Findings and Follow-up from the 5G Pilot Projects in Russia

Pavel Mamchenkov

REGULATORY AND BUSINESS ASPECTS OF 5G PILOT PROJECTS

Towards 5G Implementation

01

Regulatory Decisions

- Allocation of 3400 – 3800 MHz and 25.5 – 29.5 GHz for the trial networks as of 04.07.2017 and 29.12.2017.
- To investigate spectrum availability for future 5G implementation, to study spectrum sharing with incumbents.
- To pave the way to future national 5G spectrum strategy.

02

Pilot Projects Basic Info

- Pilot Projects in Moscow, Saint Petersburg and Kazan
- Demonstrations during FIFA World Cup 2018
- Setting the scene for innovative business cases and services

03

Equipment

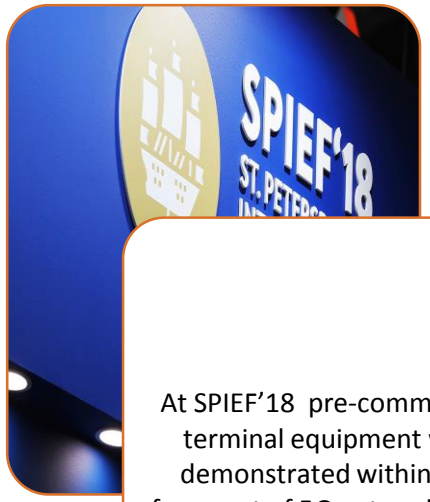
- Infrastructure of New Radio (NR) Base Stations from Nokia, Ericsson and Huawei
- Pre-commercial terminals fitted with Qualcomm Snapdragon and Huawei Balong 5G01 chip sets

04

Next Steps

- Several agreements between MNOs and municipal authorities in capital cities approved in order to implement innovative services based on 5G technology.
- 5G Applications for the Communal/Public Services based on VR, AR, Autonomous Transport, PPDR, smart cities etc.

5G Demonstrations in Saint Petersburg (June 2018)



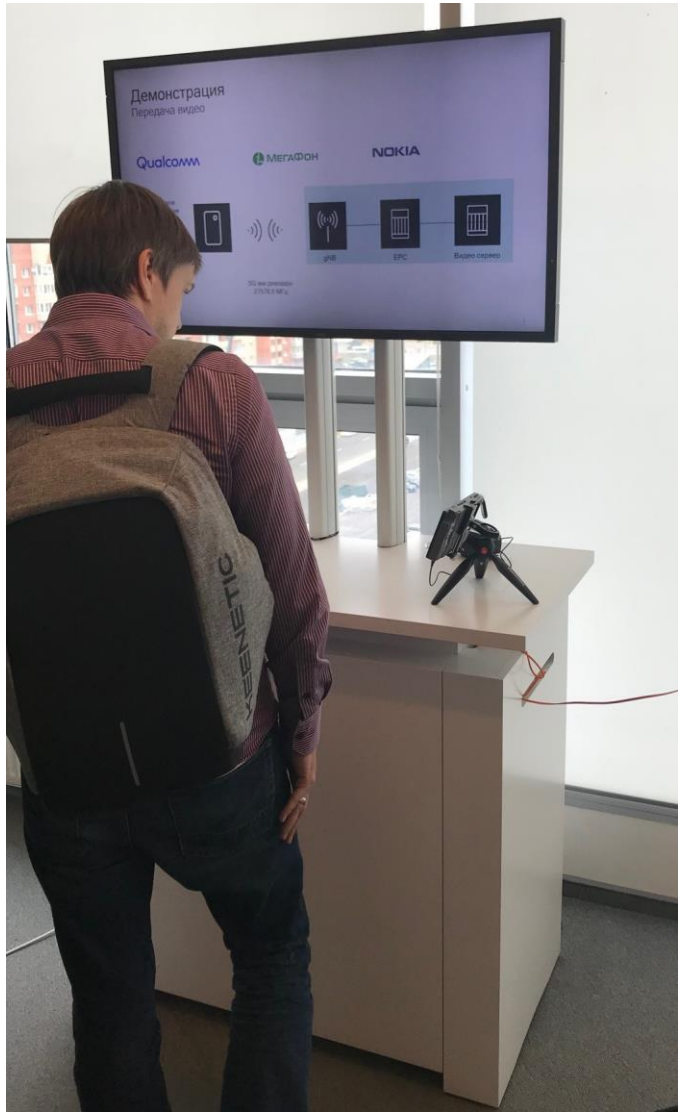
At SPIEF’18 pre-commercial terminal equipment was demonstrated within the fragment of 5G network. High speed video streaming was successfully presented.

Nokia AirScale 5G New Radio Base Station in 26 GHz.

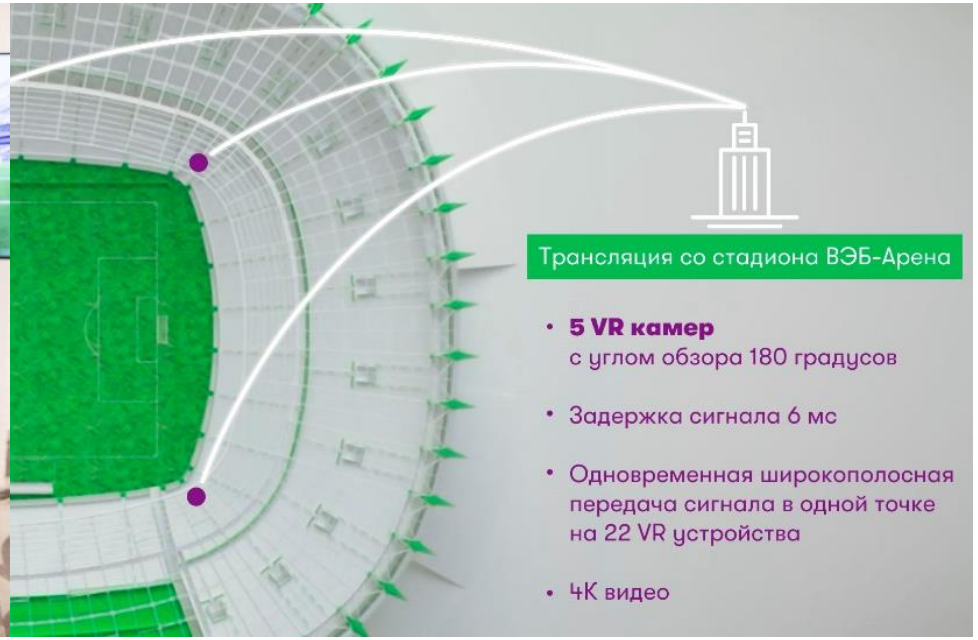
Network decision - 5G Future X from Nokia with 400 MHz channel and active massive MIMO.

