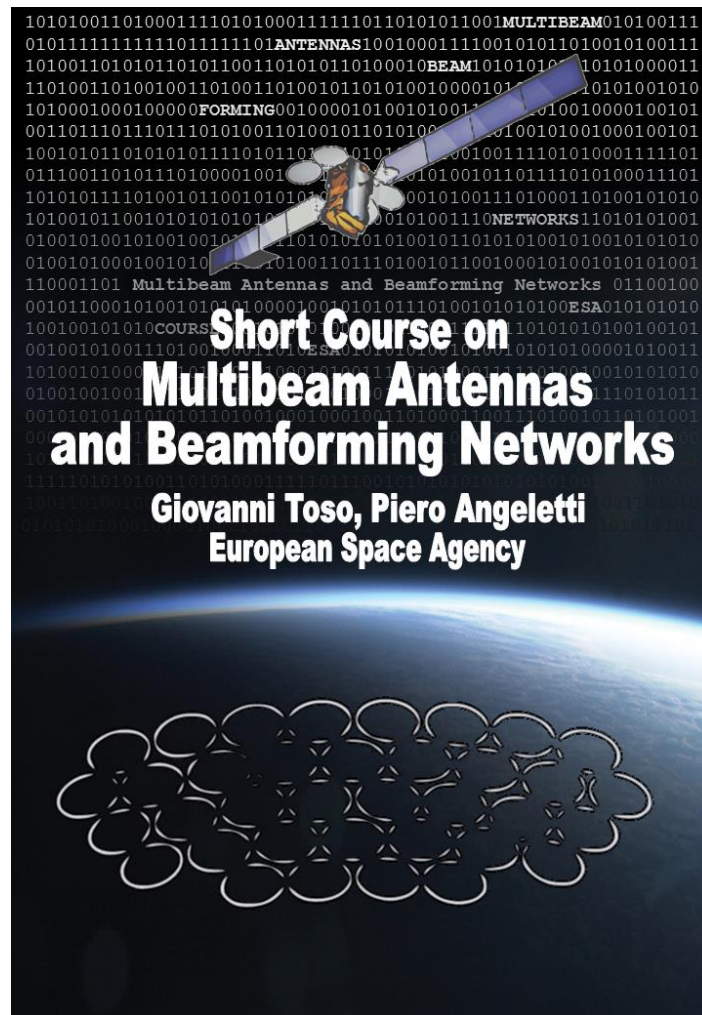


Multibeam Antennas and Beamforming Networks

Abstract

Multibeam Antennas are becoming more and more important in different areas for their performances, flexibility and reconfigurability. In particular, the topic is of interest for Space Applications but also for Radar Systems and Mobile Communications. In addition, multibeam antennas are assuming an important role in emerging MIMO and 5G communications. The course has been previously proposed during EUCAP, EuMW and IEEE conferences with excellent participation and feedbacks. The course content is updated regularly by the two co-authors who are deeply involved since more than twenty years in this field.

Graphical abstract



Recommended prerequisites

The course requires a basic knowledge on Antennas and Electromagnetism

Learning objectives

After the course the participant will be able to:

- 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;

Course outline

- Programme of the course. Please describe the format and content of the short course (200-300 words)*
- Any remarks, e.g. whether participants need to bring a laptop, etc.

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 relying 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
 - Linear and Planar Direct Radiating Arrays (based on Periodic or Aperiodic lattices)
 - Reflector-based architectures (Single-Feed-per-Beam, Multiple-Feed-per-Beam)
 - 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

Instructor 1 – Biography



Giovanni Toso (IEEE S'1993, M'00, SM '07) 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. In 1996 he was visiting scientist at the Laboratoire d'Optique Electromagnétique, Marseille (France). In 1999 he was a visiting scientist at the University of California (UCLA) in Los Angeles, he received a scholarship from Alenia Spazio (Rome, Italy) and he has been appointed researcher in a Radio Astronomy Observatory of the Italian National Council of Researches (CNR). Since 2000 he is with the Antenna and Submillimeter Waves Section of the European Space Agency, ESA ESTEC, Noordwijk, The Netherlands. He has been initiating and contributing to several R&D 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 for Telecom applications, he has been initiating several R&D activities on reconfigurable antennas with electronic, mechanical and hybrid scanning. G. Toso has been coauthoring the best paper at the 30th ESA Antenna Workshop and the most innovative paper at the 30th and 36th ESA Antenna Workshops. He holds about 20 international patents. In 2009 he has been coeditor of the Special Issue on Active Antennas for Satellite Applications in the International Journal of Antennas and Propagation. In 2014 he has been 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 (2013-2016). Since the first edition in 2006 he has been significantly contributing to the ESoA course on Satellite Antennas. Since 2010, together with Dr. P. Angeletti, he has been instructing short courses on Multibeam Antennas and Beamforming Networks during international conferences (IEEE APS, IEEE IMS, IEEE IWCS, EUCAP, EuMW) that have been attended by more than 600 participants. In 2018 G. Toso has been the chairman of the 39th ESA Antenna Workshop on "Multibeam and Reconfigurable Antennas" and received, together with Prof. A. Skrivervik, the Best Teacher Award of the European School of Antennas (ESoA).

Instructor 2 – Biography



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 20 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 200 technical reports, book chapters and papers published in peer reviewed professional journals and international conferences' proceedings.

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