

## **T8. Game-Theoretic Techniques for the Energy Efficiency of Wireless Communications and Sensor Networks**

### **Abstract:**

The issue of energy efficiency, spectral efficiency, and resource optimization has attracted a huge interest by the information and telecommunication technology (ICT) community in the last decade, as witnessed by the vast literature available in this topic. In the field of wireless communications, efficiency can be achieved by operating at all different layers of the network, spanning from system architectures and protocols, to transmission techniques, and to opportunistic spectrum sharing, just to mention a few notable examples. Similarly, sensor networks with tight energy-efficiency constraints on the sensing nodes need careful exploitation of the available energy resources to send out the sensed values. Design and optimization methods of such networks are benefiting from the adoption of sophisticated optimization techniques at large.

Game theory, traditionally studied and applied in the areas of economics, political science, biology and sociology, has recently emerged as an effective framework for the design of a wireless network, since it provides analytical tools to predict the outcome of interactions among rational entities with conflicting interests, like communication nodes. Interaction of the users in a wireless network for communications or sensing can be modeled as a game in which the user terminals are the players in the game competing for network resources (i.e., bandwidth and/or energy), which are typically scarce. Any action taken by a user affects the performance of other users as well, and game theory turns out to be a natural tool for investigating this interplay. This tutorial provides an overview of the relevant applications of game theory in wireless networks, focusing on state-of-the-art techniques for resource allocation. The very basics concepts of game theory are introduced by means of many simple examples, and special emphasis is put on how to translate a real-world problem into an analytical game model.

### **Speaker's Biography:**

**Marco Luise, University of Pisa, Italy**

**Giacomo Bacci, University of Pisa, Italy, Princeton University, USA**

**Marco LUISE** is a Full Professor of Telecommunications at the University of Pisa, Italy. After receiving his M.E. and Ph.D. degrees in electronic engineering from the University of Pisa, he was a Research Fellow of the European Space Agency (ESA) at ESTEC Noordwijk, the Netherlands, a Researcher of the Italian National Research Council (CNR), at the Centro Studio Metodi Dispositivi Radiotrasmissioni (CSMDR), Pisa, and an Associate Professor at the Department of Information Engineering of the University of Pisa.

Prof. Luise is a fellow of the IEEE, and is the co-Editor-in-Chief of the International Journal of Navigation and Observation. He also served as an Editor of the IEEE Transactions on

Communications, and the European Transactions on Telecommunications, and as a Guest co-Editor of the Proceedings of the IEEE, IEEE Journal of Selected Areas in Communication, IEEE Journal of Selected Topics in Signal Processing, IEEE Signal Processing Magazine. He is also member of the Italian Committee of URSI and of the International Committee on Global Navigation Satellite Systems (ICG) of the UNO. Recently, Prof. Luise was the general chairman of EUSIPCO 2006, the general co-chair of European Wireless 2010, and will be the general co-chair of the IEEE Intl. Conf. Acoustics, Speech, and Signal Process. (ICASSP 2014), to be held in Florence, Italy, in May 2014. His main research interests lie in the broad area of communication theory, with particular emphasis on wireless communications, mobile and satellite communication, positioning and navigation systems, and software-defined radio technologies.

**Giacomo BACCI** received the B.E. and M.E. degrees in telecommunications engineering and the Ph.D. degree in information engineering from the University of Pisa, Pisa, Italy, in 2002, 2004, and 2008, respectively. Since 2005, he has been with the Department of Information Engineering, University of Pisa, where he is currently a Postdoctoral Research Fellow. In 2006–2007, he was a Visiting Student Research Collaborator at the Department of Electrical Engineering, Princeton University, Princeton, NJ. In 2008, he has also joined Wiser srl, Livorno, Italy, as a software engineer. From May 2012 to April 2013, he is also enrolled as a Visiting Postdoctoral Research Associate at the Department of Electrical Engineering, Princeton University, Princeton, NJ.

Dr. Bacci is the recipient of the FP7 Marie Curie International Outgoing Fellowships for career development (IOF) 2011, GRAND-CRU “Game-theoretic Resource Allocation for wireless Networks based on Distributed and Cooperative Relaying Units”. He is a member of the IEEE, and serves as a reviewer for many IEEE journals and many international conferences. He was the Publication Chair of Valuetools 2011, the Publicity co-Chair of NetGCoop 2012, and will be the Exhibition co-Chair at the IEEE ICASSP 2014. Recently, he organized invited sessions at EW 2010, EUSIPCO 2010, CrownCom 2011, and Asilomar 2012, and the 2010 Newcom++ Spring School on Cognitive Wireless Communication Networks. His research interests are in the areas of digital communications, signal processing, and estimation theory. His current research topics focus on resource allocation for multiple-access and relay-based wireless networks, time delay estimation for satellite positioning systems and wireless communications, and channel coding for IMT-advanced technologies.