POLITECNICO
MILANO 1863

Supervisor Expression of Interest
MSCA-IF Marie Sklodowska Curie Action-Individual Fellowship

Supervisor name:	Maurizio Magarini
Email address:	maurizio.magarini@polimi.it
Department Name: Research topic: (https://www.polimi.it/en/scientific-research/research-structures/departments/)	• Department of Information, Electronics and Bioengineering (DEIB) • Molecular Communications
MSCA-IF Research Area Panels	☐ CHE_Chemistry ☐ ECO_Economic Sciences √ **ENG_Information Science and Engineering** ☐ ENV_Environmental and Geosciences ☐ LIF_Life Sciences ☐ MAT_Mathematics ☐ PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities ☐ Territorial Fragilities √ **Health** ☐ Industry 4.0
Brief description of the Department and Research Group (including URL if applicable):	DEIB is one of the largest European ICT departments, with nearly 1000 members, researchers, collaborators, PhD students, technical and administrative staff. The six department sections cluster consolidated competences in telecommunications, systems and control, computer science and engineering, electronics, bioengineering and electrical engineering. Research Transmission Group at DEIB is devoted to the main aspects of the information transmission systems. Its research focuses on communication and information theory. The Transmission Group, constituted by 8 professors and several post-doc researchers and PhD students, has spaces dedicated to PhD students within DEIB facilities, equipped with desktops and state-of-art software for analysis and system simulations. The supervisor currently coordinates four PhD students in technologies for mobile communications.

POLITECNICO
MILANO 1863

Brief project description: **(max 1 page)**	Molecular communication (MC) is an emerging technology directly inspired by natural cells' communications in biology where information is encoded into and decoded from molecules, rather than electrons or electromagnetic waves. Although MC has been envisioned at the forefront of novel bio-hybrid pervasive sensing, actuation, and computing systems, *i.e.*, the Internet of Bio-Nano Things, there is currently a gap between communication theoretical results and deployable technologies based on which MC systems can be designed and implemented. Recent advances in synthetic biology are providing new tools for the design, realization, and control of biological processes. The engineering of synthetic biological circuits, through genetic code manipulation, has enabled the programming of specifically designed functions to be executed by cells. Amongst diverse synthetic biology implementations, engineered cell-to-cell communication systems have been experimentally demonstrated, where controlled exchange of information molecules is implemented through biological circuits that include genetic programs to realize transmitting and receiving cells. As is well known communication systems are usually designed to transmit as much data as possible and to achieve low probability of error at the receiver. Considerations about the capacity limits of communication systems are studied by using concepts from information theory. Recent progresses in information theory have allowed to extend channel capacity considerations to a variety of diffusion-based MC mechanisms. In these mechanisms, the timing modulation, which conveyed information into the emitting time of molecules, guarantees a high transmission rate in the fluidic medium. The goal of the project is the developing of a method to compute the theoretical performance of an engineered cell-to-cell communication system, based on the stochastic simulation of biochemical reactions, which is utilized to understand the potential of an existing synthetic biology design, in terms of mutual information. Also, the design of digital coding schemes, working entirely in the biochemical domain, will be pursued based on the technology of biological circuit engineering from synthetic biology. Points that will be investigated are: detailed noise characterization of receiving and transmitting biological circuits; cellular reproduction and its impact on coding scheme performance; genetic mutations of biological circuits over time; study of energy requirements; interference of other transmitting cells and impact on performance; adaptation to a dynamic environment with multiple inputs and multiple outputs (MIMO); feasibility studies and analysis.