Abstract

This Thesis investigates and develops novel bidirectional and reconfigurable optical access architectures based on WDM technology with the aim of solving the problem of cost and complexity associated to the WDM-PON transceivers. In particular, depending on the capacity requirements of the network, the investigation and development deal with two specific environments of application.

In case of low capacity access platforms, we propose and validate new dispersion tolerant optical transmission systems based on the employment of optical broadband sources operating in the third transmission band and whose adaptability to the transport of RoF signals is realized, for the first time, by means of Mach-Zehnder optical interferometer structures.

The optical bandpass filtering feature of the Mach-Zehnder device is key to overcome the chromatic dispersion-induced limitations arising from the spectral width of the source and, thus, significantly increase the system operative bandwidth to several tens of GHz. The incorporation of a Mach-Zehnder structure has a relatively low degree of implementation complexity and opens the possibility to transmit RoF signals using cost-effective optical broadband sources in optical access platforms being, at the same time, a viable alternative to other dispersion compensation techniques under certain scenarios. Good RoF transmission performance is experimentally achieved over single mode and multi mode fiber links employing optical amplitude and optical phase modulation. The SCM technique is also used for the generation of down- and up-stream signals to improve the link bandwidth utilization and allow converging transport of wired and wireless services. Service flexibility is demonstrated by means of different types of codification concerning the transmitted binary information. In spectrum sliced optical broadband source multichannel applications, the dynamical assignment of capacity is realized by means of a compact routing scheme based on optical switching and validated over different routing scenarios. Moreover, two extra functionalities offered by the Mach-Zehnder device, such as the photonic suppression of harmonic and intermodulation distortion and the all-optical microwaves generation and up-conversion, are demonstrated.

For optical access platforms requiring high capacity transport we propose and validate light sources-centralized optical transmission systems where the PolMUX technique is employed for the first time in the access platform as a novel strategy to minimize the cost and complexity of the terminal units in accordance with the centralization concept.

The PolMUX principle uses light polarization as a degree of freedom to efficiently multiplex two orthogonal optical fields at the same wavelength into the same optical channel. Under this principle, the optical carriers required for the down- and uplink transmission can be provided by a single and centralized coherent source. It means that the terminal unit can be kept source-free and operative wavelength-independent. This concept is firstly validated over a single-channel full-duplex optical transmission system adopting RoF and SCM techniques for the generation and transport of the down- and upstream signals. Apart of fulfilling the requirements of quality

of transmission after the polarization demultiplexing process, we demonstrate that the tracking and control of polarization can be also centralized at the central office for further minimization of the terminal unit complexity. Finally, the effectiveness of the PolMUX technique is exploited in the access network in order to perform full-duplex multichannel communications where reconfiguration of capacity depending on the actual demand and service convergence, required in RoF, are also demonstrated.