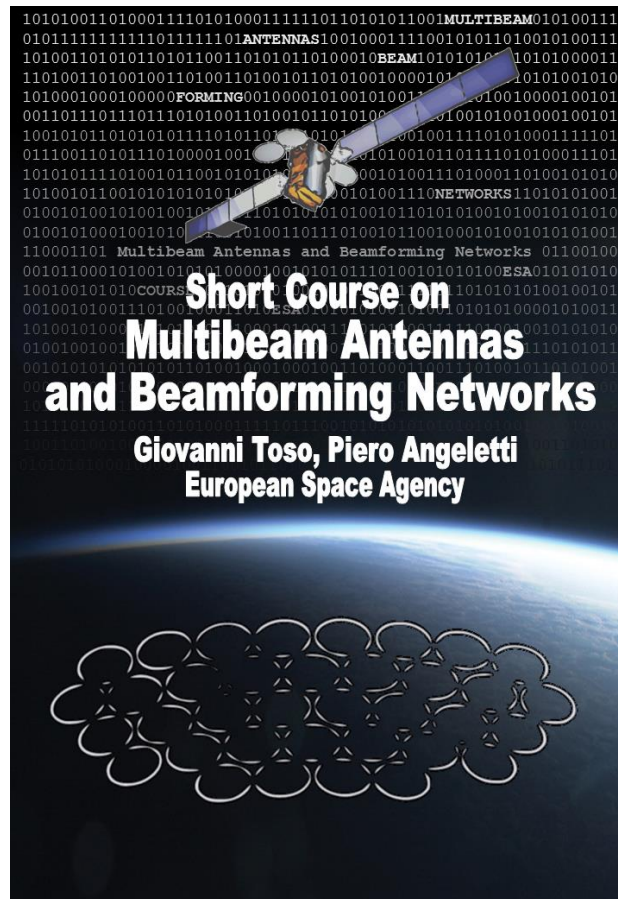


## Multibeam Antennas and Beamforming Networks

### Abstract

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). 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 five years in this domain.

### Graphical abstract



### Recommended prerequisites

The course requires a basic knowledge on Antennas and Electromagnetism.

### Learning objectives

- 1) know the main types of 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

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
  - 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. 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 several R&D activities on satellite antennas based on arrays, reflectarrays, discrete lenses and reflectors. In the field of onboard satellite antennas, he has been coordinating activities on multibeam antennas mainly for Telecom Applications. In the field of terminal antennas, he has been initiating R&D activities on reconfigurable antennas with electronic, mechanical and hybrid scanning. 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 900 participants. In 2018 G. Toso has been the chairman of the 39<sup>th</sup> ESA Antenna Workshop on "Multibeam and Reconfigurable Antennas" and received, together with Prof. A. Skrивervik, the Best Teacher Award of the European School of Antennas (ESoA). G. Toso is the organiser of the new ESoA course on Active Antennas.

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

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