

L2S, UMR 8506 CNRS

LABORATORY OF SIGNALS AND SYSTEMS



The laboratory of Signals and Systems (L2S) is a joint research unit of the CNRS, CentraleSupélec and the University of Paris-Saclay created in 1974. Research at L2S focuses on fundamental and applied mathematical aspects of control theory, artificial intelligence, data science, information, signal and image processing, communication, and network theory. The laboratory is organized into three main scientific domains: systems and control, signal processing and statistics, networks and telecommunications. Interdisciplinary themes related to life and health sciences, industry, and energy have an essential place.

Thematic groups

The laboratory is structured in 3 thematic groups:

SIGNALS AND STATISTICS GROUP

focuses on signal and image processing and statistical modeling. Research activities are inspired from data processing challenges in various application fields such as health engineering, nondestructive testing of materials, acoustics, remote sensing, astrophysics, transportation, electrical and mechanical engineering. Our research aims at proposing solutions to big and possibly heterogeneous data analysis, statistical learning, data mining, temporally and spatially correlated signal analysis, optimal design of experiments, and inverse problems in signal and image processing. The proposed methods and algorithms rely on various tools such as multivariate statistics, numerical optimization, random matrix theory, sparse representation, and Bayesian inference. The group is also interested in Algorithm-Architecture Matching issues, at the interface between signal processing and High Performance Computing. This activity aims at fully exploiting the significant potential of parallel computing of signal processing algorithms on GPU and FPGA hardware accelerators.

SYSTEMS AND CONTROL GROUP

deals with fundamental control theory methods and their applications. Its activities are carried out in a broad international context. Among its research interests, one can distinguish the following topics: modeling; estimation, identification and observation; stability, synchronization and robustness; geometric control; predictive and optimal

control; optimization, formal methods and artificial intelligence for systems and control; nonlinear, switched and hybrid systems; infinite-dimensional systems (PDEs, systems with time delays...); networked and multi-agent systems; stochastic systems. In parallel, applications are conducted through academic and industrial collaborations. They concern energy systems (smart grids, wind farms, energy conversion, batteries, electric vehicles, etc.); health and life sciences (neurosciences, oncology, bioreactors, artificial respiration, etc.); autonomous systems (robotics, cobotics, drones, autonomous vehicles, etc.); transport (automotive, aeronautics and rail); industry 4.0 and quantum technologies.

TELECOMS AND NETWORKS GROUP

carries out research in the field of wireless mobile and self-organizing networks, from Physical to Application layers. Its main interests are in cross layer design, coding, modeling and performance evaluation, as well as resource allocation. It also has a strong interest in the connection between communication and energy networks. It is making heavy use of such tools as joint source-protocol-channel coding and decoding, robust image and video compression, distributed source coding, game theory, information theory and stochastic geometry.

Projects

The laboratory takes part in various types of projects. These include:

- **9 European projects:** **ERC-PROCSYS** (Towards programmable cyber-physical systems: a symbolic control approach), **ICT-RISE 6G** (Reconfigurable Intelligent Sustainable Environments for 6G Wireless Networks), **RIA-ATHLETE** (The Exposome from Evidence to Translation), **MSCA-INTEGRATE** (joint wireless communication and sEnsinG by holographic surface Transceivers), **MSCA-META WIRELESS** (Future Wireless Communications Empowered by Reconfigurable Intelligent Meta-Materials), **MSCA-PATHFINDER** (Harnessing multipath propagation in wireless networks: A meta-surface transformation of wireless networks into smart reconfigurable radio environments), **MSCA-SURFER** (Surface waves in smart Radio Frequency Environments), **MSCA-TOAST** (Touch-enabled Tactile Internet Training Network and Open Source Testbed), **MSCA-5GSmartFact**

(Industrial Doctorate Training Network on Future Wireless Connected and Automated Industry enabled by 5G).

- **5 Industrial Chairs:** **APHP- Centrale-Supélec- INRIA Chair** (Exploration of frailty related to aging), **FORVIA** (Processing of Massive and Heterogeneous Data for Intelligent Vehicles), **ORANGE** (6G Durable), **RTE Chair** (Digital transformation of electricity networks), **TRANSVALOR** (Intelligence Artificielle pour la Simulation du Forgeage).

