200km Repeaterless 10Gb/s Transmission on Standard Single-Mode Fiber with Single-Sideband (SSB) Modulation and Raman Amplification

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Abstract: We demonstrate error free transmission of a single sideband (SSB) modulated signal on standard single-mode fiber (SSMF) up to 200km without any inline amplification or dispersion compensation.

1. Introduction

Standard single-mode fiber (SSMF) with a zero dispersion wavelength at 1310nm is the customary fiber in optical communication networks. By using this fiber in the third transmission window at 1550nm distortion induced by chromatic dispersion is the most relevant limiting effect. Therefore, dispersion tolerant modulation formats are required, particularly with regard to a relaxed dispersion management in WDM-systems and for higher data rates (>10Gb/s). Some modulation formats such as multilevel, duobinary or single-sideband modulation offer more dispersion tolerance than binary transmission [1-3]. SSB and duobinary modulation can use a conventional direct detecting receiver, whereas multilevel modulation requires a more complex receiver design.

In this paper we investigate - for the first time to our knowledge - the maximum transmission length that can by bridged with SSB modulation without any inline amplification or dispersion compensation. We compare SSB modulation with conventional NRZ binary transmission.

2. Setup

A schematic of the experimental setup is shown in Fig. 1. The setup consists of a transmitter followed by a booster amplifier, SSMF with varying length from 100km to 200km, a backward pumping Raman source, and finally a receiver.

Transmitter: In order to generate a SSB signal both an intensity and a phase modulation is used. For obtaining an optical single-sideband signal the intensity modulated signal (using a single arm Mach-Zehnder modulator, MZM) is phase modulated, in a second step, with the Hilbert transformed signal of the data signal, using a phase-modulator (implemented as a dual MZM) [3,4]. The Hilbert transformer is approximated by a finite impulse response (FIR) filter with only 2 coefficients.

Receiver: A conventional standard receiver consisting of an optical preamplifier, an optical/electrical converter and a clock recovery was used in this experiment.

3. Results and discussion

We measure the bit error ratio (BER) as a function of optical launch power into the fiber. Backward Raman pump-power is held constant.

Raman amplifier: In Fig. 2 the effect of Raman amplification is demonstrated for both binary and SSB modulated signals. Both BER curves are shifted about 10 dB to lower launch power values when using

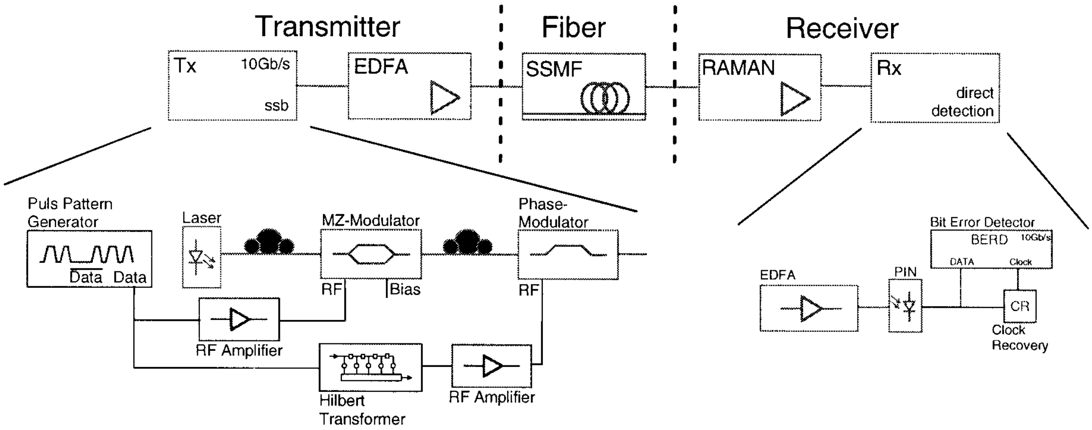

Fig. 1: experimental setup of the transmission system, transmitter and receiver