

Terrestrial and Aerospace Broadband Radio Transmissions (Tera-BIT)



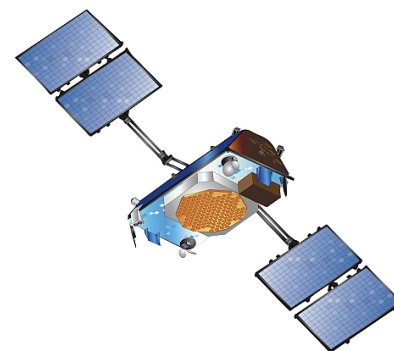
UNIVERSITY OF TRENTO - Italy
Information Engineering
and Computer Science Department

MASTER THESIS PROJECT PROPOSALS: SIGNAL PROCESSING FOR WIRELESS AND SATELLITE COMMUNICATIONS



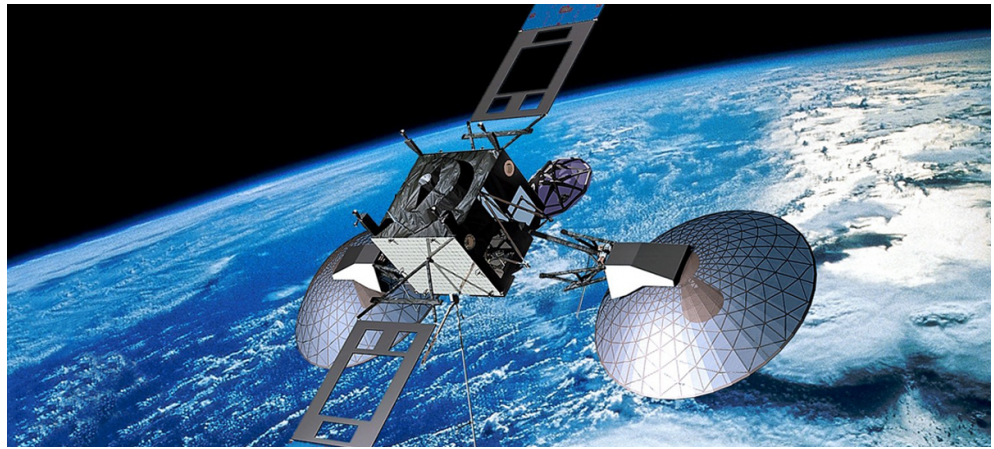
Prof. Claudio Sacchi

Academic year 2017-2018



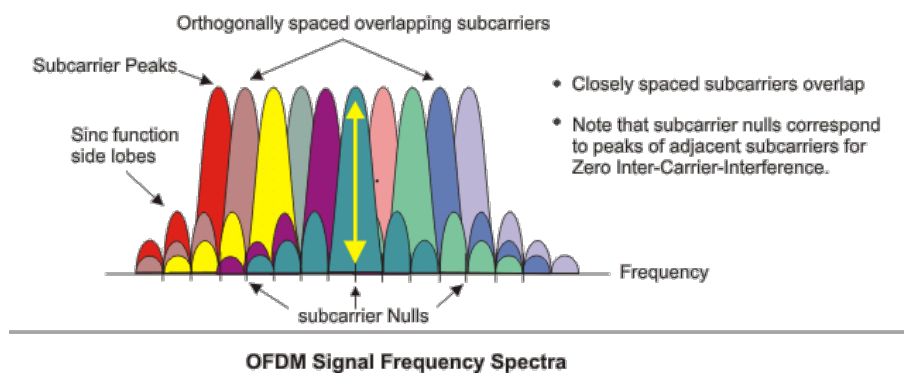
General rules

- The listed thesis projects are specifically available for Master Students coming from **University of Trento**, MSc. course on Telecommunications Engineering;
- BUT: if a Master student enrolled in another university (Italian, EU, extra-EU, etc.) was strongly committed to work on one of such projects, this is, in principle, allowed PROVIDED THAT he can find an internal supervisor of his/her University interested to the topic of the project as well and be ready to work in remote modality with my research group;
- **Pre-requirements** for the proposed thesis works are:
 - *Programming skill (MATLAB, SIMULINK, C, C++);*
 - *Capability of critically analyzing literature and state-of-the-art;*
 - *Capability of timely delivering software tools and reports;*
 - *Serious commitment and attitude to autonomous research.*
- Submission of papers to international journals and conferences at the end of the thesis project is welcome and strongly encouraged.



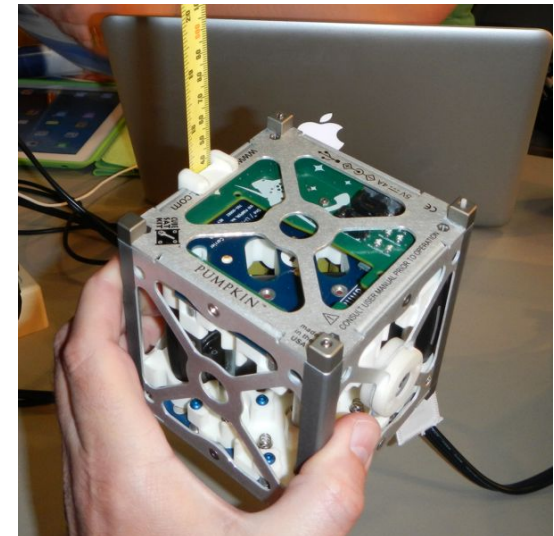
INTERNAL THESIS PROJECTS

What 5G is about



P1: Reconfigurable SDR satellite transceivers

- **Framework and scenario:**
 - Small satellites (cubesats) operating at low frequency bands (2 GHz);
- **Project topics:**
 - Study of communications constraints and impairments of Cubesats;
 - Software-Defined-Radio (SDR) based waveform reconfigurability: narrowband single-carrier, Spread Spectrum, OFDM and/or SC-FDMA: study of a formal criterion for PHY-layer reconfiguration;
 - Simulation of a modular SDR-based reconfigurable satellite modem;
 - Performance analysis by means of simulations and cost/benefits analysis (with tradeoff).