- **4 Industrial actions:** **Risegrid Institute** (Research institute for smarter electric grids, coordinated by L2S), **OpenLab with PSA** (Electrical engineering for mobility), **BPI WIFIP** (Surface waves in smart Radio Frequency Environments), **Scientific Interest Group LARTISSTE** in Uncertainty Quantification (Paris-Saclay area).

- **5 Projects in the frame of “Programmes d’Investissement d’Avenir”:** Institut DATAIA, LABEX DIGICOSME, OI HCODE, ITE “Super-Grid”, RHU REVEAL Reshape the Evaluation Efficiency and Accuracy of non-small cell Lung cancer.

- **Several ANR Projects:** BMWs, Dark-ERA, ESTHER, HANDY, HEIDIS, HERMIN, IGNITION, MAESTRO 5G, MindMadeClear, NEPTUNE 3, NICEWEET, Q-COAST, ReVeRY, RELOAD, ROCH, RubinVase, SAMOURAI, SMARTinMS, SPATIALX, UMICROWD, ZL-LVC.

HIGHLIGHTS 2023

- **Antoine Girard** was elevated to IEEE Fellow for “for contributions to formal verification and synthesis of cyber-physical systems”.



- **Antonello Venturino** and **Cristina Stoica** received the 2023 Control Engineering Practice Best Paper Award for the paper “Multi-vehicle localization by distributed MHE over a sensor network with sporadic measurements: Further developments and experimental results”, co-authored with Sylvain Bertrand, Teodoro Alamo and Eduardo F. Camacho.

- **Riccardo Bonnalli** received the 2023 IEEE Control Systems Magazine Outstanding Paper Award for the paper “Convex Optimization for Trajectory Generation: A Tutorial on Generating Dynamically Feasible Trajectories Reliably and Efficiently”, co-authored with D. Malyuta, T. P. Reynolds, M. Szmuk, T. Lew, M. Pavone, and B. Açikmeşe.



- **Gilles Chardon** is a chair holder of the AI program with Forvia (ex-Faurecia): Processing of Massive and Heterogeneous Data for Intelligent Vehicles.
- **Emmanuel Vazquez** was the general chair of the annual workshop of GdR Mascot-Num on Uncertainty Quantification (Le Croisic, April 2023, 130 participants).

- **Nabil El Korso** and **Charles Soussen** were appointed associate editors of IEEE Transactions on Signal Processing.

- The chair with Orange on “6G and sustainability” was inaugurated, and **Salah El Ayoubi** was appointed as its chairholder.



- **Marco Di Renzo** was the recipient of the IEEE COMSOC Fred W. Ellersick Prize.

- **Giuseppe Valenzise** was appointed as the Chair of the IEEE SPS MultiMedia Signal Processing Technical Committee.



SIGNALS AND STATISTICS

The Square Kilometer Array (SKA) radiotelescope in South Africa (left) and Australia (right)- SKAO credit. ANR Dark-era aims to tackle the SKA HPC challenges for the imaging pipeline



SYSTEMS AND CONTROL

Human-robot interaction test bench for co-manipulation control laws validation.



TELECOMS AND NETWORKS

Left : original uncompressed point cloud,

Middle : compressed point cloud using the proposed data-driven geometry compression method based on learned convolutional transforms,

Right : MPEG anchor.

Industrial Partners

- ALSTOM
- ATOS
- AVANTIX
- BRAKES
- BULL
- CEA
- CNES
- DxO
- EDF
- FALGUIERES
- FORVIA
- GE MEDICAL
- HITACHI
- HUAWEI
- IEEE
- IFPEN
- Institut Pasteur
- INTERDIGITAL
- IRCAM
- IRT SYSTEMX
- Just AI
- LNE
- MeilleursAgents
- MICHELIN
- MITSUBISHI
- NOKIA
- ONERA
- OpenLab PSA
- ORANGE
- PICKUP
- PSA
- RTE
- SAFRAN
- SHERPA
- SNCF
- STELLANTIS
- SYSNAV
- TCT
- THALES
- TOTAL
- TRANSVALOR
- VALEO
- VEDECOM

Academic Partners

At national level, the laboratory cooperates with most French laboratories of our areas of research.

At international level, the laboratory has 58 partnerships (38 in Europe, 10 in North America, 3 in South America, 2 in Australia, 4 in Asia, 1 in Africa).

Key figures

- Professors, Associate Professors & Researchers 97
- Engineers & Administrative staff 11
- PhD Students 90
- PostDocs 13
- Visiting Professors 9
- Publications of the year (WoS) 265

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