Current Trends towards PON systems at 50+ Gbps

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Current Trends towards PON Systems at 50+ Gbps

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Next generation PON physical layer will target 50 Gbit/s/lambda while using significant lower bandwidth transceivers. In this paper, we review our results on best modulation formats and equalization strategies.
Keywords: Optical Access Netowork, Passive Optical Network (PON)

1. Introduction

Passive Optical Network (PON) standardization is evolving towards 25 Gb/s (per wavelength) (25G-EPON under IEEE) [1-2], while the next step, focused on 50 Gb/s (HSP-PON, Higher Speed PON) is under discussion in ITU-T [3]. It is envisioned that 50 Gb/s/λ will still be based on intensity modulation and direct detection (IM-DD), but the limited bandwidth available in PON optoelectronic transceivers may require adopting more complex modulation formats, such as electrical duobinary (EDB) or PAM-4, and/or some simple form of digital signal processing (DSP) at the receiver (RX). Our group at Politecnico di Torino, in close collaboration with Telecom Italia (TIM), has been active in this area for the last two years [4-5]. In this paper, we experimentally discuss the required optoelectronic bandwidth (at both TX and RX) to support either 25 Gb/s/λ or 50 Gb/s/λ for different modulation formats.

2. Performance vs. available bandwidth

We focused on required optoelectronic bandwidth. We performed a set of experiments at 25 Gb/s/λ and 50 Gb/s/λ measuring BER vs. Optical Distribution Network (ODN) loss for three different modulation formats: traditional OOK NRZ (indicated as PAM-2 in the following), quaternary PAM (PAM-4), and electrical duobinary (EDB). Then we developed a very detailed numerical simulation framework taking into account experimentally measured transfer functions and noise levels. Results are given in Fig. 1, showing a good matching between experiments and simulations at both 25 and 50 Gb/s/λ. We consider adaptive equalization using either FFE or FFE+DFE approaches. After obtaining a validated simulation model, we use it to study the performance in terms of achievable ODN loss versus available electrical bandwidth at the transmitter and receiver for a 50Gbps system, showing results in Fig. 2. Simulation curves with or without FFE adaptive equalization are reported. This graph allows deriving important system considerations:

- Traditional NRZ (i.e. PAM-2) allows obtaining the highest ODN but only when the available bandwidth is sufficiently high, in particular for f_{3db}>20 GHz. Adaptive equalization is very effective for PAM-2, but still requires at least 25G class optoelectronics (i.e., optoelectronics having at least f_{3db}≈20GHz).
- EDB has significantly better performance than PAM-2 for f_{3dB}<20 GHz, and it allows reaching a target 29 dB ODN loss down to f_{3db}≈15GHz. For EDB, adaptive equalization improves the performance, but in a less pronounced way compared to the other formats
- For even lower bandwidth, PAM-4 has the best performances among the three considered modulation formats, and again adaptive equalization is quite useful. If ODN loss target is lowered to 24 dB, it allows using f_{3db}≈10GHz optoelectronics.

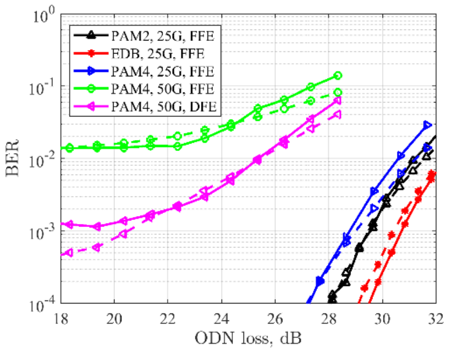

Fig. 1 Comparison between experiments (solid) and simulation model (dashed).

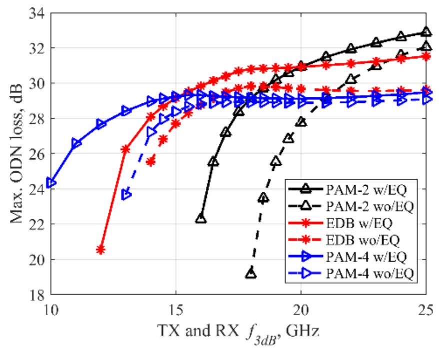

Fig. 2 ODN loss vs. available bandwidth (same at TX and RX) for different modulation formats, with and without equalization, for 50Gbps system.

***Acknowledgements:** the authors thank the support of the PhotoNext initiative at Politecnico di Torino. This work has been carried out in the framework of a research contract with Telecom Italia.*

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