Radio Resource Management in Heterogeneous 5G Cellular Networks

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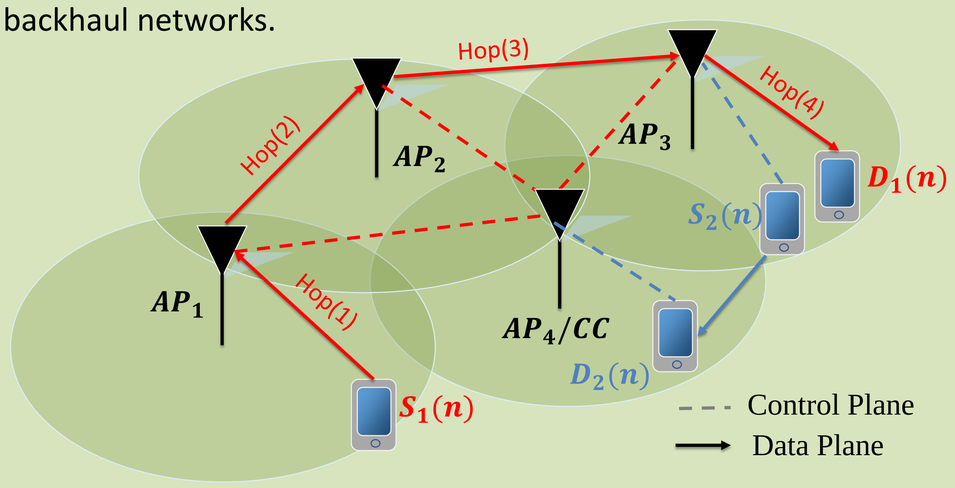
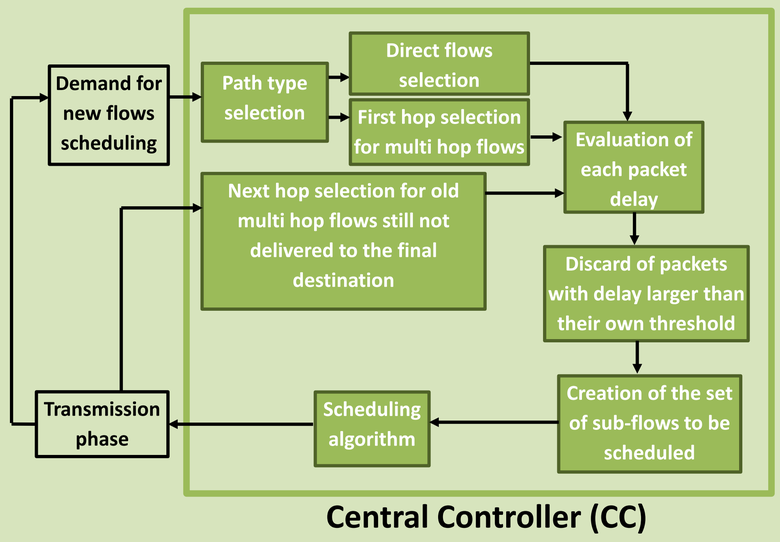
A New Centralized Access Control Scheme for D2D-Enabled mmWave Networks

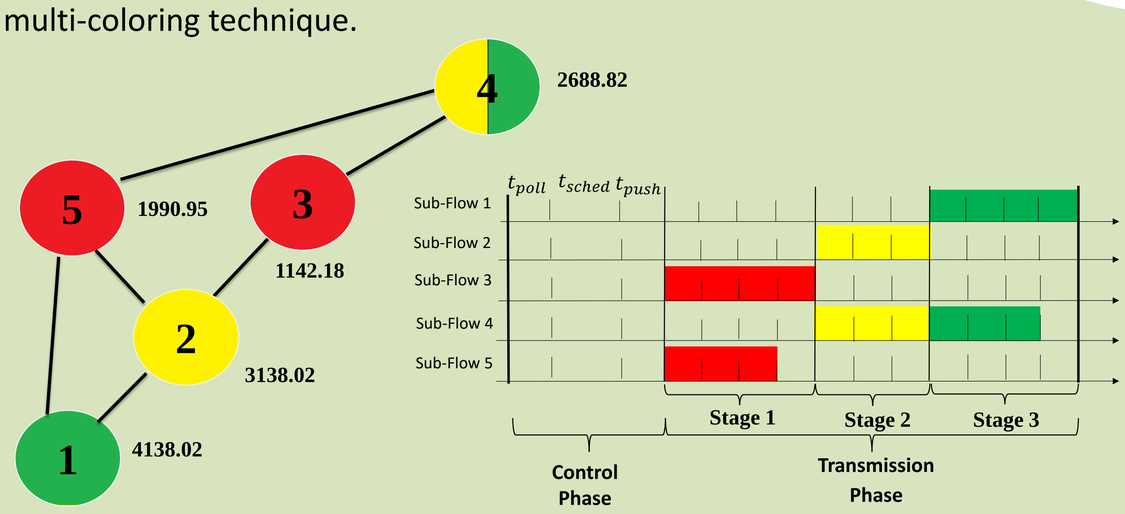
In this research activity [1]-[3], we present an innovative Access Control Scheme for Millimeter-Wave Mobile Broadband (MMB) systems, which jointly manages Device-to-Device (D2D) communications and transmissions in access and backhaul networks.



