Performance Analysis Of OFDM Based RoF System

Arunima S Kumar, Arya S Mohan,Anju B,Archana S Babu,Jijo Jose, Mithun Vijayan

Abstract— The growth of wireless data systems is seen in the many new standards which have recently been developed or currently in under development. The two major development trends of communication are broadband and wireless, and the existing wireless communication system cannot carry high-speed multimedia service signals because of limited bandwidth, so how to realize high-speed wireless access has become a key problem. The continuing increase in customer demand for broadband applications coupled with mobile cellular and personal communications has also becoming a global phenomenon. One of the solutions is radio over fiber (RoF), alternatively known as Hybrid Fibre Radio (HFR), where millimeter-wave (mm-wave) or microwave signals at the carrier frequency are delivered over an optical network from a central station (CS) to base stations (BSs). This technology combines two media: radio and optical. Typically, the optical part is used to interconnect a central radio processing facility with a remote radio antenna, the latter providing coverage to wireless broadband users. Some of the advantages offered by a RoF system include low signal attenuation (in the fibre), improved coverage and system performance, enhanced capacity, low RF power dissipation, reduced complexity due to the centralised processing of RF signals and ultimately low system costs. In recent, Orthogonal Frequency Division Multiplexing (OFDM) is an emerging technology for high data rates at particular new and upcoming mobile generation and fixed broadband. OFDM is a multicarrier transmission; it congenial for frequency channel selection with high data rates. This technique transforms a frequency selective with wide band channel into a group of non-selective narrowband channels, which make large orthogonality in frequency domain.

The OFDM through RoF system is to increase modulation technique and it overcomes various limitation of the wireless transmission such as electrical power attenuation, chromatic dispersion and phase modulation through the optical link. The combination of system has many advantages for future high speed data transmission system. The organization of paper includes an overview of OFDM system, RoF technique and combination of RoF-OFDM. And to analyze the implementation of RoF-OFDM system and various parts of the Radio over Fibre system which is designed for various no: of channel counts and simulated at various power levels with the help of software optisystem. And results are analyzed on the basis of Q factor, BER.

Index Terms — BER, CAPC DSB, OFDM, Optisystem , Q Factor, RoF, SDDPMZM.

1 INTRODUCTION

The concept of broadband communication has caught on very well. As fibre penetrates closer to the end-user environment, wired transmission speeds will continue to rise. Transmission speeds such at 100 Mbps (Fast Ethernet) are now beginning to reach homes. The demand to have this broadband capacity also wirelessly has put pressure on wireless communication systems to increase both their transmission capacity, as well as their coverage.[1]

Therefore, one natural way to increase capacity of wireless communication systems is to deploy smaller cells . This is generally difficult to achieve at low-frequency microwave carriers, but by reducing the radiated power at the antenna, the cell size may be reduced somewhat. Another way to increase the capacity of wireless communication systems is to increase the carrier frequencies, to avoid the congested ISM band frequencies. Higher carrier frequencies offer greater modulation bandwidth, but may lead to increased costs of radio front-ends in the BSs and the MUs/WTUS.

Smaller cell sizes lead to improved spectral efficiency through increased frequency reuse.But, at the same time, smaller cell sizes mean that large numbers of BSs or RAPs are needed in order to achieve the wide coverage required of ubiquitous Communication systems. Furthermore, extensive feeder net works are needed to service the large number of BSs/RAPs. Therefore, unless the cost of the BSs/RAPs, and the feeder network are significantly low, the system-wide installation and maintenance costs of such systems would be rendered prohibitively high. This is where Radio-over-Fibre (RoF) technology comes in. It achieves the simplification of the BSs/RAPs (referred to as Remote Antenna Units – RAUs) through consolidation of radio system functionalities at a centralised headend, which are then shared by multiple RAUs. In addition, a further reduction in system costs may be achieved if low-cost multimode fibres are used in the extensive feeder network.

2 RADIO OVER FIBRE TECHNOLOGY

Radio over Fiber system is very attractive technique for wireless access network, because it can transmit microwave and millimeter wave through optical fiber for long and short distance. It is also possible to support WLAN and current 4th generation mobility network. Radio over Fiber system, it is the integration of RF and optical network and it increase channel

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capacity of mobility and application systems, as well as decreasing cost and power consumption. This system provide radio access has a number of applications to merge in the recent and next generation wireless systems includes Central Site (CS) and Base Stations (BS) connected to an optical fiber link, and signal is transmitted between CS and BS in the optical band through RoF network. to deploy small, low-cost remote antenna units and ease of upgrade for future explore. It reduces the deployment and maintenance costs of wireless networks while providing low power consumption and large bandwidth for very attractive technique in the wireless access. In addition, RoF technology enables such as macro-diversity for handover. The block diagram of RoF as shown in the following Fig. 1.