Terminal equipment - pre-commercial smartphone equipped with 5G Qualcomm® Snapdragon™ X50 chipset.

Commercial 5G terminals with Qualcomm® Snapdragon™ X50 are expected to be supplied to markets in 2019.



5G Pilot Project in Moscow (World Cup 2018)



Data streaming from the stadium taken by means of five VR 180 degree cameras successfully linked to the fragment of 5G network deployed in MegaFon's office.

5G NR Base Station transmitted video and audio content to a set of VR glasses. Immersive virtual presence at the stadium has been achieved in practice.

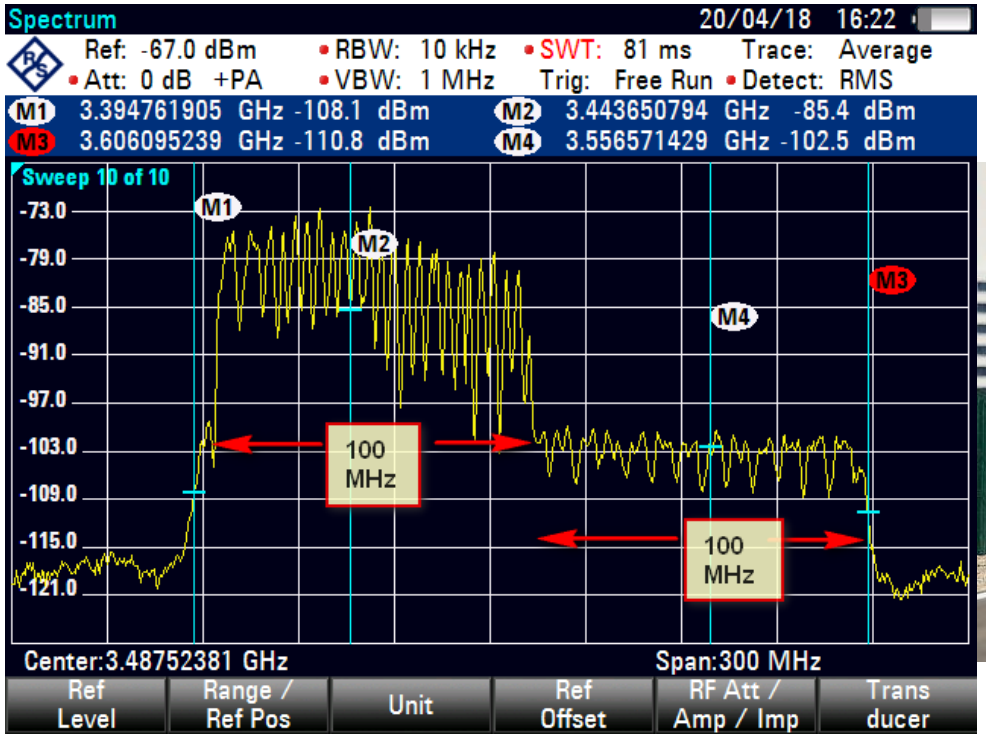
Radio coverage provided in 27578-27975 MHz band, terminals with advanced QoS user-centric aggregation (AQUA). 400 MHz bandwidth channel + MIMO 2×2 + 64QAM.

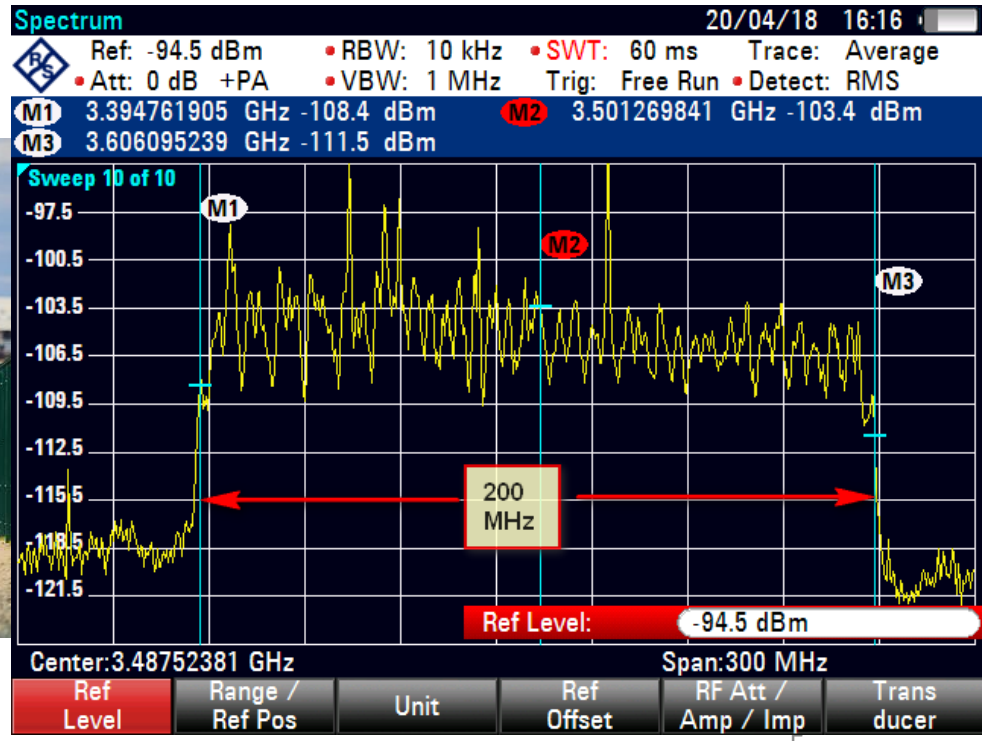
Autonomous Electro Bus with 45 km per hour in Kazan

