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Multi-domain CAD Solutions for Energy Autonomous RF/microwave Systems

Invited talk

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There is an increasing number of application scenarios both civil and industrial that can take advantage of many miniaturized wireless systems, performing localization and sensing and featuring the concept of "pervasive intelligence". This is foreseen to be the added value in many fields, such as e-health [1], for continuous monitoring of patients, to extend their autonomy capabilities and normal life; industrial plants [2], for predictive maintenance and automation and e-mobility, for enhancing autonomous driving and integrated mobility among many others. With these goals in mind, one of the main challenging tasks is the need for maintenance-free and perpetual operation of such wireless system. To satisfy this goal, low-power technologies must be addressed in conjunction with the integration of energy harvesting sub-systems able to collect the needed power exploiting the radiative system on board of the sensors [3]. A block representation of such concept is provided in Fig. 1 where the coexistence of communication, sensing and energy collection and storage is represented together with the main operation requirements.
The scenarios described above can be implemented successfully only if an accurate co-design of the sub-system building blocks is carried out, for both the sensor systems and the energy provider, with the unmissable goal of ensuring overall energy efficiency, as depicted in Fig. 2.
This talk is dedicated to discussing accurate and efficient CAD techniques that can be adopted to reach these goals from both the energy provider sides and the EH subsystems. Possible RF architectures of transmitting and receiving systems for battery-less scenarios are analysed and the multi-domain design approach is discussed step-by-step, combining EM theory and EM numerical simulation with nonlinear circuit design. The final part of the talk will be dedicated to describe demonstrators such as a UHF/UWB system for high-precision localization (centimeter-level) and tracking, and a battery-less sensor network for predictive maintenance in machineries and industrial plants. Design challenges for both the transmitting and receiving subsystems are presented together with the performance achievements in real scenarios.

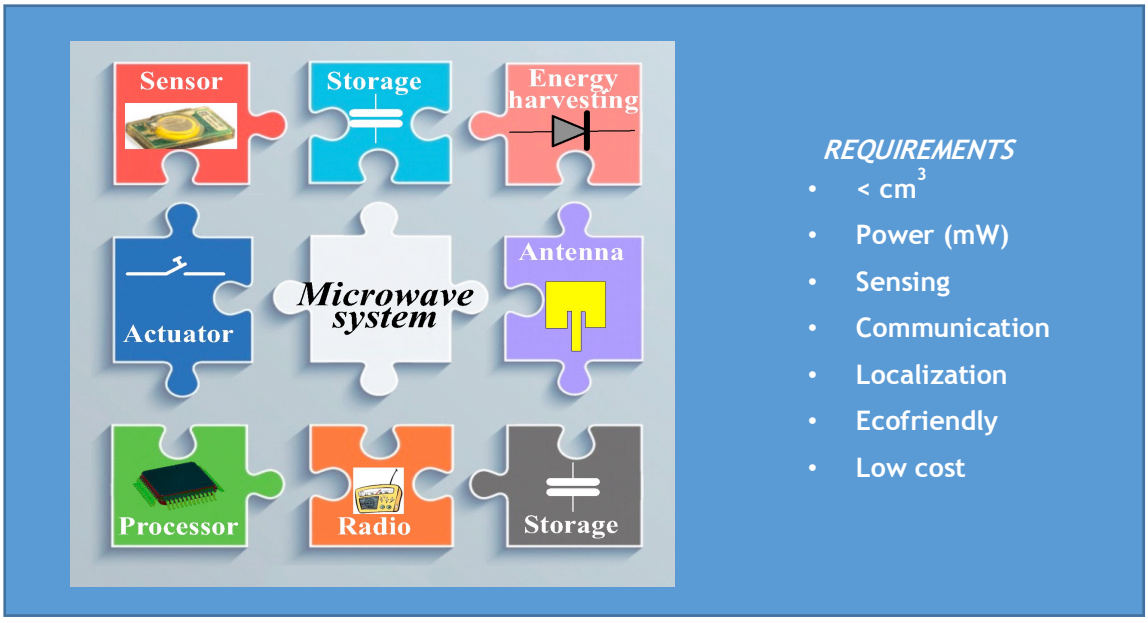

Figure 1. Schematic representation of a battery-less wireless node with energy harvesting communication and sensing capabilities [3].

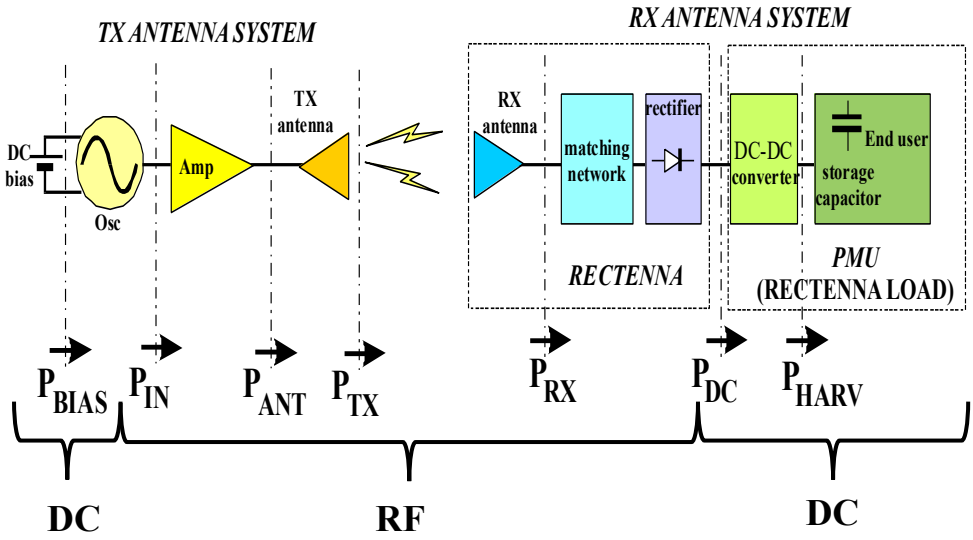

Figure 2. End-to-end circuit-level representation of a wireless power system [3].

References

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[2] G. Paolini, D. Masotti, M. Guermandi, M. Shanawani, L. Benini and A. Costanzo, "An Ambient-Insensitive Battery-Less Wireless Node for Simultaneous Powering and Communication," 2020 50th European Microwave Conference (EuMC), Utrecht, Netherlands, 2021, pp. 522-525, doi: 10.23919/EuMC48046.2021.9338073.

[3] A. Costanzo, D. Masotti, M. Fantuzzi and M. Del Prete, "Co-Design Strategies for Energy-Efficient UWB and UHF Wireless Systems," in IEEE T-MTT, vol. 65, no. 5, pp. 1852-1863, May 2017.