

Research options available for topic A

Research topics a) and b) offered by every Doctoral Course involved in UNIPH_D are frameworks within which every applicant has to present an original research project in collaboration with a Supervisor at the University of Padua.

Potential Supervisors at Unipd have proposed the following detailed research options, which are related to the research topic. They are offered as a guideline and should facilitate your contact with potential Supervisors. Supervisors' e-mail is specified in every research option table. You are welcome to contact them directly.

Note that this research option list is not at all exhaustive and, within the topic you have chosen, you are free to propose a different research project.

Doctoral Course	INFORMATION ENGINEERING
Macro-area	Physical Sciences and Engineering
Department name	Department of Information Engineering
Webpage	https://phd.dei.unipd.it/
Research topic A	<p>Ultra-reliable and low-latency wireless technologies for mission-critical applications</p> <p>The demand for ultra-reliable and low-latency wireless communication (URLLC) has been constantly growing over the last years, fueled by a number of relevant and challenging application scenarios, such as vehicular networks, industry 4.0, telemedicine, tactile Internet, and so on. URLLC has become one of the key requirements of 5G cellular systems, and is related to the H2020 Information and Communication Technologies calls under the Industrial Leadership pillar.</p>
Link to the UNIPH_D Call (Academic Year 2022/2023)	https://www.unipd.it/en/uniphd
Latest Update	12.01.2022
#Number of available Research Options	2 <i>Scroll down to see all the Research Options</i>

#1 Research Option Description

Doctoral Course	Information Engineering
Department name	Department of Information Engineering
Research topic A	Ultra-reliable and low-latency wireless technologies for mission-critical applications
Research option	Wireless management of swarm of autonomous mobile devices
Supervisor	Andrea ZANELLA (andrea.zanella@unipd.it), Michele ROSSI (michele.rossi@unipd.it), Michele ZORZI (michele.zorzi@unipd.it)
Webpage	www.dei.unipd.it/~zanella
Context of the research activity and objectives	<p>The demand for ultra-reliable and low-latency wireless communication (URLLC) has been constantly growing over the last years, fueled by several relevant and challenging application scenarios, such as autonomous driving vehicles, industry 4.0, telemedicine, tactile Internet, and so on.</p> <p>The project consists in the study of solutions to provide reliable wireless connectivity to mobile devices in challenging scenarios, e.g., in presence of high nodes' mobility, high link/node failure probability (battlefield, road accident, natural disaster scenarios), strict delay requirements and so on. Topics of interest include, but are not limited to, the design of multi-technology joint routing and scheduling algorithms for mobile networks (e.g., swarm of drones, or terrestrial autonomous vehicles); delay-sensitive transport protocols; machine-learning techniques to handle channel access among competing nodes for the transmission of critical information; joint path-planning and task scheduling of autonomous robots in factory scenarios; and so on. One target scenario regards the management of a swarm of flying or road autonomous vehicles that must coordinate to reach a common goal (e.g., the patrolling of a certain area or the accomplishment of a multi-stage task). Coordination is obtained by exchanging sensor data and other information by means of a communication plane whose key performance indexes may vary with the context and the considered applications.</p> <p>The research will leverage different tools, including mathematical modeling (stochastic processes, Markov chains, Markov decision processes, ...), machine learning (Deep Reinforcement Learning, LSTM, etc), simulations (ns3, SUMO, Carla).</p>
Infrastructures	The student will have access to high-performing computing clusters (with CPUs and GPUs), simulation tools.
Skills and competencies for the development of the activity	Strong background on classical telecommunication engineering topics (wireless channel, transmission/modulation techniques, network protocols). Good understanding of stochastic analysis and probability theory. Good programming skills (C++, Python, MATLAB).

Training offer	PhD Program courses and seminars: https://phd.dei.unipd.it/courses/
Possible Secondments	Mandatory secondment of 3 months at Aalborg University, Denmark. Optional secondment of 3 months at CTTC, Spain.

#2 Research Option Description

Doctoral Course	Information Engineering
Department name	Department of Information Engineering
Research topic A	Ultra-reliable and low-latency wireless technologies for mission-critical applications
Research option	Communication and sensing for autonomous vehicles and improved road safety
Supervisor	Andrea ZANELLA (andrea.zanella@unipd.it), Michele ROSSI (michele.rossi@unipd.it), Michele ZORZI (michele.zorzi@unipd.it)
Webpage	www.dei.unipd.it/~zanella
Context of the research activity and objectives	<p>The project consists in studying solutions to provide reliable wireless connectivity to mobile users in challenging scenarios, e.g., in presence of high nodes' mobility, high link/node failure probability (road accident, natural disaster scenarios), strict delay requirements and so on. One target scenario consists in instrumenting road vehicles (particularly, e-bikes, e-kick scooters) with sensing, processing, and communication boards, and developing context-aware decision making and coordination strategies with the aim to improve the safety for vulnerable road users (pedestrians, cyclists, kids, ...).</p> <p>The research will involve the development of demos and prototypes by means of embedded systems (e.g., the Infineon AURIX boards), and the implementation of the designed algorithms on such platforms for real-world testing. The aim is to prove the capacity of the road vehicles and users to acquire context-awareness by sharing sensors' measurements and other information and running coordination algorithms.</p>
Infrastructures	The student will have access to high-performance computing clusters (with CPUs and GPUs), simulation tools, and AURIX development kits provided by Infineon.
Skills and competencies for the development of the activity	Strong background on classical telecommunication engineering topics (wireless channel, transmission/modulation techniques, network protocols). Good understanding of stochastic analysis and probability theory. Good programming skills (C++, Python, MATLAB).
Training offer	PhD Program courses and seminars: https://phd.dei.unipd.it/courses/
Possible Secondments	Mandatory secondment of 3 months in Infineon s.r.l., Italy. Optional secondment of 3 months at Aalborg University, Denmark.