5G: FROM MYTH TO REALITY

mmMAGIC

mmMAGIC: Enabling 5G Mobile Radio Access above 6 GHz

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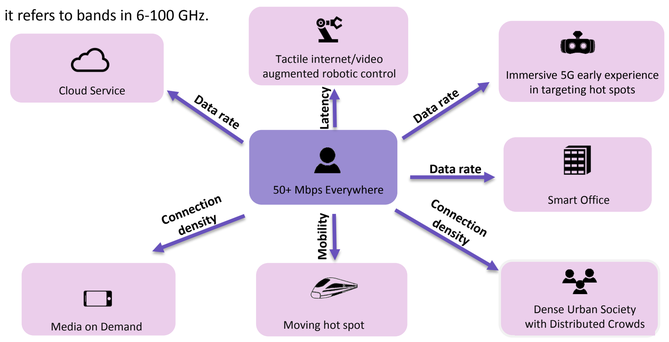
What mm-wave in 5G will offer you?

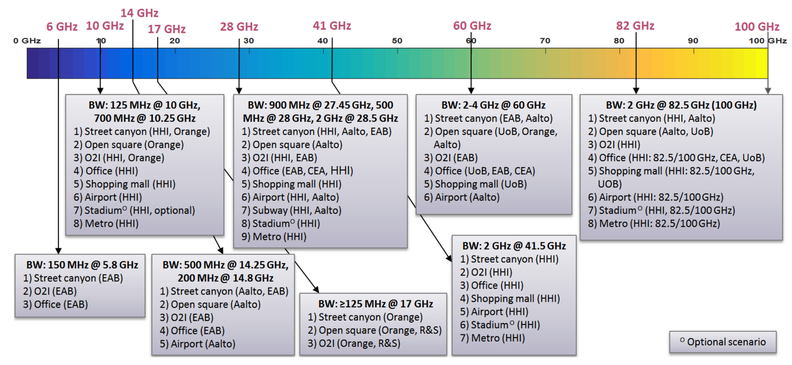
- mm-wave bands* can offer larger bandwidths that will upgrade the users' quality of experience to an outstanding level termed as "edgeless user experience".
- Leveraging mm-wave bands, new use cases and services will emerge that change human life and business aspects such as smart office, augmented robotic control or tactile internet. Some use cases will also take entertainment, organisation of data or connectivity to another level such as immersive 5G early experience, cloud service, media on demand or moving hotspot.

* Here, it refers to bands in 6-100 GHz.



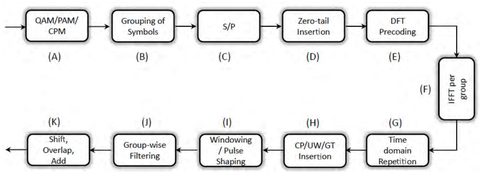
Channel Measurement and Modelling

- Measurement campaigns: over 20 measurement campaigns in more than 8 frequency bands from 6 to 100 GHz are ongoing across Europe, and will continue till the end of the project.
- Scenarios: UMi street canyon, UMi open square, indoor office, indoor shopping mall, indoor airport, outdoor to indoor (O2I), metro station and stadium.
- Initial channel model in line with the 3GPP-3D has been implemented supporting 10-80 GHz.



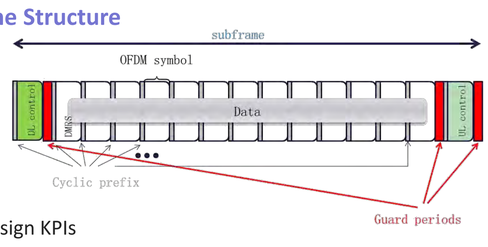
Radio Interface Design

Waveform Design



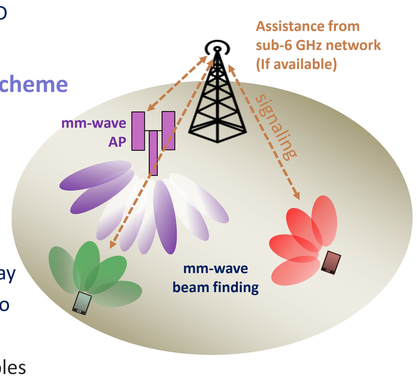
- Important design KPIs
  - Peak-to-Average-Power-Ratio (PAPR)
  - Robustness against RF impairments and Doppler
  - Compatibility with multi-antenna technologies
- Two waveform families
  - Multi-carrier vs. single carrier
- A number of waveform candidates being investigated
  - A high-level comparison available