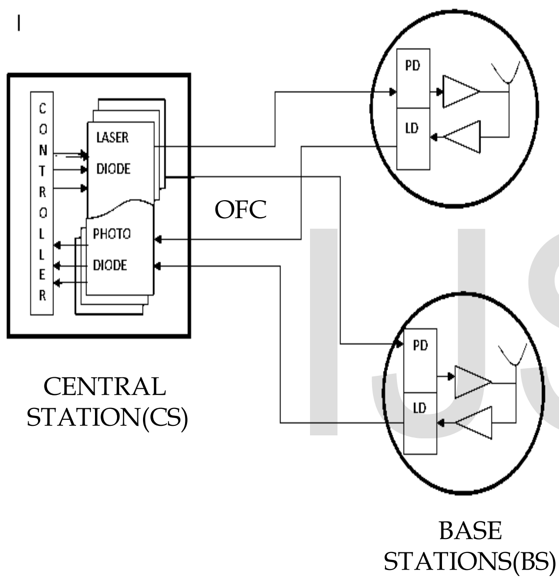


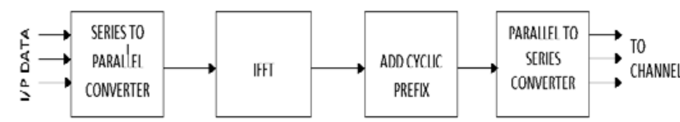
Fig 1: Block Diagram of RoF

The RoF technology compared with electronic signal distribution have some of the merits that they have low attenuation loss,large bandwidth,immunity to radio frequency interference,easy installation and maintenance,reduced power consumption,multi operator and multi service operation and dynamic resource allocation.

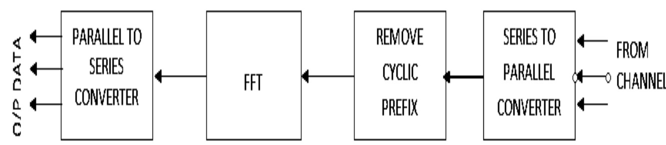
In this paper we are discussing about some of the problems in the RoF and how to overcome.The main problems are selective frequency fading, optical adjacent channel interference (O-ACI), intersymbol interference and inter block interference.

3 Orthogonal Frequency Division Multiplexing (OFDM)

OFDM is a subset of frequency division multiplexing in which a single channel utilizes multiple sub-carriers on adjacent frequencies. The sub-carriers in an OFDM system are overlapping to maximize spectral efficiency. Ordinarily, overlapping adjacent channels can interfere with one another. However, sub-carriers in an OFDM system are precisely orthogonal to one another. Thus, they are able to overlap without interfering. As a result, OFDM systems are able to maximize spectral efficiency without causing adjacent channel interference [2],[3],[4].The block diagram of OFDM is shown in the following Fig. 2.



Transmitter Side Of OFDM



Receiver Side Of OFDM

Fig 2: Block Diagram Of OFDM

OFDM sub carriers do not interfere with each other as they are orthogonal to each other. It can be used for high-speed multimedia applications with lower service cost[5].It tran mit a high-speed data stream by dividing it into multiple low-data-rate subcarriers.It support dynamic packet access and integrated with smart antenna.High spectrum efficiency can be achieved by OFDM with overlapped subcarrier arrangement, so the system capacity can be greatly increased.The selective frequency fading in the RoF system can be removed by using the OFDM.

4 Optical Adjacent Channel Interference (O-ACI)

Considering a unified schematic diagram of the wavelength reuse RoF systems based on carrier re-modulation, shown in Fig.3. In downlink, the modulation signal with the subcarrier frequency of $f1$ is modulated on the optical signal and transmitted to BS. In uplink, the modulation signal with the subcarrier frequency of $f2$ is re-modulated on one part of the downlink optical signal and transmitted to CS. Because of the re-modulation, the received signal in CS actually contains four microwave components: $f1$, $f2$, $2f1 - f2$, and $2f2 - f1$. When the system works for multi-channel wireless communication, the new generated microwave components $2f1 - f2$ and $2f2 - f1$ would generate adjacent channel interference. This is called optically generated ACI (O-ACI) [6].

