

Scenarios, Use cases, Requirements

METIS II Workshop, 28-29 Sep. 2015, Kista, Sweden

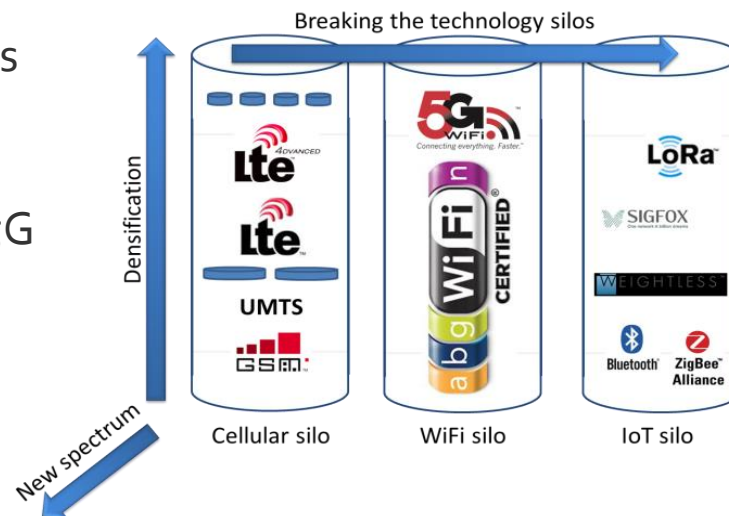
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Outline

- ▶ Quick overview
- ▶ Main aspects to be covered by the project
- ▶ Use cases overview
 - Massive IoT (indoor/outdoor)
 - Broadband wireless (indoor/outdoor): this covers also home femtocells
 - Reliable communications (indoor/outdoor)
 - High-speed mobility (e.g., vehicles on highways; high-speed trains)
- ▶ Potential deployment options
- ▶ Way forward

Quick overview

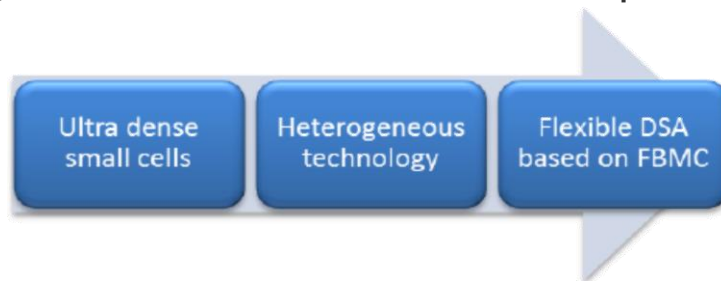
- ▶ The main objective of SPEED-5G is to achieve a significantly better exploitation of heterogeneous wireless technologies, providing higher capacity together with the ultra-densification of cellular technology, and effectively supporting the new 5G Quality of Experience (QoE) requirements.
- ▶ In SPEED-5G we will develop new techniques for optimizing spectrum utilization, following three main dimensions:
 - ultra-densification through small cells,
 - additional spectrum,
 - exploitation of available resources across technologies
- ▶ In SPEED-5G this three dimensional model is referred to as **extended-Dynamic Spectrum Allocation (DSA)**, where several spectrum bands, cells and technologies are jointly managed in order to offer improved QoE and a tremendous capacity increase in a cost-efficient manner.



Project Coordinator: Sistelbanda
Partners: Eurescom, British Telecom, CEA-Leti, Intel Deutschland GmbH, Intracom Telecom, Instituto de Telecomunicações, Rohde & Schwarz, University of Surrey, WINGS ICT Solutions
More information at: <https://5g-ppp.eu/speed-5g>
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Main aspects to be covered by the project