Frame Structure



- Design KPIs
  - Throughput
  - Robustness to HW impairments and Doppler
  - Latency
  - Mobility support
- Candidates
  - Separation of control and data channels
  - Self-contained structure
  - Flexible TDD

Initial Access Scheme

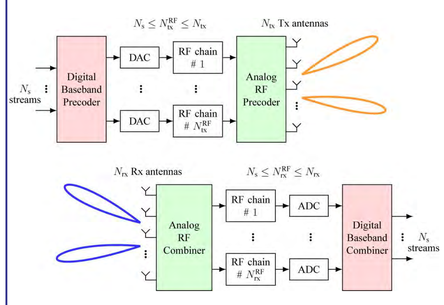


- Design KPIs
  - Access delay
  - Access ratio
  - Overhead
- Design principles
  - Coupling with BF (optimised code book design)
  - Exploitation of context information
  - Utilising sub-6 GHz network for signalling

RAN Functions and Architecture Integration

		Solutions for integration	
Architectural enablers and deployment aspects	*Provide cost and energy efficient architecture design and deployment requirements for 5G networks*	***Network Slicing*** Multiple logical networks as independent business operations on a common infrastructure.	***Multi-layer/ Multi-RAT management*** Abstracting logical functions at different layers in a unified structure.
Network integration for an edge-less mm-wave access	*Design solutions for interworking of mm-wave nodes*	***Multi-connectivity*** Providing a given UE with radio resources from two or more radio links.	***Agile Mobility*** Providing agile and low-overhead mobility via mm-wave cell clustering and new radio control states.
Methodologies for dynamic deployments	*Provide backhaul connectivity and overall network planning, networks flexible both in structure and operation*	***Self-backhauling*** Coverage/capacity extension by means of utilizing the same radio resources used by users.	***Low-band integration*** Supporting some control signals via greater reliability over the lower frequency RAT.

Multi-Antenna Multi-Node Design



- Multi-antenna designs and schemes
  - A wideband , low complexity scheme for hybrid beamforming in mm-wave access
  - Multi-connectivity backhaul provision for moving hot-spots through macro cells and mm-wave small cells
  - Optimising complexity / performance trade-off for massive antenna M2M communications
- Multi-node designs and schemes
  - Multi-connectivity based joint mm-wave/free space optical links
  - Multi-node coverage analysis with ray tracing data and node positions
- Hardware imperfections/ models
  - Phase noise analysis and models
  - Behavioural models for power amplifier non-linearities
  - Phased array distortion analysis for wider bandwidths

Key Facts

Part of 5G PPP under the Horizon 2020 - Research and Innovation Framework Programme (Proposal 671650)

Partners: Samsung (Coordinator), Ericsson (Technical Manager), Alcatel-Lucent, Huawei, Intel, Nokia, Orange, Telefonica, CEA-LETI, Fraunhofer HHI, IMDEA Networks, Aalto University, University of Bristol, Chalmers University of Technology, TU Dresden, Qamcom, Keysight Technologies, Rohde & Schwarz

Project Duration: July 2015-June 2017 (+6 pro-bono months)

Read more at https://5g-mmmagic.eu/

Achievements

- Four public deliverables so far characterising KPIs and key use cases and suitable frequency ranges in 6-100 GHz (D1.1), measurement campaigns and initial channel model (D2.1), initial concepts of 5G architecture (D3.1) and initial multi-node and multi-antenna transceiver architectures and schemes (D5.1),
- Ongoing activities to evaluate different waveforms and multi-antenna schemes in common simulation platforms by July 2016,
- Two white papers on channel measurements and modelling in mmMAGIC (W2.1) and architectural aspects of mm-wave radio access integration with 5G ecosystem (W3.1),
- Active contributions via key partners into 3GPP TSG RAN WG1 on channel modelling above 6 GHz,
- 1st workshop with European regulators and ETSI was held in November 2015,
- Contributing to 5G PPP cross-project working groups Architecture, Spectrum and Pre-standards,
- 10+ workshops, panels and keynotes at flagship conferences and industry events,
- 30+ research publications (accepted / submitted) in key scientific conferences and journals.

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