

Development of wireless communication antennas is typically realized using advanced computer simulation models. Upon design, the resulting structures undergo validation of real-world performance based on measurements of their manufactured prototypes. Given that antenna can be perceived a converter of signals between wired (guided lines) and wireless medium (air), it is characterized by duality of performance responses. Hence, appropriate protocols are required for their evaluation. On the wired side, antenna properties can be directly validated using specialized measurement equipment. However, wireless performance responses are obtained indirectly from a series of spatial experiments. The procedure involves evaluation of signals transmitted over the air between two antennas—i.e., the prototype and probe antenna, both connected to a suitable test gear—as a function of their spatial orientations.

Properties of wireless medium such as humidity, temperature, but also electromagnetic noise and signal reflections affect accuracy of antenna measurements. Consequently, a tight control over the environment is required to ensure high-quality of experiments which is normally ensured in professional antenna laboratories. These facilities are isolated from external sources of radiation and lined inside using specialized structures that suppress unwanted signals. Furthermore, they are equipped with precise equipment that orchestrates positioning and measurement of responses. Although capable of ensuring high accuracy (sufficient for certification), high cost of construction and maintenance make professional sites inaccessible for many applications such as budget-limited research or teaching. Furthermore, versatility of discussed facilities in terms of supported experiments or testing configurations is restricted by their design (i.e., installation in dedicated building/room, use of heavy gear, determination of frequency ranges at the laboratory design stage, etc.).

Potential alternative to professional sites involves the use of portable measurement equipment dedicated to operate in uncontrolled (a so-called non-anechoic) environments. Unfortunately, due excessive noise (unwanted wireless signals) and time-variant conditions, such simplified setups are unsuitable for reliable evaluation of antenna performance. To mitigate the problem, conventional measurements can be substituted by a two stage procedure where signals from the two antenna system are first acquired and then corrected using appropriate algorithms. The goal of the process is to reconstruct the performance of a prototype antenna through separation of desired signals from unwanted components of responses (i.e., reflections and electromagnetic noise). However, existing algorithms suffer from poor performance, over-reliance on engineering insight, and lack of scalability. Mentioned limitations make conventional methods unsuitable for correction of measurements performed in diverse uncontrolled conditions (indoor and/or outdoor), but also for evaluation of small antennas, or accurate extraction of complex radiation responses. The outlined problems indicate that, while promising in terms of cost and diversity of supported experiments and/or test environments, mobile non-anechoic systems are not a viable alternative to professional laboratories.

The aim of the project is to develop a robust, reliable and portable system for measurements of antenna prototypes in diverse uncontrolled environments. The platform will integrate inexpensive positioning gear with advanced algorithms for accurate evaluation of antenna performance in two complementary domains—i.e., far-field (with large separation between antennas that constitute the test system) and near-field (small separation between antennas) regimes—that normally require different testing equipment. Support for both domains is crucial to enable high flexibility in terms of antenna performance figures that can reliably and accurately extracted. To enable quick (below 30 minutes) and easy deployment, the system will feature a modular architecture with self-leveling towers, suitable gear, and robotic manipulator (required to ensure precise and unconstrained positioning for diverse measurement scenarios). The key novelty of the proposed platform lies in the development of advanced algorithms for automatic correction of measurements performed in uncontrolled propagation environments. The methods will be capable of self-adapting to operational conditions and further enhanced using suitable models to limit the number of experiments required for reconstruction of complex radiation responses with high accuracy and speed.

The proposed portable platform will enable reliable and robust experiments in challenging uncontrolled setups. The outlined capabilities will make the system of use for applications that include rapid prototyping, teaching, research, or in-the-field (including in-situ) experiments. At the same time, tight integration of hardware, software and advanced signal processing algorithms within the proposed platform will facilitate realization of antenna measurements in diverse indoor and/or outdoor setups at up to 100-fold lower cost (compared to professional laboratories) while ensuring high accuracy and repeatability of experiments.