Bandwidth Efficient Techniques for Mega-constellation based Non-Terrestrial Networks

Research project plan

Tutor: Prof. Alessandro Vanelli-Coralli

(alessandro.vanelli@unibo.it)

The research activity roots into the H2020 Space-tec-29 funded project Dyansat (www.dynasat.eu) and addresses the design and assessment of **Bandwidth Efficient Techniques for Non-Terrestrial Networks based on mega-constellations**.

The proposed activity encompasses the study, design, and implementation of multi-satellite cooperative multiuser Multi Input Multi Output (MIMO), beam hopping, multibeam precoding with user clustering, and advanced interference management. In particular, the activity will assess and possibly demonstrate how such techniques, part of which have been already adopted in terrestrial networks, e.g., the coordinated multipoint transmission (COMP), can be designed for satellite architectures and can significantly improve the performance of a satellite network infrastructure, fully integrated in the 5G ecosystem for future Non-terrestrial Networks. Emphasis will be given to the very Low Earth Orbit satellites mega-constellations with and without regenerative payload.

The activity will address, but will not be limited to, the design and assessment of digital beamforming techniques with distributed antennas, e.g., multi-satellite transmission with reference to a scenario consisting of a dense constellation of very Low Earth Orbit Satellites each one equipped with a low-cost radiating element. In particular, the activity will be organized as follows

- definition of representative system scenarios;
- analysis of the existing literature of digital beamforming;
- analysis of the existing literature of digital beamforming for a distributed antenna system;
- analysis of the terrestrial COMP techniques;
- analysis of the existing literature of vLEO cooperative transmission;
- development of the system model, i.e., mathematical modeling, of the scenario under consideration;
- design and implementation of centralized and distributed algorithms for digital beamforing assuming cooperative and non-cooperative satellites, i.e., distributed optimization;
- performance analysis
- writing of scientific publications, project reports, and standardization contributions.

The project will be carried out in the framework of the DYNASAT funded H2020 Space-tec-29 research project currently coordinated by the Digicomm Research group of the Department of Electrical, Electronic, and Information Engineering (DEI) at the University of Bologna.

The research environment is international and challenging. The working language is English. It is expected a strong interaction with several ongoing European Commission and European Space Agency initiatives.

The activity will be performed by using mathematical tools as well as numerical simulation mainly based on Matlab and C++.