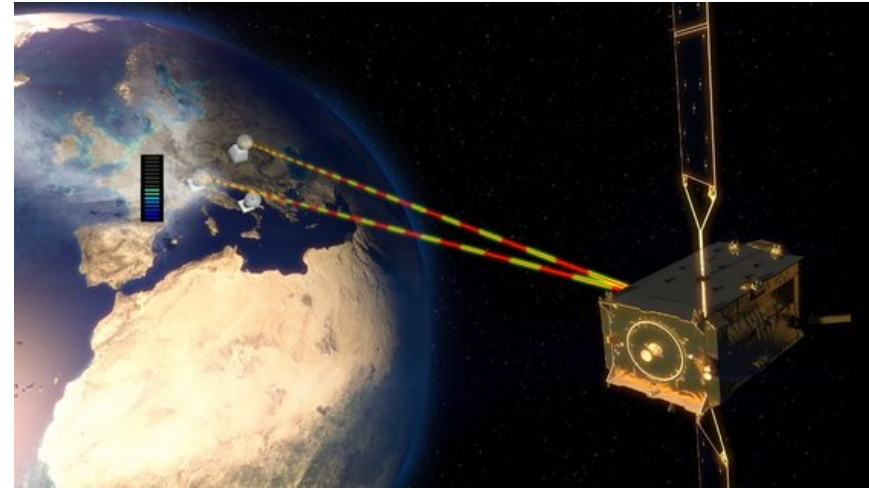


SOFTWARE TOOLS TO BE USED: MATLAB

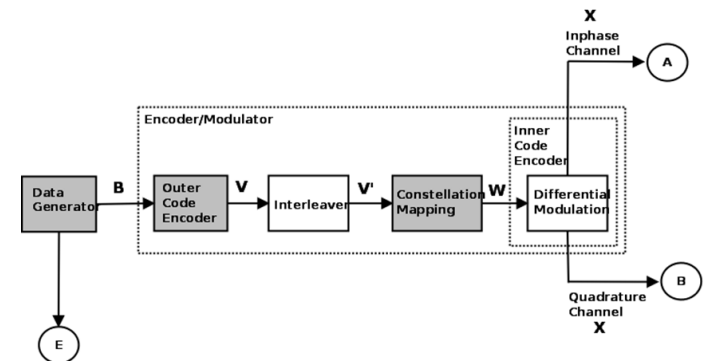
Supervisors: **Claudio Sacchi (UNITN)**

P2: Iterative detection for turbo-coded satellite OFDM

- **Framework and scenario:**
 - Broadband satellites using OFDM modulation, non-linearly distorted by High-Power-Amplifiers.
- **Project topics:**
 - Implementation of state-of-the-art differential turbo-coded modulation for OFDM systems with related (non-coherent) iterative decoding;
 - Nesting of iterative channel estimation and equalization in the iterative decoder;
 - Channel distortions due to phase noise and nonlinear amplifier distortions;
 - Performance analysis by means of simulations – comparison with state-of-the-art solutions (coherent OFDM, CE-OFDM, etc.)



ESA Alphasat's 'Aldo Paraboni Q/V Band' hosted payload



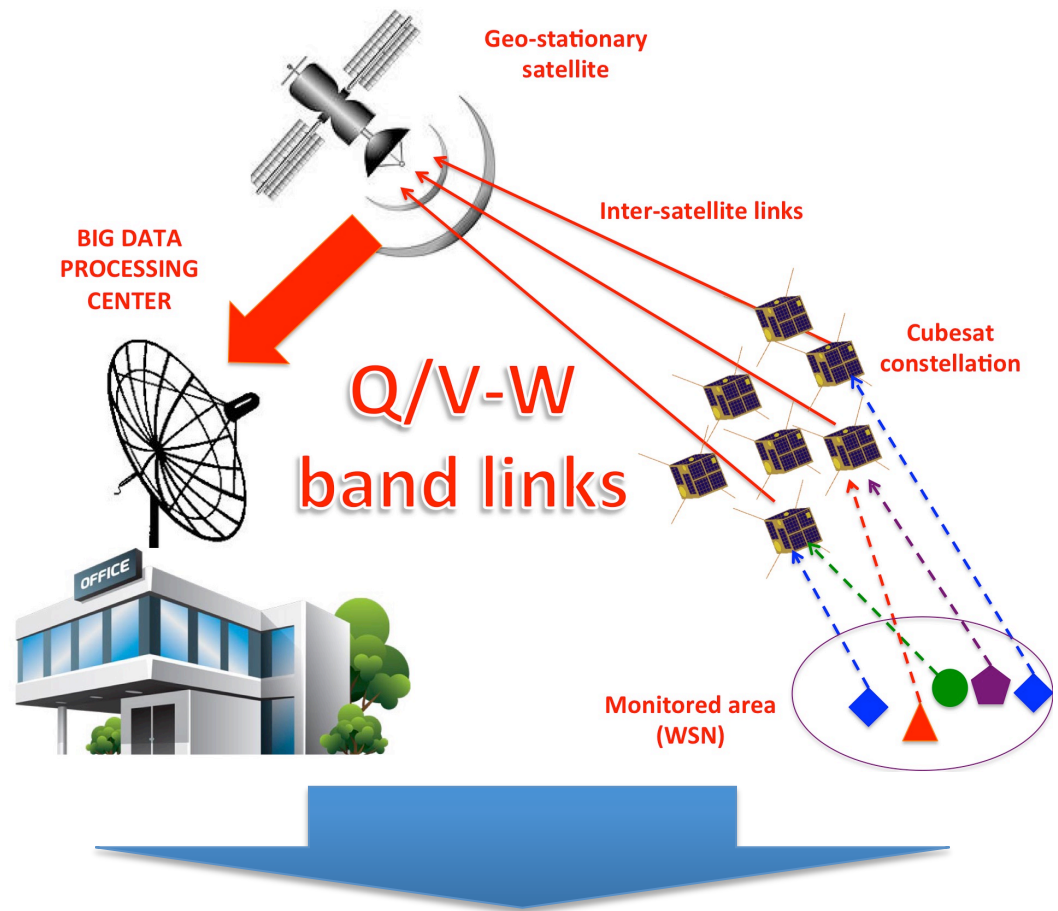
Thesis in cooperation with Dalhousie University (CANADA)