Kazan 5G Pilot Project in 3400 – 3800 MHz spectrum band.

The fragment of 5G network for real time video and control/command data exchange with autonomous bus has been deployed using Huawei E2E planning & engineering fast delivery solution:

- 5G with the aggregation of two carriers 100 MHz bandwidth each complied to 5G NR 3GPP R15;
- New Generation Core (NGC);
- CPE 5G with Huawei chipset.





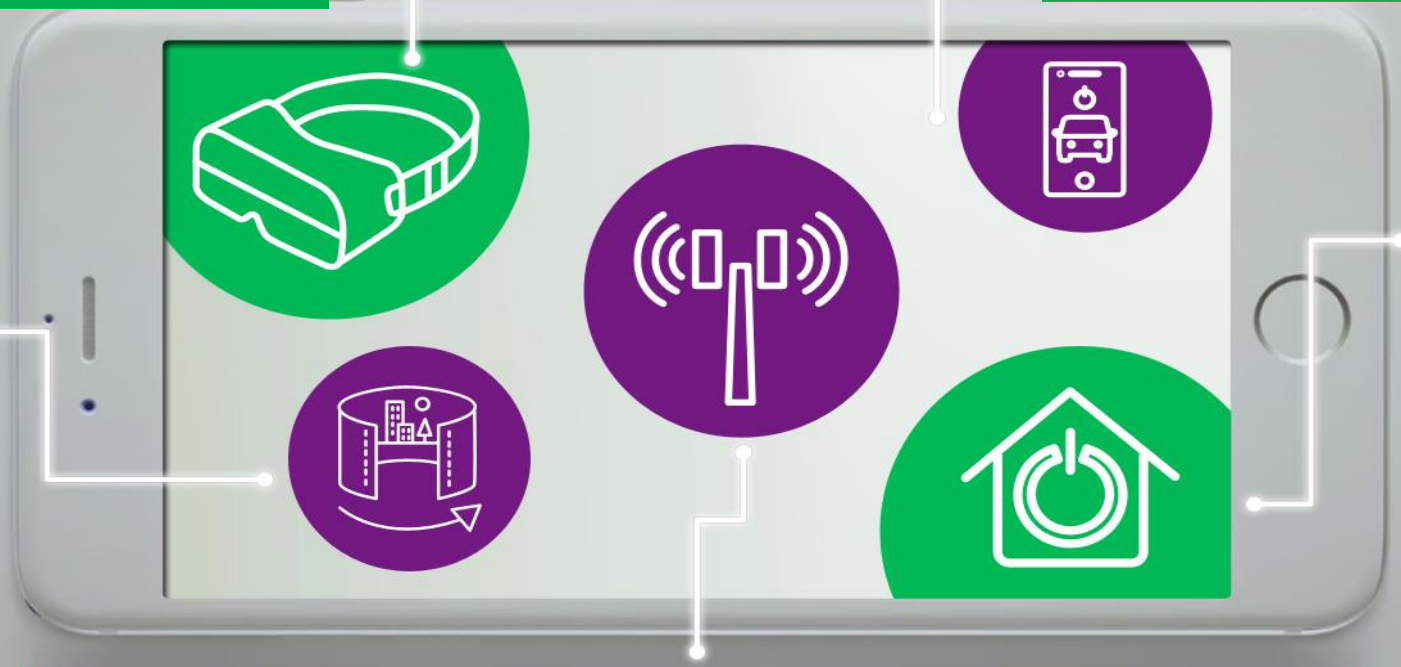
Future 5G Project in Moscow

Case # 1

5G Pilot Project Launch in Moscow with demonstration of VR functions

Case # 3

5G Pilot Project Launch in Moscow with autonomous car functionality



Case # 2

5G Pilot Project Launch in Moscow demonstrating AR functionalities

Case # 4

5G Pilot Project Launch in Moscow demonstrating smart city and IoT functionalities

Case # 5

5G Pilot Project Launch in Moscow with demonstrations of functionality in PPDR and Communal Services

TECHNICAL ASPECTS OF 5G PILOT PROJECTS

Towards 5G Implementation

01

Out-of-Band Emissions

- To estimate levels of out-of-band emissions.
- To decide on the need for guard band between adjacent sub-bands of different MNOs.
- To decide on frequency and geographic separation with incumbents.

