SCATTERING BY LOAD-MODULATED ANTENNAS
BACKGROUND AND SENSING APPLICATIONS

Speaker: Prof. J.Ch. Bolomey
(Emeritus Professor at University Paris-Sud XI, France)

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Note: The seminar will be held in English
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• Abstract
While transmitting and receiving properties of antennas are fully formulated and well understood, scattering issues remain more mysterious, even if they have been extensively exploited for a while in the antenna engineer practice for shaping radiation patterns, adjusting input impedances, or for characterization purposes. This presentation is more specifically focused on modulated scattering-based systems, which have been successfully developed during the last decades. Operating an antenna in a scattering mode allows avoiding any RF front-end, resulting in very simple and compact passive or battery-assisted transponders. These advantages are now widely exploited in low-cost RFID tags, as well as in low-invasive MST (Modulated Scatterer Technique) probes for EM-field measurements.

This presentation consists of two major parts. The first one consists of a short tutorial review of the minimum engineering background required for a comprehensive approach to modulated scattering systems. Small antennas will be more particularly considered because low-invasiveness and high spatial resolution constitute significant advantages in many sensing applications. The power budget, a key issue for such systems, is derived from a very simple reciprocity-based formulation. The advantage of this analytical formulation is to apply, whatever the distance, for arbitrarily complex scenarios. In addition, the influence of various parameters can be clearly identified, paving the way for optimizing the antenna design in terms of global system performance. Examples of both active and passive scatterers illustrate the efficiency of this approach.

The second part is more speculative and aims to identify transfer opportunities between RFID’s and MST technologies for sensing applications. As compared to existing MST probes, passive RFID tags offer, at a glance, the indiscutable advantage of being modulated from their own, without any wire or fiber. However, they may suffer autonomy/life time limitations and are constrained by standard regulations in terms of frequency range and power level. Furthermore, they exhibit specific technical difficulties, such as non-linearity of the IC chips loading the antenna. Various solutions to these drawbacks are addressed. Focusing on the case of systems involving arrays of modulated scatterers for its growing relevance in rapid imaging and wireless sensing (e.g. antenna measurement, industrial testing, medical diagnostic…), it is explained how the architecture of MST systems has conceptually changed during the last decades, primarily to face the critical sensitivity issue. Extrapolating such an evolution suggests promising solutions based on either RFID-derived or breakthrough technologies. To conclude, it is remembered that, while microwaves suffer no competition in the field of communications, they are loosing this comfortable privilege for Industrial Scientific Medical (ISM) applications where they must compete with many other efficient and already well-established modalities. In this competition, new modulated scattering technologies are reasonably expected contributing to valorize the specific advantages already recognized to RF- and microwave-based sensing modalities.

• About the Speaker
Jean-Charles Bolomey is currently an Emeritus Professor at Paris-Sud University. He graduated from the Ecole Supérieure d'Électricité (Supelec) in 1963, received his Ph.D. degree from Paris-Sud University in 1971, and became a Professor at this University in 1976. His research has been conducted in the Electromagnetic Research Department of the Laboratoire des Signaux et Systèmes, a joint unit of Supelec and the National Center for Scientific Research (CNRS).

Since 1981, his research contributions have been devoted to Near-Field techniques in a broad sense, including antenna measurement, EMC testing as well as Industrial-Scientific-Medical (ISM) applications. These contributions have largely concerned measurement techniques and have been deliberately oriented toward innovative technology transfer and valorization. Jean-Charles Bolomey has more particularly promoted the modulated probe array technology, demonstrating its univaled potential for rapid Near-Field scanning. He has co-authored with Professor P. Gardiol a reference book on principles and applications of the Modulated Scattering Technique (MST). He is holder of numerous patents covering various MST-based probe array arrangements for microwave sensing and imaging systems. In 1986, under the impulsion of the National Agency for Valorization (ANVAR) and of the CNRS, Professor Bolomey founded the Société d’Applications Techniques de l’Imagerie Micro-Orde (SATIMO), which is now considered as a leading company in the field of antenna measurement. He has been also involved in industrial applications of microwave heating as a Chairman of the Microwave Group of Electricité de France (EDF) and was appointed as a consultant by the Délégation Générale de l’Armement (DGA) in the field of High Power Microwave (HPM) metrology. He has also actively contributed to several cooperative European Programs ranging from medical hyperthermia to industrial process tomography and has contributed to various prototype transfer and evaluation procedures in these areas. Recently, his research was related to RF dosimetry and rapid SAR measurements for wireless communication devices. Professor Bolomey is now continuing his research on load-modulated scattering antennas, and, more particularly, novel sensing applications of RFID technology. He is also contributing as a member of several Scientific Advisory Boards of European Institutions (Chalmers University, Queen Mary London University) and startup companies.

Jean-Charles Bolomey has received several awards, including the Blondel Medal of the Société des Electriciens et des Electroniciens (SEE) in 1976, the Général Férét Award of the French Academy of Sciences in 1984, and the Best Paper Award of the European Microwave Conference (EuMC) in 1983. In 1994, he has granted the Schlumberger Stitching Fund Award for his contribution to inverse scattering techniques in microwave imagery. In 2001, he has received the Distinguished Achievement Award of the Antenna Measurement Technique Association (AMTA) for his pioneering activity in the field of modulated probe arrays, and in 2007, elected as Edmond S. Gillespie Fellow for AMTA. He received the 2004 Medal of the French URSI Chapter. He has obtained the 2006 H.A. Wheeler Best Application Prize Paper Award of the IEEE AP-Society for his co-authored paper on “Spherical Near-Field Facility for Characterizing Random Emissions”. Professor Bolomey is Fellow of the Institution of Electrical and Electronic Engineers (IEEE) and received the Grade Emeritus of SEE in 1995.