WDM-OFDM-PON to Enhancing Band Width in High Speed Communication Systems

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Abstract

We give an account of a wavelength division multiplexed-orthogonal frequency division multiplexed-passive optical net-work (WDM-OFDM-PON), using a tunable mode bolted brush source for downstream transmission. The 10 brush tones are separated by 10GHz and modulated by 12.75 GB/s compatible single side band (SSB) OFDM signal. Transmission over 50 km and 87 km of standard single mode fiber was successfully demonstrated. The average spectral efficiency of 1.12 and 1 bit/s/Hz were obtained in conjunction with the use of low complexity electronics. Relative to the back-to-back case the penalties after transmission over 50km were 1dB at a bit error rate (BER) of of 3 × 10−3 this indicates improved efficiency in transmission. All channels after 87km transmission achieved performance below the 20% forward error correction (FEC) limit.

Index Terms: *Arbitrary waveform generator (AWG),Brush source, Multi-carrier transmitter, orthogonal frequency division multiplexing (OFDM), passive optical networks (PON),.*

I. INTRODUCTION

Interest for data transmission hints at no decreasing and is pushing administration suppliers to convey whole deal, metro and access systems with expanded limit. Wavelength division multiplexing (WDM) innovation has been effectively used to extend limit in these optical systems and meet increasing data transfer capacity requirements. As of late, orthogonal frequency division multiplexing (OFDM) has attracted in much research enthusiasm as an issue strategy because of its high spectral efficiency coupled with its capacity to defeat the impacts of chromatic scattering [1]. High otherworldly effectiveness is an outcome of the covering of subcarriers, whilst self-assertive measures of scattering can be taken care of by utilizing a cyclic prefix (CP) which encourages the development of a basic greatest probability equalizer in the recurrence space. The utilization of OFDM in optical access systems has been widely researched as of late for both down-stream (DS) and upstream (US) information transmission all things considered frameworks give high devoted data transfer capacity to the client [2], [3]. Taking into account the framework prerequisites, different arrangements, for example, utilizing a solitary OFDM transporter for every client, to assigning a wavelength to every client have been proposed. In a large portion of these proposed WDM-OFDM-PON arrangements, single side-band (SSB) OFDM modulation created by optical filtering of a twofold side-band (DSB) OFDM signal at the transmitter [3]–[5] is utilized together with immediate identification for downstream transmission. DSB OFDM experiences chromatic scattering induced power fading [6], [7] and obliges a bigger dispersing between optical bearers in a WDM-PON situation contrasted with SSB OFDM signals. Be that as it may, a standard SSB OFDM signal era builds the expense of the simple gear as an issue optical channel is ordinarily needed to dispense with one of the side-groups at the transmitter. The good SSB OFDM tweak method [8]–[11] defeats the weaknesses of both routines said above. Nonetheless, the high bearer to-flag degree, which is a property of power balanced OFDM flag, for example, good SSB OFDM, makes these frameworks defenseless against optical noise [10] and obliges the utilization of optical brush sources which show incredible sign to noise ratio on each one brush line.

In this paper, we show surprisingly, downstream transmission of good SSB OFDM in a WDM-PON where a tunable mode-locked laser (TMLL) is utilized as an issue bearer transmitter. Ten brush tones, divided by 10 GHz, are separated from the TMLL brush and each one tone is modulated with a 12.75 G b/s SSB OFDM signal. The execution of the framework is evaluated under consecutive (B2b) and standard single mode fiber (SSMF) transmission situations (50 and 87 km). Results got show superb execution of the proposed framework with short of what a 1 db punishment at a bit error rate (BER) of 3 × 10−3 after 50 km transmission contrasted with the B2b case. Besides, BER estimations after 87 km transmission without inline intensification demonstrate that all the channels accomplished execution underneath the 15% FEC.

