



Simulative Comparison of 40 Gbps OTDM Transmission System operating at S-band and C-band over ITU G.653

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Abstract: Optical Time Division Multiplexing (OTDM) is a promising alternative to Wavelength Division Multiplexing (WDM) in order to achieve high capacity optical network and large distances. In this paper, different dispersion compensation techniques has been compared using ITU G.653 fiber on 40 Gbps OTDM system operating at C-band and S-band. The dispersion compensation is done using Dispersion Compensating Fibers (DCF). 40 Gbps OTDM transmission system achieved maximum transmission distance of 1200 km over ITU G.653 using symmetrical dispersion compensation with acceptable bit error rate of 2.39×10^{-9} and Q value of 5.95 dB.

Keywords: OTDM, ITU G.653, S-band and C-band

I. INTRODUCTION

The predicted growth in the demand for new challenges to modern communication such as an expanded internet and increasing the bandwidth of optical fiber communication systems has been a challenge. Capacity can be increased by enhancing the bit rate of already existing channels using time division multiplexing (TDM). OTDM is more economic than WDM. Also narrow-band erbium-doped fiber amplifiers (EDFA) works better and do not need to be replaced by broadband amplifiers [1]. As the bit rate increases, dispersion limits the transmission to a few kilometres over standard fibre. 40 Gbps OTDM transmission over 111 km installed G.652 fibre has been demonstrated experimentally using dispersion-compensating fibre or fibre gratings [2]. The first field trial of 40Gbit/s OTDM transmission over 140km of standard fibre using midspan spectral inversion for dispersion compensation was achieved[3]. The investigations on the usefulness of SMF for single-channel 40 Gb/s transmission at 1.55µm have been demonstrated experimentally [4], also compared to DSF and NZDF [5]. Dispersion shifted fiber has a dispersion-zero point located near 1.55 µm which enables transmission in EDFA gain regimes and fiber-loss-minimum [6]. The performance evaluation of erbium doped fiber amplifier (EDFA) using standard erbium doped fiber in S-band has been done [7]. Upto this moment, the work on 40 Gbps OTDM system on C-band has been observed. This paper demonstrates the performance comparison of 40 Gbps OTDM transmission operating on S-band and C-band. After the introduction, block diagram of 40Gbps OTDM is explained in Section II. Section III simulation set up of dispersion compensation techniques which is followed by

results and conclusion in Section IV and Section V respectively.

II. SYSTEM DESCRIPTION

The block diagram of 40Gbps OTDM system is shown in Fig.1. The transmitter comprises of a amplitude modulator pseudo-random bit sequence (PRBS) generator, continuous wave (CW) laser diode, an electrical RZ pulse generator, optical time delay blocks and optical MUX. Four channels from a CW laser are RZ modulated with a different PRBS patterns. The PRBS block generates multiple pattern outputs, each different from the other and at a bit rate 10Gbps. All the channels from CW laser are operating at same wavelength of 1552nm and 1460 nm. Before being multiplexed together, each signal is followed by an optical delay of 0 ns, 0.025 ns, 0.05 ns and 0.075 ns and then fed to corresponding 4x1 multiplexer. The OTDM signal travels over a fiber. After travelling through fiber, the pulse gets broadened due to chromatic dispersion. So to compensate dispersion, fiber span consists of DCF to make the total dispersion zero and optical fiber (ITU G.653) of 50 km length. The total length of fiber span is 3200 km. After then it is de-multiplexed at the receiver side.

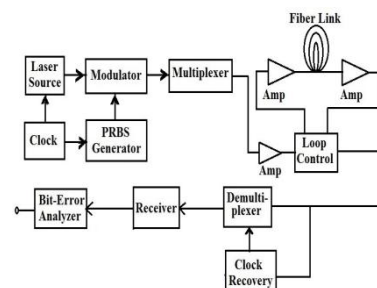


Fig.1. Block diagram of 40Gbps OTDM System



The receiver consists of 1x4 demultiplexers. The 40 Gbps signal is splitted into four different signals. Each signal is delayed with different time delays and consists of a pulse train generator with same repetition rate as the transmitter. The signal is then converted into electrical signal using PIN photodiode as a photodetector. The BER analyzer is connected at output port to get the results.

III. SCHEMATIC OF DISPERSION COMPENSATION TECHNIQUES

The schematic of three dispersion compensation techniques: pre-, post- and symmetrical- is shown in Fig.2. The schematic consists of 40 Gbps transmitter, fiber span and 40 Gbps receiver. EDFA is also used to compensate the power loss within the fiber span.

