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Innovative technologies for optical access towards 100 Gbit/s and beyond

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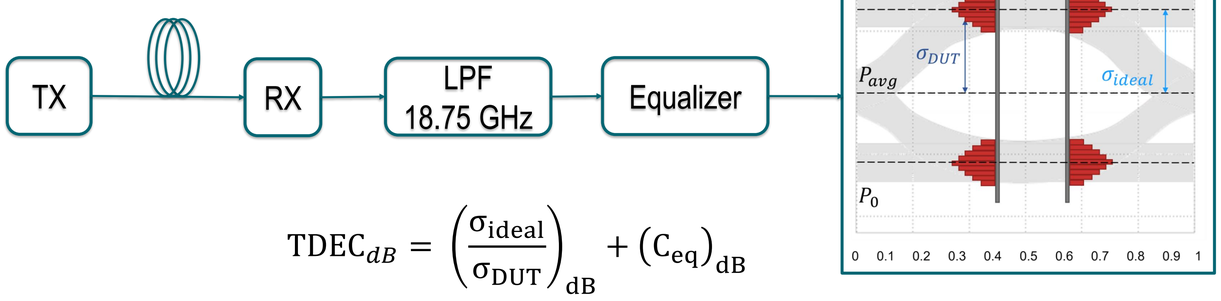
Research context and motivation

- Telecommunication networks allow data to be exchanged around the world and are organized depending on the distance and capacity they cover.
- The final part of this is the ***access network***, which delivers data to the end-user using PON architecture.
- The PON (Passive Optical Network) is a point-to-multipoint, bidirectional, and passive architecture based on IM-DD modulation. Over the years, it has gained success because it is relatively simple and cost-effective.
- The capacity of PON is defined by the two main standardization bodies, ITU-T and IEEE.
  In September 2021, ITU-T released the 50G-PON standard, setting the downstream rate at 50 Gb/s.
- To determine if the transmitter can be used in this type of network, a parameter called ***TDEC*** was introduced, which evaluates the quality of the transmitter.
- Standardization bodies have already begun studying the ***next generation of PON*** to determine if it can be based on IM/DD.

Addressed research questions/problems

TDEC

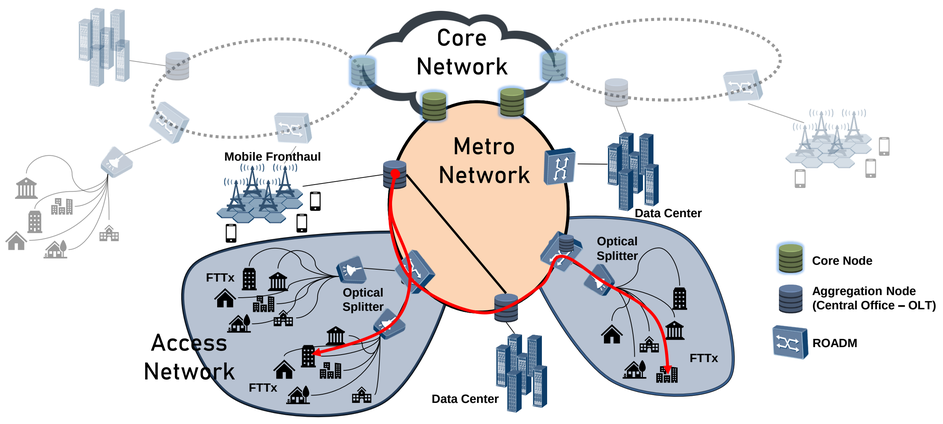
- The TDEC's algorithm (Transmission Dispersion Eye Closure) evaluates the performance of transmitter comparing it with an ideal one.
- To do this, the algorithm add noise to the signal emitted by the TX under test until to reach a BER target ($@BER = 10^{-2}$) and the perform the ratio between this noise and the one calculated with the same condition but that and only two power level (ideal).
- *Implementation details? Optimization? Extension to other scenarios?*



$$\mathrm{TDEC}_{dB} = \left(\frac{\sigma_{\mathrm{ideal}}}{\sigma_{\mathrm{DUT}}}\right)_{\mathrm{dB}} + \left(\mathrm{C_{eq}}\right)_{\mathrm{dB}}$$

Metro-Access convergence

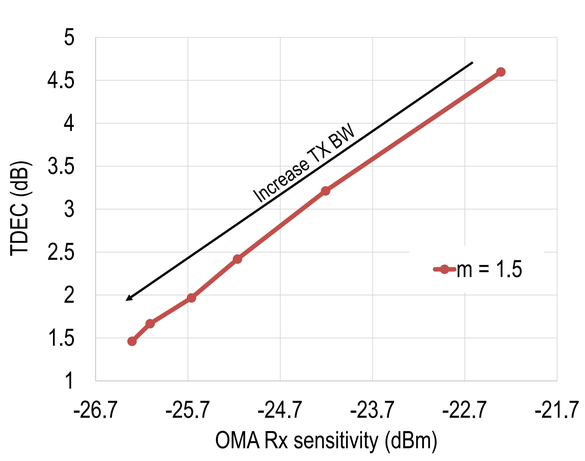
- The next generation of PON, such as 100G-PON or 200G-PON, might still be based on ***IM/DD***. However, we are approaching its limits due to ***bandwidth limitations*** of optoelectronic components and ***power budget*** constraints (distances over 20 km and numbers of users exceeding 64).
- The introduction of ***coherent transmission*** into the access network can address these issues. However, it introduces new drawbacks, such as increased ***cost and complexity***.
- Regarding ***cost***, the trend shows a 60% reduction in price over 4 years (for example, for a 100G TRX), though it remains an order of magnitude higher than IM/DD.
- Regarding ***complexity***, the issue arises from a bidirectional network where non-bidirectional devices are used (current coherent TRX units use the same wavelength for both upstream and downstream). To address this, new devices could be developed (increasing cost), or sub-carriers could be utilized (increasing complexity).



