uplink. Aim of bidirectional RoF system based on RSOA is to provide a economical system with more capacity. Parameters like eye diagram, BER, gain may be analyzed to compare bidirectional RoF system with the existing systems.

Keywords: RoF, RSOA, OQPSK, OOK, Eye diagram, BER.

I. INTRODUCTION

The Indian telecommunication industry is one of the world's fastest growing industries, with 904.56 million telephone (landlines and mobile) subscribers and 875.48 million mobile phone connections as on October 2013[1]. It stands the second largest telecommunication network in the world in terms of number of wireless connections after China. As the fastest growing telecommunications industry in the world, it is projected that India will have 1.159 billion mobile subscribers by 2013[1]. To meet the explosive demands of high-capacity and broadband wireless access, modern cell-based wire-less networks have trends, projecting continuous increase in the number of cells and utilization of higher frequency bands which leads to a large amount of base stations (BSs) to be deployed; therefore, cost-effective BS development is a key to success in the market [2]. In order to reduce the system cost, radio over fiber (RoF) technology has been proposed. RoF systems transmit an optically modulated radio frequency (RF) signal from a central station (CS) to a base station (BS) via an optical fiber. The RF signal recovered using a photo detector (PD) at the BS arrives at a mobile station (MS) through a wireless channel. This architecture provides a cost-effective system since any RF oscillator is not required at the BS [3] and [4]. Due to high propagation and penetration loss in the frequency bands a typical room in a building surrounded by walls must be supported by at least one BS. As a result, numerous BSs are required to cover the building. In such an environment slight movement of mobile hosts (MHs) could trigger handover, which is quite different situation compared to conventional WLAN systems.

II. BIDIRECTIONAL RoF SYSTEM DESCRIPTION

Generally, in a RoF system the light wave is modulated with radio signal directly without any electrical / optical conversion. Radio transmission over is used for many purposes like in satellite base stations and in Cable Television Networks (CATV) [11] and [12].

RoF system mainly consists of three parts

- Central Office.
- Optical Link.
- Remote Link.

Fig 1.1: RoF Structure

For RF Signal Generation & Transportation, several RoF concepts have been developed. The main difference between these concepts resides in techniques used for carrier generation and data distribution over optical fiber. They are implemented according to their frequency bands, which are:

(i) RF band.
(ii) IF band
(iii) Baseband .

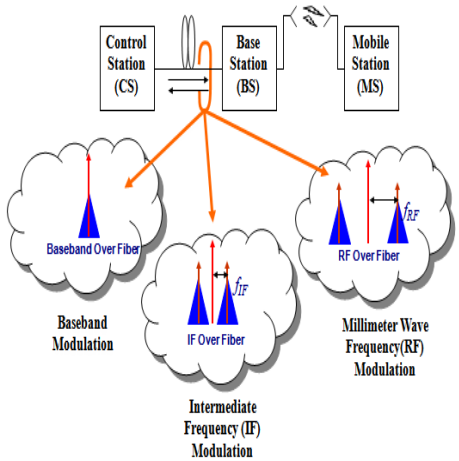

Fig.1.2. Architectures for Fiber/Wireless System [10]

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 6, June 2014

(i) In Baseband approach, light wave is modulated by using a message data signal to transfer through the optical link. In other words, we can say that light wave is the carrier signal and message signal is the modulating signal.
(ii) In RF band approach, an optical light wave signal is used to modulate the Radio Frequency signal with a high frequency before being transported over the optical link. That is why, at high frequencies RF signals are optically distributed to the base stations directly.
(iii) In IF band approach, light is modulated by using an Intermediate Frequency radio signal with a lower frequency before it is being transported over the optical link.

The architecture for bidirectional wired/wireless RoF access network is shown. In this scheme both the injection locking technique and optical suppression based on Fabry-Perot laser diode (FP-LD) is used as cost-effective wavelength division multiplexing (WDM) optical source in order to generate the wired and wireless signals at the same time.

