



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

Research Area n. 1 - Computer Science and Engineering

PNRR\_352 Research Field: HYBRID SOFTWARE SYSTEMS BASED ON CLOUD-EDGE  
COMPUTING

**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**

Nowadays complex systems are actually conceived as the federation of multiple decentralized components or subsystems that collaborate for the purpose of accomplishing a specific task. Examples of such systems can be a fleet of robots in the production line of a factory or a network of electrical charging stations and related generation plants.

The complexity of such systems depends on the variety of different devices and software components that are involved, on the need to guarantee an efficient communication and coordination among them. Often, software that contains the logic running behind such systems are deployed among a local site and a remote location, in this context the so called computing continuum plays a central role to facilitate the manageability of edge to cloud architectures.

The goal of this project is to study proper software architectures, interoperability mechanisms, as well as development, verification, and management approaches for complex and decentralized systems that can be deployed in a hybrid environment that includes edge nodes and things at the periphery and remote cloud components.

The envisaged approaches will be experimented in the context of electrical mobility platforms. In particular, the



	<p>software will facilitate the management of the new public Electrical Vehicles Fast and Ultrafast Charging Network, 100% grid integrated and enabled by renewables and Energy Storage.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The PhD student will adopt the following methods and techniques to develop the activity:</p> <ul style="list-style-type: none"> <li>- Systematic Literature Review (SLR): in the first phase of the work, the SLR approach will be adopted to study the literature relevant to the problem under analysis.</li> <li>- Experiments: the research will focus on formulating hypotheses on the behavior of decentralized software systems and of edge to cloud approaches and on creating prototypes and using them to check whether the hypotheses are confirmed or not.</li> <li>- Case study development: after the preliminary experiments, industry-level case studies will be developed using the developed prototypes to demonstrate the effectiveness of the new contributions in real contexts.</li> </ul>
<p><b>Educational objectives</b></p>	<ul style="list-style-type: none"> <li>- Understand the main challenges of edge and cloud computing, decentralized systems, and of the computing continuum.</li> <li>- Learn how to apply the research methods listed above within the context of the proposed research project.</li> <li>- Learn how to write scientific papers.</li> <li>- Learn how to conduct research work in an international and multidisciplinary team.</li> <li>- Learn how to present the results of the developed research work.</li> <li>- Learn how to teach and guide younger researchers, typically, master students.</li> </ul>
<p><b>Job opportunities</b></p>	<p>The development of skills in the context of edge and cloud computing, decentralized systems, and IoT, are certainly a hype not just for IT-intensive companies. Being able to send, collect and analyze data from IoT devices, and managing such a complex system is becoming a must for many industries (e.g. Manufacturing and Utilities). In addition, electrical mobility is growing day by day worldwide. Employment in both research units or</p>



	production units is possible. Of course, the PhD curriculum opens up also the possibility to pursue an academic career in an international context.
<b>Composition of the research group</b>	1 Full Professors 1 Associated Professors 4 Assistant Professors 0 PhD Students
<b>Name of the research directors</b>	Prof. Elisabetta Di Nitto

<b>Contacts</b>	
elisabetta.dinitto@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>	NHOA Group: ATLANTE ( <a href="https://nhoa.energy/">https://nhoa.energy/</a> )
<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>	Eindhoven University of Technology (TUE) & Jheronimus Academy of Data Sciences (JADS) ( <a href="http://tue.nl">tue.nl</a> , <a href="http://jads.nl">jads.nl</a> )
<b>By number of months abroad</b>	6

<b>Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information</b>
<p><b>Attinenza PNRR</b></p> <p>Il Progetto di ricerca è attinente alle seguenti missioni del PNRR:</p> <ol style="list-style-type: none"> <li>1. Digitalizzazione, innovazione, competitività, cultura e turismo</li> <li>2. Rivoluzione verde e transizione ecologica</li> <li>3. Infrastrutture per una mobilità sostenibile</li> </ol> <p><b>Impresa, presso cui si svolgerà l'attività esterna</b></p>



6 mesi NHOA Group: ATLANTE <https://nhoa.energy/> sviluppo di una piattaforma atta a efficientare la gestione delle applicazioni eseguite in ambienti ibridi, nei quali il software è distribuito tra punti di elaborazione locali detti edge, e punti di elaborazioni remoti in Cloud. L'utilizzo di tecnologie di Computing Continuum abiliteranno tali sistemi ibridi ad indirizzare problemi legati alla latenza o alla differente capacità di elaborazione dei nodi presenti nel nostro sistema, garantendo così che i requisiti di performance e availability siano sempre rispettati. Tale approccio può essere rivoluzionario nel mondo eMobility e più in generale nel settore delle utilities, consentendo di garantire non solo la fornitura di servizi di rete front-of-the meter ma anche di ottimizzare le transazioni behind-the-meter in una comunità energetica. Tale piattaforma IoT-Edge-Cloud sarà composta oltre che da risorse in Cloud, da vari IoT devices e nodi di Edge computing installati presso le stazioni di ricarica rapida di Atlante.

**Ente, università, azienda, centro di ricerca presso cui si svolgerà il periodo di studio e ricerca all'estero**

6 mesi Eindhoven University of Technology (TUE), Jheronimus Academy of Data Sciences (JADS) [tue.nl](http://tue.nl), [jads.nl](http://jads.nl) Questa fase del lavoro di ricerca si concentrerà principalmente a valutare su larga scala il concetto, i costrutti teorici e la design solution proposta per il problema e percorso scientifico descritto, focalizzando l'attenzione sulla verifica della external validity cioè della generalizzabilità e utilizzabilità dell'approccio in ambiti diversi da quelli di concepimento e validazione in-lab. Nel contesto di questa fase, saranno strumentati e messi in opera una serie di studi controllati, casi studio, e altri tipi di esperimenti o espedienti empirici per ottenere la detta validazione. Sempre in questo contesto, è previsto il coinvolgimento diretto o indiretto di aziende terze e già partner del JADS o di Tue per creare un'impostazione di ricerca di tipo Action Research in modalità Living Lab in industria

**All information regarding educational activities, personal funding, regulations and obligations of Ph.D. candidates are available on the web site <https://dottoratoit.deib.polimi.it/>**