02

Antenna Radiation Patterns

- Active antenna systems, their radiation patterns for EMC estimations
- Measurements of antenna radiation patterns in echoless camera

03

Compatibility with Stations of Fixed Service

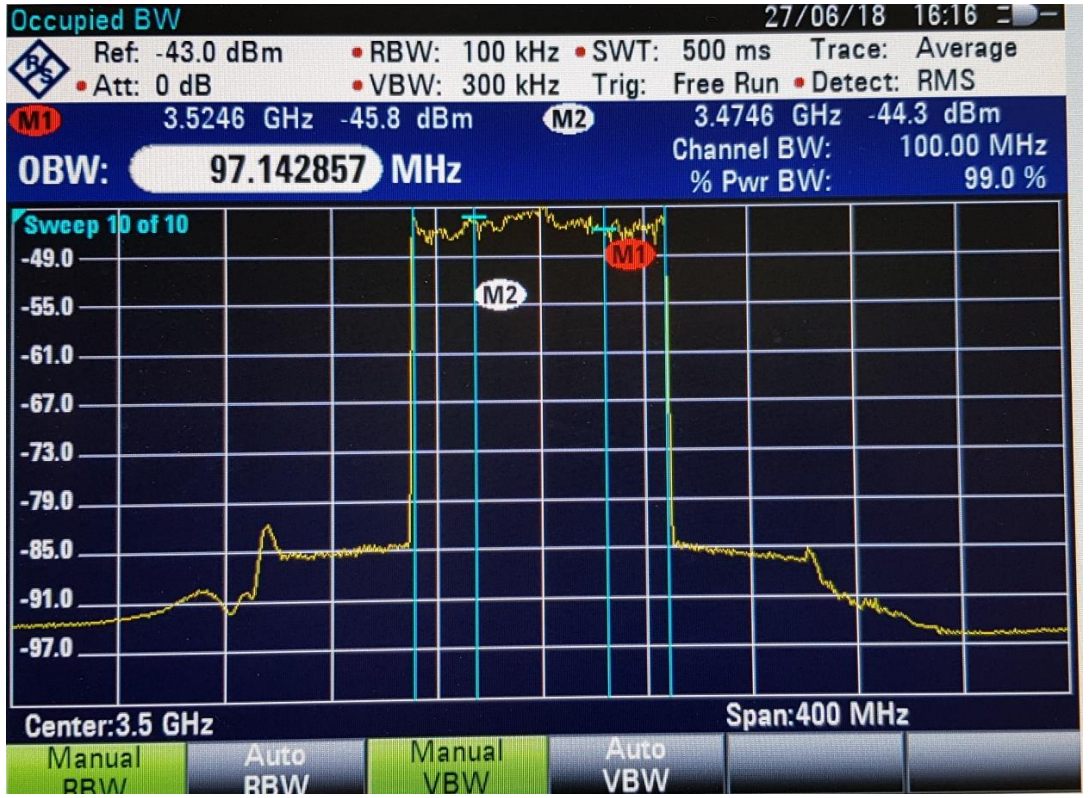
- Estimation of protection ratio of microwave stations being interfered by 5G emissions
- Field tests of practical interference cases

04

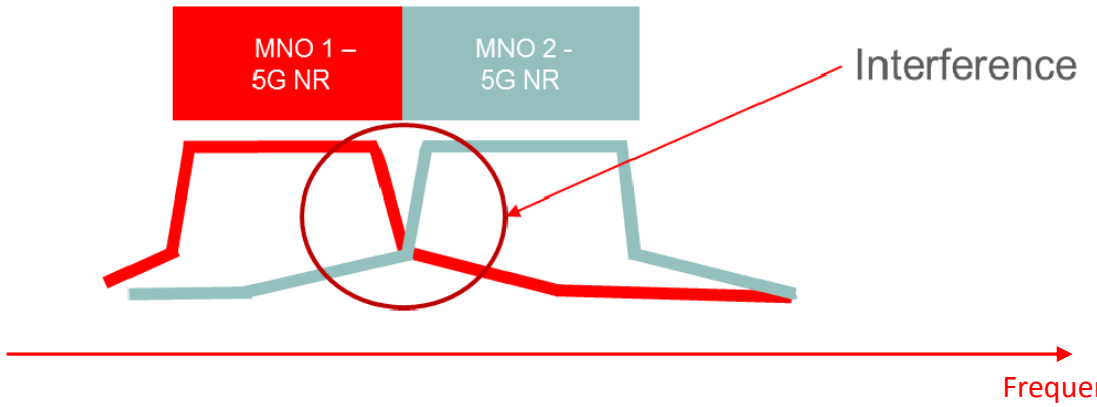
Innovative EMC Assessment

- Variable Coverage and EIRP.
- Higher EIRP not always worsening sharing scenarios.
- Statistical methods should prevail over deterministic.

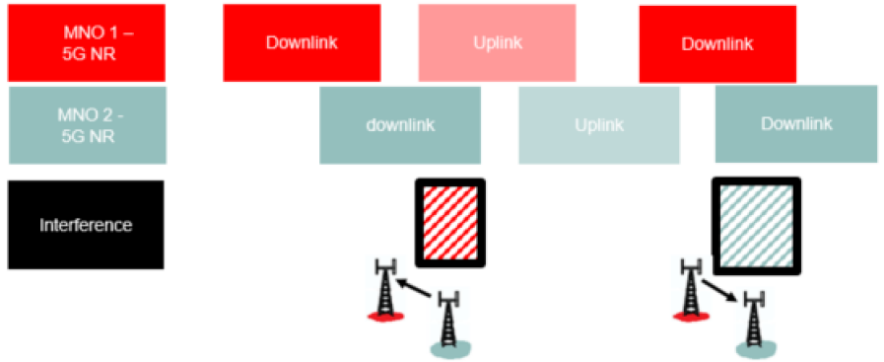
5G Out-of-Band Emissions and Their Implications



Out-of-Band emission level Is the crucial parameter influencing the decision on the need for Guard Bands between the sub-bands of different MNOs or requirements for their networks to be synchronized.



Out-of-Band Emissions falling to the adjacent band of another operator may require a guard band

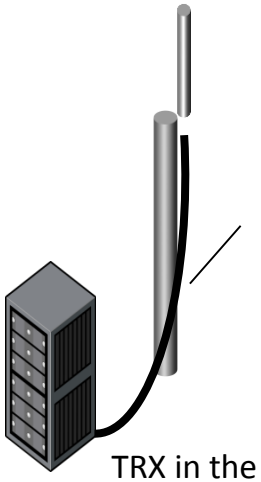


If synchronized MNO should agree on the same traffic asymmetry ratio and latency in their networks. The issue is currently being studied by GSMA.