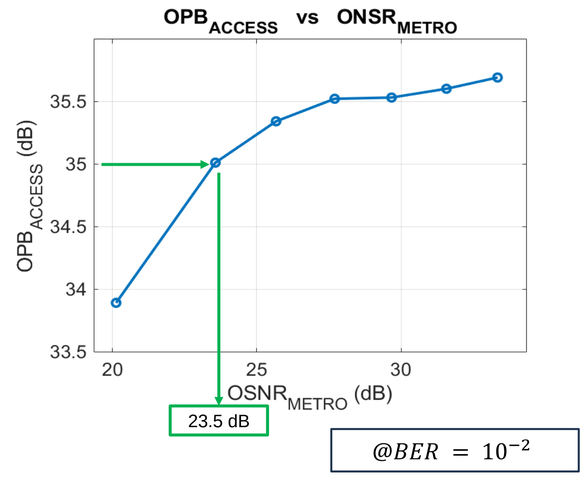
- *Design of the two segments? Power budget? Increase the covered distance?*

Novel contributions

TDEC

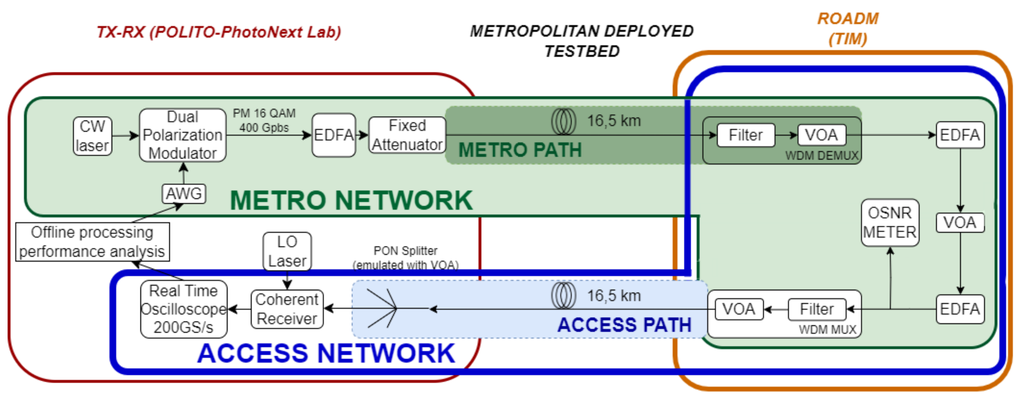


Metro-Access Convergence

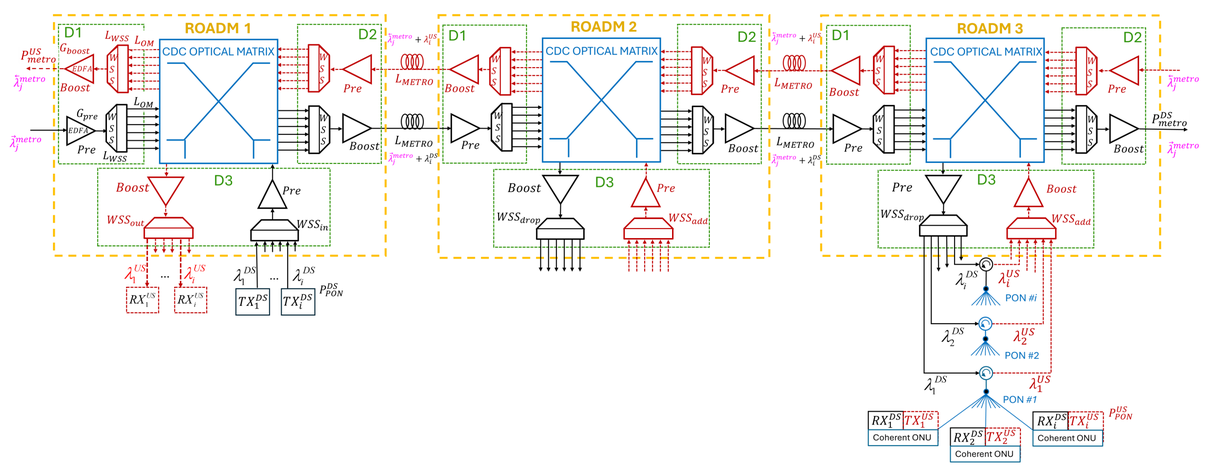


Adopted methodologies

Metro-Access Convergence



Future work



Publications

- Published works: 3 journal (+1 accepted), 5 conferences

- Most important publications:

1. M. Casasco, G. Caruso, I. N. Cano, D. Nesset, M. Valvo, V. Ferrero and R. Gaudino, "*TDEC metric in 50G-PON: analytical and experimental investigation on several implementation aspects*," J. Optical Communication and Networking (JOCN), Vol. 15, pp. 480–487 (2023).
2. G. Rizzelli, M. Casasco, A. Pagano, V. Ferrero and R. Gaudino, "*Experimental Demonstration of in-field 400 Gb/s Coherent Metro-Access convergence*," in OFC 2024, San Diego (USA).

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