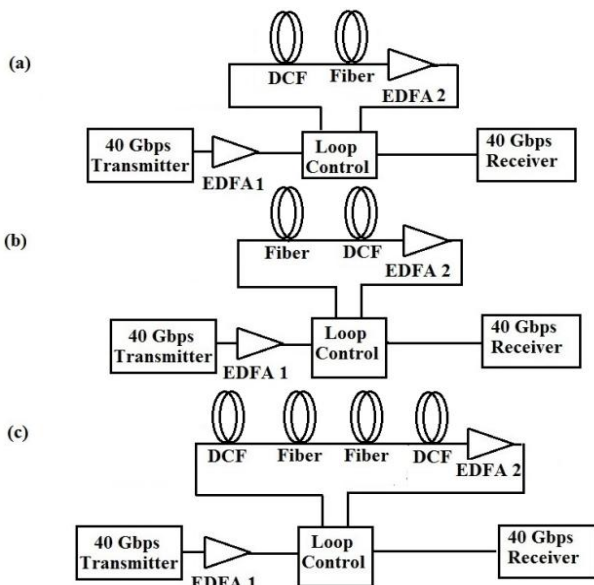
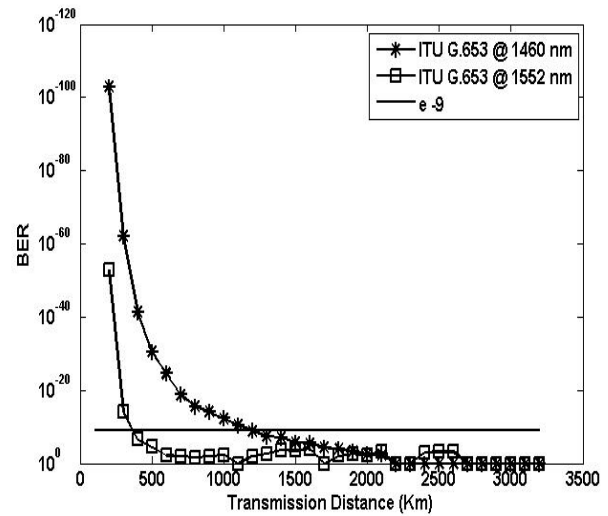


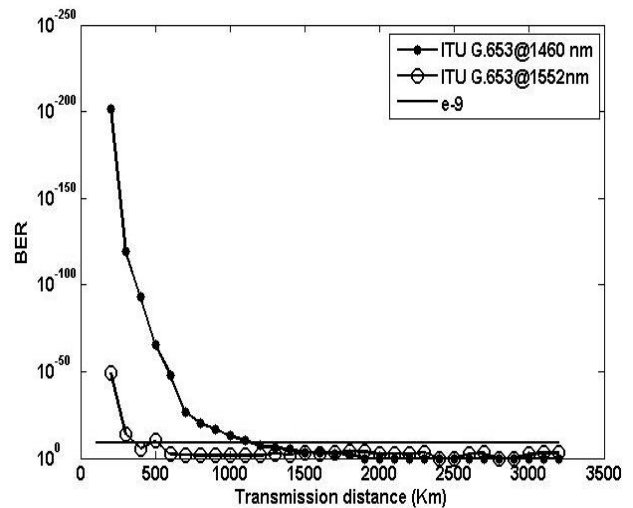
Fig.2. Simulation setup for (a) pre-, (b) post- and (c) symmetrical- dispersion compensation using ITU G.653 and dispersion compensating fiber

IV. RESULTS AND DISCUSSIONS

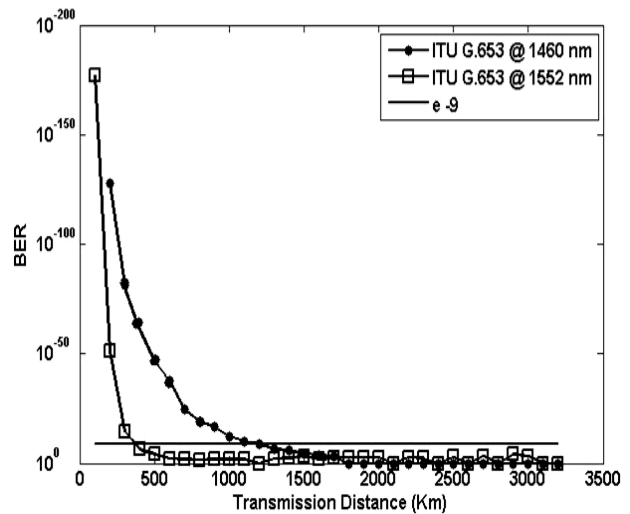
The dispersion profile of ITU G.653 is $D = 0.169$ [ps/(km-nm)] at wavelength 1552 nm and $D = -8.38$ [ps/(km-nm)] at wavelength 1460 nm. The fiber span is made up of optical fiber ITU G.653 of 50 km length and dispersion compensating fiber (DCF) of length 0.105 km with dispersion of 80[ps/km-nm] at C-band. The dispersion profile of DCF used at S-band is 100 [ps/km-nm] with a length of 4.19 km. The different dispersion compensation techniques have been compared for 40Gbps OTDM operating at S-band and C-band over ITU G.653 in terms of received BER and transmission distance. To analyze the system, the results have been taken at first channel as shown in Fig.3.



3(a)



3(b)



3(c)

Fig.3. BER w.r.t transmission distance for (a) Pre-, (b) Post- and (c) Symmetrical- compensation at S-band and C-band



The comparison has been made on the basis of maximum transmission distance achieved by the fiber (ITU G.653) operating at S-band and C-band shown in Table I.

Table I

Maximum transmission distance for ITU G.653 at S-band and C-band

Fiber Type	Transmission Distance (km) achieved for Different Dispersion compensation in S-band			Transmission Distance (km) achieved for Different Dispersion compensation in C-band		
	Pre-	Post-	Symmetrical-	Pre-	Post-	Symmetrical-
ITU G.653	1150	1150	1200	350	500	350

V. CONCLUSION

It has been concluded that the performance of the ITU G.653 fiber performs better at S-band as compared to C-band where it exhibits worst performance. In S-band, the performance of ITU G.653 with pre-, post- and symmetrical- compensation using DCF shows almost similar results but with symmetrical- compensation the longest distance is achieved by the fiber. The maximum distance achieved using ITU G.653 is 1200 km with . acceptable bitt error rate is 2.39×10^{-9} in S-band and 500 km in C-band with post- compensation.

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