Scenarios and models for 5G performance evaluation in SPEED-5G

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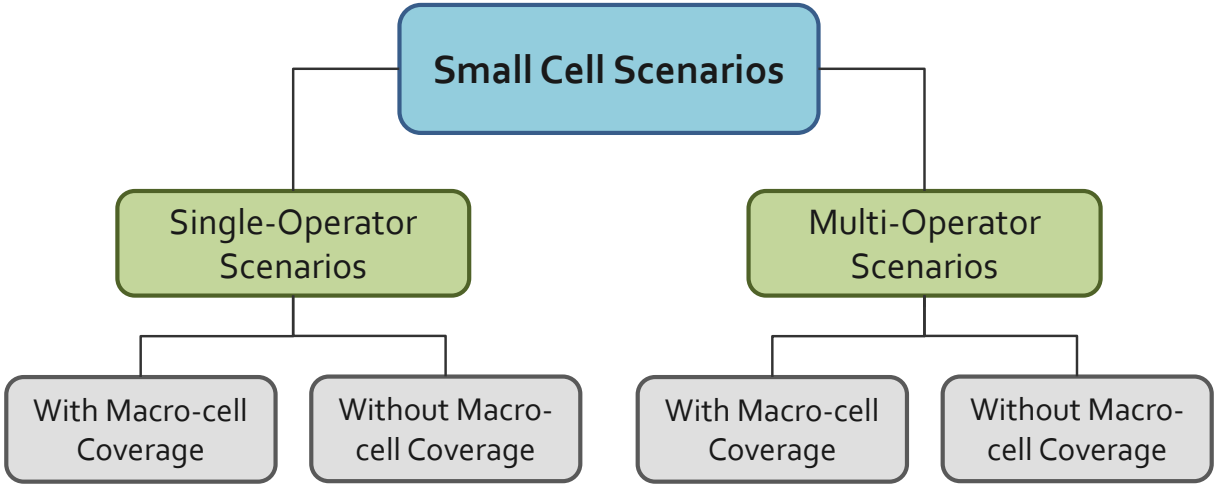
Introduction

- Defining a proper Validation Framework is highly relevant for the 5GPPP program, as it allows having a common approach for providing results, and mapping them to the defined KPIs
- The main sources of scenarios relevant for 5G system level simulations are 3GPP, NGMN and METIS
- The scenarios can map more than one Use Case or KPI
- This Common Validation Framework will enhance the benchmarking of the different technologies developed in the 5GPPP program and its feasibility for the envisaged Use Cases
- Some common tools, like LUTs would be needed as well for having the same starting point across the different projects

Performance Evaluation in SPEED-5G

- SPEED-5G is focused in Dynamic Spectrum Access in dense and ultra-dense small cell networks in both indoor, outdoor and mixed indoor / outdoor scenarios using licensed, unlicensed and lightly-licensed spectrum using contention based RA
- SPEED-5G is addressing mainly 2 Use Cases, Ultra-Broadband Wireless, Massive IoT for System Level Simulations, but the other two use cases, Ultra-Reliable Communications and Vehicular Mobility are also mapped to some of the scenarios as well, all of them focused in the Sub 6GHz spectrum
- FBMC System Level Simulations with SPEED-5G technology will be one of the biggest contributions to the 5GPPP program, simulating new RRM and MAC mechanisms for the selected Use Cases
- The Methodology will be based in using both synthetic and realistic scenarios following 3GPP and METIS simulation guidelines

Initial Scenario Classification



This initial classification is also mapped to the different scenarios in order to apply some constraints depending on the specific characteristics of each one