Supervisor: **Claudio Sacchi** (UNITN), *Co-supervisor:* **Christian Schlegel** (Dalhousie)

**SOFTWARE TOOLS TO BE USED: MATLAB/
SIMULINK**

P3: IoRT and satellite communications

- Framework and scenario:
 - Internet of Remote Things (IoRT) for environmental monitoring and/or emergency communications;
- Project topic:
 - Development of efficient WSN-cubesat multi-user transmission techniques;
 - Analysis of link performance of the end-to-end transmission chain (Earth-Cubesats, ISL link, GEO Downlink);
 - Analysis of overall link throughput.



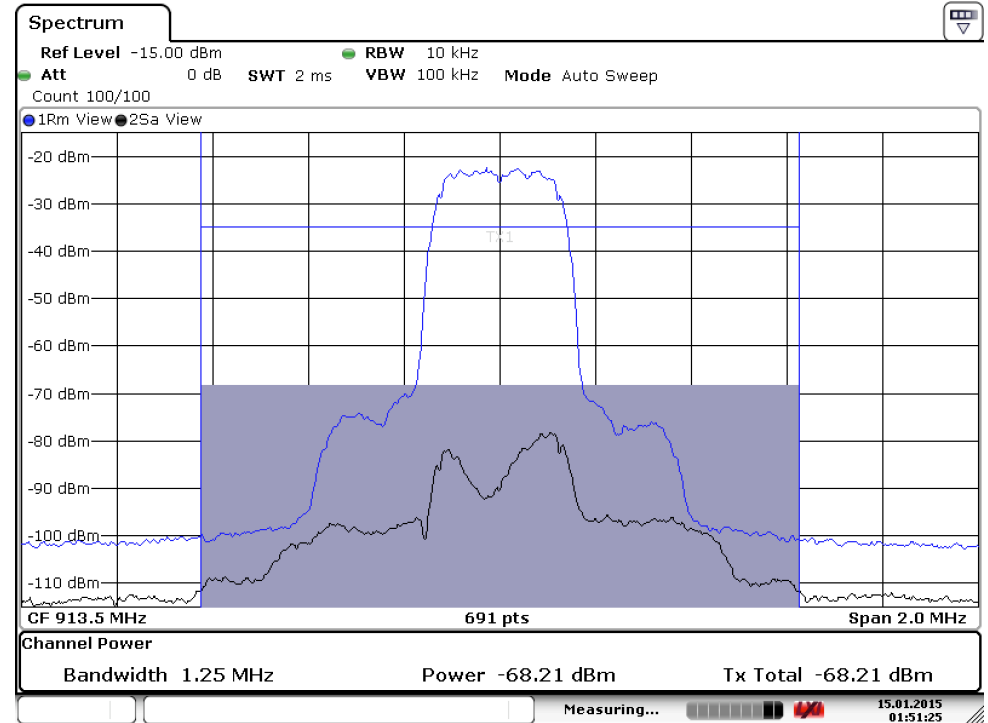
Internal supervisors: **Claudio Sacchi, Fabrizio Granelli** (UNITN)

External supervisor: **TBD** (from an external University)

SOFTWARE TOOLS TO BE USED: MATLAB (TBD)

P4: Full-duplex EHF satellite communications

- Framework and scenario:
 - Full-duplex LEO/GEO satellite communications;
- Project topic:
 - Analysis of full-duplex interference in satellite EHF (Q/V, W-band) channels;
 - Iterative interference cancellation and channel estimation in the RF and baseband domain;
 - SDR-oriented implementation.



