



# PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 38th cycle

Research Area n. 4 - Telecommunications

**PARTENARIATO PNRR Research Field: TIME-MODULATED RECONFIGURABLE  
INTELLIGENT SURFACES**

**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**

This research project is in the framework of  
RESTART  
PARTENARIATO ESTESO RESEARCH AND  
INNOVATION ON FUTURE TELECOMUNICATION  
SYSTEMS AND NETWORKS TO MAKE ITALY MORE  
SMART  
CUP D43C22003080001  
Decreto di Concessione D.D. 1549 del 11/10/2022

Reconfigurable intelligent surfaces (RISs), have recently boosted the interest of both wireless communication and electromagnetic (EM) communities as the most promising Key Enabling Technology (KET) candidate for propagation augmentation in 6G wireless. The research aims at extending the concept of RIS to a new model where RIS is time-modulated (TM-RIS) and not necessarily passive. Pervasive deployment of RIS implies that TM-RIS will play a key role in coverage augmentation, in definition of novel space-time modulation of RIS. The objective of the research activity is to study and evaluate this novel concept of TM-RIS and frame it into the future 6G ecosystem. Interference analysis of RIS and TM-RIS is part of the research plan. Furthermore, the research is part of the 6G open-lab, called high-frequency campus lab at Politecnico di Milano, and this is framed



	within a broad cooperation program of RESTART (a large National project) with 30+ partners.
<b>Methods and techniques that will be developed and used to carry out the research</b>	Methodologies are related to the criteria for designing the spatial and temporal phase pattern of TM-RIS. The use of the Universal Snell Law generalizes the RIS: TM-RIS that can be either passive or active and with a higher level of intelligence. Goal is to evaluate the methods for RIS-modulation design. Moreover, the possible co-location of multiple TM-RIS augments coverage but also the mutual interference, and a way to evaluate the statistical distribution of the latter is part of the methods to be employed. Techniques are for target localization capabilities in a RIS/TM-RIS dominated systems. Techniques are based on statistical signal analysis in smart EM environments.
<b>Educational objectives</b>	The PhD student will consolidate the theoretical foundations of metasurfaces. Applicants are preferred if already familiar with the topics in graduate course link: <a href="http://spagnolini.faculty.polimi.it/?page_id=181">http://spagnolini.faculty.polimi.it/?page_id=181</a>
<b>Job opportunities</b>	There is a very strong request of PhD students with specific background knowledge in 6G systems and the specific design of RIS networks. Recently, some of our former PhD students have been hired in top high-tech companies as Ericsson, Qualcomm, Huawei, and more.
<b>Composition of the research group</b>	1 Full Professors 2 Associated Professors 3 Assistant Professors 7 PhD Students
<b>Name of the research directors</b>	Umberto Spagnolini

<b>Contacts</b>	
Umberto.Spagnolini@polimi.it <a href="https://spagnolini.faculty.polimi.it">https://spagnolini.faculty.polimi.it</a>	

<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>	--



(more than 80Km out of Milano)	
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Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

**Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information**

LIST OF UNIVERSITIES, COMPANIES, AGENCIES AND/OR NATIONAL OR INTERNATIONAL INSTITUTIONS THAT ARE COOPERATING IN THE RESEARCH: Politecnico di Milano; Università di Bologna, Università di Padova.

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  
5.707,13 Euro

TEACHING ASSISTANTSHIP: (availability of funding in recognition of supporting teaching 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.

COMPUTER AVAILABILITY: individual use

DESK AVAILABILITY: individual use

D.D. 341 del 15/03/2022 Avviso pubblico per la presentazione di Proposte di intervento per la creazione di "Partenariati estesi alle università, ai centri di ricerca, alle aziende per il finanziamento di progetti di ricerca di base" - nell'ambito del Piano Nazionale di Ripresa e Resilienza, Missione 4 "Istruzione e ricerca" - Componente 2 "Dalla ricerca all'impresa" - Investimento 1.3, finanziato dall'Unione europea - NextGenerationEU