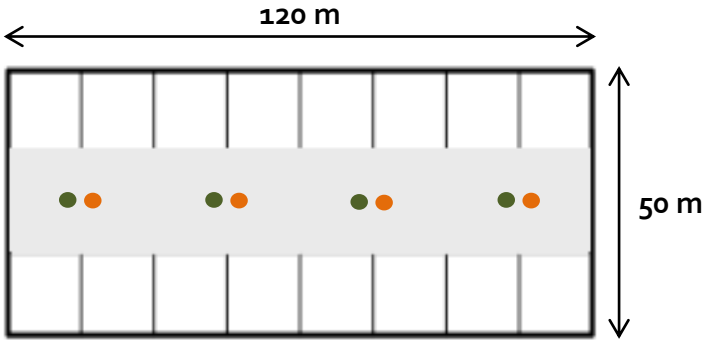
Synthetic Scenarios SPEED-5G

Basic Assumptions

- Synthetic Scenarios have been selected from 3GPP TR 36.889
- The Small Cells can be either WiFi or LTE, using unlicensed carriers in the 5GHz frequency bands
- The unlicensed or lightly licensed carriers can deliver only DL or DL+UL traffic
- Both Contention-Free Random Access (RA) and Contention based Random Access procedures are considered, using always Contention-Free RA for the licensed carrier
- Coexistence Mechanisms are taken into account in these scenarios
- User mobility and Service-oriented Traffic Sources

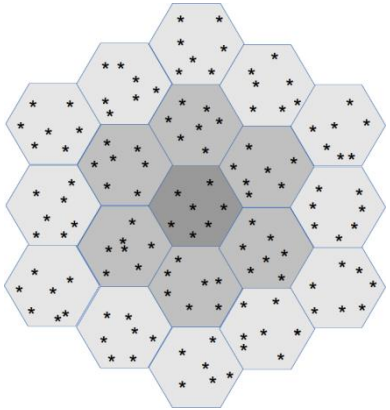
TR 36.889 Dense Indoor Scenario

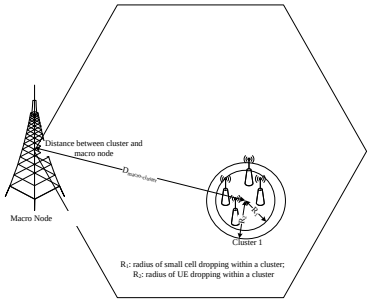
- Two operators deploy 4 small cells each in the single-floor building
- The small cells of each operator are equally spaced and centered along the shorter dimension of the building. The distance between two closest nodes from two operators is random. The set of small cells for both operators is centered along the longer dimension of the building
- Small Cells can have WiFi or LAA unlicensed carriers
- The whole system can use FBMC

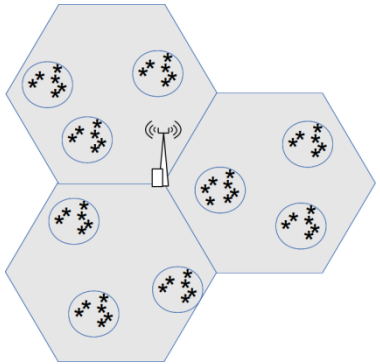


TR 36.889 HetNet Scenario

- Hexagonal grid, 3 sectors per site, 500m ISD
- Macro eNBs of the two networks are collocated
- Both 19 Macro sites and 7 Macro sites can be used
- Clusters uniformly random within macro geographical area; 4 small cells per operator, uniformly random dropping within cluster area
- Small Cells can have WiFi or LAA unlicensed carriers
- The whole system can use FBMC