II. EXPERIMENTAL SETUP

The exploratory setup utilized for the WDM-OFDM-PON framework is demonstrated in Fig. 1. The optical line terminal (OLT) comprises of a wavelength tunable mode bolted semiconductor laser. A 10 GHz sinusoidal signal, got from a signal generator, is opened up and connected to the TMLL to accomplish dynamic mode locking. The ghastly yield from the effectively mode bolted TMLL is a recurrence brush comprising of about 40 tones divided by 10 GHz, which display unearthly swell of 10 db.

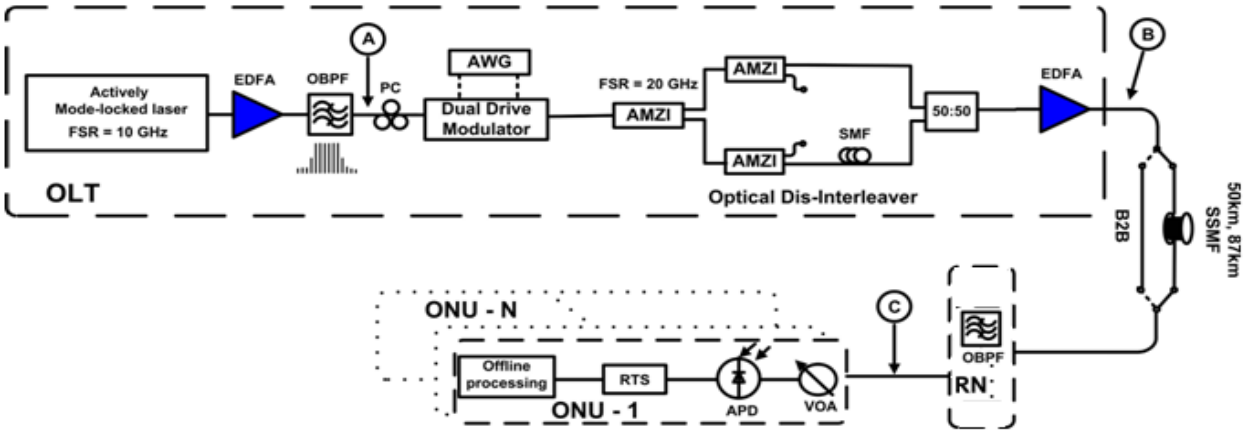


Fig.1. Schematic of the Experimental Setup

Tunability in free spectral range (FSR) of the utilized TMLL is restricted (9–11 GHz). A transmission capacity and wavelength tunable optical channel is then used to choose 10 brush tones, differentiated from one another by 10 GHz, which display an spectral ripple of less than 3 db. An Erbium doped fiber Amplifier (EDFA) is utilized to beat the loss of the channel. In field establishments, the produced brush lines would be divided by a de-multiplexer and every individual channel would be regulated freely. Notwithstanding, in this experiment every one of the 10 brush tones are adjusted by a solitary double drive Mach-Zehnder modulator (DD-MZM). The DD-MZM is biased at the quadrature point and afterward balanced with a good SSB OFDM signal waveform [8]–[11] got from a subjective waveform generator (AWG).

The 12.75 Gb/s perfect SSB OFDM sign is composed of 77 subcarriers with 16QAM balance arrange on every subcarrier, and an OFDM image rate of 39.06 MHz. The consolidation of the 7% (50 km transmission) or 20% (87 km transmission) forward error correction (FEC) overhead together with a cyclic prefix length of 6.25% of the IFFT size (which has 256 inputs) gives a net information rate of 11.2 Gb/s and 10 Gb/s, separately. The aggregate data transfer capacity of the sign is around 5 GHz.

