

KEYNOTE TALK

The Role of millimeter-wave Beamforming and Integration Technologies on Non-Terrestrial Networks

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Abstract –

This presentation explores the critical technologies underpinning the next generation of global communication. The talk posits that Non-Terrestrial Networks (NTNs), which utilize satellites and other aerial platforms, are becoming a core part of our communication infrastructure to meet the growing demand for ubiquitous, high-bandwidth connectivity. A central challenge highlighted is the significant infrastructural cost required to build these systems.

The presentation identifies millimeter-wave (mm-wave) phased array antennas as a foundational technology for enabling the directive, dynamic communication links that NTNs require. It examines the key design choices and trade-offs, including various beamforming architectures such as analog, digital, and hybrid. A significant focus is placed on integration domains—Printed Circuit Board (PCB), package, and chip (MMIC)—arguing that the ability to increase circuit density is crucial for reducing costs and managing the complexity of advanced mm-wave systems.

To illustrate these principles, the lecture presents numerous examples, including currently available commercial user terminals, the historical cost reduction of Transmit/Receive (T/R) modules, and state-of-the-art integrated circuits for SatCom applications.

Looking ahead, the presentation identifies NTNs as a key component of future 6G system architectures. It concludes that further innovation is necessary to reduce costs and power consumption. This will be achieved through the development of new beamforming architectures, improved component efficiency, and a reduction in the overall complexity of hardware design.

Speaker:



Luigi Boccia (S'00–M'03) was born in Lungro (Italy), in 1975. He received his MSc in Information Technology Engineering from the University of Calabria in 2000 and his PhD in Electronic Engineering from the University "Mediterranea" of Reggio Calabria in 2003. Since 2005, he has been with the University of Calabria, where he is currently an Associate Professor of Electromagnetics and scientific coordinator of the Millimeter-wave Antennas and Integrated Circuit (MAIC) Laboratory. He teaches courses on microwaves and RF integrated circuits. Previously, he held research positions at the European Space Agency (ESTEC, NL), the University of Birmingham (UK), and the University of Surrey (UK). He also co-founded the university spin-off AnTecnica in 2018.

His research focuses on antenna systems, high-frequency integrated circuits (particularly SiGe BiCMOS/CMOS for phased arrays), and RF system integration. Application areas include satellite communications (K/Ka-band), 5G and beyond mobile communications, automotive radar, and remote sensing.

Dr. Boccia co-edited the "Space Antenna Handbook" (Wiley, 2012). He is an IEEE Distinguished Microwave Lecturer (2024-). He currently serves as an Associate Editor for the International Journal of Microwave and Wireless Technologies and IEEE Antennas and Wireless Propagation Letters. He has been involved in numerous research projects funded by the EU, ESA, and industry, often in coordination roles.