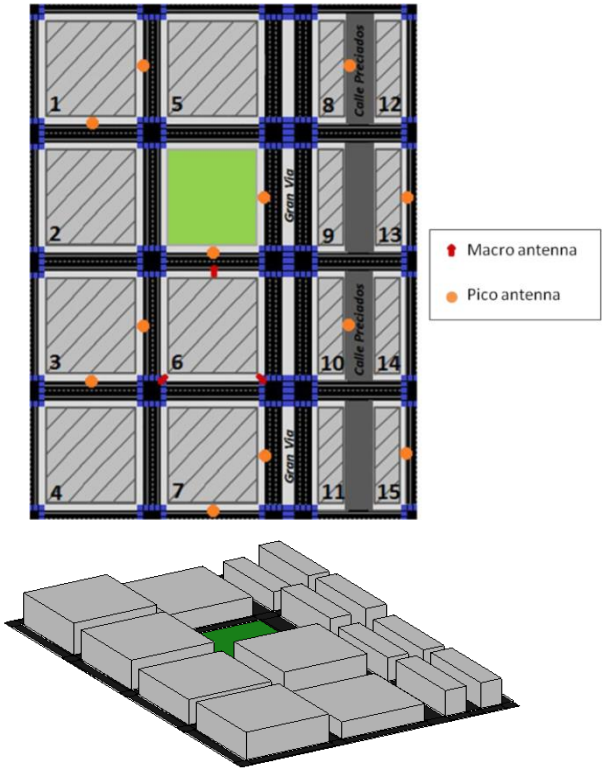
Realistic Scenarios SPEED-5G

Scenario Selection

- SPEED-5G decided to use METIS as the first source for Realistic Scenarios
- The baseline of the scenario selection are the existence of the small cells in both indoor, outdoor or mixed deployments, selecting the most appropriate for the considered Use Cases
- The novelty of the simulation work is using the Dynamic Spectrum Access technology of SPEED-5G in conjunction with using FBMC, a 5G candidate waveform for evaluating the feasibility of this approach in highly complex and demanding realistic scenarios
- A new scenario has been defined in order to fill the gap, adding the Extended Suburban Scenario
- User mobility and Service-oriented Traffic Sources

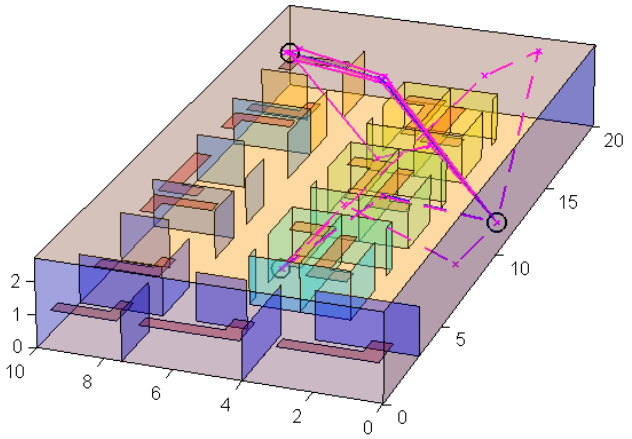
Dense Urban Information Society

- The Madrid Grid is defined in TC2 of METIS
- This scenario maps with Ultra-Broadband Wireless, Massive IoT and can allocate as well Ultra-Reliable Communications and high mobility (vehicular mobility) scenarios
- Includes a mix of pure indoor users, pure outdoor users and indoor/outdoor users, covering the Use Cases supported at SPEED-5G
- It allows evaluating Dense Networks, in a realistic example of typical European city, one of the main potential deployment environments for SPEED-5G technologies