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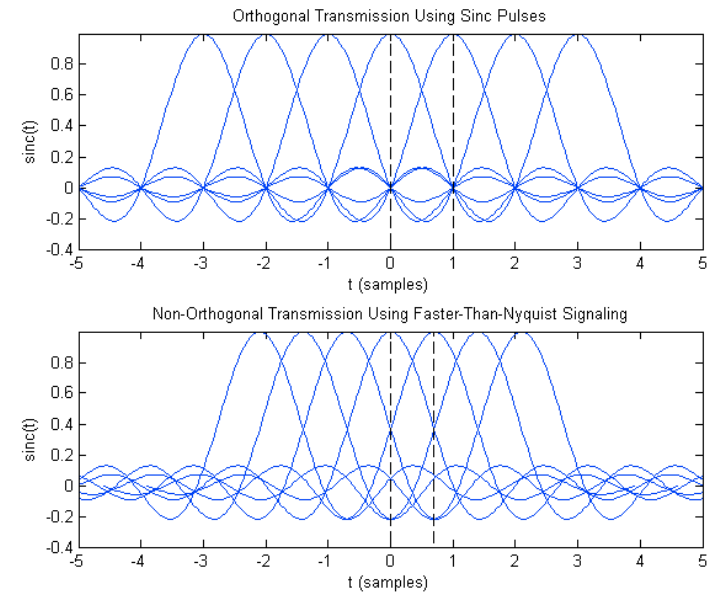
Thesis in cooperation with Dalhousie University (CANADA)

Supervisors: **Claudio Sacchi** (UNITN), *Co-supervisor:* **Christian Schlegel** (Dalhousie)

**SOFTWARE TOOLS TO BE USED:
MATLAB SIMULINK**

P5: SDR implementation of multicarrier systems

- Framework and scenario:
 - SDR implementation of new waveforms with cognitive capabilities;
- Project topic:
 - Implementation and testing of Faster-than-Nyquist (FTN) transmission systems over open-source SDR platforms;
 - Comparison with OFDM and FBMC in cognitive emulated scenarios.

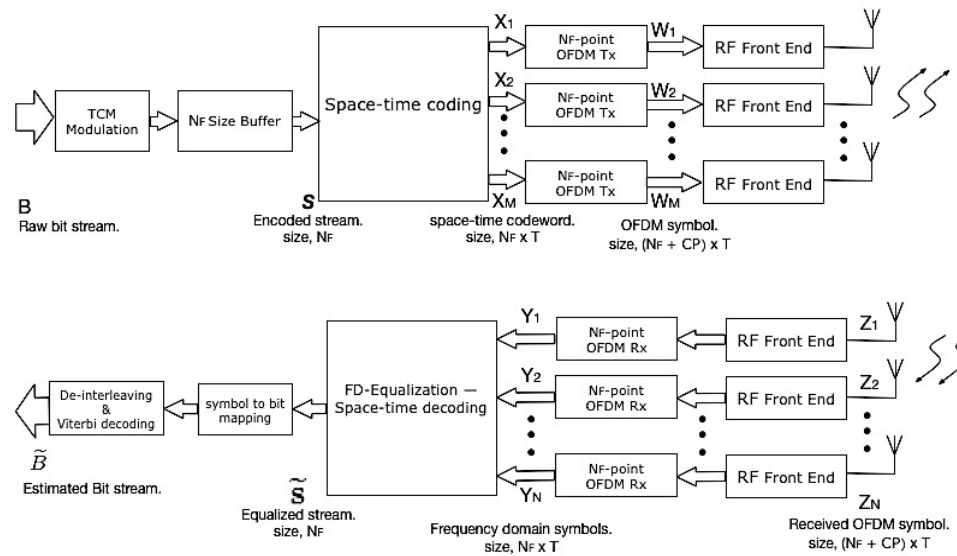


SOFTWARE TOOLS TO BE USED: OPEN SOURCE GNU-RADIO (OR LABVIEW) AND FPGA-BASED USRP HARDWARE PLATFORMS

Supervisors: Claudio Sacchi, Fabrizio Granelli (UNITN),

P6: SDR implementation of virtual MIMO coding

- Framework and scenario:
 - Advanced Space-Time MIMO (ST-MIMO) coding techniques based in virtual (cooperative) MIMO configurations;
- Project topic:
 - SDR implementation of Space-Time Shift Keying (STSK) with OFDM transmission in 2x2 virtual MIMO transmission configuration;
 - Comparison with Spatial Modulation and Spatial Multiplexing in virtual MIMO configurations.