5G Sets Precedent in Traditional EMC Assessment

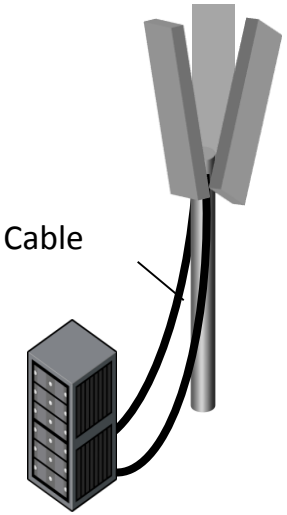
Evolution of the Architecture "RRU-Antenna System" 1G - 4G

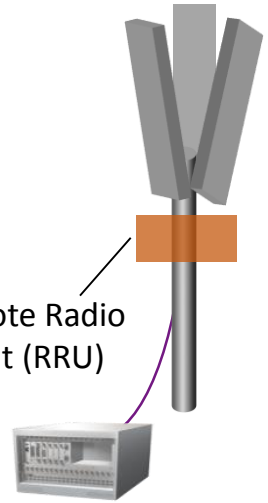
Omni antenna



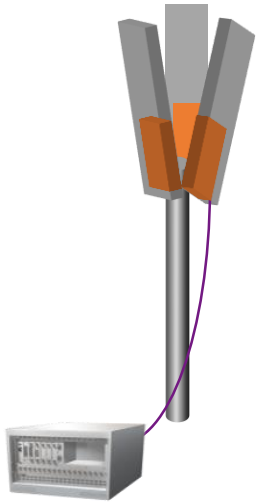
TRX in the Equipment Frame

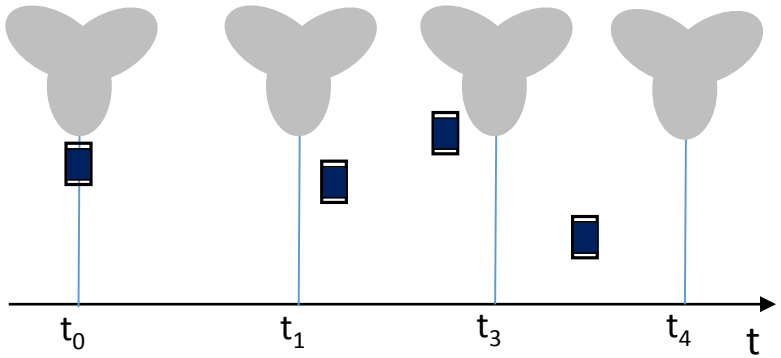
Sector Antennas





RRU Integrated into the Antennas

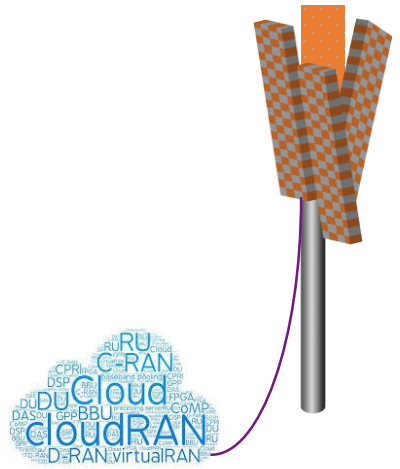


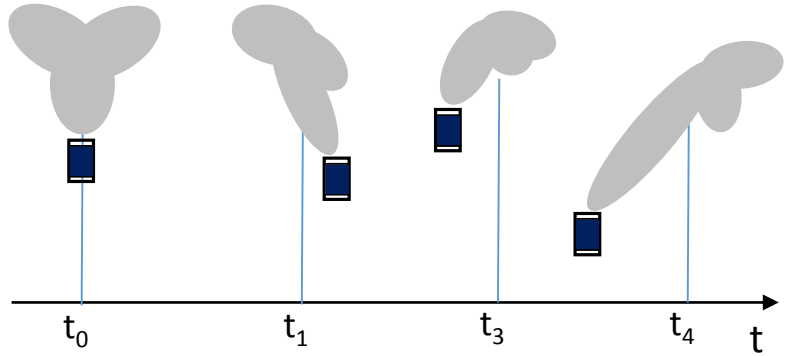


Static (Constant) EIRP and Coverage