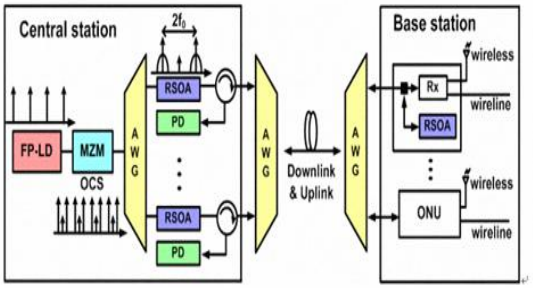

Fig 2: Schematic of simultaneous transmission of wired and wireless signals

Fig. 2 shows the cost-effective bidirectional WDM-ROF system with multiple optical carrier suppression. In this scheme, a RF sub carrier of f_0 modulates the all modes from FP-LD at Mach-Zehnder modulator (MZM) biased at a V_{Π} bias voltage for OCS. If the frequency response of the MZM is valid to generate then any frequency of RF subcarrier can be generated. Array Wave Guide (AWG) is used to de-multiplex each mode. The mode spacing of the FP-LD should be matched to that of AWG. Reflective Semiconductor Optical Amplifier (RSOA) is used as an external modulator because the gain saturation effect of RSOA reduce the Mode Partition Noise (MPN) of each FP- mode. A 1.25-Gb/s baseband signal at RSOA is mixed with two side carriers of each FP- mode. AWG is used to combine each FP-mode with two side carriers and it is transmitted through the single mode fiber (SMF) and is assigned to each BS [5] and [6].

III. BASIC PRINCIPLE OF WDM/SCM-PON

WDM-PON is based on the RSOA. RSOA acts as a modulator and have many advantages. RSOA accomplishes the task of modulation as well as amplification function and this amplification function provides the additional gain. The gain provided by the amplification function is used for the incident optical power in order to overcome the transmission losses. In this way amplifier less-PON can be accommodated. RSOA can reduce the intensity noise of the optical signal when it operates in the gain saturation region[8]. RSOA can be used as a modulator as well as amplifier in a passive optical network as shown in fig 3.

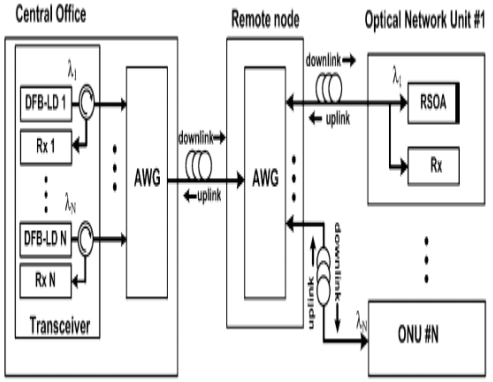

Fig 3: Schematic diagram of WDM/SCM -PON.

It represents the WAVELENGTH- DIVISION multiplexed- passive optical network. This type of Network is a solution for high speed access network such as fibre to home or fibre to office in terms of large capacity, protocol transparency, security and upgradability [7] and [8]. In this a CO consist of DFB-LD array which consist of wavelength from λ_1 to λ_N. The wavelength is used for the down-link and up-link signals and array waveguide grating (AWG).AWG operates as wavelength MUX/DEMUX the circulator operates between the AWG and DFB-LD/receiver array in order to separate down-link and up-link signals. An another AWG is used in the remote node (RN) which is used as a DEMUX for down-link and as a MUX for up-link signals. The ONU is composed of RSOA and a receiver. In this a simple concept of SCM re-modulation technique of down-link for up-link transmission is used.