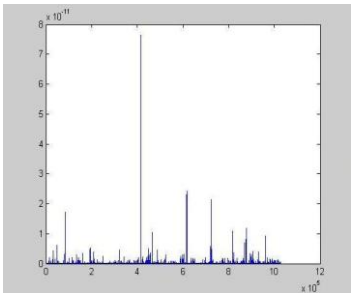
The balanced signal is then passed through a set of tunable fell dis-interleavers focused around unbalanced Mach Zehnder interferometers (AMZI), with a FSR of 20 GHz. The dis-interleaver differentiates the 10 optical brush tones into odd and even sub-channels with a 40 db extinction ratio. The 5 even channels are hence passed through a 5 m de-relationship fiber patch cord, and afterward inactively joined with the 5 odd channels. The consolidated signs are then optically intensified with an EDFA which works in steady power mode, before being portrayed by measuring the BER as an issue of the got optical power under B2b and, 50 and 87 km SSMF transmission situations. At the remote hub (RN) the wanted channel is separated with a slender optical band-pass Filter (OBPF).

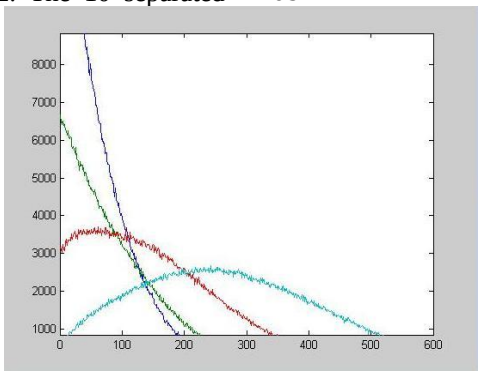
In a pragmatic situation, a proper de-multiplexer would be utilized rather than a solitary optical channel. Contingent upon framework prerequisites, a solitary wavelength can be committed for every client, or further partitioned among clients after discovery. The separated channel is recognized inside the optical system unit (ONU) by utilizing a 10 GHz recipient that comprises of a torrential slide photo detector (APD) and a coordinated trans-impedance enhancer (TIA). The got signal is caught with an ongoing oscilloscope working at 50 Gsa/s. Computerized preparing of the got signal and bit error rate estimations are performed logged off utilizing Mat lab

III. RESULTS AND DISCUSSION

The high transporter to-flag proportion is a property of force regulated OFDM signals, for example, perfect SSB OFDM. The high power in the transporter in respect to the signal is determined by peak-to-average-power ratio (PAPR) of the OFDM signal [8]. With a specific end goal to guarantee the straight operation of a MZM, a little tweak record of the data signal is obliged, which will result in that flag sideband to have much lower power than that of the bearer. Subsequently, such frameworks will be more defenseless against optical clamor [10]. Thusly, the decision of an ideal optical multi-transporter source, (for example, the TMLL) which displays a high signal to noise ratio (~55 db) on each one unmodulated line can guarantee great execution of the framework. Optical spectra at diverse stages are demonstrated in Fig. 2. The 10 separated brush tones are indicated in Fig. 2 (measured at point An in Fig. 1), whilst the sign after adjustment (at point B in Fig. 1) is displayed in Fig. 2. This figure unmistakably outlines the good SSB balance and high bearer to-flag degree and also Fig. 2 portrays one separated channel at the beneficiary before identification (point C on Fig. 1). Fig.3 shows efficiency of WDM-OFDM compatible network in this figure sky blue colored waveform indicates half power transmission and violet color waveform indicates full powered transmission.fig. 4 indicates SSB transmission spectrum of available signal power.

The got trial results are exhibited in Fig. 5. In both cases, B2b and 50 km SSMF transmission, the force at the collector is constrained, with the support of a variable optical attenuator (VOA), to a greatest of −15 dbm





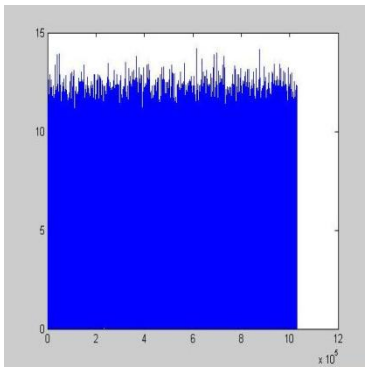


Fig.2 single brush tone indication. Fig.3 efficiency of WDM-OFDM compatible network. Fig. 4 SSB transmission spectrum power.