5G Active Antenna System

Antenna pattern is changing in real time both in vertical and horizontal planes

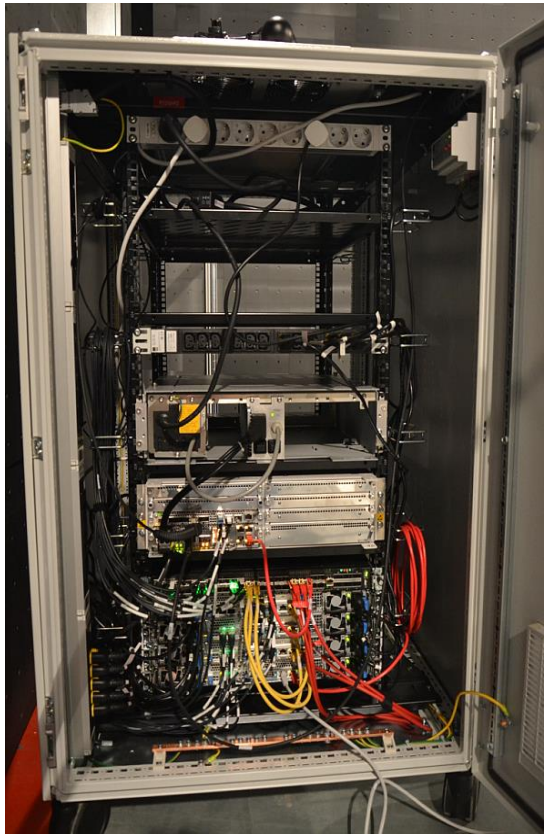


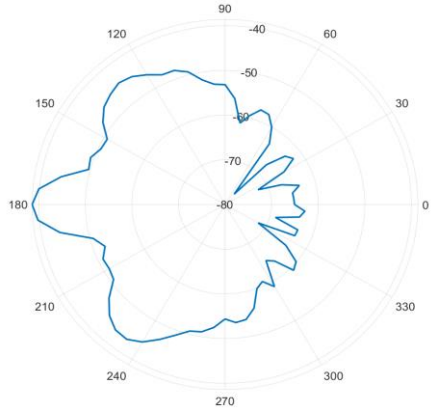


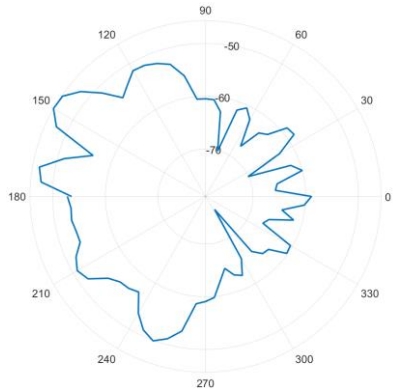
Variable Coverage and EIRP

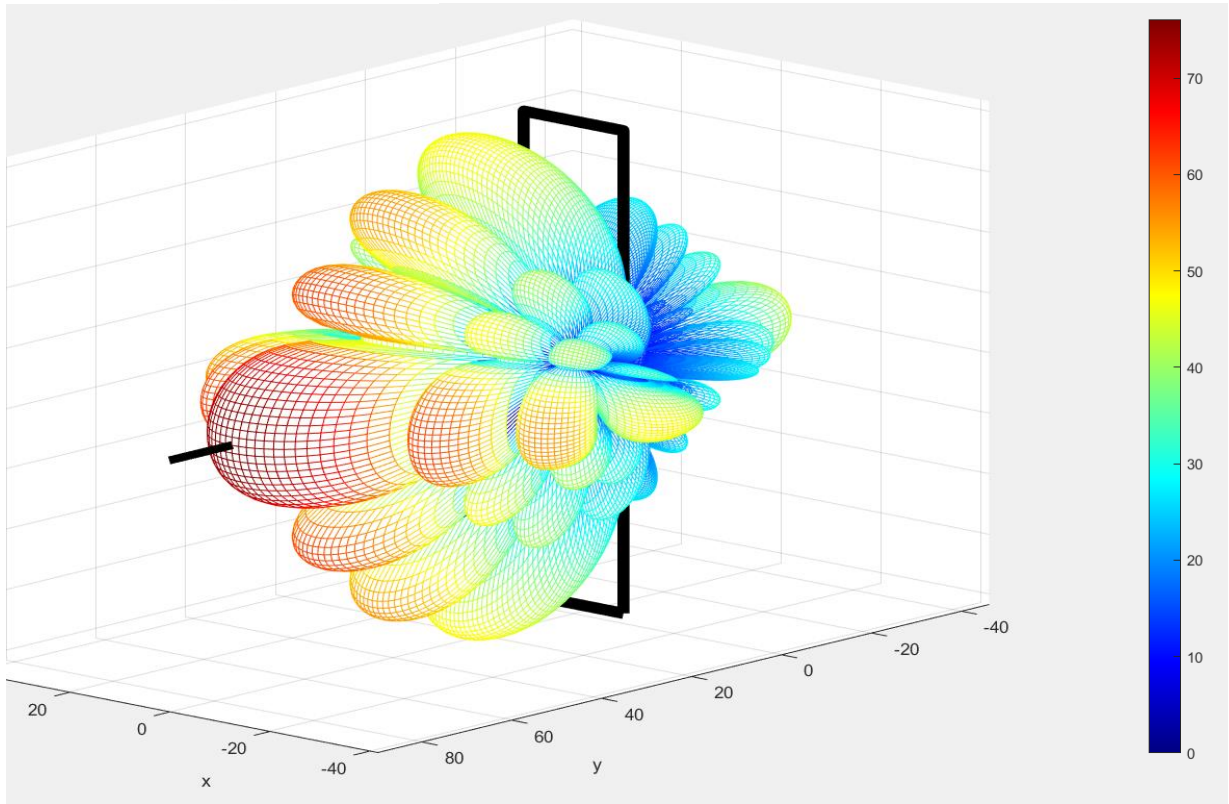
Active Antenna Tests in Echoless Camera

Antenna patterns of 5G Base Stations are becoming ever more crucial in spectrum sharing and compatibility scenarios with incumbent radio services