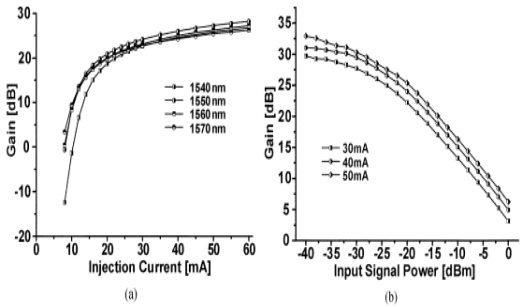

Fig:4 Performance characteristics of RSOA

The fig 4(a) shows the performance characteristics of the RSOA with various injection currents from 8 to 60 mA. With input power of -20 dBm. In the wavelength range from 1540 to 1570 nm with the injection current of 30 mA the RSOA gives the 23-dB.The fig 4(b) shows the gain saturation characteristics of RSOA with the wavelength of 1550 nm. With an input power of about -30 dBm the gain of RSOA begins to saturate. The gain of RSOA is saturated when the input power of -15 dBm entered into the RSOA [9].

IV. CONCLUSION

A RSOA can be used for both modulation and amplification functions. Amplification function gives additional gain. Gain of RSOA is saturated after a particular value of the input. When RSOA is operated in gain saturation region, it can reduce effect of noise signal.

REFERENCES

[1] http://en.wikipedia.org/wiki/Telecommunications_Statistics_in_India.
[2] Y. Kim et al., "Beyond 3G: Vision, requirements, and enabling technologies," IEEE Commun. Mag., vol. 41, no. 3, pp. 120–124, 2003.
[3] A. Alphones, "Double-spread radio-over-fiber system for next-generation Wireless technologies," OSA J. Opt. Netw., vol. 8, no. 2, pp. 225–234, Feb. 2009.
[4] T. Koonen, "Fiber to the Home/Fiber to the Premises: What, Where, and When?," Proceedings of the IEEE, Vol. 94, No. 5, May 2006.
[5] Y. Y. Won, H. C. Kwon, and S. K. Han, "1.25-Gb/s Wavelength-Divisions Multiplexed Single-Wavelength Colorless Radio-on-Fiber Systems Using Reflective Semiconductor Optical Amplifier, "J. Light.Technol., vol 25, no. 11, pp.3472-3478, Nov.2007.
[6] Hyun-seung et al. , "Bidirectional WDM-ROF Transmission for wired and wireless signals, "in 2009.
[7] R.D. Feldman, E.E. Harstead, S. Jiang, T. H. Wood, and M. Zirngibl, "An evaluation of architectures incorporating wavelength division multiplexing for broad-band fiber access," J. lightw. Technol. , vol. 16, no.9, pp. 1546-1559, Sep. 1998.
[8] K . Sato and H. Toba, "Reduction of mode partition noise by using semi-conductor optical amplifiers," IEEE J. Sel. Topics Quantum Electron. , vol. 7 , no.2, pp. 328-333 , Mar./Apr. 2001.
[9] H. C. Shin, J.S. Lee, I. K . Yun, S. W. Kim, H. I. Kim, H. S. Shin, S. T. Hwamg, Y.J. Oh, and C.S. Shim, "Reflective SOAs optimized for1.25 Gbit/s WDM-PONs,"in proc. 17th Annu. Meeting IEEE LEOS (LEOS 2004), Puerto Rico, Nov. 2004, pp. 308-309.
[10] H. Chettat, L. M. Simohamed, Y. Bouslimani, and H. Hamam, "RoF Networks: A Comprehensive Study," International symposium on wireless pervasive computing 2008 (ISWPC 2008), May 7-9, 2008.
[11] M. Kang and S.K Han, "A novel hybrid WDM/SCM-PON sharing wavelength for up and down link using reflective semiconductor optical amplifier," IEEE photon, vol. 18, no.3, pp. 502-504, Feb. 2006.
[12] M. C. R. Medeiros, R. Avo, P. Laurencio, N.S. Correia, A. Barrada, H.J.A.daSilva I.Darwazeh, J.E Mitchell and P.M.N Monteiro, "Radio over Fiber Access Network Architecture Employing Reflective Semiconductor Optical Amplifier," IEEE, 2007.