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Performance Analysis of Band-mapped RoF system for Integrated Broadband Wireless transmission

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Abstract *:* This paper studies the performance of a novel RoF (Radio over fiber) architecture – band-mapped RoF, which is used for the integrated transmission of multiple wireless broadband signals. The use of optical fiber links to distribute RF signals from a central BS to multiple RAU's (Remote Access Units) is the basis of RoF technology. In the band-mapped RoF system the wireless services and millimeter wave services are mapped to four frequency sub-bands in the electrical domain and are optically up-converted to the 60 Ghz sub-bands. This architecture utilizes the 7 Ghz bandwidth of the free and abundant 60 Ghz RF band. This system can be widely implemented in the LAN's as it consumes very low power and suffer minimum losses in the optical-wireless networks.

Keywords: Band-mapping, Radio-over-fiber (RoF), WDM-PON, OFDM.

INTRODUCTION

The rising demand for high speed internet connectivity is a major challenge faced by the technology in the present days. With the development of wireless technologies for the broadband services the requirement for more bandwidth within the available spectrum is a limitation faced by the service providers. These services are required to provide wide area connectivity for a very large number of users.

RoF is a promising cost effective solution to meet the ever increasing user bandwidth and wireless demands [1-7]. Many works has been done on the integration of RoF network with the wireless services. A work on the generation and transport of independent Wi-Fi, WiMAX, and 60 Ghz optical millimetre wave signals on a single wavelength using RoF networks has been proposed by Hsueh, Jiaet al. in [8]. The system is designed using large number of interleavers used for the filtering of the sidebands from the optical phase modulated signals. Hsueh, Huang et al. [9] has proposed another system in which a centralized bidirectional hybrid network integrates RoF with WDM-OFDM-PON. Here, WDM-PON network is combined with RoF using OFDM-16 QAM modulation in downlink and OFDM QPSK technique in uplink. This system greatly reduces Rayleigh backscattering, up to distances of over 25 km.

Jiang, Lin et al. describes in [10] about a similar work on the simultaneous generation and transmission of 60 Ghz wireless signals along with wired signals using reflective semiconductor optical amplifier (RSOA) modulation technique for uplink communication. Here frequency quadrupling technique is used. The system utilizes the wavelength reuse technique via a RSOA.

Hsueh, Jiaet al. demonstrate a dispersion tolerant fully duplex RoF system in [11]. Here the remodulation technique is used for the generation of the downlink signal. Multiband downstream signals, including millimeter-wave, microwave, and baseband signals, are modulated based on multicarrier modulation using intensity modulator and subsequent optical filtering.

The 60 Ghz millimetre wave band has a great significance in the future wireless broadband communication systems [12].This unlicensed free spectrum can be utilized for meeting the tremendous growth of broadband technologies. Beas, Castanon et al. has discussed different optical millimetre wave generation techniques in [13]. Similar methods has been proposed in [14] by Yong, Chong et al. Ming Zhu , Liang Zhang et al. describe in their work [15] about the implementation of all-band and band-mapped RoF architectures for integrated broadband wireless services. It demonstrates the integration of multiple wireless signals, namely, Wi-Fi, WIMAX, and a 60 Ghz analog signal through a single RoF-WDM network. While the all-band architecture transmits the signals at their original carrier frequencies, the band-mapped architecture up-converts all the signals to 60 Ghz band and transmits them through a shared fiber network.

The simulation and analysis of the band-mapped architecture has been done here. The performance evaluation is done based on the BER plots, eye diagram, power level measurements, etc. The performance levels of the architecture for various transmission distances are also evaluated. Optisystem 13.0 and Matlab software are used for the simulation and analysis work.

The structure of this paper is as follows. Section 2 describes about the basic concept of the band-mapped architecture. The performance evaluation of the architecture is studied in Section 3. Section 4 describes the conclusion of the paper.

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BAND-MAPPED RoF ARCHITECTURE FOR THE INTEGRATION OF BROADBAND SIGNALS

The simulation and analysis of a RoF architecture designed with a backbone optical network unified with wireless interface is discussed here. The architecture is based on optical subcarrier multiplexing of OFDM modulated lower band RF signals as well as millimeter-wave signals. The system is proposed for wide deployment in indoor networks (LANs).

