# RESEARCH INFRASTRUCTURES AND TECHNICAL SERVICES

## IOT


UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

# INTRODUCTION

The Universitat Politècnica de Catalunya – BarcelonaTech (UPC) is a national reference in research across all fields.

This catalog includes a range of scientific and technical services from our **research infrastructures** in the field of Internet of Things (IoT).

The rates are valid until December 31, 2024.

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# COMMUNICATION SYSTEMS

## INSTRUMENTATION, SENSORS AND INTERFACES LABORATORY

## NANOSAT LAB - COMMSENSLAB

## 6G OPENLAB

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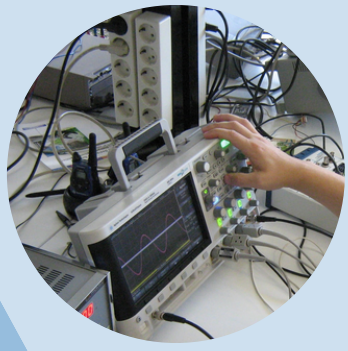
# INSTRUMENTATION, SENSORS AND INTERFACES LABORATORY

## ABOUT US

Search for new sensors and measurement methods based on variations in electrical impedance and electronic interfaces for the conditioning and processing of signals and energy to power them. The emphasis is on macrosensors based on low-cost technologies, autonomous and intelligent sensors, sensor networks, analog signal processing, data acquisition systems, design of measuring instruments and instrumentation systems, spectroscopy and electrical impedance tomography, reduction of interference and noise in instrumentation, measurement of physiological parameters with non-invasive methods and biotelemetry. Technology transfer in sensors and measurement systems for engineering and medicine.

## EQUIPMENT

- HP4291A Impedance Analyzer
- HP4191A Impedance Analyzer
- R & S ZVL3 Network Analyzer
- R & S SMB 100A Function Generator



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# INSTRUMENTATION, SENSORS AND INTERFACES LABORATORY (II)

## RATES (IVA not included)

| | |
|---|---|
| Schematic design and printed circuit board (PCB) | 34,03 € / h |
| Physical performance of PCB | 57,84 € / h |
| Welding and assembly of components | 69,74 € / h |
| Electronic prototype assembly | 60,81 € / h |
| Characterization of materials with measurements with HP4294A impedance analyzer | 62,60 € / h |

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# NANOSAT LAB

## ABOUT US

The facilities of the UPC NanoSat Lab have been designed to carry out environmental qualification tests (vibrations, and vacuum and thermal cycling), in a clean environment (Class 8 clean room) for the integration of payloads , subsystems and small satellites.
Outside the clean room, there are helmholtz coils and an air pad for carrying out the attitude control system pots.

## EQUIPMENT

- Vibration table
- Vacuum chamber
- Helmholtz coils

## RATES (IVA not included)

| | |
|---|---|
| Access to Nanosat Lab infrastructure | 1.350 € / day |

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# 6G OPENLAB

## ABOUT US

The infrastructure, in deployment phase, comprises an extensive field test bench for designing, deploying, validating, or monitoring different components, services, applications and protocols of 5G/6G technology.
This end-to-end multitechnology is based on a 5G/6G radio access network (FR1), WiFi6, WDM optical, millimeter-wave backhaul (FR2), TSN and MEC.
With a high-capacity core network (100Gbps), two data centers with AI/ML algorithms, measuring equipment (FR1, FR2, optical), and simulators/emulators (radio, WiFi, PON, etc.) deployed around the Castelldefels Campus and the UPC Nord Campus connected by a WDM optical network of over 25 km.

## EQUIPMENT

- Signal generators and converters for FR2 and FR1, 5G NR R15 with 2 channels 6GHz and 20 GHz.
- Network and signal analyzers up to 26 GHz.
- MEC emulators.
- Sensor network.
- Oscilloscope up to 33 GHz 4 channels.
- Backhaul stations in FR2 millimeter waves.
- Telit development kits.
- 5G emulators and simulators (Amarisoft, OpenAir interface, srsRAN).
- Edge computing elements based on NVIDIA ORIN with sub 6 5G, WiFi6, and positioning communications.

