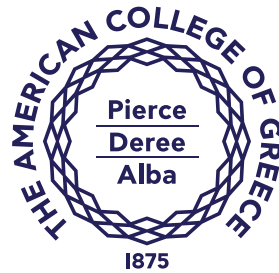


ACG 150

Futureproof Greece

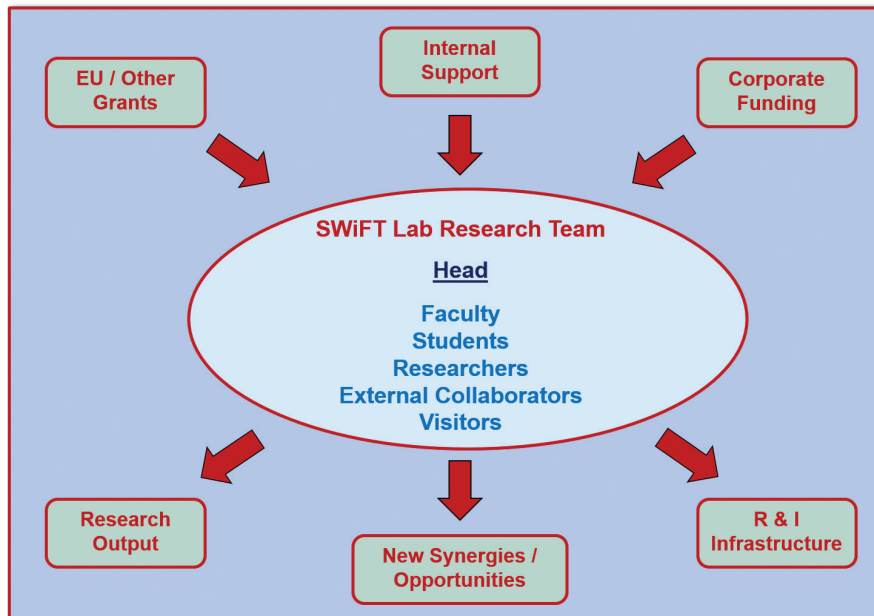


Smart Wireless Future Technologies (SWiFT) Lab An RTIN Research Laboratory at The American College of Greece

The Smart Wireless Future Technologies (SWiFT) Lab is the first research laboratory of The American College of Greece's (ACG) Research, Technology & Innovation Network (RTIN). The Lab's mission is to perform and demonstrate frontier research leading to intelligent wireless concepts, techniques and systems that can impact the shaping and usage of future networks, technologies and applications benefiting from wireless technology. Inspired by both the Stanford-incited Silicon Valley technology innovation paradigm and the MIT Media Lab's "Demo or Die" motto, ACG's SWiFT Lab equally values the development of theoretical breakthroughs of high potential impact and their experimental demonstration. To this end, it offers one of Southeast Europe's most advanced wireless research facilities.



SWiFT Lab Research Model



Overview

The SWiFT Lab hosts both theoretical and experimental work aimed at advancing state-of-the-art wireless technology and showcasing the corresponding findings. The involved research fields include:

- Communication system design; communication theory; interference management; cooperative communications; resource allocation; wireless access and backhauling; heterogeneous networks; hybrid terrestrial / satellite networks; wireless network security and policy reinforcement.
- Signal processing and machine learning techniques; constrained optimization; cross-layer optimization; adaptive filtering; wireless channel modeling and estimation; spectrum sensing and sharing; cm and mmWave systems; positioning techniques.
- Antenna design; multi-antenna and massive MIMO systems; hybrid antenna arrays; cell-free MIMO; wireless relaying and intelligent reflective surfaces; cloud-RAN; net-zero energy networks and non-terrestrial networks.

A number of emerging research fields, such as battery-less / passive RFID technology, simultaneous wireless information and power transfer, Terahertz wireless, visible light communication and quantum-enabled wireless transmission are also within scope. The theoretical work performed in the above areas is accompanied by a number of lab-grade prototypes and systems, over-the-air trials and measurement campaigns, based on an extensive hardware, software and instrumentation infrastructure that keeps being renewed in order to keep up with the experimental demands of novel and emerging systems and concepts.