Band-mapped architecture is based on the mapping of the wireless signals and the millimeter-wave signals to four sub-bands in the 60 Ghz spectrum. The multiplexed signals undergo optical up-conversion to the 60 Ghz band (ie. they occupy the spectrum from 57 Ghz to 66 Ghz). Thus the 7 Ghz unlicensed spectra within the 60 Ghz band is utilized here. The band-mapped signals are demodulated at the BS to their original carrier frequencies by envelope detection or simple heterodyne demodulation techniques.

A simulation model of the architecture is shown in Fig. 1. The spectrum of the band-mapped 60 Ghz RoF signals is shown in Fig. 2.

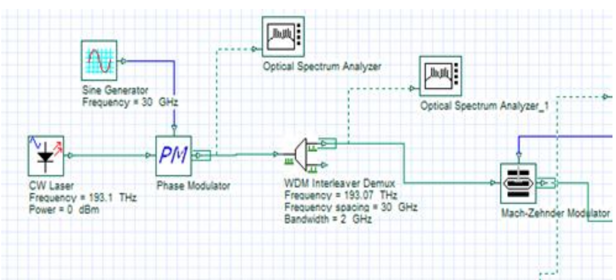

Fig 1: Simulation model of band-mapped architecture

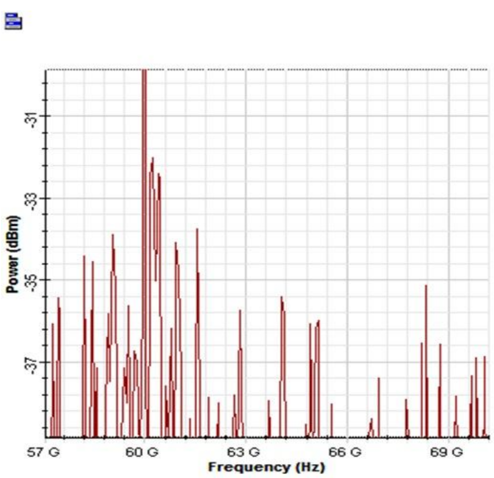

Fig 2: Spectrum of 60 Ghz band-mapped electrical signals

PERFORMANCE ANALYSIS OF BAND-MAPPED RoF ARCHITECTURE

Performance evaluation of the system for different transmission lengths was tested by varying the fiber lengths (indoor transmission distances) – 0.5 km, 5km, 10 km and 15 km. The system gives varied Q factor for each fiber lengths.

Table I summarizes the parameters of the band-mapped architecture for different transmission distances. It can be observed that as the transmission length of the fiber is increased to longer distances performance degradation takes place in the form of reduction in the Q factor and received power level. The eye height and the BER are also reduced due to longer transmission distances. This suggests that band-mapped architecture is suitable for indoor environments.

The eye diagram and BER response are evaluated for each of these transmission lengths. Fig. 3 shows the BER curves plotted for different fiber lengths.

The BER performance of the architecture for different transmission distances is shown in Fig. 4. Fig. 5 illustrates the variation of total received electrical power and optical power for different fiber lengths.

Table I: Parameters of band-mapped architecture for various transmission distances
(Transmitted optical power = -8.477 dbm)

Length of SSMF fibre (L)	Max Q factor	Min BER	Eye Height	Received power (dbm)
0.5 km	3.0627	0.00022824	-0.00156993	1.383
5 km	2.81214	0.00907356	-0.00196453	0.668
10 km	2.7330	0.00312666	-0.00048145	-0.756
15 km	2.3697	0.00901715	-0.00086719	-1.877