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# 6G OPENLAB (II)

## SERVICES

- Automation of the computing environment configuration. Provisioning, and management of 5G/6G network elements both in the core and access by combining with Multi-access Edge Computing (MEC) based on multicore technologies, containerization, and Kubernetes with GPU accelerators to run Deep Reinforcement Learning algorithms. xApp and rApp applications for the Open Radio Access Network (O-RAN).
- Field trials in controlled TSN-5G and 6G environments offering real-time process control for Industry 4.0, combining 5G gateways with TSN switches, with the potential to be centrally managed by DRL algorithms.
- Configuration, deployment, and functional validation of various elements, services, and applications using the open multi-domain and multi-operator 5G and 6G testbed, composed of Remote Radio Access (RRH) 5G+/6G, Base Band Units (BBU) 5G+/6G, Core 5G+ with MIMO techniques, high-capacity picocells, and MEC.

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# ARTIFICIAL INTELLIGENCE

- PERCEPTION AND MANIPULATION LABORATORY
- MOBILE ROBOTICS LABORATORY
- ADVANCED NETWORK ARCHITECTURES LAB
- IOC ROBOTICS LABORATORY
- COMPUTATIONAL ROBOTICS LABORATORY
- INNOVATION AND RESEARCH LABORATORY INLAB FIB
- CD6 LABORATORY
- OBSEA

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# PERCEPTION AND MANIPULATION LABORATORY

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## ABOUT US

The Perception and Manipulation Laboratory occupies 142 m2 on the second floor of the FME, and part of it houses a full-scale model of a small apartment (35 m2). Two TIAGo PAL mobile single-arm robots inhabit the apartment, but are occasionally taken out to experiment elsewhere. There is also a handling area equipped with four collaborative manipulator robots (two WAM and two KINOVA robots), and workstations are distributed along the perimeter. Next to the laboratory, with a direct view through a window, is the scientific-technical support office. The laboratory is also equipped with commercial and self-developed clamps, detection devices and augmented reality systems. The lab also hosted the Humanoids Lab Initiative in the past, and we still maintain 15 small humanoid robots for educational or promotional purposes.

## EQUIPMENT

- 2 robots TIAGO Steel PAL Robotics
- 2 manipulator robots WAM
- 2 manipulator robots KINOVA Gen3 Ultra Lightweight

## SERVICES

- Rapid experimental setup.
- Standardized software tools.
- Expertise in robot control and perception algorithms.

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# MOBILE ROBOTICS LABORATORY

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## ABOUT US

The Mobile Robotics Laboratory is an experimental area mainly dedicated to practical research with mobile robot devices.

The lab includes two service robots for urban robotics research based on Segway platforms, a dual mobile manipulator arm custom-built by the company PAL Robotics, a 4-wheel mobile robot for uneven outdoor terrain, a fully automated electric vehicle , 3 Pioneer robots, three autonomous aerial robots (from 500gr to 5Kg payload) and a large number of smaller robots, sensors and cameras. The laboratory is also equipped with an aerial test area (14x7m2) which includes an Optitrack positioning system of 20 IR cameras.

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# MOBILE ROBOTICS LABORATORY (II)

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## SERVICES

- Development of computer vision techniques, augmented reality, deep learning with applications in autonomous driving, human motion analysis, medical image processing, etc. 3D scanning of objects and people.
- Development of software and hardware for interaction between robots and humans with assistive applications, manufacturing, etc. Includes management of ethical aspects.
- Development of software and hardware to automate industrial processes, including the application of artificial intelligence techniques.

## EQUIPMENT

- Barcelona Robot Lab (10,000 m² pedestrian area to deploy robots in a real and controlled urban setting)
- Robot IVO
- Robots Tibi and Dabo
- Optitrack indoor testbed
- Robot Teo

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# ADVANCED NETWORK ARCHITECTURES LAB

## ABOUT US

The Advanced Network Architectures Laboratory supports the activities of the CRAAX research group, formally created in 2009 when it was recognized as an official research group by the Generalitat de Catalunya.
The main objectives of this laboratory are high quality research, student training and technology transfer.
Research activities carried out in the laboratory, usually in close collaboration with industry, set the right stage for PhD candidates to engage in real, close-to-market, potentially high-impact, innovative research.

