

Coherent OIDMA technique for next generation long reach PONs

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Abstract: We present a coherent optical interleave-division multiple-access (OIDMA) PON uplink scenario. Results demonstrate that coherent OIDMA can be deployed in long reach PONs with large number of users at a reasonably low launch power.

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1. Introduction

Passive optical networks (PONs) have been deployed all over the world as the last mile broadband access technology to the end users. Current gigabit PONs and 10G-PONs employ time-division multiplexing (TDM) technique to share the bandwidth among the different users [1,2]. Increasing bandwidth requirements with the new emerging services pushes TDM-PONs to its capacity due to higher complexity. Next generation PONs (NG-PONs) are envisioned to support larger number of users, bandwidth and distance coverage. Recently, different multiple access techniques have been proposed for NG-PONs, e.g., wavelength-division multiple-access (WDM), optical code-division multiple-access (OCDMA), orthogonal frequency-division multiple-access (OFDMA), and optical interleave-division multiple-access (OIDMA) [1-3].

In this paper, we introduce a novel coherent detection OIDMA- PON uplink scenario. OIDMA uses user specific interleavers as the only means for user separation [4,5]. Information bits from optical network unit (ONU) $k \in \{1, 2, \dots, K\}$, denoted by $\{b^{(k)}\}$, are spread using low rate spreading codes. This generates a coded sequence $\{c_j^{(k)}\}$, then a chip level user specific interleaver is applied to produce the transmitted sequence $\{x_j^{(k)}\}$ which then modulates the optical carrier using quadrature phase shift keying (QPSK) modulation. All optical signals from users are combined at the remote node to the fiber until reaching the optical line terminal (OLT). The optical signal is then coherently detected, and the result is applied to the OIDMA receiver [6]. The OIDMA receiver is an iterative receiver that utilizes the soft decoding (turbo) algorithm [1,2].

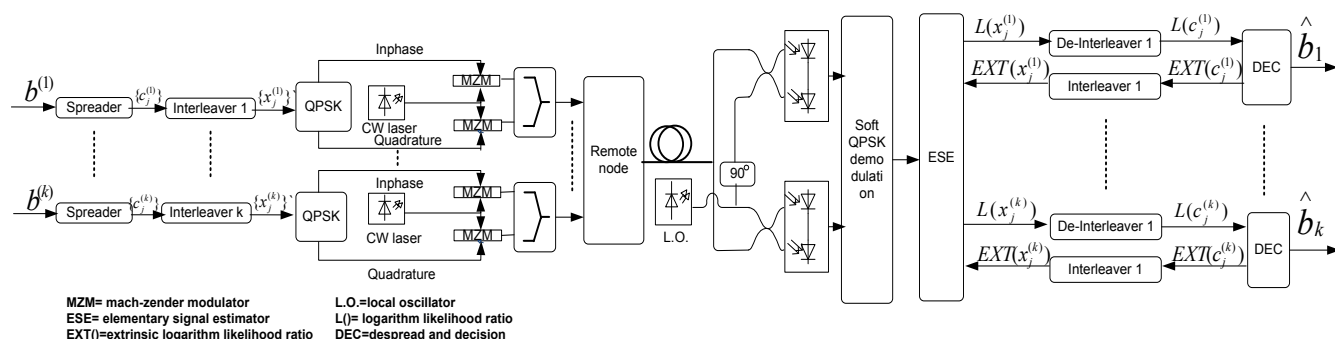


Fig. 1. Coherent OIDMA-PON uplink architecture.

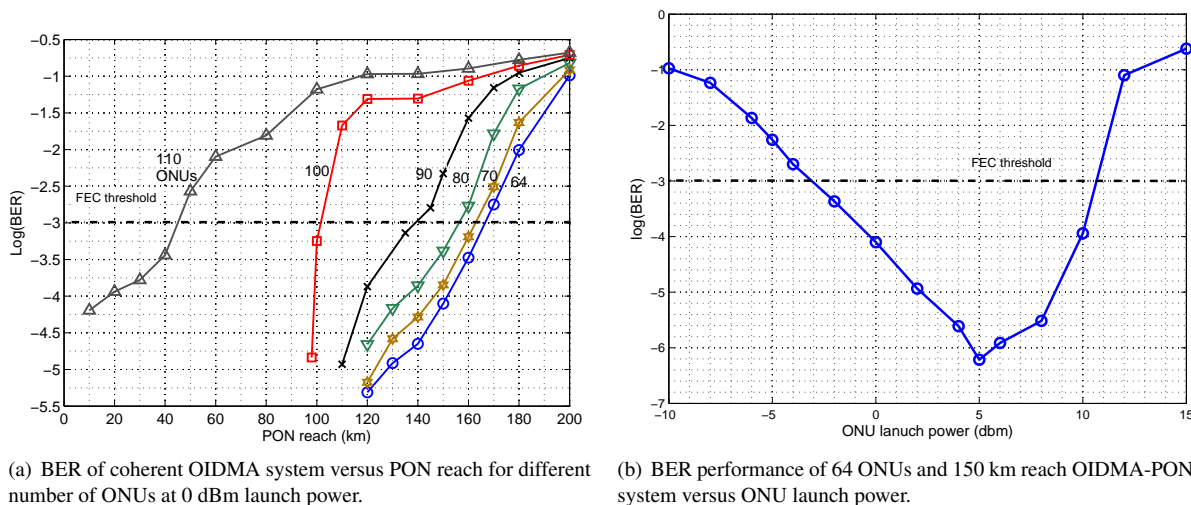


Fig. 2. Uplink BER performance of coherent OIDMA-PONs.

2. Performance of the proposed coherent OIDMA-PON system

In this section, we provide a Matlab/Optisystem co-simulation for the bit error rate (BER) of coherent detection OIDMA system. Fig. 2a shows BER versus PON reach for different numbers of ONUs and Fig. 2b shows BER versus ONU launch power for 64 simultaneous ONUs and 150 km PON reach. For our simulation, the information block length is set to be 256 bits, QPSK is used as a modulation scheme at the transmitter side, and the spreading code length is set to 64. The laser in the ONU is set to 0 dBm power and 1550 nm wavelength. We also consider a standard single mode fiber (SMF-28). Also, thermal and shot noise are considered at the receiver. Local oscillator power in the OLT is set to 0 dBm and iterative decoder iterations are set to 10. The maximum chip rate is 10 Gchips/s and we use spreading code length of 64 chips, so the baud rate per ONU is 156.25 Mbaud and spectral efficiency is doubled due to QPSK modulation.

It is observed from Fig. 2a that coherent OIDMA can accommodate large number of ONUs and long PON reach, which is better than current TDM-PONs [1,2], and still achieving the error free FEC threshold. For example, coherent OIDMA with 64 spreading length can accommodate 100 ONUs for longer than 100 km PON reach, but TDM-PONs with 64 slots is only limited to 64 users for 20 km PON reach [1,2].

Figure. 2b shows that coherent OIDMA have a good performance, near FEC threshold, even at low launch power until -3 dBm and PON reach of 150 km. Also, BER performance is optimal at 5 dBm for 64 users and local oscillator power 0 dBm.

As a result, coherent OIDMA can be deployed in long reach PONs with large number of users at a reasonably low launch power.

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