PhD 2026-2029

Power and Radio over Fiber for Internet of Things in constrained environments

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Context

Within the **ANR PEPR French national project titled PLEIADES (P**hotonics techno**L**ogies for high-p**E**rformances w**I**reless **A**n**D** fib**E**r communication**S)**, the work in this thesis addresses the need of simultaneous connections to sensors which is expected to increase in the context of 5G and beyond and Internet of things (IoT) sensor networks. Here, we will focus on sensor networks which are localized in a hostile and/or high constrained environments, as nuclear centrals, railway applications or maritime one. The innovative aspect is to propose an architecture based on standard optical fiber overs distances up to 10km to transmit simultaneously Power, through Power over Fibre (PoF) technology, and analog signals, through Radio over Fiber (RoF) technology, in order to simultaneously supply sensors in energy and to transmit reliable information to where sensors are located. The energy supply allows remote sensors to operate without battery in a hostile environment or in applications where battery replacement is impracticable. PoF technology allows power to be transmitted over optical fiber and converted into electrical power to supply remote sensors. Similarly, the RoF offers the advantage of transmitting analog signals over optical fiber by directly converting them from electrical to optical domain, thereby eliminating the need for complex and costly digital modulation blocks. The transmitted analog signal can also be directly re-emitted in the environment of the sensor network owing to an antenna on wireless link in a specified frequency range (from microwave to millimeter wave).

This research will be carried out both

- in the Lab-STICC ASMP team at Bretagne-INP/ENIB which has expertise in developing fiber power systems for power supply (PoF) and joint/simultaneous data transmission to remote sensors. This technology has been used, within the Lab-STICC, in the field of observation and monitoring of seafloor for the power supply of low-power instruments several kilometers from a terrestrial station [1]. Recent experimental studies conducted between the TIA (Technological Institute of Aeronautics) in Brazil and the Lab-STICC shows the possibility of supplying 200 mW electric power to a 10 km remote RF sensor using a 33 dBm continuous optical source without degrading the quality of the transmitted RF signals [2].
- in ESYCOM lab which has developed a high expertise on characterization, modelling, simulation and optimization in terms of noise and non-linearity of the most key transducers which take part of RoF links but also of different RoF architectures. Home-made models have been developed with the electronic design automation software system: ADS software from Keysight technologies, which allows us to extract the RF gain and the noise figure of components and system of RoF link, but also in terms of data bit rate [3]. ESYCOM is also interested in Photonic Integrated Circuits (PIC) based on silicone platform [4].

The integration of Microwave Photonics (MWP) and Power over Fiber (PoF) is a promising solution for the transmission of data and optical power to feed remote RF sensors based on optical fibers. With the rise of 5G and 6G technology, more and more research are being carried out to improve the efficiency of existing photonic links.

Subject of the thesis

The study will focus on determining the most appropriate topology to implement the "MWP-PoF" system according to various key parameters which will have to be determined such as the length of the standard optical fiber used to control the sensor network (long or short fiber links), the wavelengths of power lasers for the PoF and laser for transmitted data. Particular attention will be given to PIC as part of collaboration with the III-V Lab.

The thesis will aim to optimize the simultaneous transmission of power and RF signals to a sensor network through an experimental characterization approach coupled with modelling activities. The analog system performances (gain, noise factor, etc.) with be optimized through the use of advanced and specifically selected new laser sources and photodetectors. The opportunity of PIC on Si platform developed at III-V lab, as integrated transceiver on Si, will be specially investigated for the implementation of a dedicated PoF/RoF system.

The overarching objective of this optimization of PoF/RoF system is to maximize the power delivered to the sensors while preserving and ideally improving the transmission quality of analog signals.

Work requested

- Study of the state-of-the-art of PoF and RoF technologies and topologies in the specific context of IoT mainly for sensor networks.
- Definition of use cases for operation in constrained environments.
- First proposals of PoF/RoF topologies integrating PICs for IoT sensor networks identified use cases.
- Experimental laboratory demonstration of the proposed systems.
- Optimization of the PoF/RoF architecture through modelling approach.
- Experimental proofs of the concept: characterization and validation of a new system of simultaneous PoF/RoF on standard optical fiber with experimental characterization in Sense-city platform of Gustave Eiffel University
- Writing and submission of papers to national/international conferences and peer-review journals.

Profile sought

Basic knowledge in semiconductor physics, particularly in laser and heterojunction phototransistor operation.

Basic knowledge in RF communication engineering.

Experimental expertise of RF and/or photonic components and system measuring benches (VNA, electrical spectrum analyser).

Experience with ADS software and MATLAB will be appreciated.

Master 2 in photonic and/or RF/microwave fields: RF/Photonic Components and Systems would be the ideal profile.

Contact

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Salary: 2400€ per month (~1800€ net)

Application deadline: August 17, 2026

Position available : October 1st, 2026

The **ASMP** team at the **Lab-STICC** conducts research activities in the field of Photonics, Optoelectronics and Telecommunications, structured around several research axes:

- High-capacity all-optical transmission.
- Modelling and characterization of photonics structures, functions, and systems.
- Power over Fiber and data transmission for low-power sensors.
- Performance optimization of photonic and opto-microwave systems using an experimental approach.

https://labsticc.fr/fr

The **ESYCOM laboratory** operates in the fields of communication systems engineering, sensors, and microsystems for urban environments, the environment, and personal applications.
Its specific areas of focus include:

- Antennas and propagation in complex environments, and photonic-microwave components.
- Microsystems for environmental analysis and pollution remediation, as well as for healthcare and interfaces with biological systems.
- Micro-devices for harvesting ambient mechanical, thermal, or electromagnetic energy.

https://esycom.univ-gustave-eiffel.fr

Bibliography

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[3] M.Moutaly, P.Assimakopoulos, S.Noor, S.Faci, A-L.Billabert, N.J.Gomes, M.Lemine Diakité, C.Browning and C.Algani, "Phase modulated radio-over-fiber for efficient 5G fronthauling", Journal Lightwave of Technology, Vol.37, Issue : 23, pp.5821-5832, September 2019, DOI 10.1109/JLT.2019.2940200.
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