## SERVICES

- Authentication of IoT devices and users in highly dispersed and mobile environments
- Predictive Maintenance tool for complex ICT systems
- System modeling tool (digital twin)
- Cloud continuum management system


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# ADVANCED NETWORK ARCHITECTURES LAB (II)

## EQUIPMENT

- Management of edge/cloud environments: Service optimization tool that allows the distribution of the different tasks within the set of resources between the device and the cloud.
- Authentication of users and IoT devices: Blockchain-based tool that allows authentication of users and IoT systems, particularly useful when working in highly mobile environments.
- Modeling by digital twin: A tool that facilitates the modeling of systems, currently defined in a preliminary phase by humans.
- Smart City Testbed: Allows the development and evaluation of services deployed in an emulated Smart City environment.
- Predictive Maintenance: Tool that allows advanced detection of AI-based attacks.

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# IOC ROBOTICS LABORATORY

## ABOUT US

The IOC robotics laboratory has robots, drones, mechanical hands, specific sensors, vision cameras, software programs and "haptic" devices in order to carry out research and testing in all the robotic projects that are developed at the center.

## SERVICES

- Robot-human interaction. Task and movement planning. Dexterous grip and manipulation. Co-working robots (“cobots”).
- Teleoperation and haptic systems. Computer vision.
- Robot control and programming. Simulation of robotic systems. Industrial applications of robotics.
- Sensory perception and integration systems.
- Service robotics. Robot task and motion planning, robot programming, specific applications of service robotics, dexterous manipulation.

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# IOC ROBOTICS LABORATORY (II)

## EQUIPMENT

### ROBOTS

- 2 Stäubli TX90 robots, one mounted on a rail.
- 2 Kuka LWR robots mounted on mobile platforms.
- A bi-arm omnidirectional mobile robot (with two UR robots as arms).
- An ABB Yumi robot.
- A PAL Tiago robot.

### DRONES

- DJI Phantom 2 Vision+.
- Parrot AR.Drone 2.0.

### DEXTEROUS MECHANICAL HANDS

- Schunk SAH.
- Schunk SDH.
- 3 Allegro hands.

### SPECIFIC SENSORS

- Magnetic trackers.
- Sensorized gloves.
- Touch sensors.

### VISION

- 2D – 3D cameras.
- 3D projector.
- VR Oculus Rift.

### SOFTWARE

- Motion planning and simulation software.

### HAPTIC DEVICES

- Phantom Omni.
- Phantom Premium 1.5/6DOF.
- Phantom Premium 1.5/6DOF High force.

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# COMPUTATIONAL ROBOTICS LABORATORY

## ABOUT US

The Computational Robotics Laboratory was created to investigate the computational and implementation aspects that arise in the design, construction, and control of advanced robotic systems. Among these systems we can highlight parallel robots, anthropomorphic robotic arms, intelligent prostheses, biomechanical support systems for movement or rehabilitation, or other robots of various topology that, due to having sensory capacity and of sufficient adaptation, they can interact with humans in an agile and safe way.

The activity of the laboratory focuses on the analysis and construction of robotic prototypes to validate positional analysis algorithms, collision detection, characterization of the configuration space, calculation of singularities, obtaining workspaces, kinematics and direct or inverse dynamics, or planning and optimal control of trajectories.

## EQUIPMENT

- The prototyping workshop (or maker lab)
- Manipulator robots, parallel and mobile.