Technology and Application Domains

The Lab targets wireless networks that range from body area networks and the Internet-of-Things (IoT) to next (6G) generation mobile broadband and satellite networks, as listed below:

- 5G and emerging 6G mobile networks
- Satellite, UAV-based and other non-terrestrial networks
- Fixed broadband wireless networks
- Personal and local area / WiFi networks
- The Internet-of-Things and wireless sensor networks

Smart power grids / net-zero energy networking, wireless as an enabler of human-computer interaction and cyber-security are also key themes within the lab's scope. Our device-oriented research targets wireless system components such as antenna modules and power autonomous sensors, handsets, access points and base stations. The developed technologies can benefit a large number of related industries / verticals, sectors and processes, such as the automotive industry and other transportation sectors, including aviation and shipping; the energy sector (smart energy networks / smart grid); the security and safety sector, including surveillance, emergency and first responder systems; the manufacturing sector; the municipal sector (e.g., smart cities); the medical industry; the agricultural sector, the space sector, the government sector (e.g., spectrum regulation, environmental monitoring); e-commerce; e-banking; social media; video-conferencing; content streaming and sharing platforms, etc. The intended and envisioned applications include location-aware spectrum management and services, smart manufacturing, intelligent transportation networks, energy-autonomous and non-terrestrial networks, wireless-based network security, biomedical systems and quantum-based wireless security.

Experience and Visibility

Through its researchers, members and collaborators, the SWiFT Lab maintains a strong track record in cutting-edge, theoretical and applied research, as well as technology innovation, aiming at technology readiness level (TRL) up to 4 or 5 (validation in laboratory / relevant environments, respectively). The Lab's activities are reflected in the generated publications, student theses, patent applications, funded research projects, industrial grants and participation in relevant think-tanks, technical / scientific committees, standardization activities, technology expert / leadership positions of its members, etc. We pursue high-caliber scientific publications, proof-of-concept demos and prototypes, as well as regulatory and standardization activities. As part of the ACG community, we collaborate with other faculty members and students from all ACG's schools and various departments. As part of ACG's RTIN unit, the SWiFT Lab also collaborates with other research teams of the unit and with the other ACG 150 Centers of Excellence and continuously explores innovation opportunities related to its research findings. These include the generation of intellectual property in collaboration with ACG's Tech Transfer Office, the link to innovation through the upcoming ACG Innovation Hub, as well as through its network of partners, collaborators, donors and investors.

Facilities and Lab Infrastructure

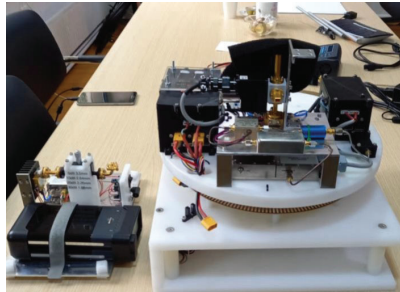
The SWiFT Lab benefits from state-of-the-art wireless research premises, as well as offices and meeting spaces for its members, collaborators and visitors, hosted on the main campus of The American College of Greece in Aghia Paraskevi in Athens, Greece. The Lab is an integral part of the campus, enjoying access to all the campus services and facilities (e.g., libraries, teaching auditoriums, science labs, meeting rooms, administrative services, social interaction spaces, etc.) and benefiting from interactions with the faculty, students and researchers of all ACG's schools, institutes and centers, as well as facilities in the other locales of ACG. Some examples of our research infrastructure follow.

Channel Sounders

The Lab is equipped with two mmWave channel sounders. These allow directional channel sounding at frequencies around 60 GHz. The first one, provided by the TIP Alliance, relies on a massive MIMO antenna array that provides electronic beam steering. The second one, on loan from Nokia US, provides mechanical steering through a rotational spinning platform.



Massive MIMO-based channel sounder



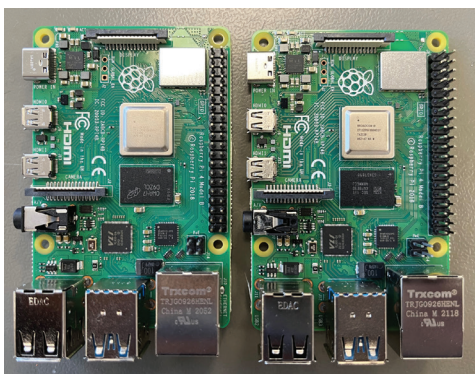
mmWave channel sounder provided by Nokia Bell Labs

Software-defined Radio and Programmable IoT Platforms

The Lab comprises several software-defined radio (SDR) platforms, for both broadband and narrowband (such as IoT) applications. These include a number of Universal Software Radio Peripherals (USRP™ by National Instruments – NI), a WARP SDR, a HackRF, several Arduinos and Rapsberry Pi's. Some indicative examples are shown below:



An NI USRP B210 software-defined radio modem



Programmable (Pi 4 Model B) Rapsberry Pi's

Measurement, Prototyping & Testing Equipment

The SWiFT Lab houses several measurement, prototyping and testing modules for the various experiments and demos that it runs. These include digital oscilloscopes and signal generators, a spectrum analyzer, a network analyzer, circuit design breadboards, a digital microscope, a laser cutter and a 3D printer. Some examples are shown in the pictures below.