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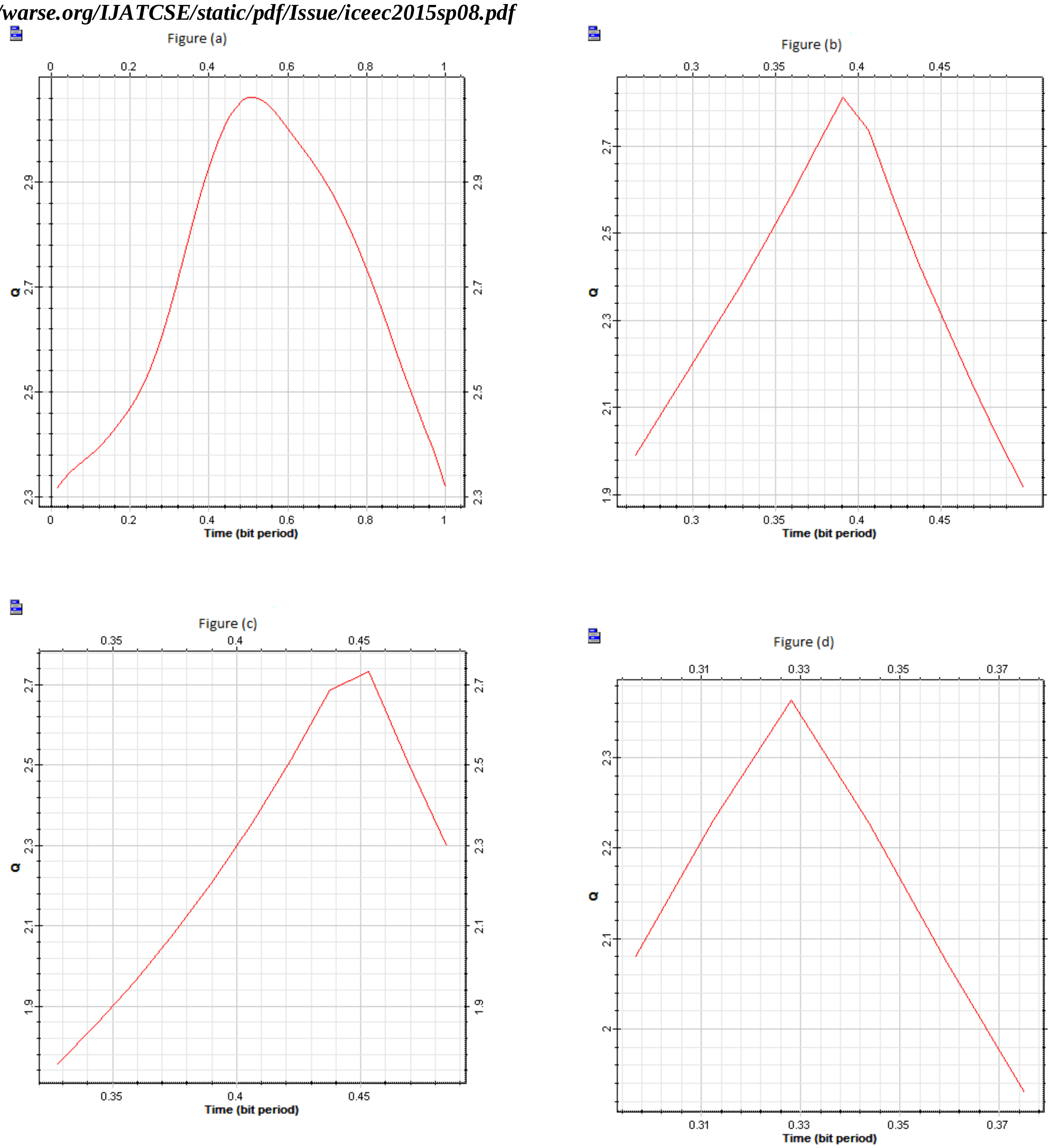

Fig 3: BER plot for transmission length 'L' of (a) 0.5 km (b) 5 km (c) 10 km (d) 15 km