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# COMPUTATIONAL ROBOTICS LABORATORY (II)

## SERVICES

- **COMPUTATIONAL KINEMATICS:** Problems of positional analysis, characterization of the space of configurations, calculation of singularities, and obtaining the working spaces of a complex mutisolid system. Continuation, pruning and bisection, or algebraic-geometric methods for solving these problems. Methods based on the geometry of distances. Applications to the positional analysis of biomolecules.
- **DYNAMIC ANALYSIS AND SIMULATION:** Methods for obtaining dynamic models of general multisolid systems. Algorithms for obtaining accurate simulations that can take into account the collisions of systems with their environment. Applications to robotic and biomechanical systems.
- **MOTION PLANNING:** Algorithms for finding feasible motions between two given configurations of a multisolid system, taking into account the kinematic, dynamic, and non-collision constraints of the system, as well as the limited motor capacity, or boundaries imposed by the finite resistance of the manufacturing materials. Obtaining energetically efficient trajectories in order to achieve long periods of autonomy in these systems. Calculation of minimum time trajectories.
- **MOTION CONTROL:** Control strategies that stabilize systems, either around a reference state, or along a planned trajectory. Optimal, nonlinear, and robust control techniques for multisolid systems with closed chains and singularities.

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# INNOVATION AND RESEARCH LABORATORY - INLAB FIB

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## ABOUT US

The mission of inLab FIB is to innovate and transfer knowledge to society in the field of ICT, through the development of human talent and the carrying out of multidisciplinary R+D+i projects.

The inLab FIB enjoys extensive experience of more than 30 years developing multidisciplinary ICT R&D projects, both in competitive projects (whether national or European projects) and in contracts with companies or public administration. Many of these projects are currently in operation and have made it possible to provide new solutions that have improved the competitiveness of the company or public administration by differentiating the services offered to customers. Information on all projects developed in recent years can be found in inLab FIB projects.

## EQUIPMENT

- 2 TIAGO Steel PAL Robotics robots.
- 2 WAM manipulator robots.
- 2 KINOVA Gen3 Ultra Lightweight manipulator robots.

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# INNOVATION AND RESEARCH LABORATORY INLAB FIB (II)

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## SERVICES

- **DATA SCIENCE AND BIG DATA:** Data management and analysis, Dashboarding and data visualization, predictive and classification models and advanced artificial intelligence (Deep Learning).
- **SMART MOBILITY:** Management of new mobility concepts, advanced traffic and mobility data processing, vehicle fleet management through real-time routing algorithms, micro, meso and macroscopic simulation of traffic, air quality prediction, analysis and improvement of intermodal and transport processes, machine learning algorithms to make traffic predictions.
- **KNOWLEDGE ENGINEERING AND SERVICES:** Data representation, information modeling and processing, requirements engineering, information systems, web technologies, Software as a Service, Internet of Things, innovation and research projects in knowledge management.
- **CYBERSECURITY:** Computer security (audits, forensic analysis, network monitoring), development of malware and electronic fraud detection systems, application security, training and awareness on cybersecurity.
- **MODELLING, SIMULATION AND OPTIMIZATION:** Digital twin - Feasibility studies and/or improvements of systems and processes through the use of modeling, simulation and optimization techniques applied to logistics and processes of the agri-food industry.

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# CD6 LABORATORY

## ABOUT US

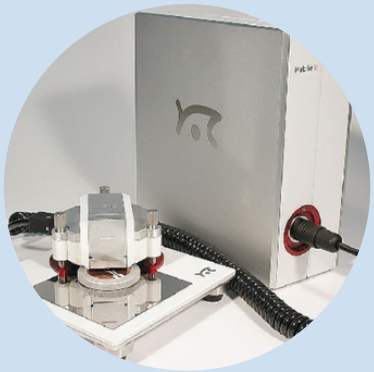
CD6 is an R&D center of the Universitat Politècnica de Catalunya, which operates in the field of optical and photonic engineering. CD6's activity is focused on applied research in the following areas: Optical Metrology, Visual Biophotonics, Optical Design, Color and Spectral Technologies, and Non-Destructive Optical Testing.

The CD6 has a team of 40 people with complementary experience (Optics and photonics, electronics, mechanics and software). This multidisciplinary combination helps to develop fully operational prototypes and develop solutions for industry, medicine, smart cities, etc.

Research at CD6 is focused on supporting innovation and entrepreneurial projects. The results have led to the creation of eleven spin-off companies that manufacture and market new products worldwide in different sectors and with leading global customers.

## EQUIPMENT

- Hyperspectral camera.
- UV-VIS-IR spectrophotometer.
- Optical profilometer.