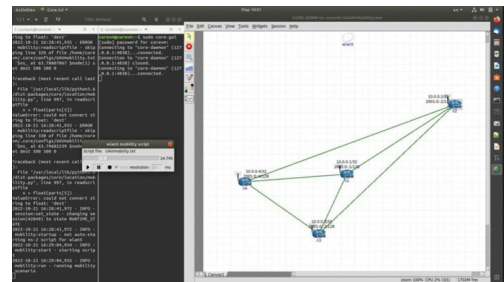
Lite vector network analyzer (VNA)



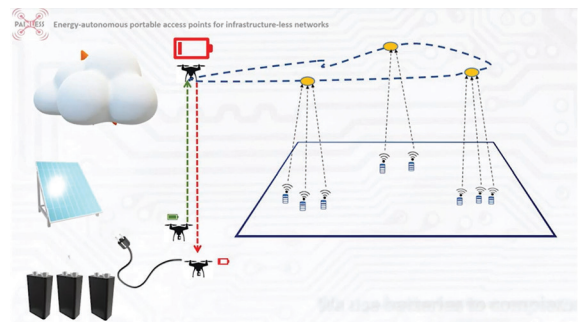
Laser cutter

Software Platforms

The Lab also features a number of software simulation tools and platforms, including some of its own. These include network simulation tools, electromagnetic simulation software, portable access point trajectory optimization software, SDR interfacing software, etc. Some examples are shown below.



Combined CORE / EMANE network simulator GUI



DRONESS tool for UAV trajectory optimization

Research Projects & Collaborations

The SWiFT Lab actively pursues and is engaged in a number of joint research projects and collaborations with the industrial and scientific community. Some examples are shown below.



• EU ITN Project PAINLESS

Energy-autonomous portable access points for infrastructure-less networks.

PAINLESS is a recently-completed multi-partner project within the framework of the H2020 Marie Skłodowska-Curie Innovative Training Networks (ITNs) of the Horizon 2020 Program of the European Commission, with a budget exceeding 4M€. It focused on energy-autonomous portable access for wireless networks beyond 5G. For more info, see <https://painless-itn.com/>.



• EU CHIST-ERA Project FIREMAN

Framework for the Identification of Rare Events via Machine learning & IoT Networks.

FIREMAN is an EU CHIST-ERA project on the topic of Big Data and process modeling for smart industry (BDSI) with a budget exceeding 1M€. It proposes an Internet of Things (IoT)-based industrial cyber-physical system (CPS) and its core goal is the development of predictive maintenance systems for Industry 4.0. For more info, see <https://fireman-project.eu/>.

• Nokia Bell Labs US project on mmWave channel measurements and modeling



This industrial collaboration with Nokia Bell Labs US focuses on an extensive set of channel propagation measurements for the characterization of directional mmWave channels in residential environments.

• Spirit Aeronautical Systems (S.A.S) – collaboration on UAV-based portable access prototyping



We have an ongoing collaboration with local company S.A.S. for the joint prototyping of a self-backhauled portable access point (PAP), based on a UAV platform provided by them.

Collaborators

The SWiFT Lab works with a large pool of external collaborators on a number of joint projects and publications, including visits, scientific collaborations, technology consulting, infrastructure sharing, etc. Our collaborating partners include academic institutions such as University College London, Trinity College Dublin, the University of Cyprus, Aalborg University, the University of Edinburgh, the University of Manchester, University Carlos III of Madrid, Telecom Paris Tech, KTH, University of Oulu, Lappeenranta-Lahti University of Technology, Technische Universität Darmstadt, Friedrich-Alexander-Universität Erlangen-Nürnberg, Technische Universität Berlin, Universitat Pompeu Fabra, Stanford University, New York University, Princeton University, Columbia University, Rutgers University, University Hassan II in Casablanca and several Greek Universities such as the National Technical University of Athens, the University of Athens, the University of Piraeus, the Athens University of Economics and Business, the Technical University of Crete, the Democritus University of Thrace, among others. We also collaborate with several research institutes, such as the National Center for Scientific Research "Demokritos," the Athena Research Center, Eurecom Institute, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), etc. On the industrial front, the SWiFT Lab collaborates with Nokia, Samsung, Huawei, Ericsson, Intel, National Instruments, Orange, Cosmote, OTE, Intracom Telecom, Intracom Defense, Nova and more. On the front of innovation, the Lab collaborates closely with the startup ecosystem and VC communities in Greece and Cyprus.



Portable wireless access live demo during PAINLESS Summer School at ACG

ACG 150

Futureproof Greece



Contact: Constantinos B. Papadias, PhD
Head, SWiFT Laboratory

Website:
<https://acg150.acg.edu/initiatives/institute-for-hellenic-growth-and-prosperity/research-technology-innovation-network/swift-laboratory/>

The American College of Greece
6 Gravas Street, 153 42 Aghia Paraskevi, Athens - Greece