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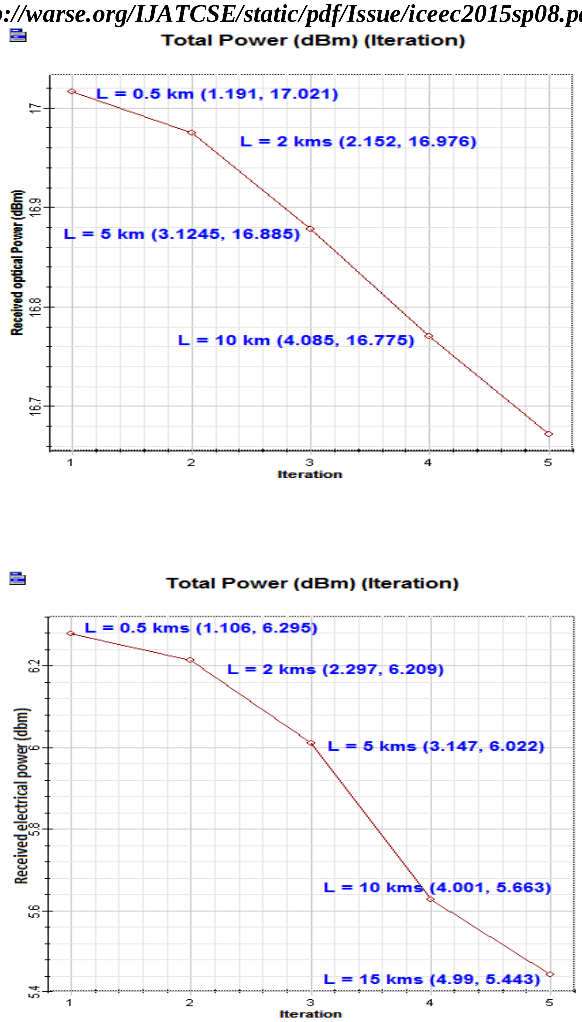

Fig 4: Variation of (a) received optical power (b) received electrical power for different transmission distances (L – length of fiber)

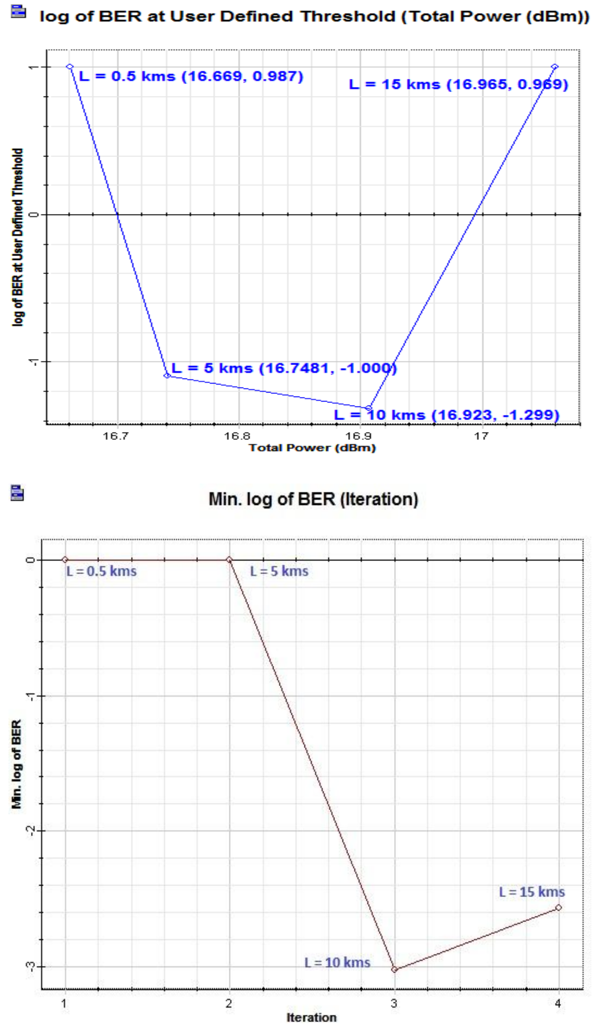

Fig 5 (a) and (b) : BER performance for different transmission distances (L – length of fiber)

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CONCLUSION

In this paper the work has been done mainly concentrating on the development of a RoF architecture for the integration of multiple wireless signals. In this architecture the signals which are electrically modulated by OFDM modulation are combined and optically modulated before transmission through the fiber network.

The architecture is designed for a SSMF transmission length of 10 km. This was further extended to shorter and longer distances - 0.5 km, 5 km up to 15 km and tested. The performance evaluation of the architecture for different transmission lengths and for different power levels of optical modulation is done. It was observed that the band-mapped architecture is most suitable for indoor RoF network applications.

