



Fondo Sociale Europeo

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SICILIA 2020
PROGRAMMA OPERATIVO



Radio Resource Management in Heterogeneous 5G Cellular Networks

**PhD Course in Systems, Energy, Computer,
and Telecommunications Engineering
XXXIII Cycle**

Catania, October 29, 2019

Student: Salvatore Riolo
Tutor: Prof. Daniela Panno
Academic Year: 2018/2019

Research activity

Our research activity focuses on:

mmWave radio transmissions

- Device-to-Device (D2D) communications
- Beamforming techniques
- Radio Resource Management

Massive Machine Type Communications (mMTC)

- Non-Orthogonal Multiple Access (NOMA)-based Radio Resource Allocation Scheme
 - Sparse Code Multiple Access (SCMA)
- Access Class Barring (ACB) Schemes

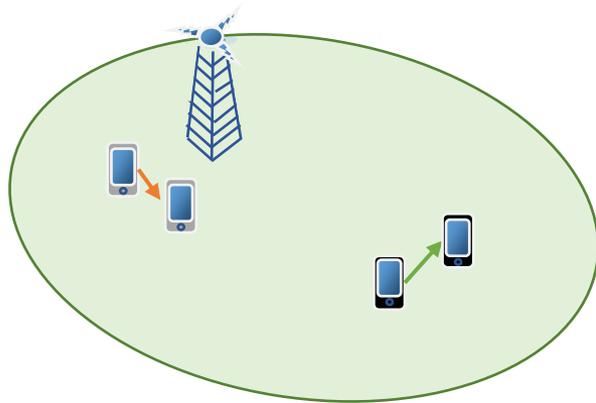
...In progress

- Multi-Numerology Systems
- Ultra-Reliable and Low-Latency Communications (URLLC)
- Machine Learning techniques

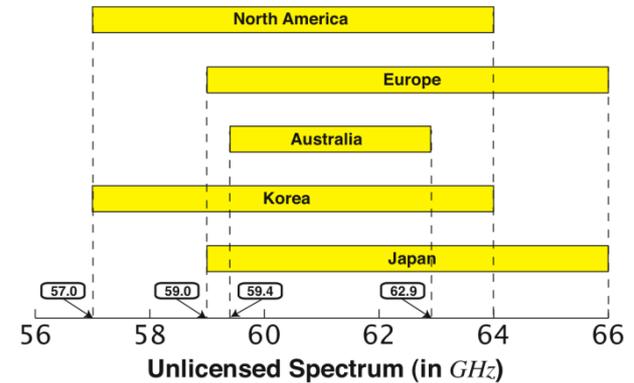
mmWave radio transmissions

In this research activity, we explore the symbiosis of:

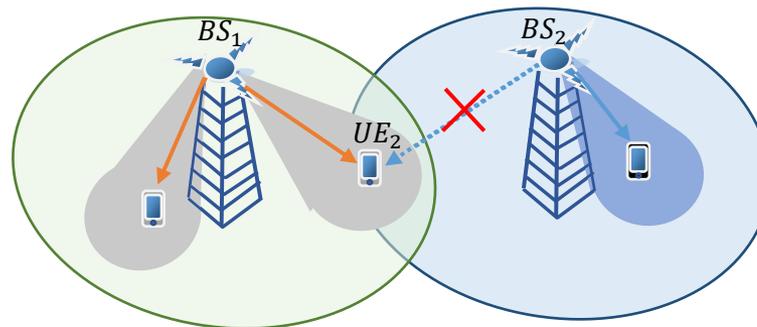
➤ Device-to-Device (D2D) communications



➤ 60 GHz unlicensed band transmissions



➤ Adaptive beamforming technique



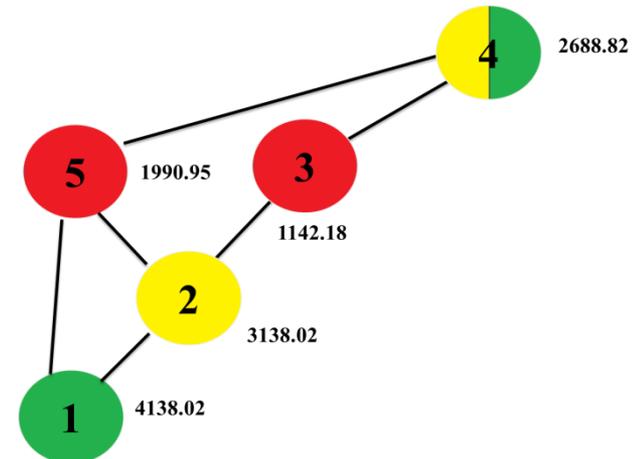
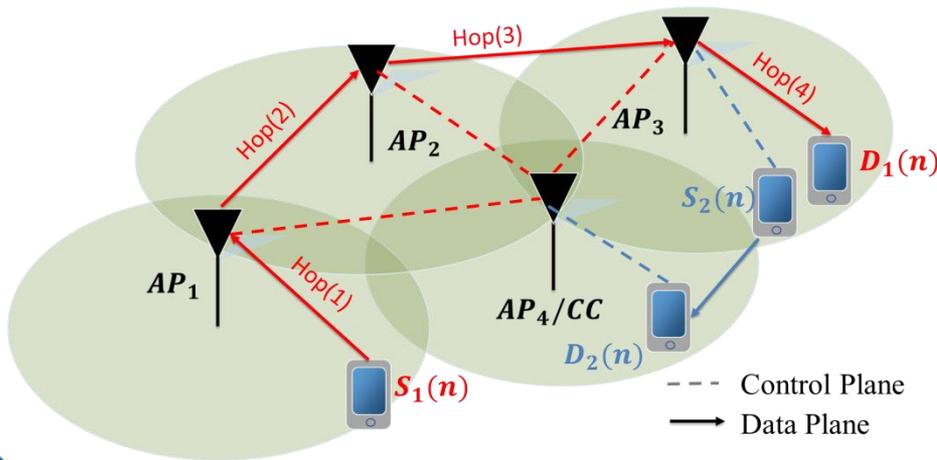
A new Access control for mmWave systems

