



# PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 4 - Telecommunications

PNRR 118 PNRR Research Field: OPTICAL SENSING IN DEPLOYED TLC FIBER NETWORK

**Monthly net income of PhDscholarship (max 36 months)**

**€ 1400.0**

In case of a change of the welfare rates during the three-year period, the amount could be modified.

## Context of the research activity

**Motivation and objectives of the research in this field**

In the last years, the EU H2020 Digital Agenda promoted a huge increase of the amount of deployed fiber in our cities and a further investment is expected in urban fiber infrastructures for 5G development. This pervasive metro TLC fiber web can be leveraged also as a distributed optical sensing network providing a real-time monitoring in our cities. The research aims to use the already installed TLC networks to support urban infrastructures surveillance and monitoring through the exploitation of breakthrough fiber sensing solutions. The alternative usage of the TLC fiber networks to include also urban infrastructures monitoring features could represent a mean to boost the effectiveness of the made investments, creating also new revenue opportunities.

Objectives of the research are:

- guarantee the coexistence of sensing and TLC signals in the same deployed optical networks, whose distribution fiber links represent themselves the sensing mean;
- use the passive optical networks and the metropolitan area networks already deployed for TLC purposes in the urban area for real-time and distributed diagnostics and surveillance in a “smart city” context;
- exploit the newly installed fibers associated to utilities networks for the detection of plants, apparatus and infrastructures related to the utilities in view of Industry 4.0.



<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>Innovative sensing solutions exploiting the access and the metro networks already deployed for TLC purpose in the urban area for real-time and distributed diagnostics and surveillance in a “smart city” contest will be analyzed and experimented. In particular, the performance of sensing solutions based on optical back-scattering (such as Brillouin and DAS sensors) and based on interferometric schemes will be compared theoretically and experimentally, also in terms of their sustainability in terms of cost, power consumption, footprint, complexity in data processing and storage, reliability, transparency to TLC signal. Regarding the passive optical network, this ubiquitous already-deployed fiber-web, characterized by a tree-architecture, will be studied for a real-time and remote surveillance of civil buildings connected by FTTH access links. The onset of dynamic stress events and structural vibrations modes will be analyzed. Moreover, in the typical MAN topologies, including rings and network nodes, the possibility of new sensing applications carried by dedicated wavelengths in parallel with the dense wavelength division multiplexed (WDM) TLC traffic grid will be explored.</p> <p>Suitable experimental tests are expected to be performed in-field by using the fiber infrastructure made available by different Italian operators. The research will be strictly connected to the PNRR focused project SPOKE1-FP11 SENSING NET, part of the RESTART program.</p>
<p><b>Educational objectives</b></p>	<p>The student will develop knowledge and skills for understanding and organizing research in a systematic way, for dealing with new topics and problems, for managing technological constraints to be faced when designing innovative solutions, for challenging with difficult issues, gaining important experiences precious for his/her future job.</p>
<p><b>Job opportunities</b></p>	<p>Nowadays, the high-capacity optical network, also with sensing capabilities, represents an extremely interesting field for research and development, with significant job opportunities in telecommunications operators, systems and equipment vendors and TLC SMEs, both in Italy and</p>



	also at the international level.
<b>Composition of the research group</b>	0 Full Professors 4 Associated Professors 0 Assistant Professors 0 PhD Students
<b>Name of the research directors</b>	Pierpaolo Boffi

<b>Contacts</b>	
E-mail: pierpaolo.boffi@polimi.it	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--

<b>Scholarship Increase for a period abroad</b>	
<b>Amount monthly</b>	700.0 €
<b>By number of months</b>	6

<b>National Operational Program for Research and Innovation</b>	
<b>Company where the candidate will attend the stage (name and brief description)</b>	Politecnico di Milano
<b>By number of months at the company</b>	6
<b>Institution or company where the candidate will spend the period abroad (name and brief description)</b>	Politecnico di Milano
<b>By number of months abroad</b>	6

<b>Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information</b>
<p>The research aims to use the optical fiber networks already deployed for telecommunications for a smart and pervasive monitoring of our cities. Extensive sensing can be achieved by employing the optical fiber also as a sensing element to support infrastructures surveillance and structural monitoring of civil buildings. Several optical fiber sensing techniques will be analyzed and experimented in the access/metro TLC network, comparing their performance also in terms of sustainability.</p> <p>EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student 5.707,20 Euro per student</p> <p>TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching</p>



activities by the PhD student There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.