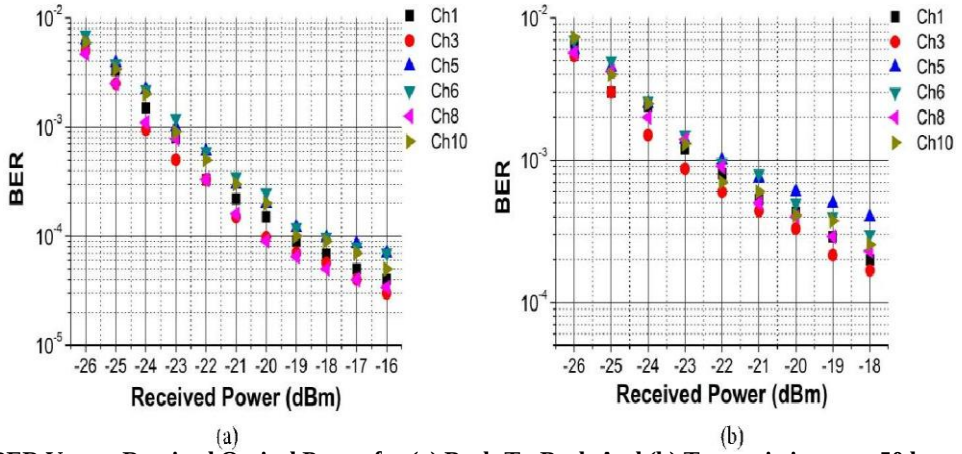


Fig. 5. BER Versus Received Optical Power for (a) Back-To-Back And (b) Transmission over 50 km of SSMF.

To the low saturation power of the APD. In both B2b and 50 km transmission cases, the center channels show more regrettable execution contrasted with external channels for the most part because of the higher cross-talk. In any case, the force punishment between the external channels can be described to the force asymmetry of the recurrence brush and the obstruction from the non-conceivably smothered undesirable sidebands amid de-relationship. The optical band-pass channel at the recipient is advanced to get the best execution for the craved channel, i.e. discovering an ideal level between transporter to-flag degree and concealment of neighboring channels. The measured ideal bearer to-flag degrees are in the reach 4–5 db,

which is lower than for a solitary channel case [10], [12] because of solid optical separating that is done to minimize the obstruction from contiguous channels. Fig. 4 shows star groupings for the third direct (Ch3 in Fig. 3) measured for different got controls in the B2b and 50 km situations. Good SSB WDM-OFDM-PON demonstrates short of what 1 db power punishment at a 7% FEC limit (BER = 3 × 10 −3) after transmission in excess of 50 km SSMF contrasted with the B2b case, for all channels. Apparently, impacts of transmission weaknesses on the proposed framework are low.

This is somewhat because of the way that dispersive blurring is unimportant for SSB OFDM signals. Besides, the optical dispatch control (12 dbm and 15 dbm for 50 km and 87 km transmission individually) to avoid significant non-linear distortions. Framework performance after transmission in excess of 87 km of SSMF is further investigated and results acquired are given in Fig. 5. The BER of each one channel is measured at a got force of −28 dbm because of the extra power misfortune created by the amplified fiber trans-mission. Nonetheless, the results got demonstrate that a BER beneath the 20% FEC limit (BER=1.48• 10−2) [13] is accomplished on all channels. The restricted transmission capacity of the OFDM signal (∼3 GHz) and a channel separating of 10 GHz give sufficient dividing to upstream information transmission. One conceivable arrangement, which would give productive utilization of the accessible data transmission, would be to utilize minimal effort tunable lasers [14], [15] at the Onus. Considering the admissible level of intricacy, the wanted transmission separation, and the obliged baud rate at every ONU, an ideal tweak group with a maximum ghastly data transfer capacity of 5 GHz could be picked, and the upstream information could be set between two downstream channels.