SOFTWARE TOOLS TO BE USED: OPEN SOURCE GNU-RADIO (OR LABVIEW) AND FPGA-BASED USRP HARDWARE PLATFORMS

Supervisors: Claudio Sacchi, Fabrizio Granelli (UNITN),

P7: Optimum detection of CE-OFDM signals

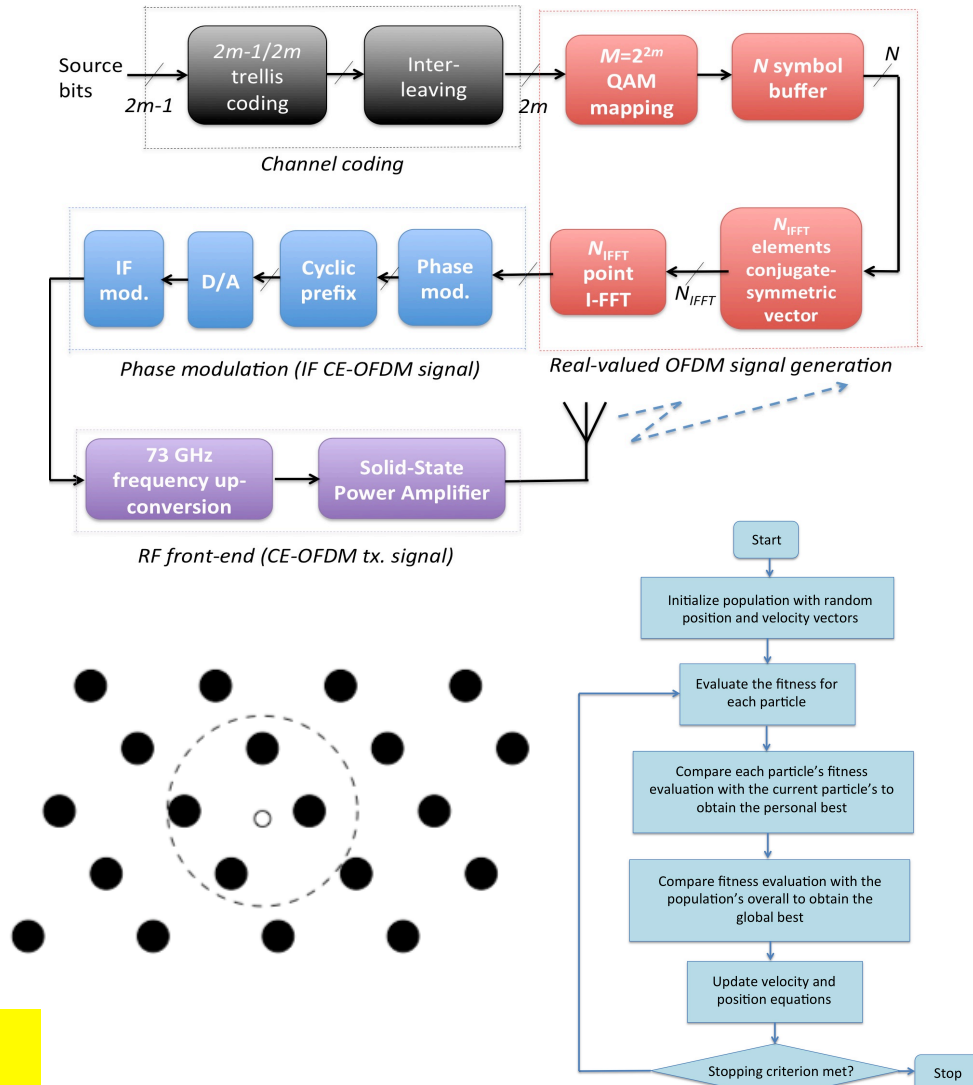
● Framework and scenario:

- Theoretical study and practical implementation of optimum ML detection for CE-OFDM signals;

● Project topic:

- Study of analytical bounds on performance of ML detection of CE-OFDM signals;
- Implementation of practical implementation of near-optimal ML detection (with iterative methodologies, sphere decoding, evolutionary algorithms, etc.)

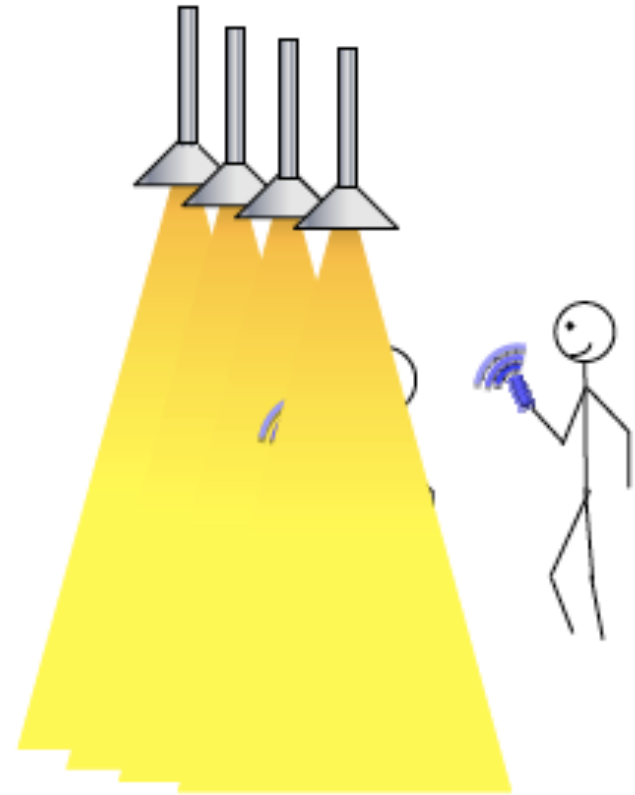
SOFTWARE TOOLS TO BE USED: MATLAB



Supervisor: **Claudio Sacchi (UNITN)**

P8: Information Shower Radio Access Interface

- Framework and scenario:
 - Design and implementation of an efficient radio access interface for information showers (very-short range multi-gigabit/sec. millimeter wave content delivery nodes);
- Project topic:
 - Study of MIMO techniques for efficient information multiplexing in mm-wave short-range links (propagation is under study and evaluation);
 - Waveform analysis, modulation and coding formats for information showers.

