



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

Research Area n. 1 - Computer Science and Engineering

**THEMATIC Research Field: RETARGETABILITY AND LONG TERM SUSTAINABILITY OF IOT SOFTWARE SYSTEMS, A METHODOLOGICAL APPROACH**

<b>Monthly net income of PhDscholarship (max 36 months)</b>
<b>€ 1450.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

<b>Context of the research activity</b>	
<b>Motivation and objectives of the research in this field</b>	<p>The Internet of Things (IoT) has rapidly emerged as a transformative technology, facilitating seamless communication between users and devices. IoT products are increasingly prevalent in everyday life, from smart homes to industrial automation. However, developing a sustainable IoT product portfolio can be challenging due to device-level heterogeneity, operating system (OS) heterogeneity (RTOS vs Linux), and the overall lifespan of a product that can last years if not decades. Recent paradigms such as edge computing, which pushes computation towards end products to improve security and load balancing, may even exacerbate the costs of developing for device heterogeneity. Although developing industry standards for IoT devices and protocols can help reduce the cost of device heterogeneity and improve interoperability for end-users, companies must still identify appropriate software engineering methods to develop for device and OS heterogeneity with customized strategies. The primary objective of this research is to identify a novel methodology to support in a sustainable way the development of current and future IoT products at the scale and maturity level required by the industry. The specific research objectives are as follows-</p> <p>To gather formal or semi-formal requirements around the primary objectives from BTicino, also considering their</p>



	<p>current day to day practices. In particular, we foresee a context analysis and identification of the main pain points through interviews with a group of designers and R&amp;D managers to gather information on the current development practices and related issues and elements to improve.-</p> <p>To evaluate existing component-based software engineering, software virtualisation, design patterns and code generation techniques suitable for addressing the research objective.-</p> <p>To develop a methodology that harnesses such techniques especially considering the integration with current software development methodologies at BTicino.-</p> <p>To test the developed methodology on different case studies provided by BTicino.-</p> <p>To disseminate the research findings through publications, presentations and proof of concepts (PoC). We foresee a presentation of the activity every 4 months (indicatively) to a group of Bticino designers. The goal is to inform them on the progress of the work and collect useful feedback. When possible such presentations should be supported by demonstrators and proof of concepts inspired by the expected outcomes</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The expected outcomes of this research are a novel methodology that supports the development of sustainable IoT products that can be easily adapted and maintained. The methodology should mainly target RTOSes such as Zephyr and incorporate component-based software engineering, software virtualization, design patterns and code generation techniques to enable efficient development while reducing costs and time-to-market. The methodology should also be tested on different case studies provided by BTicino to ensure its applicability and effectiveness. The research findings will be disseminated through publications and presentations, which will contribute to the advancement of knowledge in the field of IoT software engineering. Ultimately, the outcomes of this research should provide guidance on how to develop sustainable IoT products that can adapt to device heterogeneity while reducing costs and time-to-</p>



	market. Results should be linked to a demo prototype or objective analysis at maximum TRL 4.
<b>Educational objectives</b>	<ul style="list-style-type: none"> <li>- Understand modular software architecture design principles.-</li> <li>- Learn virtualization and abstraction layer integration techniques.-</li> <li>- Apply software design patterns to IoT smart home systems.-</li> <li>- Develop proficiency in code generation and component-based engineering.</li> </ul>
<b>Job opportunities</b>	<ul style="list-style-type: none"> <li>.- IoT Software Architect for smart home systems.-</li> <li>- Firmware/Embedded Systems Developer in diverse industries.-</li> <li>- Research and Development Engineer in IoT advancements.-</li> <li>- Software Consultant for modular architecture and virtualization solutions.</li> </ul>
<b>Composition of the research group</b>	0 Full Professors 1 Associated Professors 0 Assistant Professors 0 PhD Students
<b>Name of the research directors</b>	Prof. Vittorio Zaccaria

<b>Contacts</b>
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<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>	725.0 €
<b>By number of months</b>	6

<b>Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information</b>
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.

**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