REFERENCES

[1] M.S Rahman, J.h. Lee, Y.park, K.Kim, “Radio over Fiber as a Cost Effective Technology for Transmission of WiMAX Signals”, *World Academy of Science, Engineering and Technology*, vol. 3,Aug 2008.

[2] Kwansoo Lee, "Radio over Fiber for Beyond 3G ", Samsung Electronics Co.Suwon-city, Gyeonggi, 2011.

[3] M. Sauer, A. Kobyakov, and J. George, “Radio over fiber for picocellular network architectures,” *J. Lightw. Technol.*, vol. 25, no. 11, pp. 3301–3320, Nov. 2007.

[4] D. Wake, A. Nkansah, and N. J. Gomes, “Radio over fiber link design for next generation wireless systems,” *J. Lightw. Technol.*, vol. 28, pp. 2456–2464, 2010.

[5] Marianna Fabbri, Pier Faccin, Member, Via De Crescenzi, "Radio over Fiber Technologies and Systems: New Opportunities", ICTON , 2007.

[6] Anthony Ng’oma, “Radio-over-fiber Technology for Broadband Wireless Communication Systems," in Eindhoven University of Technology, June, 2005.

[7] Wake, Anthony Nkansah, Nathan J. Gomes, Guilhem de Valicourt, Romain Brenot, Manuel Violas, Zhansheng Liu, Filipe Ferreira, and Silvia Pato , "A Comparison of Radio Over Fiber Link Types for the Support of Wideband Radio Channels ", Journal Of Lightwave Technology, vol. 28, no. 16 , " August 2010.

[8] Y.T. Hsueh, Z. Jia, H.-C.Chien, A. Chowdhury, J. Yu, and G.-K. Chang, “Generation and transport of independent 2.4 GHz (Wi-Fi), 5.8 GHz (WiMAX), and 60-GHz optical millimeter-wave signals on a single wavelength for converged wireless over fiber access networks,” in *Proc. Opt. Fiber Commun. Conf. / Nat. Fiber Opt. Eng. Conf.,* San Diego, CA, USA, 2009, paper OTuJ1.

[9] Y.T. Hsueh, M.-F.Huang, S.-H.Fan, and G.-K. Chang, “A novel lightwave centralized bidirectional hybrid access network: seamless integration of RoF with WDM-OFDM-PON,” *IEEE Photon. Technol. Lett.*, vol. 23,no. 15, p. 1085, 1087, Aug. 1, 2011.

[10] W.-J. Jiang, C.-T.Lin, P.-T.Shih, and L.-Y. W. He, “Simultaneous generation and transmission of 60-GHz wireless and baseband wireline signals with uplink transmission using an RSOA,” *IEEE Photon. Technol. Lett.*, vol. 22, no. 15, pp. 1099–1101, Aug. 1, 2010.

[11] Y.T.Hsueh, Z. Jia, H.-C.Chien, J.Yu, and G.-K.Chang, “A novel bidirectional 60-GHz radio-over-fiber scheme with multiband signal generation using a single intensity modulator,” *IEEE Photon. Technol. Lett.*, vol. 21,no. 18, pp. 1338–1340, Sep. 15, 2009.

[12] R. C. Daniels and R. W. Health, “60 GHz wireless communications: emerging requirements and design recommendations,” *IEEE Veh. Technol.Mag.*, vol. 2, no. 3, pp. 41–50, Sep. 2007.

[13] Beas, J., Castanon ,G. , Aldaya, I. , Aragon-Zavala, A. ,Campuzano, G.,“Millimeter-Wave Frequency Radio over Fiber Systems: A Survey”, *IEEE Comm. Surveys*, vol. 15, no. 04, pp. 1593–1619, 2013.

[14] S.K. Yong, C.C Chong, “An Overview of Multigigabit Wireless through Millimeter Wave Technology: Potentials And Technical Challenges”, *Research article, EURASIP Journal on Wireless Communications and Networking*, vol. 2007.

[15] Ming Zhu , Liang Zhang , Jing Wang ,Lin Cheng ,Chen Liu ,Gee-Kung Chang , “Radio-Over-Fiber Acces Architecture For Integrated Broadband Wireless Services”, *J.Lightw.Technol.*, vol. 31, no. 23, pp. 3614-3620, Dec. 2013.