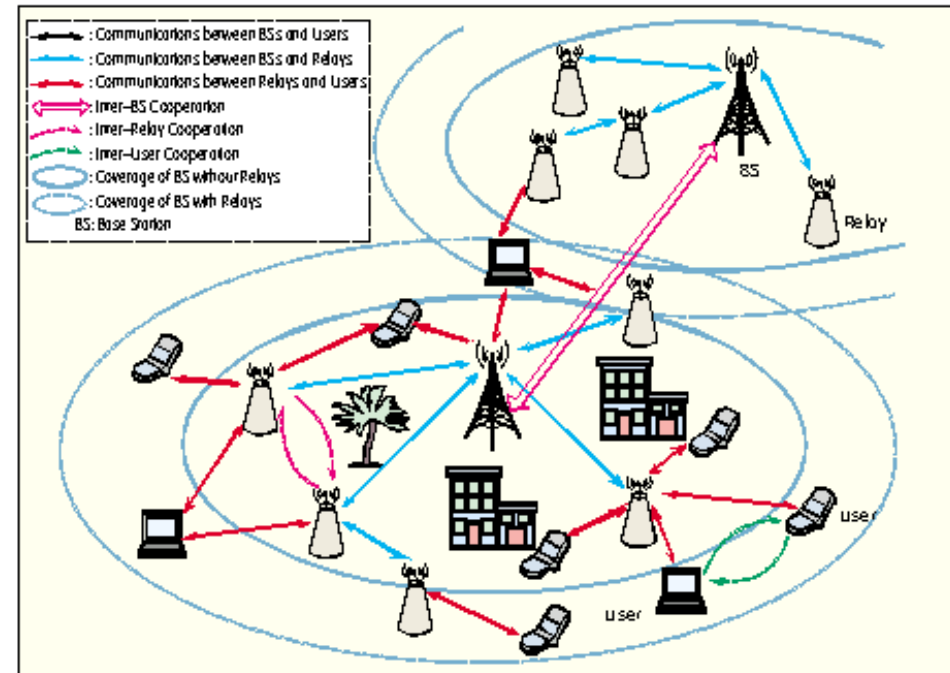


**SOFTWARE TOOLS TO BE USED:
MATLAB-SIMULINK**

Supervisor: **Claudio Sacchi** (UNITN), Co-supervisor: **Simone Morosi, Agnese Mazzinghi** (University of Florence)

P9: Cooperative relaying in mm-wave small cells

- Framework and scenario:
 - Design and implementation of efficient cooperative relaying strategies for mm-wave small cells in 5G systems;
- Project topic:
 - Relaying configurations for mm-wave links (LOS/NLOS outage tradeoff);
 - Suitable radio resource management strategies for cooperative relaying;
 - Energy efficiency and power consumption aspects.



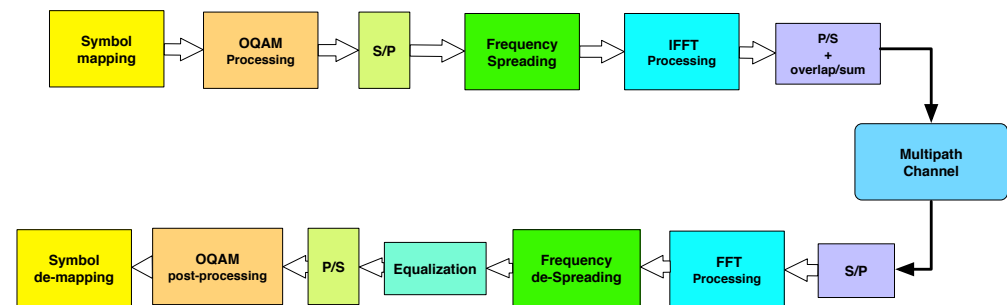
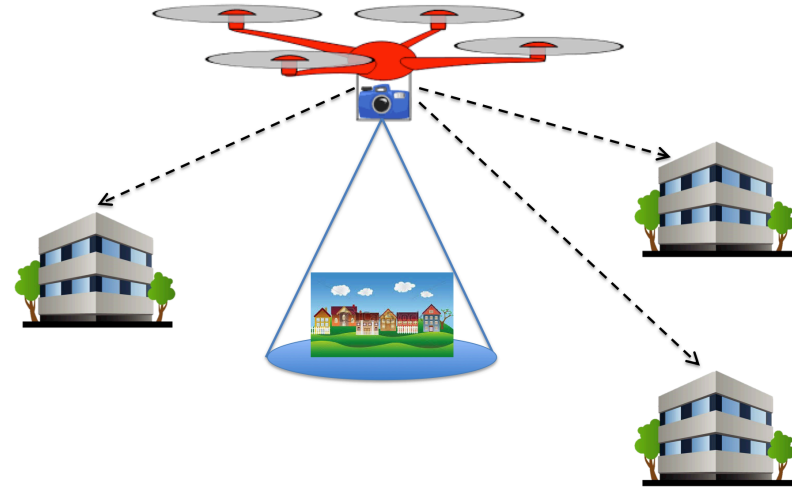
▲ Figure 1. Relay-assisted communications network.

Supervisor: **Claudio Sacchi** (UNITN), Co-supervisor: **Simone Morosi**, (University of Florence)

**SOFTWARE TOOLS TO BE USED:
MATLAB-SIMULINK**

P10: Drone-to-Earth cognitive transmission

- Framework and scenario:
 - Multicast drone-to-Earth transmission in remote monitoring applications;
- Project topic:
 - Cognitive radio resource management using smart and cognitive waveforms (Filter-Bank Multicarrier (FBMC)) instead of usual OFDM;
 - Adaptive bandwidth/power/modulation allocation on the basis of QoE requests and priorities.



