

Performance improvement of long reach optical access systems using hybrid optical amplifiers

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The internet traffic has increased exponentially due to the high demand for data rates by the users and forecasts show that increase in mobile data from 51 EB in 2020 to 236 EB in 2026 at the same time, increasing the amount of carbon dioxide (CO₂) emissions produced by the telecommunications industry reaching 4% of the total global emissions [1]. The constantly increasing metro networks and access networks are focused on improving the maximum transmit distance of the long reach optical networks. One of the common methods to improve the maximum transmit distance of the long reach optical networks at the component level is to use broadband optical amplifiers. The Erbium Doped Fiber Amplifier (EDFA) provides high amplification with low noise figure but due to the characteristics of EDFA, its operation is limited to C-band and L-band [2]. In contrast, the Raman amplifier exhibits a wide amplification spectrum, and negative noise figure values can be achieved. For obtaining such results, high powered pumping sources are required. Operating Raman amplifiers with such high-powered optical sources may cause fire hazards and it may damage the optical system. In this paper, we implement a hybrid optical amplifier configuration. EDFA and Raman amplifiers are used in this hybrid setup to combine the advantages of both EDFA and Raman amplifiers to improve the reach of the system. Using this setup, we analyze the maximum transmit distance of the network by obtaining correlation diagram between the length of the single mode fiber (SMF) and Bit Error Rate (BER). This hybrid amplifier configuration is implemented in a Wavelength Division Multiplexing (WDM) system with a BER of 10^{-9} by using NRZ modulation format, and the gain uniformity noise ratio (signal-to-noise ratio (SNR)), the efficiency of the pumping source, and the optical signal gain efficiency of the amplifier is studied experimentally in a mathematical modelling environment. Numerical simulations were implemented in RSoft OptSim simulation software based on the nonlinear Schrödinger equation using the Split-Step method, the Fourier transform, and the Monte Carlo method for estimating BER.

Keywords: *Raman amplifier, Erbium Doped Fibre Amplifier, Bit Error Rate, Hybrid optical amplifiers.*

[1] Ericsson, Ericsson Mobility Report - November 2020, Ericsson. (2020) 36.

[2] Ahmad Atieh, Ajaybeer Kaur, Manjit Singh Bhamrah “Simulations and Optimizations of Optical Amplifiers” 2020 Photonics North (PN). DOI:10.1109/PN50013.2020.9166933