



Software-defined energy-efficient Photonic transceivers Introducing Intelligence and dynamicity in Terabit superchannels for flexible optical networks

### At a Glance: ICT SPIRIT

**Project website:**

www.spiritproject.eu

**Project coordinator:**

Prof. H. Avramopoulos

**Project partners:**

- ICCS/NTUA
- Fraunhofer-HHI
- IMEC
- AMO GmbH
- Linkra S.R.L.
- Ericsson Telecomunicazioni
- Hellenic Telecommunication Organization S.A. – OTE AE

**Duration:**

Dec 2013 – Nov 2016

**EC financial contribution:**

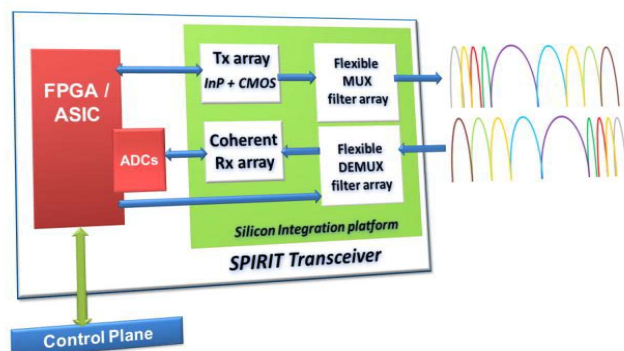
2,870,000 €

### The Challenge

The advent of cloud applications and the proliferation of mobile devices have imposed a dramatic increase of the IP traffic. The emerging ZettaByte Era forces operators to seek a cost-efficient way of upgrading their network in order to accommodate the vast amount of data without compromising QoS and wasting bandwidth resources. Technology paradigms shift towards coherent modulation formats for upgrading channel capacity, yet at the cost of power-hungry DSP residing outside the transceiver line cards and bulky component configurations. What is more, current implementations rely on fixed-grid network elements ignoring efficient spectrum management that can benefit from high-order QAM modulation.

### Vision

SPIRIT aims to build a fully programmable transceiver in a single package for Terabit optical transport networks capable of superchannel grooming on a gridless basis and SDN functionality on board. The new transceiver technology platform targets power and cost savings up to 50%.



The SPIRIT programmable transceiver concept

## Project Objectives

SPIRIT aims to fulfill the existing telecommunication gap with a near-to-market transceiver product merging the benefits of high performance and mature photonic and electronic technologies into a single platform. In order to achieve its mission, SPIRIT has defined the following ambitious objectives:

- Fabrication of high-speed, low-voltage drive, InP modulators with segmented electrodes
- Fabrication of low-power CMOS Periodically Amplified Travelling-wave Hybrid (PATH) modulator logic and driver arrays
- Fabrication of an optical MUX/DEMUX for superchannel grooming on a gridless basis
- Development of fully-programmable, high-speed, low-power, integrated photonic and electronic flexible transceivers
- Fixed-grid and gridless 400G, 1T and flexible (super)channel data transport with advanced DSP and monitoring built-in functions enabled by software control

## Photonic Integration

SPIRIT leverages the power of photonic integration as the key enabling technology to deliver its objectives. It blends high performance InP technology and 40nm CMOS electronics onto a common SOI integration platform and a fully packaged design. SPIRIT will particularly focus on:

- Photonic-electronic co-design
- Optical and electrical interfaces
- Thermal management

## System Exploitation

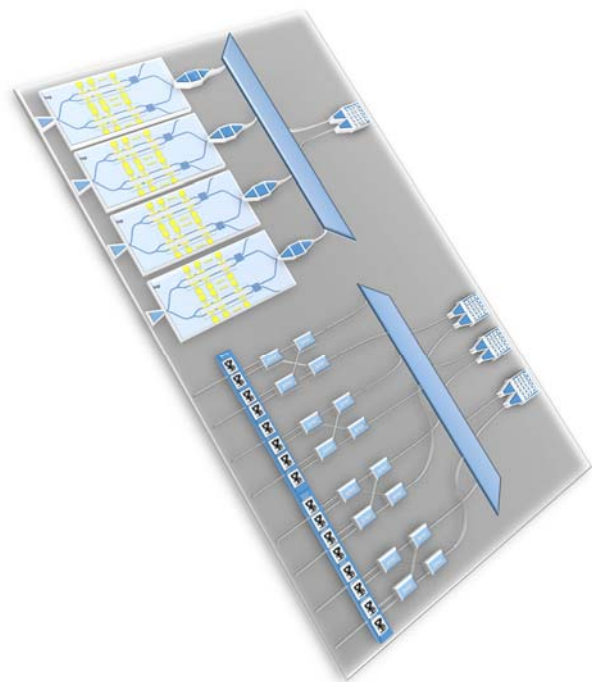
The SPIRIT transceiver will support near future 400G implementation and forthcoming 1T traffic demands providing the necessary flexibility in modulation format by dynamic adjustment of single and multi-carrier QAM up to 16 bits/s/Hz spectral efficiency and multi-level modulation with 5-bit resolution driving electronics. Variable

baud rates up to 32 GBaud will generate throughputs up to 512Gb/s on a single wavelength and 1Tb/s on two wavelengths on a single device.

Traffic shaping of coherent superchannels will be performed in less than 10GHz steps by properly adjusting the passband width of the tunable MUX/DEMUX. Finally, the SPIRIT transceiver will introduce intelligence to the transport layer via the on-board DSP algorithms and physical layer performance monitoring tools featuring a software-defined technology platform.

In a nutshell, SPIRIT will deliver reliable optical components with a strong focus on rapid commercialization and key system specs:

- **Ultra-low power** stemming from the revolutionary InP PATH modulator design. The total power consumption of the SPIRIT transceiver is estimated 14.4W.
- **Cost-efficiency** due to the maturity of the InP, CMOS and SOI technologies. 40nm CMOS processing offers 50% cost reduction compared to competing silicon technologies.
- **Scalability** enabled by the 5-bit arbitrary waveform generation offering the highest resolution to date at this baud rate.



*The integrated SPIRIT flexible transceiver*