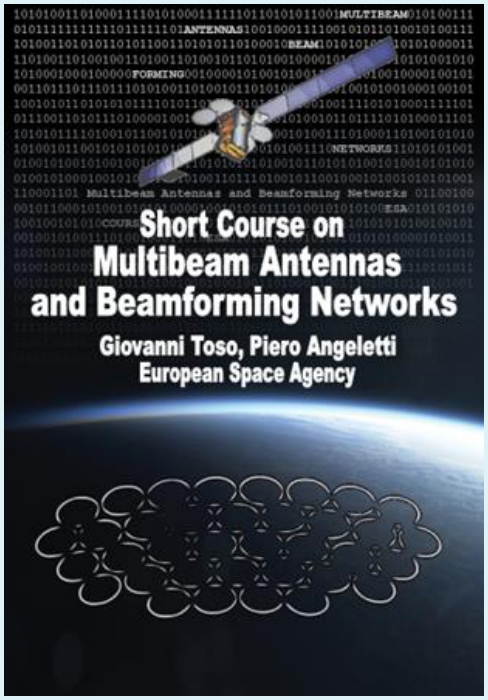
SC04 - Multibeam Antennas and Beamforming Networks



Abstract:

The objective of this course consists in presenting the state of the art and on-going developments in Multi-Beam Antennas (MBAs) and Beam-Forming Networks (BFNs). They find application in several fields including Communications, Remote Sensing (e.g. radars, radiometers, etc.), Electronic Surveillance and Defense Systems, Science (e.g. multibeam radio telescopes), RF Navigation Systems, etc. They may be installed on board satellites, airplanes, trains, buses, buildings, cars etc. MBAs and BFNs are becoming also fundamental elements in emerging MIMO and 5G communications. The course content is regularly updated by the organizers who are involved since more than twenty years in this domain

Recommended pre-requisites:

The course requires a basic knowledge on Antennas and Electromagnetism.

Learning Objectives:

1) know the antennas and BFN architectures adopted for multibeam applications;
2) understand the main challenges and criticalities in their design, manufacturing and operation;
3) understand the improvement in terms of capacity, field of view, flexibility, reconfigurability that these antennas and BFN can guarantee.

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Course Outline:

The objective of this course consists in presenting the state of the art and the on-going developments in Multi-Beam Antennas (MBAs) and Beam-Forming Networks (BFNs). MBAs find application in several fields including communications, remote sensing (e.g. radars, radiometers, etc.), electronic surveillance and defense systems, science (e.g. multibeam radio telescopes), RF navigation systems, etc. Multibeam antennas are assuming as well an important role in emerging MIMO and 5G communications. The BFN plays an essential role in any antenna system relaying on a set of radiating elements to generate a beam. The course will cover both theoretical and practical aspects for the following topics:

- Overview of system requirements
- Multibeam Antennas
  - o Linear and Planar Direct Radiating Arrays (based on Periodic or Aperiodic lattices)
  - o Reflector-based architectures (Single-Feed-per-Beam, Multiple-Feed-per-Beam)
  - o Lens-based architectures (free space and constrained)
- Beamforming Networks
- Analogue BFNs (Corporate, Blass, Nolen, Butler matrices)
- Digital BFNs
- RF Technology for Active Components
- Low Noise Amplifiers (LNAs, High Power Amplifiers (HPAs), T/R Modules, etc.
- Overview of some Operational Multibeam Antennas/BFNs
- MBAs for spaceborne Narrowband and Broadband Satellite Communication Systems
- MBAs for Wireless Communications
- On-going European Developments
- Current Design and Technological Challenges

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Instructors

Giovanni Toso (S'93, M'00, SM '07, FM '23) received the Laurea Degree (cum laude), the Ph.D. and the Post Doctoral Fellowship from the University of Florence, Italy, in 1992, 1995 and 1999, respectively. During his PhD and Post Doc he spent more than one year as a Visiting Scientist at the Laboratoire d'Optique Electromagnetique de Marseille, France. In 1999, he was a Visiting Scientist with the University of California (UCLA) in Los Angeles. In 2000 received a scholarship from Alenia Spazio, Rome, Italy. In the same year he has been appointed Researcher at the Radio Astronomy Observatory of the Italian National Council of Research (CNR). Since 2000, he has been with the Antenna and Submillimeter Waves Section, European Space Agency (ESA), European Space Research and Technology Centre (ESTEC), Noordwijk, The Netherlands. He has been initiating several research and development activities on satellite antennas based on arrays, reflectarrays, discrete lenses, and reflectors. In particular, in the field of onboard satellite antennas, he has been coordinating activities on multibeam antennas (active and passive) mainly for Telecom applications. In the field of Terminal antennas, he has been supporting the development of reconfigurable antennas with electronic, mechanical, and hybrid scanning; some of these antennas are now available as products. He has promoted the development of the commercial software tool QUPES by TICRA, now used worldwide, for the analysis and design of periodic and quasi-periodic surfaces, such as reflectarrays, frequency selective surfaces, transmitarrays, and polarizers. Dr. Toso received, together with Prof. A. Skrivervik, the European School of Antennas (ESoA) Best Teacher Award in 2018. In 2014, he has been the Guest Editor, together with Dr. R. Mailloux, of the Special Issue on "Innovative Phased Array Antennas Based on Non-Regular Lattices and Overlapped Subarrays" published in the IEEE Transactions on Antennas and Propagation and, for the same society, has been an Associate Editor from 2013 to 2016. In 2018, he has been the Chairperson of the 39th ESA Antenna Workshop on "Multibeam and Reconfigurable Antennas". Since 2010, together with Dr. P. Angeletti, he has been instructing short courses on Multibeam Antennas and Beamforming Networks during international conferences, such as IEEE Antennas and Propagation Society (APS), IEEE MTT International Microwave Symposium (IMS), IEEE International Conference on Wireless Technology and Systems (ICWITS), European Conference on Antennas and Propagation (EuCAP), and European Microwave Week (EuMW), that have been attended by more than 1300 participants. Together with Dr. P. Angeletti, he is the organizer of the EurAAP-ESoA Course on Active Antennas. From January 2023 Giovanni Toso has been elevated to IEEE Fellow grade for contributions to multibeam antenna developments for satellite applications.

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Piero Angeletti (IEEE M'07, SM'13) received the Laurea degree in Electronics Engineering from the University of Ancona (Italy) in 1996, and the PhD in Electromagnetism from the University of Rome "La Sapienza" (Italy) in 2010. His 25 years experience in RF Systems engineering and technical management encompasses conceptual/architectural design, trade-offs, detailed design, production, integration and testing of satellite payloads and active antenna systems for commercial/military telecommunications and navigation (spanning all the operating bands and set of applications) as well as for multifunction RADARs and electronic counter measure systems. Dr. Angeletti is currently member of the technical staff of the European Space Research and Technology Center (ESTEC) of the European Space Agency, in Noordwijk (The Netherlands). He is with the Radio Frequency Systems, Payload and Technology Division of the ESA Technical and Quality Management Directorate which is responsible for RF space communication systems, instrumentation, subsystems, equipment and technologies. In particular he oversees ESA R&D activities related to flexible satellite payloads, RF front-ends and on-board digital processors. Dr. Angeletti authored/co-authored over 300 technical reports, book chapters and papers published in peer reviewed professional journals and international conferences' proceedings.

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