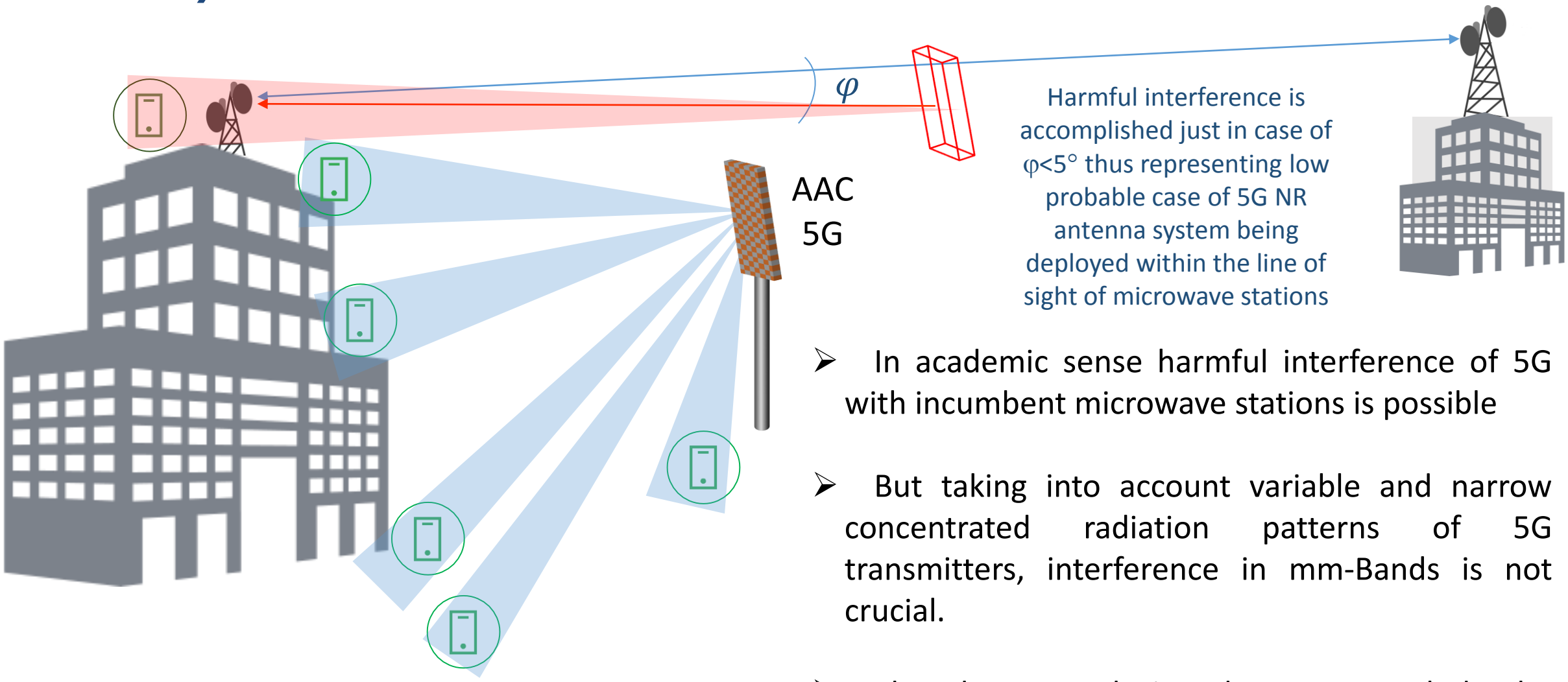






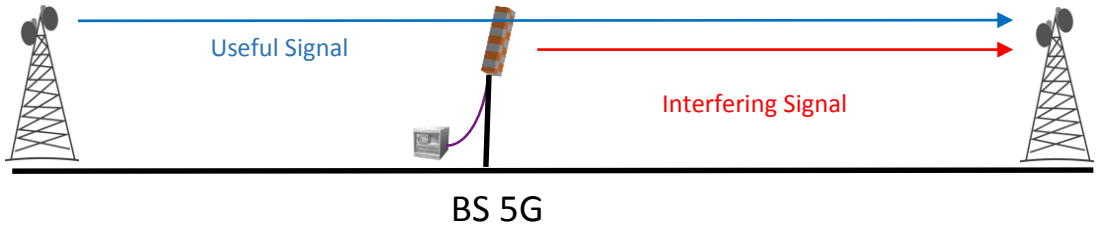
EIRP of the active antenna (3D view)

What Does It Mean for EMC (Fixed Service in mm-Band Sharing Scenario)

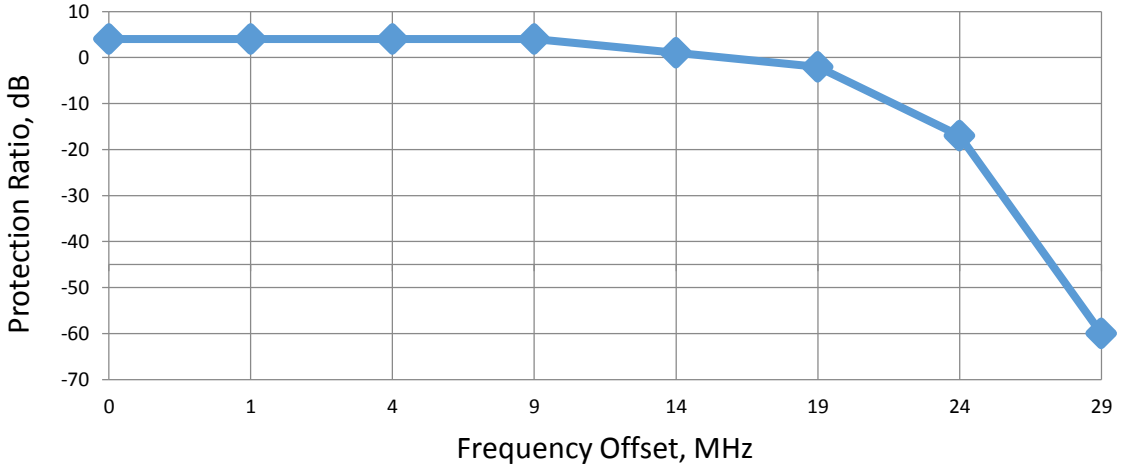


- In academic sense harmful interference of 5G with incumbent microwave stations is possible
- But taking into account variable and narrow concentrated radiation patterns of 5G transmitters, interference in mm-Bands is not crucial.
- The above conclusion does not preclude the need for microwave stations to be redeployed from the legacy 5G bands.