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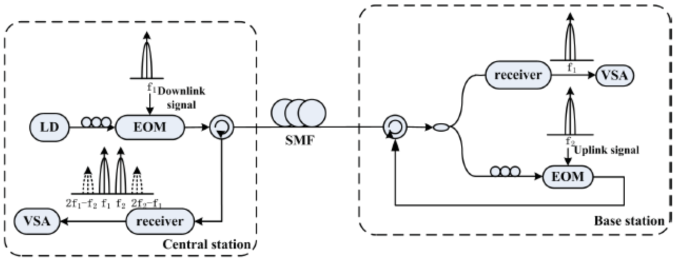

Fig 3. Wavelength Reuse RoF System based on re-modulation of carrier

The O-ACI issue due to the re-modulation of downlink optical signal in wavelength-reuse multi-channel RoF systems can be reduced by a carrier amplitude-phasecontrol double sideband (CAPC-DSB) modulation [6] and can be implemented using Dual Parallel Mach Zender Modulator (DPMZM).

4.1 Single Drive Dual Parallel Mach Zender Modulator (SDDPMZM)

Mach-Zehnder modulators (MZM) is generally treated as an electrical-to-optical (EO) converter. Special utilizations of the MZM can achieve linearization or dispersion compensation, and even resolve both the issues simultaneously.By controlling the phase and amplitude of the optical carrier, the phase and amplitude relationship between the carrier and the si bands can be altered accordingly.The structure of an SD DPMZM is shown in Fig. 4. There are three MZMs in the modulator: MZM-1 and MZM-2 are the sub-modulators, where MZM-1 is driven by radio frequency (RF) signal $V_E(t)$ and dc-bias $V1$, MZM-2 is driven by dc-bias $V2$. These two sub-modulators act as the two arms of the parent modulator, MZM-3. A dc-bias $V3$ controls the phase relationship of these two sub-MZMs. By properly biasing the MZM modulators the SDDPMZM can generate RF signal which can cancel the signals that cause O-ACI.[7]

- *Arunima S Kumar is currently pursuing bachelors degree program in electronics and communication engineering in UKF College of Engineering and Technology,Kerala,India, E-mail: arunimaskumar05.as@gmail.com*
- *Arya S Mohan is currently pursuing bachelors degree program in electronics and communication engineering in UKF College of Engineering and Technology,Kerala,India*
- *Anju B is currently pursuing bachelors degree program in electronics and communication engineering in UKF College of Engineering and Technology,Kerala,India*
- *Archana S Babu is currently pursuing bachelors degree program in electronics and communication engineering in UKF College of Engineering and Technology,Kerala,India*
- *Jijo Jose is currently working as Assistant Professor in Electronics and Communication engineering in UKF College Of Engineering And Technology,Kerala,India,. E-mail: jijojosekpza@gmail.com*
- *Mithun Vijayan is currently working as Assistant Professor in UKF College Of Engieerning and Technology,Kerala,India, E-mail:mithunv88@yahoo.com*

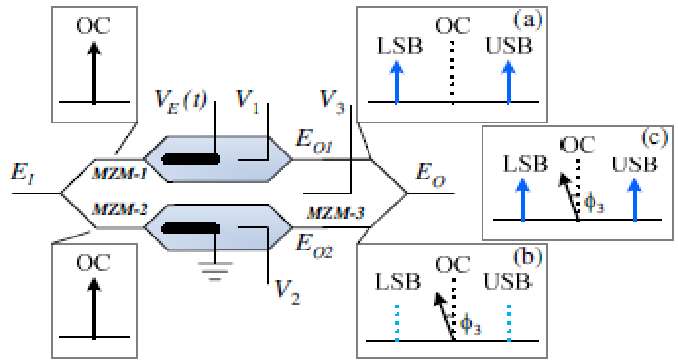

Fig 4. Basic Structure Of Single Drive Dual Parallel Mach Zender Modulator

5 RoF-OFDM WIITH SDDPMZM

The combination of OFDM and RoF system (OFDM-RoF) has considered for future broadband wireless communication. The RoF system considers higher speed and long distance than other system. OFDM-RoF system model can divided into two parts that is RF OFDM transmitter and RF OFDM receiver. Also to avoid the O-ACI, here we are using a SDDPMZM at the transmitter side.Below diagram Fig 5 shows the basic building blocks.