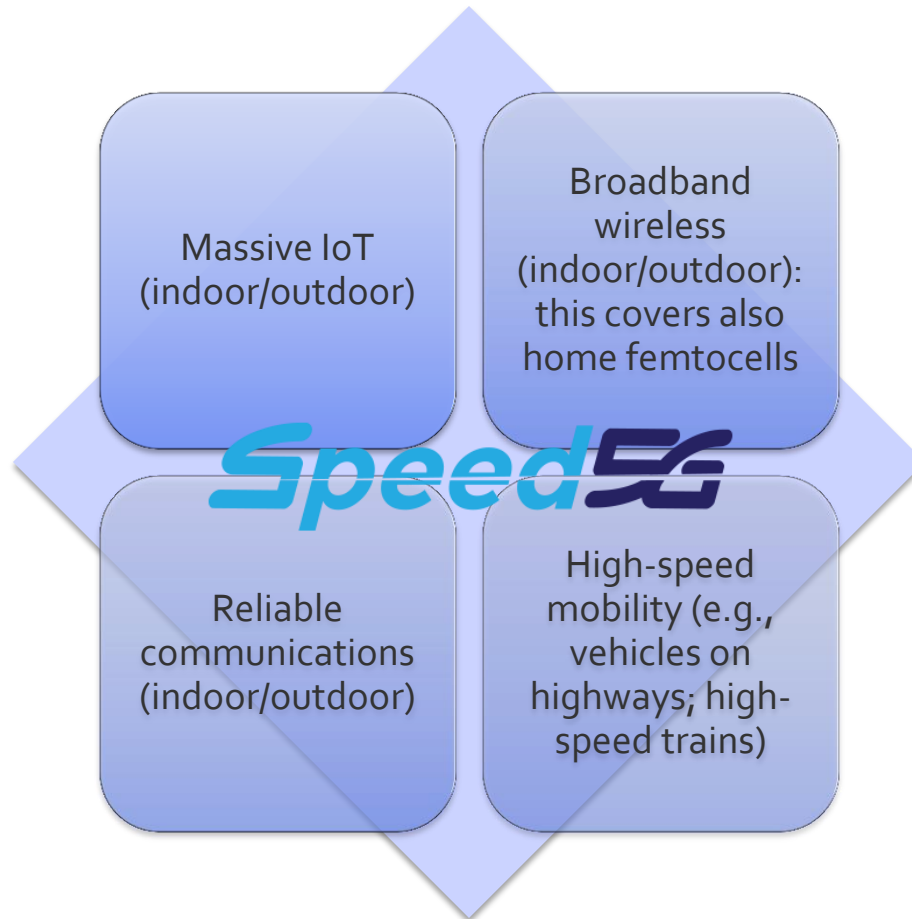
- ▶ Dynamic management of wireless network resources
 - ➔ Enhanced, multi-RAT and context-aware resource management and allocation schemes that will offer capacity and coverage extension, as well as improved resource utilization in UDN and low density environments.
- ▶ Optimised spectrum use and spectral efficiency
 - ➔ Developing and implementing efficient management and MAC mechanisms for the sharing of lightly-licensed spectrum bands at 2.3GHz and 3.5GHz exploiting LSA techniques, as well as of the available (unlicensed) spectrum below 1GHz (TVWS).
- ▶ How can Speed-5G tackle aforementioned aspects



Big Ideas behind SPEED-5G

- ▶ SPEED-5G targets providing solutions at Layer 2, Layer 3 and above to enable enhanced Dynamic Spectrum Access with multiple RATs, and especially with FBMC, a 5G waveform candidate.
- ▶ SPEED-5G can potentially use the PHY mechanisms developed in other projects, providing the enablers for using in a coordinated way licensed, lightly-licensed and unlicensed spectrum mostly in dense and ultra-dense small cell networks.
- ▶ A new MAC for the 5G will be developed and evaluated throughout different Use Cases and Scenarios
- ▶ New RRM mechanisms will be explored in order to enhance and enable a real Dynamic Spectrum Access using in a well defined set of Use Cases and scenarios mainly from 3GPP and METIS

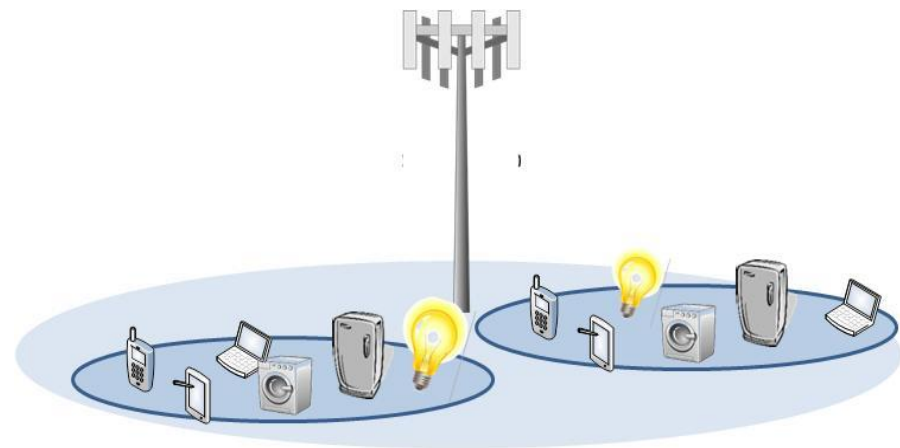
Use cases overview



Massive IoT communications

- ▶ Devices can be located in indoor or outdoor locations
- ▶ They can be connected with small cells and/or macro cells (depending the availability)
- ▶ Small cells connected with high backhaul connection with eNB for data and signaling transfer
- ▶ Devices can offload the traffic from by communicating in a D2D mode
- ▶ D2D communication can be done on licensed (i.e. LTE) or unlicensed band (i.e. WiFi)

KPI	Requirements	Notes
User Experienced Data Rate	From tens to hundreds of Kbps	Values are mainly in line with NGMN White Paper on 5G.
E2E Latency	Order of seconds or more	Values are mainly in line with NGMN White Paper on 5G.
Mobility	On demand	Mobility could range from static up to hundreds of km/h if sensors/actuators are e.g., installed on containers which are travelling by trucks on highways
Connection Density	Up to 200,000 devices/km ²	Values are mainly in line with NGMN White Paper on 5G.
Traffic Density	Not critical	Values are mainly in line with NGMN White Paper on 5G.



