

# Multi-Modal Optimization of 5G and 6G Hybrid Wireless and IoT Communication Networks in Switzerland

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The introduction of novel mobile communication technologies is often accompanied by vivid public debate concerning the possible health effects of the electromagnetic radiation emitted by telecommunication systems. Research programs to address human exposure to electromagnetic fields are commonly initiated contemporaneous to the debate and usually not until after each new technology (2G, 3G, 4G, and now 5G) is implemented. This reactive instead of proactive approach makes it impossible to assess and communicate in a timely manner the possible impacts on people's exposure, the environment, and the quality of the communication network.

With this project, we aim to address this shortcoming by assessing network performance and environmental effects of emerging and future wireless technologies – such as 5G millimeter-wave (mmW), 6G, and, more broadly, the Internet of Things (IoT) – before these advances are implemented.

The study is designed to extend the state of research and to be complementary to currently running HORIZON Europe projects, namely SEAWave, GOLIAT, and ETAIN (HORIZON-HLTH-2021-ENVHLTH-02-01 program), with a focus on future wireless technologies (6G and IoT networks) and their coverage and energy requirements, specifically on locations and the regulatory framework in Switzerland. The focus of the EU-funded projects is mainly on human and animal exposure due to 5G systems and networks.

The research topic is addressed holistically with a combined evaluation of uplink transmissions at user or IoT devices and downlink communication issues related to network infrastructure, base stations, and relay stations. A variety of endpoints will be evaluated – i.e., network capacity, bandwidth, coverage, energy consumption, radiation exposure, and the number of required base stations and relay sites. Based on existing 4G/5G infrastructure locations, a network simulation tool will investigate future wireless network topologies in Switzerland's urban, suburban, and rural geographical areas. In addition, the simulation tool will be extended to support: i) modeling of indoor exposure; ii) IoT networks dependent on cellular technologies; iii) 6G network concepts, such as the use of the D-band; and iv) absorbed power density (APD) as the dosimetric measure at frequencies above 6 GHz. The tool will then be used to plan, simulate, and optimize prospective wireless communication networks for the time horizon of 2030 – 2035 in Switzerland.

The study results will allow scientists and regulatory agencies to assess and forecast the impact of emerging (5G mmW) and future communication technologies (6G and IoT) on network capacity, human exposure, energy consumption, and the number of base stations and relay sites required. A proactive approach to answer these fundamental questions can prove to be a powerful tool in public discourse.