**SOFTWARE TOOLS TO BE USED:
MATLAB SIMULINK**

Supervisors: **Claudio Sacchi, Fabrizio Granelli** (UNITN), *Co-supervisor:* **Riccardo Bassoli** (UNITN)

P11: Drone-to-Sky Small-Satellite backhaul

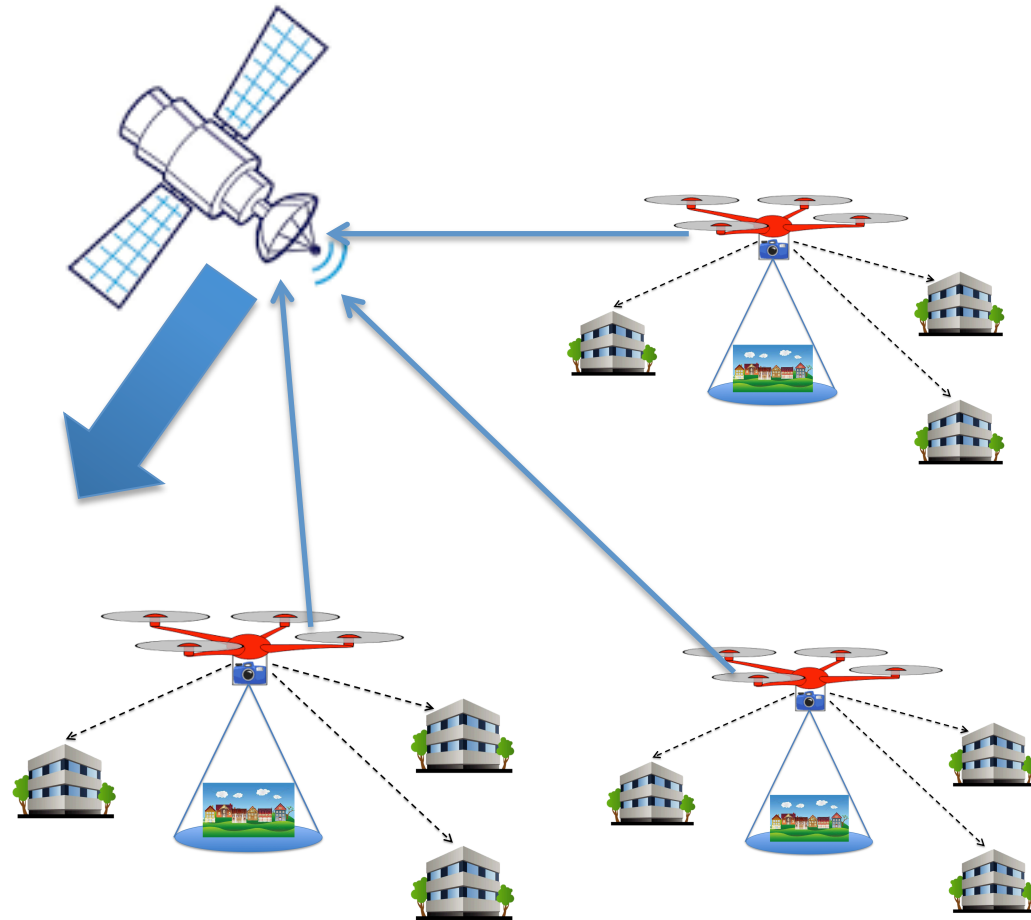
- Framework and scenario:

- Remote massive transmission from drone to a big data collection center by a small (LEO, Cubesats, Nanosats) satellite backhaul;

- Project topic:

- Feasibility study of the backhaul link: bandwidth/, power resources to be spent, coverage;
- Link simulations and throughput simulations assessing BER, FER, delays and capacities.

**SOFTWARE TOOLS TO BE USED:
MATLAB SIMULINK (NS3?)**



Supervisors: Claudio Sacchi, Fabrizio Granelli (UNITN), Co-supervisor: Riccardo Bassoli (UNITN)

P12: Drones as uplink collectors for WSNs

● Framework and scenario:

- Remote monitoring using drones and wireless sensors;

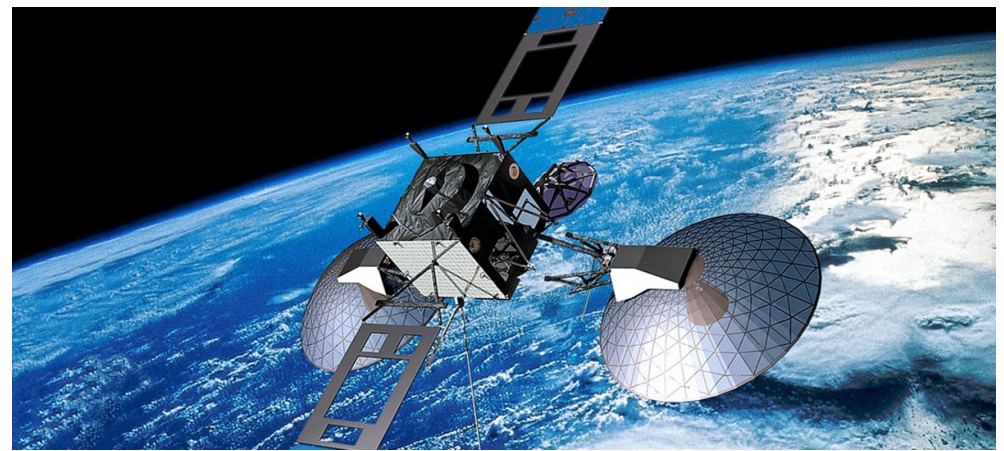
● Project topic:

- Feasibility study of the sensor-to-drone uplink: bandwidth/, power resources to be spent, coverage;
- Link simulations for fixed and mobile sensors and drones characterized by different size and speed.