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# CD6 LABORATORY (II)

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## RATES (IVA not included)

| | |
|---|---|
| Hyperspectral camera | 130 € / h |
| Liquid crystal tunable filter | 140 € / h |
| UV-VIS-IR spectrophotometer | 130 € / h |
| Radiometer - Photometer | 135 € / h |
| Telespecter - Colorimeter | 130 € / h |
| Polarimetric camera | 165 € / h |
| Spectroscopic ellipsometer | 130 € / h |
| Atomic force microscope | 130 € / h |
| Contact profilometer | 130 € / h |
| Optical profilometer | 205 € / h |
| Spectroscopic reflectometer | 130 € / h |
| Mechanical workshop | 40 € / h |
| Electronic workshop | 45 € / h |

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# OBSEA

## ABOUT US

OBSEA is a wired underwater observatory at a depth of 20 m, 4 km from the coast of Vilanova i la Geltrú, in a protected fishing area. It is connected to the coast by a mixed power and communications cable. It generates a high quantity of data and the infrastructure has developed a high knowledge of data management, communication networks, etc.

## SERVICES

- Provides uninterrupted power to scientific instruments.
- Provides a high bandwidth communication link.
- Real-time data is available and avoids problems encountered in battery-powered systems.
- An optical Ethernet network transmits data continuously from marine sensors connected to the observer
- Development of wireless energy transfer techniques and multiple access with low consumption criteria, Demonstrators and prototyping of communications solutions

## EQUIPMENT

- Surface buoy
- Hyperbaric chamber
- Climate camera
- CTD
- Hydrophone
- Seismometer
- Currentmeter
- Acoustic modems
- VEMCO Acoustic TAG Reader
- Crawler (IoV, Internet operated vehicle)

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# COMPUTATION AND CALCULUS

## JFF COMPUTER CLUSTER

## RDLAB

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# JFF COMPUTER CLUSTER

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## ABOUT US

The JFF Computer cluster has a total capacity of 3144 cores. This computing power is distributed as follows:

**JFF2 Cluster:** It has 128 nodes of 2 AMD Opteron Quad Core processors with 16 Gigabytes of RAM. The nodes are connected to an Infiniband DDR 4X network interconnect with latencies of 2.6 microseconds and a bandwidth of 20 Gbits / s. A total of 1024 colors.

**JFF3 Cluster:** It has 40 AMD Opteron 2 nodes with 16 cores for each CPU connected with 64 Gigabytes of RAM and an Infiniband QDR 4X network interconnect between nodes with latencies of 1.07 microseconds and a bandwidth of 40 Gbits / s. A total of 1280 colors.

**JFF4 Cluster:** It has 21 nodes of 2 Intel Xeon with 20 cores for each CPU connected with 192 Gigabytes of RAM and an Infiniband FDR 10X network interconnection between nodes with latencies of 0.7 microseconds and a bandwidth of 56 Gbits / s. A total of 840 colors.

## EQUIPMENT

- JFF2 cluster
- JFF3 cluster
- JFF4 cluster

## RATES (IVA not included)

| | |
|---|---|
| Usage of the computer cluster | 0,025 € / core per hour |

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# RDLAB

## ABOUT US

The Rdlab from the Computer Science department at the UPC has an exclusive service to support high - performance research computing.

The main services that we offer are:

- High Performance Computing (HPC) cluster with CPU and GPU support for research-intensive simulations and calculations.
- Execution of high-capacity simulations for national, European and technology transfer projects in the areas of Computer Science (Big Data, AI, Graphics and VR, Bioinformatics, Biomedicine...).

## EQUIPMENT

- High-performance cluster. Parallel file system with more than 200TB.
- More than 1000 execution cores with compute nodes of up to 64 cores, 256Gbytes of RAM and CUDA support for single (GTX3090/4090 blower) and dual (K20, K40, V100...) precision GPUs.
- Job and Execution Control Slurm Queue Manager - Dedicated Infiniband Data Network and 10Gbit Ethernet.
- JupyterHub support and interactive computing.

## RATES (IVA not included)

| | |
|---|---|
| Usage of the computer cluster | 0,025 € / core per hour |

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