Metro Networks Based on Multi-Band Orthogonal Frequency-Division Multiplexing Signals

The MORFEUS project demonstrates a new paradigm related to the increase of flexibility, granularity and capacity of metropolitan optical networks using a low-cost optical receiver. The technology developed within the project is suitable to be deployed in new metro networks with Tb/s interface speeds allowing to move beyond 10 Gb/s per user in access networks in the near future.

Main Project Team	
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Funding Agencies	
FCT	**140,000€**
Start Date	01/04/2013
Ending Date	30/09/2015
Indicators	
Journal Papers	10
Conference Papers	19
Concluded MSc Theses	12

Two Main Publications

T. M. F. Alves, A. Cartaxo, **100 Gb/s DD-MB-OFDM metro network with 11 Gb/s granularity and 2.85 GHz receiver**, IEEE Photonics Technology Letters, Vol. 27, No. 24, pp. 2551 - 2554, December, 2015

T. M. F. Alves, M. M. Mendes, A. Cartaxo, **High granularity multiband OFDM virtual carrier-assisted direct-detection metro networks**, IEEE/OSA Journal of Lightwave Technology, Vol. 33, No. 1, pp. 42 - 54, January, 2015

PROJECT WEBPAGE URL
https://www.it.pt/Projects/Index/1790

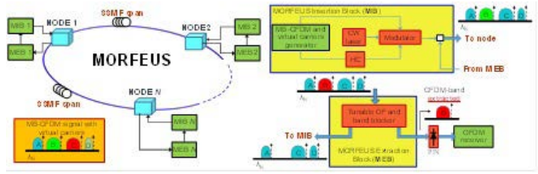

Fig. 1 Conceptual scheme of the MORFEUS network.

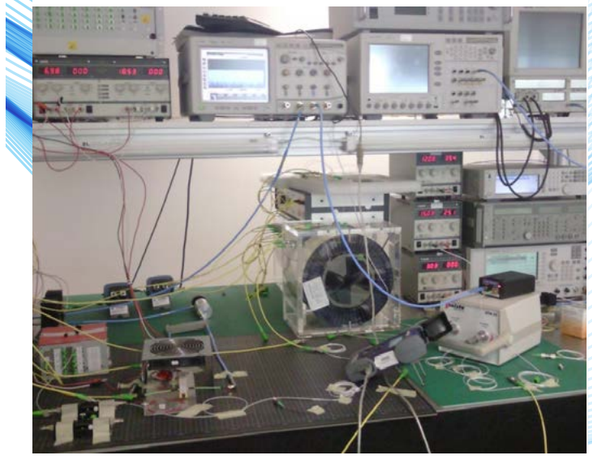

Fig. 2 Experimental setup of the MORFEUS demonstrator.

GENERAL MOTIVATION AND OBJECTIVES

The exponential growth of traffic due to Internet services and applications such as video on demand, IPTV and cloud computing has prompted research on flexible optical networks. Current networks offer high capacity and reconfigurable switching but present coarse granularity. As a consequence, provision of high speed data connectivity to end users using a dedicated channel bearing ultra-high capacity is very difficult to achieve. Therefore, the required capacity foreseen for the next years to deliver new internet services and applications to clients will lead to the capacity crunch of current networks.

The general objective of MORFEUS project consists in demonstrating the new paradigm related to the increase of the flexibility and granularity of the transmission capacity in metropolitan (metro) optical networks. Particularly, the implementation of metro networks based on high data-rate multi-band orthogonal frequency-division multiplexing (OFDM) signals employing wavelength division multiplexing (WDM) is analyzed and demonstrated as an excellent solution to provide, simultaneously, high flexibility in capacity allocation, high spectral efficiency and the possibility of upgrading the network capacity while keeping the system architecture almost unchanged.

This project has two particular objectives. First, it is focused on the investigation of the performance impairments imposed by the physical layer on the high data-rate (bit rate of 40 Gbit/s and above per wavelength) direct detection (DD) MB-OFDM signals transmission in WDM metro networks and on the system parameters optimization using analytical, simulation and experimental work. Particularly, the study and the assessment of the main system impairments is performed, such as: (i) linear crosstalk associated with the MB-OFDM transmission and with the finite selectivity of the optical devices required to select the different bands and wavelengths at each node of the metro network, (ii) linear and nonlinear fibre effects, (iii) joint nonlinear effect introduced by the electro-optic and opto-electric conversion processes. Second, this project is focused also on the study of the network layer of WDM metro networks based on MB-OFDM signals. Particularly, the assignment of OFDM bands and wavelengths, and the traffic distribution along the network are analyzed. Routing, wavelength and band assignment (RWBA) algorithms are developed based on maximum wavelength and band reuse in DD MB-OFDM metro networks. These algorithms are developed considering the impairments imposed by the physical layer of the WDM MB-OFDM metro network (cross layer design).

CHALLENGE

This project aims at addressing the triple challenge related to providing high capacity transmission at the metro network, the insertion/extraction of lower-capacity signals at the metro-access node for adequate subscribers' connectivity provisioning and the routing assignment challenges. We propose to achieve this goal by using the advantages provided by MB-OFDM based optical networks.

WORK DESCRIPTION AND ACHIEVEMENTS

The research work was focused on:

(i) the investigation of the performance impairments imposed by the physical layer on multi-band OFDM metro networks, with overall capacity of 40 Gbit/s and 100 Gb/s per optical channel, employing digital signal processing algorithms for distortion mitigation and

(ii) the investigation of network layer issues where routing, wavelength and band assignment algorithms are developed specifically for MORFEUS-based networks aiming at optimizing the traffic distribution and provision along the network.

A MORFEUS network prototype has been deployed in the laboratory of the Optical Communications and Photonics Group of Lisbon site of Instituto de Telecomunicações. With this prototype, the transmission of a 100 Gb/s MB-OFDM signal employing 9 bands, using an ultra-dense band spacing of 6 GHz and with an optical fiber reach of 150 km was successfully demonstrated.