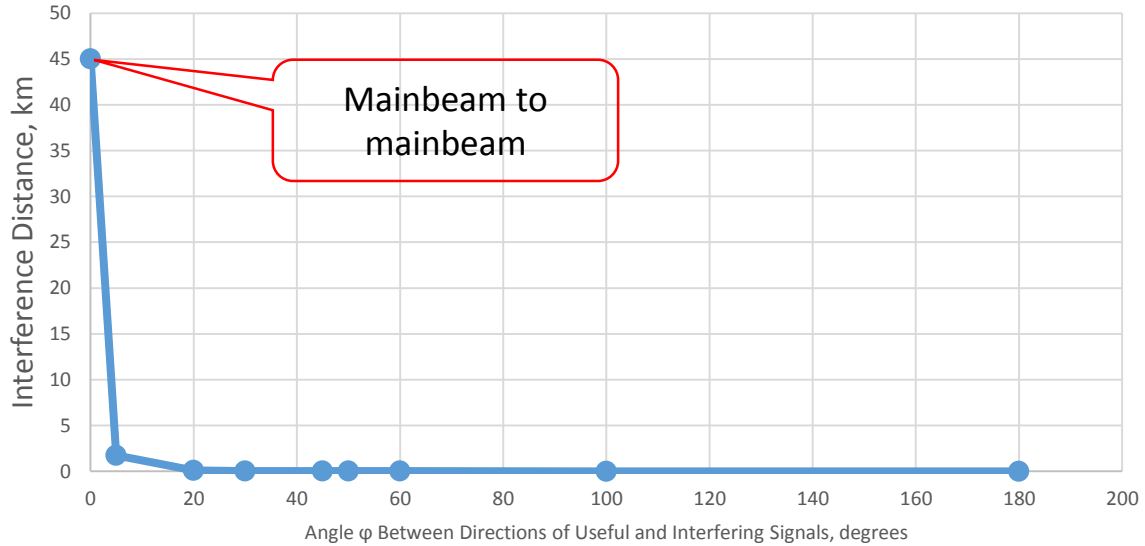
Field Tests, Compatibility 5G BS Versus Microwave Station in 26 GHz Band



Test Site and Measurements Scheme



Protection Ratio, dB. Microwave station – QPSK, 28 MHz Channel Bandwidth

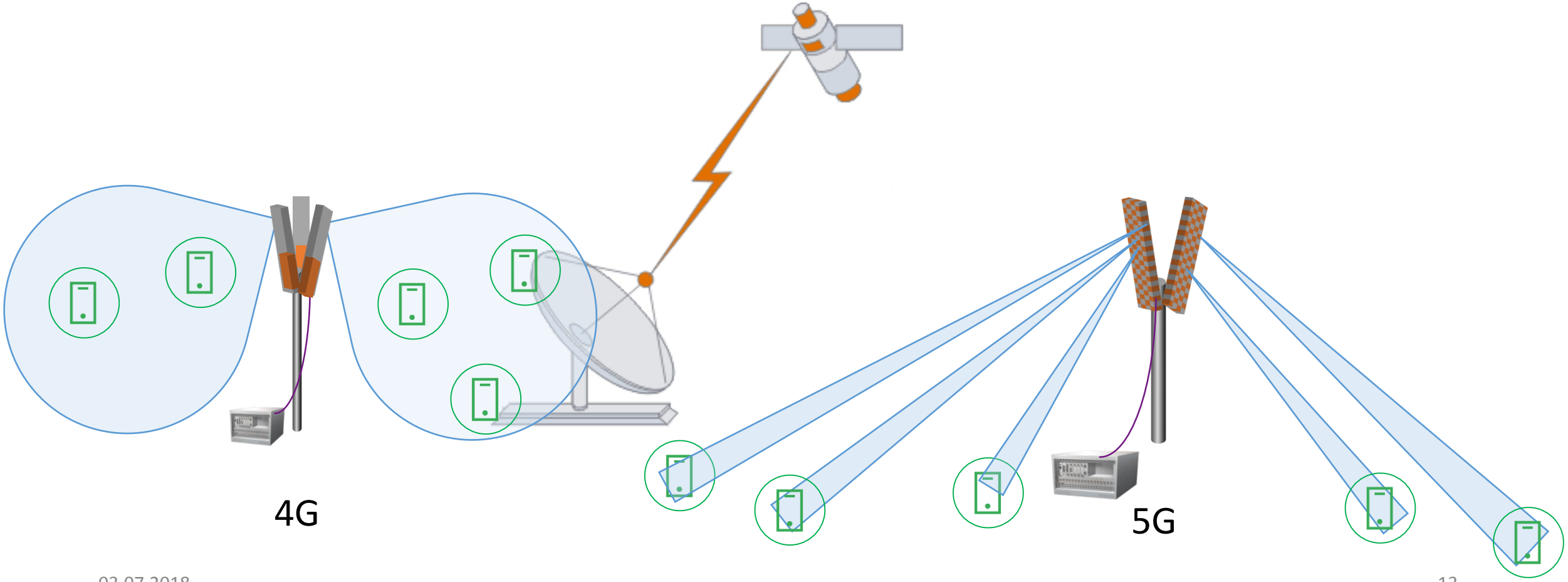


Interference Distances As a Function of an Angle in Azimuth Plane Between the Directions of Useful and Interfering Signals

Traditional EMC Estimation Methods Should Be Aligned for 5G

High but dynamic and concentrated EIRP of 5G is narrowly focused towards user terminals thus decreasing interference averaged by area. It simplifies electromagnetic compatibility scenarios with the incumbent spectrum users.

In view of variable characteristics of 5G compatibility assessment should be based on statistical methods.



Conclusions

1. 5G Pilot Projects are of great value in studying both business opportunities and technical aspects of implementation of new generation networks.

2. The trial networks currently deployed are illustrating matured equipment of 5G network infrastructure as well as demonstrating innovative functional capabilities of future networks to be utilized in a number of verticals.

3. Future pilot project should be focused on estimation how to introduce innovative 5G services at the current markets and how to guide evolution of these markets.

4. By means of pilot projects national technical spectrum strategies for 5G implementation should be clarified.

5. Pilot Projects are providing important scene for spectrum sharing studies and options on future activity of administrations with spectrum incumbents.