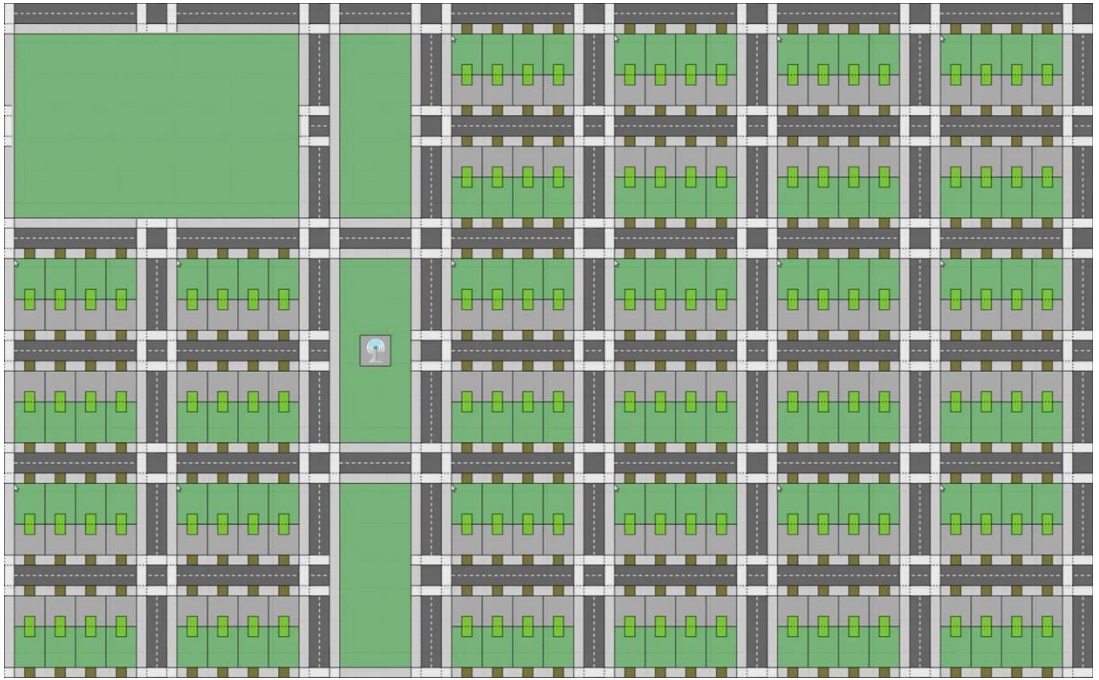
Virtual Reality Office

- The Virtual Reality Office is defined in TC1 of METIS
- Provides a perfect validation environment for SPEED-5G in purely indoor scenarios
- This scenario maps with Ultra-Broadband Wireless, and Ultra-Dense Networks with small cells
- Some of the SPEED-5G new MAC and RRM mechanisms will need this scenario for getting an general assessment



Extended Suburban Scenario

- The Madrid Grid do not cover all the city layouts, being extremely important the Suburban Use Case
- This scenario also maps with Ultra-Broadband Wireless, Massive IoT and can allocate as well Ultra-Reliable Communications and high mobility (vehicular mobility) scenarios



Extended Suburban Scenario

- The scenario includes an outdoor base station and indoor small cells
- This scenario also maps with Ultra-Broadband Wireless, Massive IoT and can allocate as well Ultra-Reliable Communications and high mobility (vehicular mobility) scenarios

Scenario elements dimensions	
Road	6m
Sidewalk	3m
Crosswalk	3m
House entrance	1m
House dimensions	9m x 9m
Number of floors	2
Garden dimensions	9m x 9m
Garden entrance	1m
Avenue (central area in green)	9m
Park Dimensions	84m x 48m

Channel Models for realistic scenarios

Large scale parameters

BS-MS	Urban Micro O2O	PS#1
	Urban Micro O2I	PS#2
	Urban Macro O2O	PS#3
	Urban Macro O2I	PS#4
	Indoor Office	PS#7

Small scale parameters

PS	Model	Correlation length
#1	ITU-R UMi	10
#2	ITU-R UMi O2I	10
#3	ITU-R UMa	50
#4	ITU-R UMa	50
#7	ITU-R InH	10
#9	ITU-R UMi *	10
#10	ITU-R UMi O2I *	10
#13	ITU-R InH *	10

License Assisted Access Assumptions

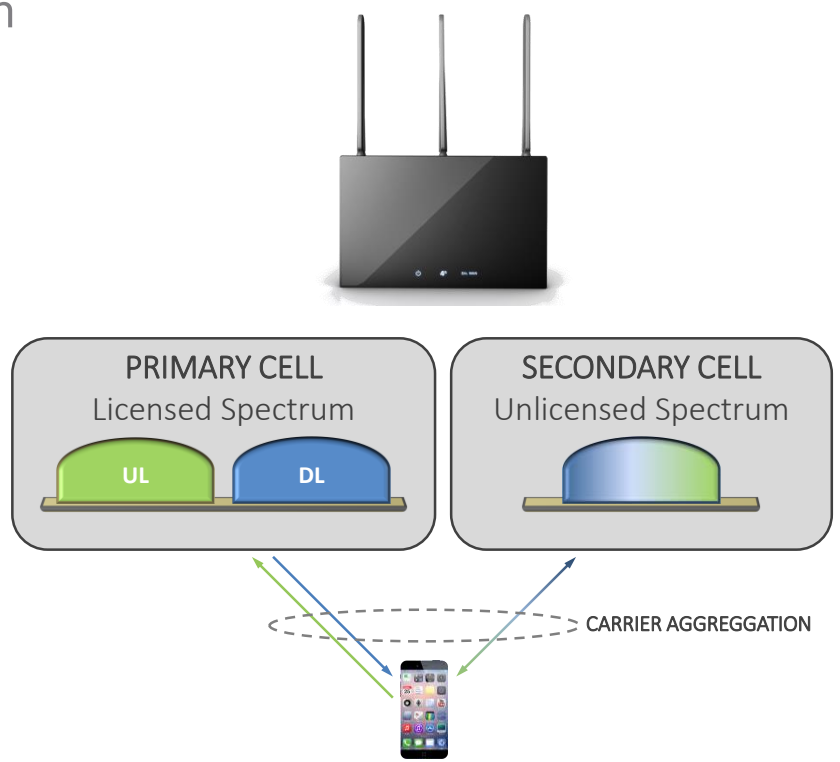
Why LTE Licensed-Assisted Access?