We explore the symbiosis of D2D communications, 60 GHz unlicensed band transmissions and adaptive beamforming technique.
Our approach provides for a new centralized data-flow management scheme and a multi-criteria scheduling algorithm.

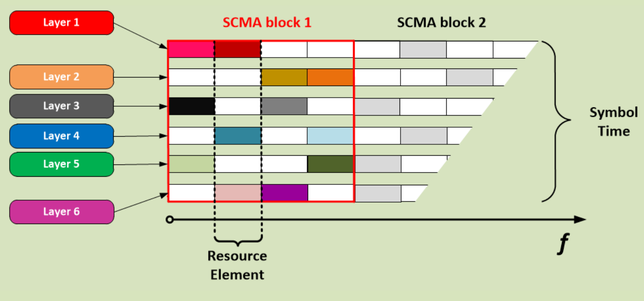


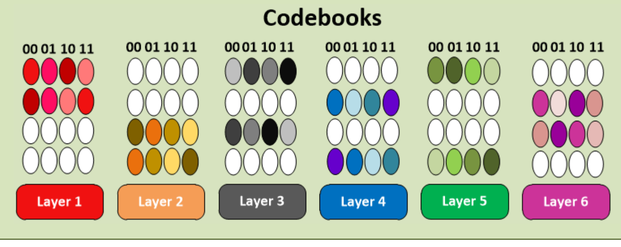
The scheduling algorithm is based on a new greedy graph vertex multi-coloring technique.



Dynamic Uplink Resource Dimensioning for Massive MTC in 5G Networks Based on SCMA

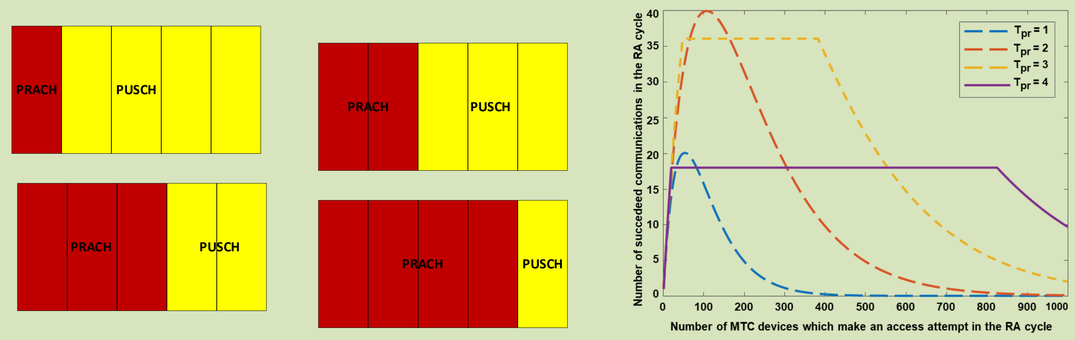
In this research activity [4], we address the uplink radio resource allocation problem in a 5G massive Machine Type Communication (mMTC) scenario, characterized by a large number of MTC devices generating small-sized bursty traffic. Since the current cellular network is unsuitable for this scenario, 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 UEs requiring small-size data. In addition, we propose a dynamic load-aware Physical Random Access Channel (PRACH) and PUSCH resource allocation, termed Dynamic Uplink Resource Dimensioning (DURD).