We consider an indoor scenario with high density on UEs. In order to extend D2D communications to the whole environment, we consider a 60 GHz stand-alone Millimeter-Wave Mobile Broadband (MMB) system.

Centralized access control
based on polling

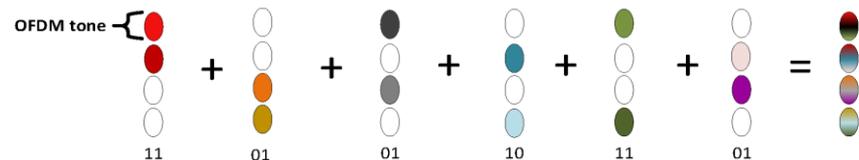
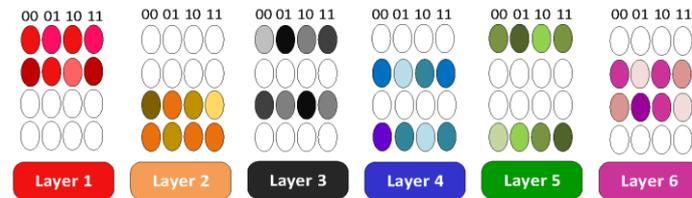
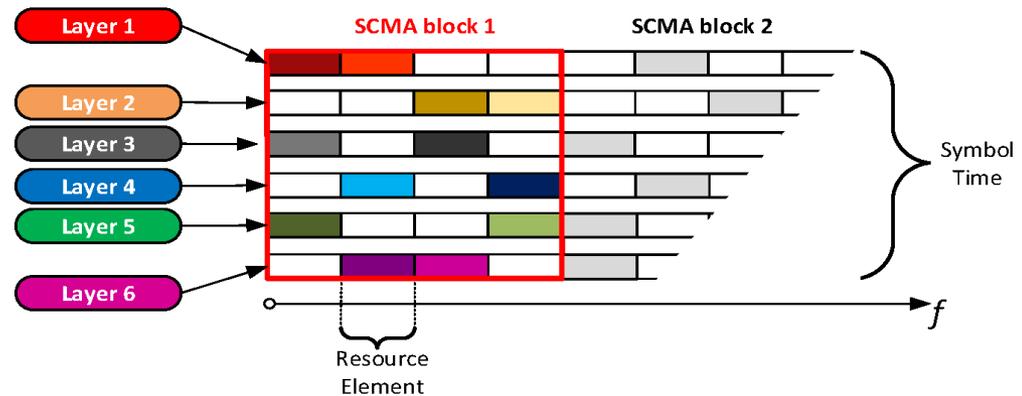
Scheduling algorithm based on
color-graph theory

Radio access and backhaul networks



Joint Congestion Control and Resource Allocation for mMTC in 5G Networks

- We adopt in the Physical Uplink Shared Channel (PUSCH) the Sparse Code Multiple Access (SCMA) technique, which is one of the most promising Non-Orthogonal Multiple Access (NOMA) techniques to multiplex a large number of User Equipments (UEs), each one requiring small-size data.