Another solution which can enable symmetric WDM-OFDMA-PON [16] can be realized by providing guard bands between DS and US signals. In such a scenario, a TMLL located at the OLT or RN can be used for US data transmission, at an offset wavelength relative to the TMLL used for DS transmission. At the ONUs, the compatible SSB-OFDM adequately defeats the inconveniences connected with DSB OFDM; in particular the scattering affected force blurring impact which is immaterial for this situation. Besides, the multifaceted nature of simple gear needed for the era of standard SSB OFDM sign is lessened. An answer where one wavelength can serve one or various clients focused around prerequisites has been proposed, and additionally conceivable answers for upstream transmission. A force punishment of short of what 1 db at a BER = 3•10−3 has been measured after 50 km transmission over SSMF. Transmission in excess of 87 km is likewise explored and the results acquired demonstrate the capability of the proposed strategy. It ought to be noted that the utilization of higher pace hardware or the lessening of the TMLL FSR can be utilized to further improve the otherworldly productivity of the proposed framework. OFDM signal would be modulated onto the optical carrier by the DD-MZM.

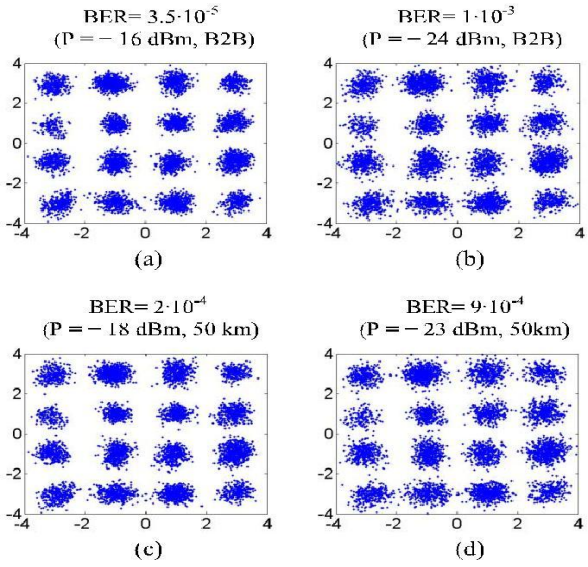


Fig. 4. Constellations Obtained for the 3 rd Channel For Various Received Powers in the B2B and 50km Scenarios a)BER=3.5.10^{-3} (P= -16dBm,B2B),b)BER=3.1.10^{-3} (P = -23dBm,50Km)

IV.CONCLUSION

A methodology for frightfully effective transmission of optical OFDM signals utilizing a multi-bearer transmitter has been displayed. Force tweaked OFDM signs, for example, good OFDM, show high bearer- to-flag degree which makes these frameworks powerless against optical noise and breaking points use of optical multi-transporter transmitters. In this paper, we utilized shockingly, a TMLL as an issue bearer transmitter in a WDM-OFDM-PON utilizing good SSB OFDM for downstream information transmission. Good SSB-OFDM adequately defeats the inconveniences connected with DSB OFDM; in particular the scattering affected force blurring impact which is immaterial for this situation. Besides, the multifaceted nature of simple gear needed for the era of standard SSB OFDM sign is lessened. An answer where one wavelength can serve one or various clients focused around prerequisites has been proposed and additionally conceivable answers for upstream transmission. A force punishment of short of what 1 db at a BER = 3•10−3 has been measured after 50 km transmission over SSMF. Transmission in excess of 87 km is likewise explored and the results acquired demonstrate the capability of the proposed strategy. It ought to be noted that the utilization of higher pace hardware or the lessening of the TMLL FSR can be utilized to further improve the otherworldly productivity of the proposed framework.

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