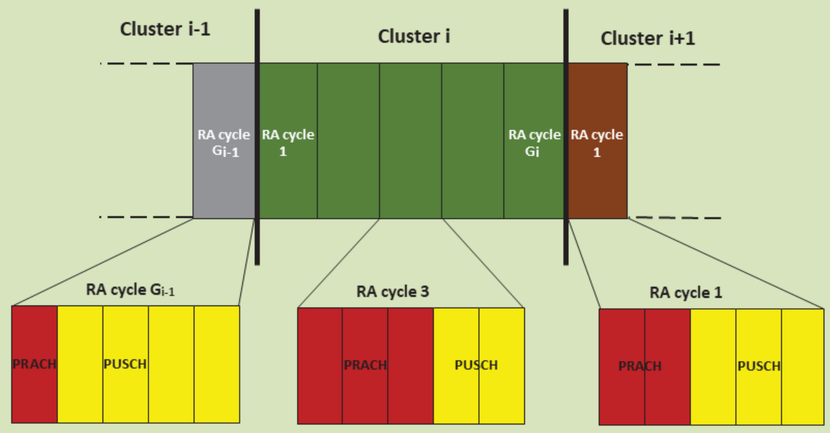


Joint Congestion Control and Resource Allocation for Massive MTC in 5G Networks

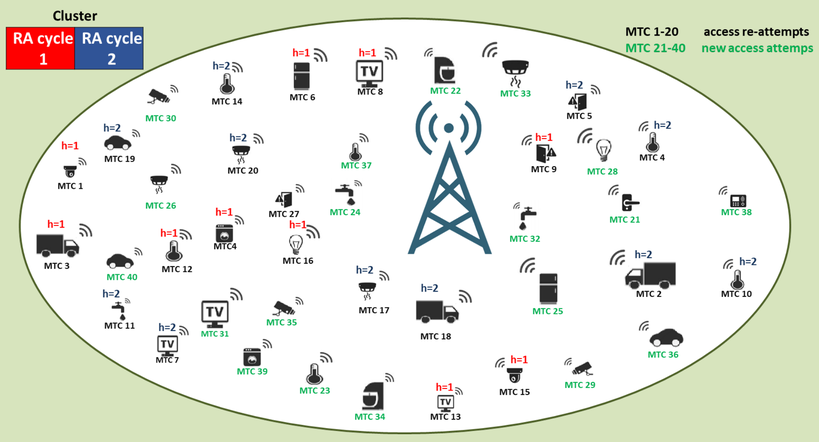
In this research activity [5], we propose a new framework, tailored for massive MTC services, that includes a joint control of the dynamic resource allocation between the PRACH and the PUSCH, and the definition of a new random access procedure based on an adaptive Access Class Barring (ACB) scheme that appropriately spreads random access re-attempts in time.



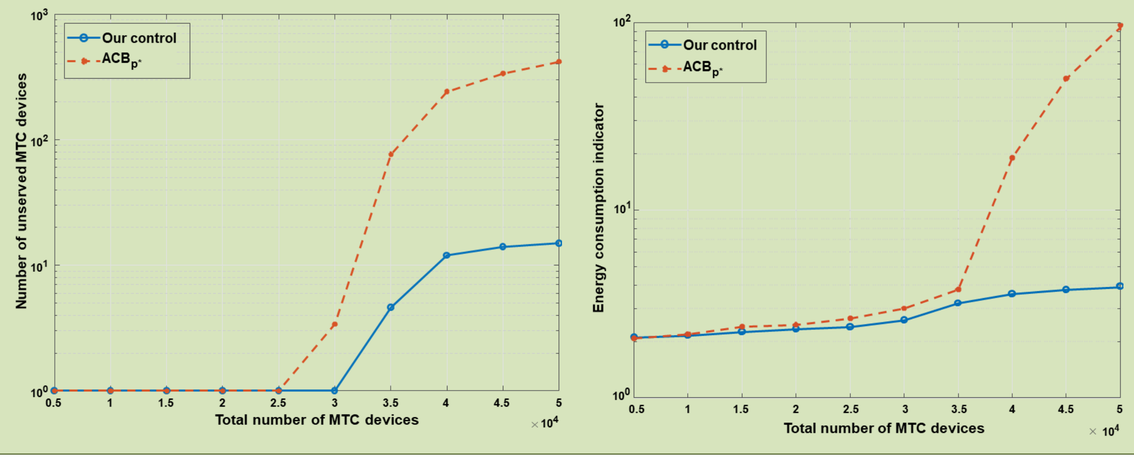
The proposed ACB scheme is based on the *Cluster* concept. A Cluster is an entity which consists of a sequence of G Random Access (RA) cycles with the same resource dimensioning.



On the basis of the Cluster concept, we define a new ACB scheme. For simplicity, it is described by an example of a cluster consisting of 2 RA cycles. We assume 20 unsatisfied requests which will be re-transmitted in the considered Cluster and 20 new access requests. Each re-transmitting MTC device draws a uniform random number $h \in \{1, 2\}$. Then, it performs its random access re-attempt only in the hth RA cycle. On average, there will be only half of the retransmitting MTC devices per RA Cycle.



Since each re-transmitting MCT device attempts only one time inside a cluster, when the cluster size is large, it can enter to the deep sleep state. Consequently, the related energy consumption is greatly reduced compared to the traditional ACB schemes.
Simulation results show that the proposed framework significantly improves the number of succeeded communications and guarantees lower energy consumption in comparison with the ACB_{p^*}, available in literature [6].



References:

[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, 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, 2018, pp. 1-8.
[3] 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.
[4] 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.
[5] 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.
[6] T. Xue, L. Qiu, and X. Li, "Resource allocation for massive M2M communications in SCMA network," *2016 IEEE 84th Vehicular Technology Conference (VTC-Fall)*, Sep. 2016, pp. 1–5.

5G

Millimeter-wave Mobile Broadband system
Massive MTC communications
D2D comunications
5G New Radio
NOMA