- LTE LAA is the first technology to use a basic dynamic spectrum access mechanism
- Provides a baseline performance for properly evaluating the assessment of SPEED-5G technology
- 3GPP has one technical report TR 36.889, devoted to analyze LAA scenarios
- The goal of 3GPP is providing a global standard, so LBT will be used across these simulations, as it is mandatory in Europe and other regulatory areas

LTE Licensed-Assisted Access

Operation of LTE in the unlicensed spectrum

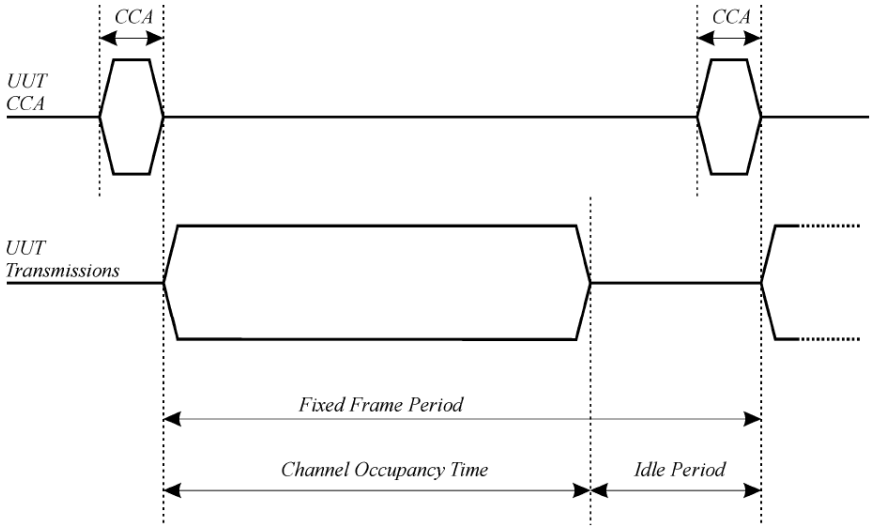
- LTE operation on the unlicensed band is built on top of LTE-Advanced carrier aggregation
  - Always accompanied by a licensed carrier – cross carrier scheduling is needed
- Primary carrier uses licensed spectrum (FDD or TDD)
  - Control signaling, mobility management, user data
- Secondary carrier(s) use unlicensed spectrum
  - Best-effort user data (DL and potentially UL)
  - Opportunistic use of the spectrum based in availability of spectrum resources



Channel Access Mechanism for LBT

Frame Based Equipment according to ETSI EN 301 893 V1.7.1

- LBT implements an automatic channel access mechanism for avoiding transmissions in a radio channel in the presence of transmissions from other radio systems in that channel
- LBT is modeled using a Duty Cycle
- This Duty Cycle can be modified by RRM mechanisms that evaluate the available spectrum during the CCA period
- The CCA utilizes energy detection to determine the presence or absence of other signals on a channel in order to analyze if a channel is occupied or clear, respectively
- WiFi systems operating in the 5GHz bands generate a ground level of interference during the transmission time



Thank you for your attention!

Find us at www.speed-5g.eu

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