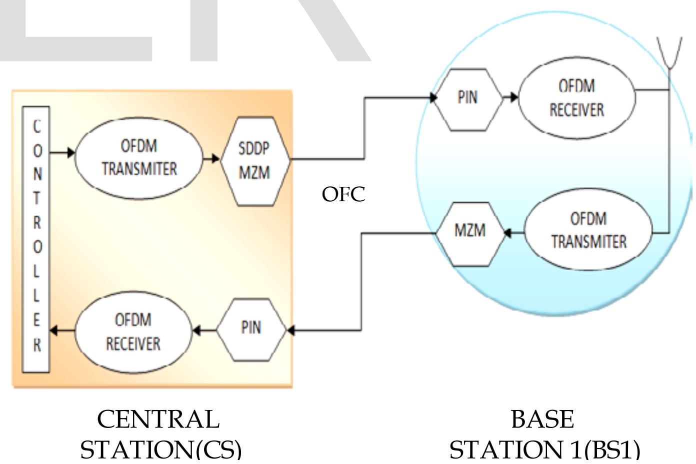

Fig 5. OFDM-RoF System Model with SDDPMZM

6 PlatForm - Opti System

Optical communication systems are increasing in complexity on an almost daily basis.The design and analysis of these systems, which normally include nonlinear devices and non-Gaussian noise sources, are highly complex and extremely time-intensive. As a result, these tasks can now only be per-

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formed efficiently and effectively with the help of advanced new software tools. OptiSystem is an innovative optical communication system simulation package that designs, tests, and optimizes virtually any type of optical link in the physical layer of a broad spectrum of optical networks, from analog video broadcasting systems to intercontinental backbones.

OptiSystem is a stand-alone product that does not rely on other simulation frameworks. It is a system level simulator based on the realistic modeling of fiber-optic communication systems. It possesses a powerful new simulation environment and a truly hierarchical definition of components and systems. Its capabilities can be extended easily with the addition of user components, and can be seamlessly interfaced to a wide range of tools [8].

7 Simulation Using Opti System

Various analysis tools are available in OptiSystem library and used in this project to do the simulation. The generation of OFDM-RoF with SDDPMZM system consists of modulator and demodulator using optisystem software is shown in Fig. 6 and the blocks are explained below.

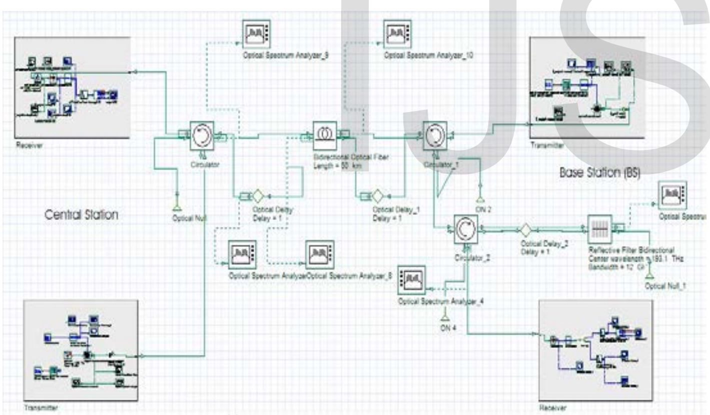


Fig 6. OptiSystem Simulation Model of RoF OFDM with SDDPMZM

7.1 RoF Central Station Model Section

The central station link is part of implementation of this RoF system network where the signal modulation from OFDM-RoF transmitter would be sent through the optical link to the base station and the data from the base station is received by the OFDM receiver in the cenral station. Basically it act as feeder network for up gradation of existing wireless network connects between the transmitter unit and receiver system, which is capable of supporting data rates of the order of Gbps.

The CS consist of both transmitter and receiver section.In the transmitter side of CS where the Single Drive Dual Parallel Mach Zender Modulator is placed inorder to remove the optical adjacent channel interference.The datas are then transmitted through the optical fiber cables which is the channel here and then fed to the BS.And also the datas from the BS is received by the receiver in the CS.The transmitting and receving section consist of OFDM transmitter and receiver,PIN, SDDPMZM,data generator.

