POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

INTERDISCIPLINARY Research Field: MODEL-BASED DIGITAL TWINS FOR SPACE CYBERSECURITY

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates or of changes of the scholarship minimum amount from the Ministry of University and Reasearch, during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Interdisciplinary PhD Grant The PhD research will be carried out in collaboration with research groups of the PhD programme in "**INFORMATION TECHNOLOGY**". See https://www.dottorato.polimi.it/?id=422&L=1 for further information.
Methods and techniques that will be developed and used to carry out the research	The proposed project has the ambition to 1) embrace digital twin concepts inspired by engineered resilient systems and 2) accelerate the adoption of model-based systems engineering (MBSE) within the space engineering community. The idea is to leverage new digital techniques to allow cyber security assessments, like those performed within cyber ranges, to deploy novel cyber threat intelligence and cyber threat analyses. The multidisciplinary MBSE approach proposed relies on the abstraction of the inherently multi-physics systems typical of the space domain, and is organized in four layers: 1) Modeling of the multidisciplinary systems from first principles, 2) Implementation of the mathematical/physical models into resilient and efficient numerical frameworks, so allowing system simulations at the fringe of their design space, 3) definition of real-life interfaces between the digital twins of the space/ground segments and a cyber range, and 4) developments of methods and tools for cyber threat intelligence and cyber threat analysis purposely developed for ground-based and

	space-segment assets. The proposed PhD project combines renowned expertise in the field of space systems modeling and simulation, and of cybersecurity threat modeling (with a specific emphasis on the peculiarity of cyber-physical systems). These two branches are both at the edge of research in their fields, and they are merged here to forge a novel research line. Within Polimi, there is a unique chance to pave the way for a massive collaboration between the two proposing research groups and to intercept the needs of the two communities. The added value of the project is in the synergy that can be deployed by the two research groups working together, with the PhD student acting as a pivot between them.
Educational objectives	The objective of this PhD is to develop skills in space system modelling and simulation as well as in space system cyber security. The candidate will gain relevant expertise in near-Earth and deep-space missions. Through this project, the candidates will develop skills in mathematical modeling, numerical analysis, computer programming (Matlab, Python, C++, or similar), and cyber security. Moreover, the candidate will develop skills in both computer and processor/hardware-in-the-loop simulations. Soft skills in disseminating the research, writing reports, performing outreach, and preparing industrial progress meetings will be also achieved through the PhD project.
Job opportunities	The current research prepares the PhD candidate for both academic and industrial careers. Knowledge of model-based system engineering, modeling, and simulation of space systems, as well as space system cyber security are fundamental skills for space careers in companies and universities.
Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 11 PhD Students
Name of the research directors	Prof. Francesco Topputo

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

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
The candidate will be hosted in the DART Lab (Deep-space Astrodynamics Research & Technology Laboratory) at the Department of Aerospace Science and Technology, Politecnico di Milano. During the PhD program, the candidate will have access to the facilities of the DART Lab to carry out experimental activities. The candidate will also have the opportunity to attend some PhD classes on both soft and hard skills. Moreover, there could be the possibility to carry out activities as a teaching assistant. The PhD candidate will receive a desk, a personal computer. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses, receive economic support to attend summer schools, and participate in conferences. There will be the possibility of paid teaching assistantship.