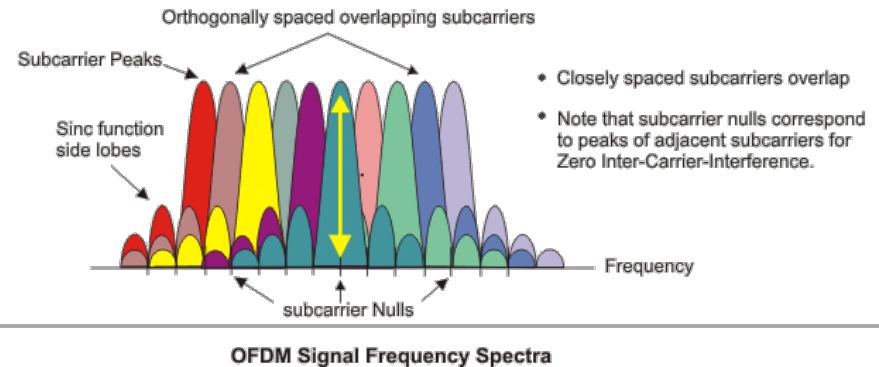
**SOFTWARE TOOLS TO BE USED:
MATLAB/SIMULINK**

Supervisors: **Claudio Sacchi**, (UNITN), *Co-supervisor:* **Luigi Atzori** (University of Cagliari), **Talha F. Rahman** (University of Cagliari)



THESIS PROJECTS IN EUROPEAN UNIVERSITIES

What 5G is about



Thesis projects abroad?

- Yes, this is possible ...
 - ... in the framework of EU ERASMUS+ programme!
- Project topics:
 - To be agreed with the reference person of the EU University member of the consortium (one of the internal projects may be proposed also for an ERASMUS+ thesis, if the reference person is interested and/or finds an internal supervisor interested to the related topics);
- Applications:
 - To be submitted on or before the fixed deadlines (see: <http://www.unitn.it/en/ateneo/55236/erasmus>)

Thesis projects abroad?

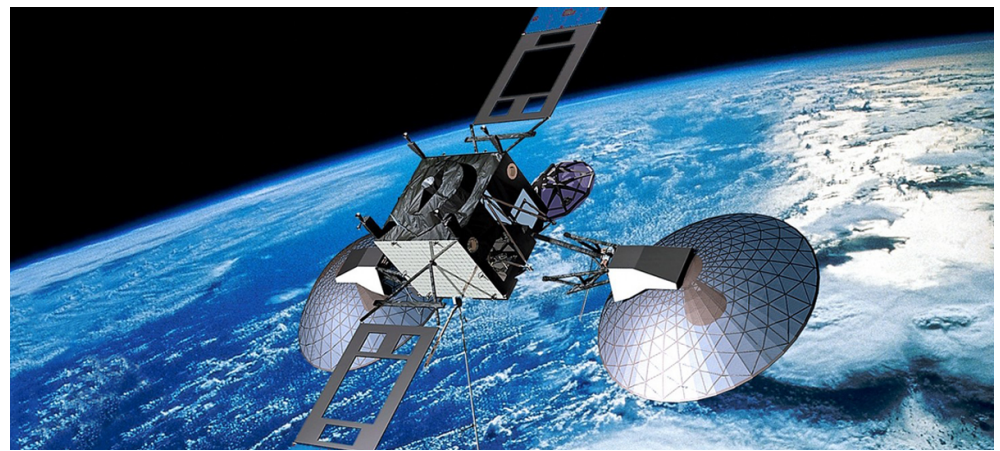
- Where?

- In the following EU Universities:



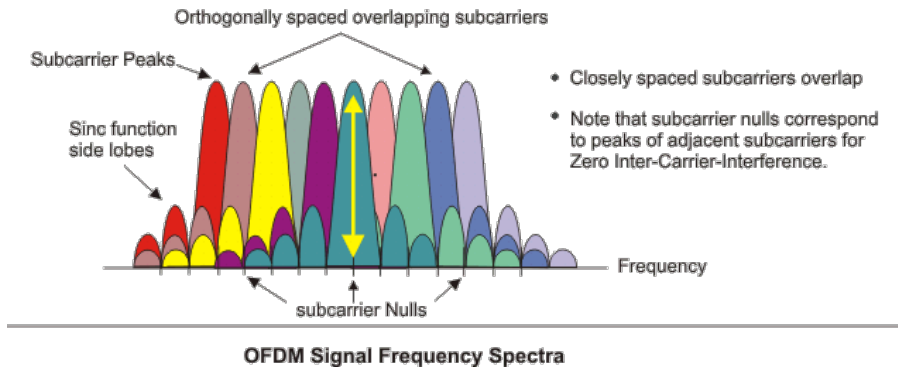
- VIENNA UNIVERSITY OF TECHNOLOGY (Austria);
- UCL UNIVERSITE CATHOLIQUE DE LOUVAIN (Belgium);
- KIT - KARLSRUHE INSTITUTE OF TECHNOLOGY (Germany);
- TECNISCHE UNIVERSITAT MUNCHEN – TUM (Germany);
- UNIVERSITY OF BARCELONA (Spain);
- TECHNICAL UNIVERSITY OF MADRID (UPM) (Spain);
- UNIVERSITY OF VIGO (Spain);
- TALLINN UNIVERSITY OF TECHNOLOGY (Estonia);
- CHALMERS UNIVERSITY OF TECHNOLOGY (Sweden);
- TAMPERE UNIVERSITY OF TECHNOLOGY (Finland).





THESIS PROJECTS IN EUROPEAN RESEARCH CENTERS

What 5G is about



Thesis projects in EU research centers?

- Also this opportunity should be available
 - But, I should contact some reference persons in order to ask more precise information. In particular, potential opportunities may be with:
 - GERMAN AEROSPACE CENTER (DLR) (Munich, Germany)
 - CNRS (Paris, France)



In a research center, the thesis project is supported by a grant, provided by the hosting institution.