7.2 RoF Base Station Model Section

An exact of the CS is performed at the BS.In BS also there is a transmitter and a receiver section. Then the data were received back from the optical link in OFDM demodulation or OFDM receiver part. In this simulation,the datas from the CS is received by the OFDM receiver at the BS and transmitted through the antenna and the datas from the BS is transmitted back to the CS by using the same OFDM transmitter and MZM through the same Optical Fibre Cable

7.3 Implementation Using OptiSystem

In OptiSystem there are various tools are used to obtain the OFDM-RoF model with SDDPMZM.The OFDM transmitter and receiver is implemented with the help of the MatLab Component.The MatLab component helps in accesing the matlab program of OFDM transmitter and receiver and to get it implemented.Circulators, SDDPMZM, Bidirectional Optical Fibre Cable, PIN, CW Laser etc are present in the component library of the OptiSystem which is incorporated in the simulation. System performance is predicted by calculating BER and Q-Factor using numerical analysis or Semi-analytical techniques for systems limited by inter symbol interference and noise. Advanced visualization tools produce OSA Spectra, Oscilloscope, and Eye diagrams.Simulations is repeated with an iteration variation of the parameters.

8 Results

Below shows the graph of BER value with respect to Bias Voltage Fig 7, and Fig 8, shows the graph of Q Factor with respect to the bias voltages.

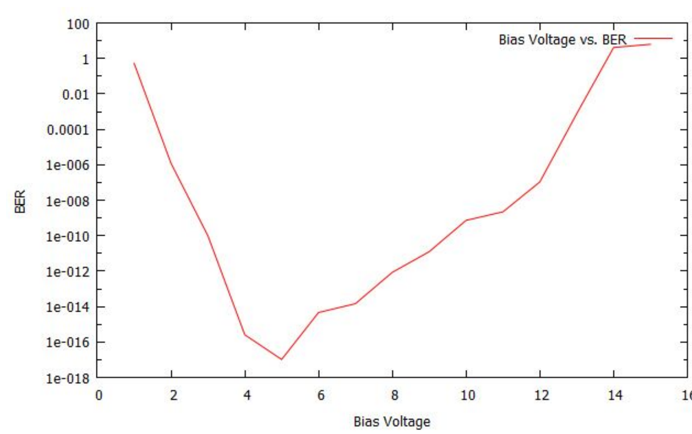
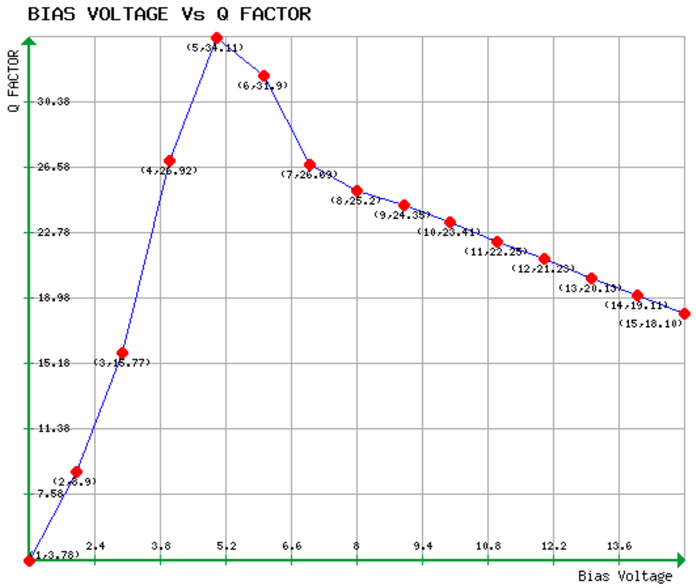


Fig 7.Graph showing BER with respect to the Biasing Voltage of SDDPMZM



7 Conclusion

The OFDM-RoF with SDDPMZM system has been analysed. RoF system has many applications for wireless and mobile communication technologies. In this paper we conclude the modulation technique of OFDM to implement RoF system for increasing high bandwidth, low attenuation, frequent subcarrier allocation and low BER at the different modulation technique and avoided the O-ACI by using the SDDPMZM.The graphs indicating that at a certain value of the bias voltage, we are getting minimum BER rate and OSNR value.That particular voltage bias suppresses the O-ACI. It expected that this study will use for further research and development of newer OFDM technology in RoF for wireless and broadband communications.

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