Ultra-Broadband Wireless

- ▶ Mixture of domestic, enterprise and public access outdoor and indoor environments located in a densely populated urban area
- ▶ In this use case, a massive deployment of small cells is necessitated to provide a uniform broadband experience to the users demanding high data rate and limited latency for the provisioning of applications such as:
 - High resolution multimedia streaming,
 - D2D,
 - gaming,
 - video calling,
 - cloud services.

KPI	Requirements	Notes
User Experienced Data Rate	DL: 300 Mbps UL: 50 Mbps	This data rate is motivated by ubiquitous support of Cloud services, video and other digital services, possibly combined.
E2E Latency	10 ms	
Mobility	Pedestrian	
Connection Density	200-2500 users /km ²	Total device density is 2000-25,000/km ² ; a 10% activity factor is assumed
Traffic Density	DL: 750 Gbps / km ² UL: 125 Gbps / km ²	Connection density x User experienced data rate



Ultra-reliable communications

- ▶ Ultra-Reliable Communication (URC) methods are intended to enable high degrees of networks availability, with guarantees on performance metrics such as latency.
- ▶ SPEED-5G aims at providing scalable solutions for networks supporting services with extreme requirements on availability and reliability
- ▶ Critical (real-time, safety) applications will require much higher reliability and lower latency than today's communication systems

KPI	Requirements	Notes
User Experienced Data Rate	DL: several kbps upwards UL: several kbps upwards	Reliability is more important than exact value
E2E Latency	1 ms upwards	Reliability is more important than exact value
Mobility	Mostly static	
Connection Density	Mostly low, but variable.	
Traffic Density	Highly variable	experienced data rate

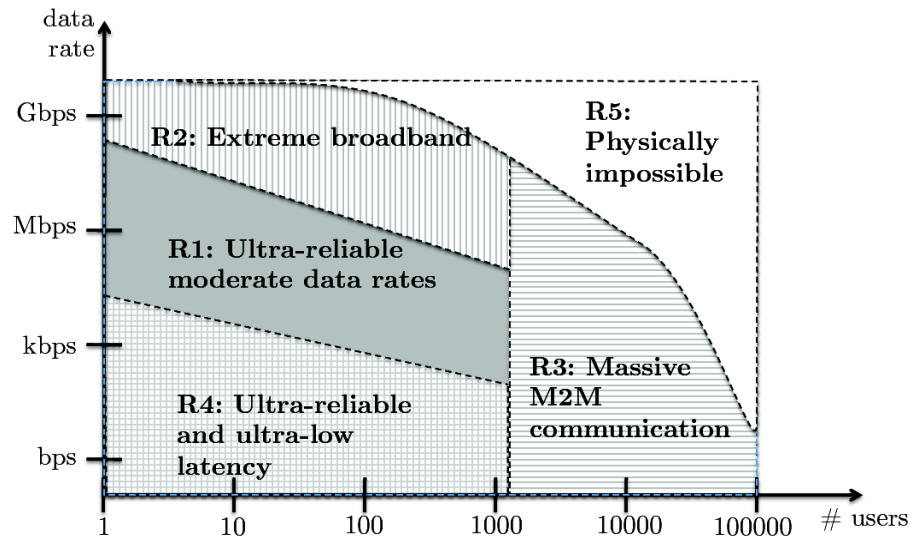


Figure source: Petar Popovski. Ultra-Reliable Communication in 5G radio systems, 5GU conference 2014