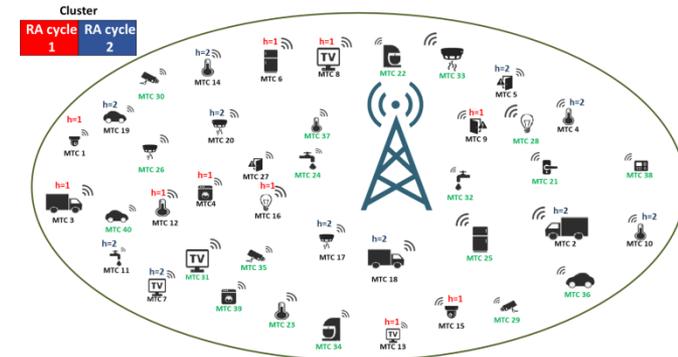
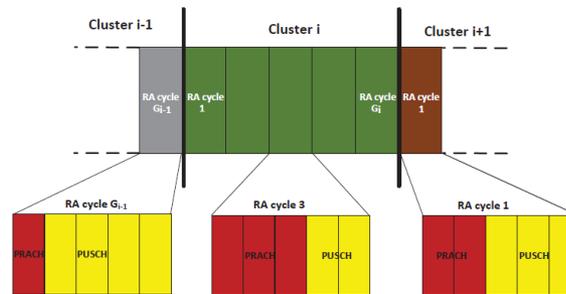
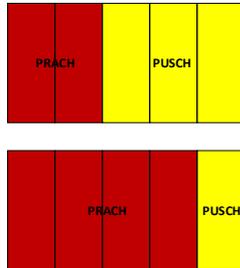
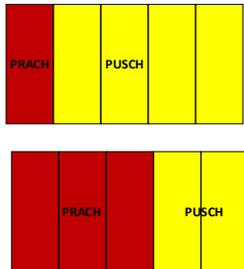
Joint Congestion Control and Resource Allocation for mMTC in 5G Networks

The proposed framework is based on:

A dynamic uplink resource dimensioning based on an estimate of the total number of MTC device access attempts

Clustering concept of successive RA cycles in order to properly spread the access re-attempts in time

An ACB scheme which regulates the number of RA attempts based on the Cluster size



IEEE Conference Papers

- 1) **S. Riolo**, D. Panno and A. Di Maria, "A new centralized access control for mmWave D2D communications," *2017 IEEE 13th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob)*, Rome (Italy), October 2017, pp. 1-8.
- 2) D. Panno and **S. Riolo**, "On mm Wave Radio Network Planning based on a Centralized Access Control," *2018 International Conference on Selected Topics in Mobile and Wireless Networking (MoWNeT)*, Tangier (Morocco), June 2018, pp. 1-8.
- 3) G. C. Valastro, D. Panno and **S. Riolo**, "A SDN/NFV based C-RAN architecture for 5G Mobile Networks," *2018 International Conference on Selected Topics in Mobile and Wireless Networking (MoWNeT)*, Tangier (Morocco), June 2018, pp. 1-8.
- 4) D. Panno and **S. Riolo**, "A New Joint Scheduling Scheme for GBR and non-GBR Services in 5G New RAN," *2018 IEEE 23rd International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD)*, Barcelona (Spain), September 2018, pp. 1-6.
- 5) L. Miuccio, D. Panno and **S. Riolo**, "Dynamic Uplink Resource Dimensioning for Massive MTC in 5G Networks Based on SCMA," *25th European Wireless Conference*, Aarhus, Denmark, 2019, pp. 1-6.
- 6) L. Miuccio, D. Panno and **S. Riolo**, "Joint Congestion Control and Resource Allocation for Massive MTC in 5G Networks Based on SCMA," *2019 15th International Conference on Telecommunications (ConTEL)*, Graz, Austria, 2019, pp. 1-8.

Journal Paper

- 1) D. Panno and **S. Riolo**, "A New Centralized Access Control Scheme for D2D-Enabled mmWave Networks," in *IEEE Access*, vol. 7, pp. 80697-80716, 2019.

Journal Papers Submitted for Publication

- 1) **S. Riolo** and D. Panno, "An Enhanced Joint Scheduling Scheme for GBR and non-GBR Services in 5G RAN," in *Wireless Networks*, Springer (In revision)
- 2) L. Miuccio, D. Panno and **S. Riolo**, "Joint Control of Random Access and Dynamic Uplink Resource Dimensioning for massive MTC in 5G NR based on SCMA," in *IEEE Internet of Things Journal* (Under review)

Training activities

- **Followed seminars:**

- 1) Graphene THz Wireless Communications for Networks-on-Chip and Programmable Metasurfaces,
Lecturer: Prof. Sergi Abadal. Catania, 09/06/2019
- 2) On the use of Machine Learning technologies in Telecommunication Systems,
Lecteur: Prof. Michele Rossi. Catania, 09/24/2019

- **Followed PhD Schools:**

- 1) 2018 International School on Informatics and Dynamics in Complex Networks – Catania
- 2) 2018 International 5G PhD School – Rome
- 3) 2019 International School on Network and Computer Sciences – Lipari
- 4) 2019 International School on Data Science & IoT – Catania

- **Followed Conferences:**

- 1) 25th European Wireless Conference, Aarhus, Denmark, 2019
- 2) 15th International Conference on Telecommunications (ConTEL 2019), Graz, Austria, 2019

Teaching support activities

- **Thesis Advisor:**

- 1) Luciano Miuccio, “Ottimizzazione dell’accesso radio per servizi massive Machine Type Communication per reti 5G basate su Sparse Code Multiple Access”, Master’s Degree in Telecommunications Engineering, November 2018.

- **Teaching Activity:**

- 1) Mobile Communications Systems Laboratory Course, Master’s Degree in Telecommunications Engineering, 2nd year.



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*Thank you for
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Catania, October 29, 2019

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