High-speed mobility

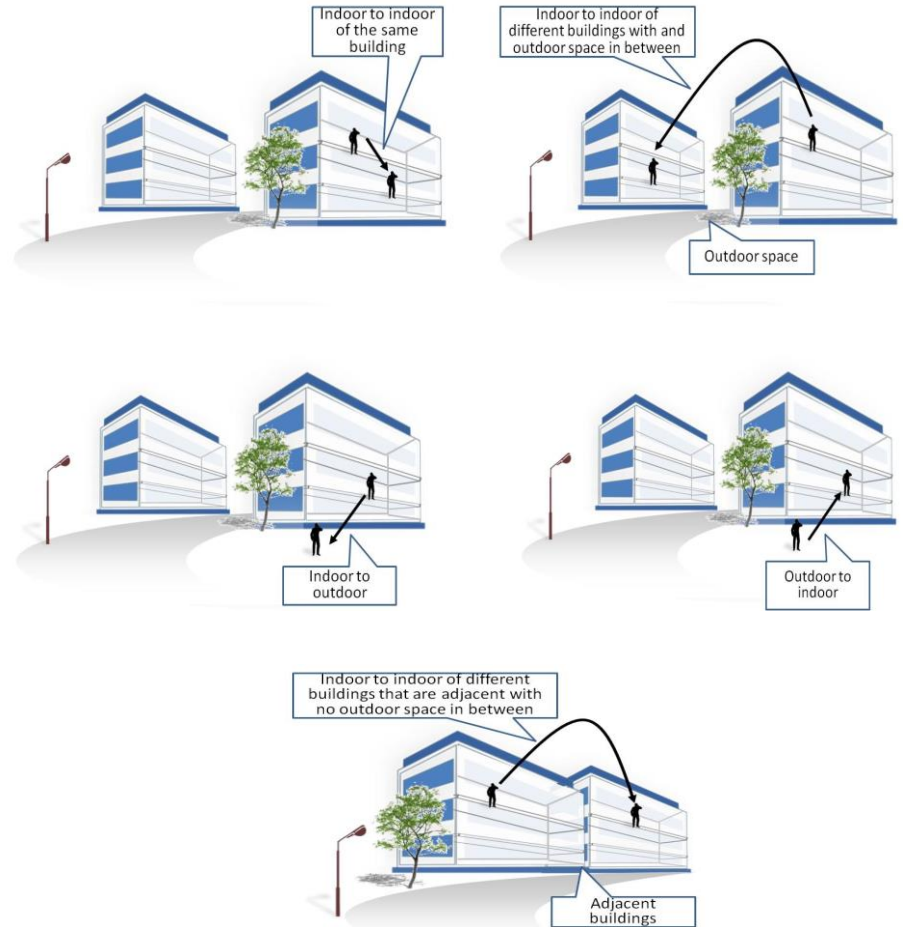
- ▶ Vehicles of the future will be part of a connected world where broadband networks give access to:
 - ➔ Communications,
 - ➔ Higher safety,
 - ➔ Improved environmental standards,
 - ➔ Entertainment,
 - ➔ Knowledge and personal contacts, to anyone, anywhere and at any time.
- ▶ Challenge: Given traffic and mobility levels of users which are the cells that should be selected and how should the traffic allocation be done?

KPI	Requirements	Notes
User Experienced Data Rate	DL: 50Mbps UL: 25Mbps	Values are mainly in line with NGMN White Paper on 5G.
E2E Latency	10 ms	Values are mainly in line with NGMN White Paper on 5G.
Mobility	On demand (it could be up to 500km/h for high-speed trains, around 100km/h for cars in highways)	Values are mainly in line with NGMN White Paper on 5G.
Connection Density	~2000/km ²	
Traffic Density	DL: 100Gbps/km ² UL: 50Gbps/km ²	Values are mainly in line with NGMN White Paper on 5G.



Potential deployment options

- ▶ Indoor to indoor of the same building
- ▶ Indoor to indoor of different buildings with and outdoor space in between
- ▶ Indoor to outdoor
- ▶ Outdoor to indoor
- ▶ Indoor to indoor of different buildings that are adjacent with no outdoor space in between



Way Forward

- ▶ Speed-5G has defined the main use cases which will be taken into account for the realization of its objectives
- ▶ Main objective is to achieve a significantly better exploitation of heterogeneous wireless technologies, providing higher capacity together with the ultra-densification of cellular technology, and effectively supporting the new 5G Quality of Experience (QoE) requirements
- ▶ Technical work continues with autonomous resource management solutions and smart medium access definition and development

5GPPP Proposed Coordination

- ▶ Speed-5G aims to coordinate its work with other projects, in order to enhance the results of the overall research program
- ▶ FANTASTIC-5G
- ▶ mmMagic
- ▶ METIS – II

Thank you for your attention!

Find us at www.speed-5g.eu

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Backup Slides

Technical Challenges

- ▶ On the research front, SPEED-5G will investigate and develop different sets of mechanisms and techniques for dynamic capacity and coverage expansion, including:
 - ➔ Combining radio technologies, spectrum and transmit energy,
 - ➔ Coexistence and interference control mechanisms using emerging multicarrier waveforms,
 - ➔ Operation in dirty/grey spectrum,
 - ➔ Management mechanisms in support of spectrum micro-trading in lightly-licensed bands, which are currently not utilized,
 - ➔ Techniques in support of centralized / distributed smart resource management.