

# Sharing in the 5G mm bands

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## Spectrum sharing in EU context (I)

- ❑ For 5G development, new radio bands have been introduced and novel bands in mm-wave spectrum (over 40 GHz) are under investigation.
- ❑ In Europe a number of **5G pioneer bands** have been identified by RSPG to provide 5G services in Europe by 2020 on a large scale: 700 MHz, the 3.5 GHz and the **26 GHz** band.
  - These bands offer a mix of spectrum below 6 GHz and in the millimetre wave (mm-wave) region in order to provide a wide range of 5G services such as improved mobile broadband, ultra-reliable low-latency communications and massive machine-type communications.
- ❑ In order to guarantee proper time frames of spectrum availability for 5G in Europe, ECC approved a comprehensive list of actions named “**CEPT roadmap for 5G**”
  - The list of actions includes the development of a harmonisation process (like in the 26 GHz band) setting the conditions for the introduction of 5G in the pioneer bands, taking into account the compatibility and protection with all existing services in the same and in adjacent frequency bands

## Spectrum sharing in EU context (II)

### ❑ RSPG Opinion on Spectrum Sharing

- spectrum sharing in the Union implemented in a rather static and conservative manner
- RSPG Work Programme to improve spectrum sharing and to implement innovative sharing solutions
- in this Opinion the RSPG investigated: options to promote spectrum sharing, identified key pioneer initiatives and bands and developed a roadmap for increased spectrum sharing with actions to favour the introduction of innovative and more dynamic spectrum sharing solutions and proposals for coordinated actions.

### ❑ Options for promoting Spectrum Sharing

- Italian “club use” at 26 GHz, which follows the principle of “use-it-or-share-it”, spectrum pooling approach in the IMT-Bands, Licensed Shared Access
- solutions based on device features (“dynamic frequency selection” or authorisation from a database)
- consider network slicing and roaming agreements
- Member States could consider sharing solutions that may help vertical industries
- Member States should consider sharing spectrum between incumbents and new users using innovative and more dynamic solutions.
- Member States should encourage industry to design receivers able to tolerate a given degree of unforeseen interference, in line with the need to avoid building sharing solutions based on worst-case scenarios

## Spectrum sharing in EU context (II)

### □ Identification of key pioneer initiatives and bands

- RSPG recognises that already today radio spectrum is used on a shared basis. Free resources are hardly available, neither in time, nor in geography. Innovative sharing solutions and initiatives are mainly based on improving the authorisation process and on defining and implementing advanced technical sharing conditions.
- all spectrum bands potential candidates for introducing and enhancing spectrum sharing solutions
- automate (e.g. via Artificial Intelligence) or authorise "secondary"/additional spectrum usage

### □ Roadmap for increased Spectrum Sharing: Investigation of more dynamic spectrum sharing options

- sharing conditions should be based on realistic scenarios, rather than worst-case, and take into account as far as possible results of measurements to better understand the impact of real case interference
- To facilitate sharing scenarios, Member States may consider the on-line availability of information about radio spectrum usage. Member States should adapt the information, before making it available, in an appropriate anonymized format of spectrum usage, e.g. protection or exclusion zones, protection criteria, time of usage, in line with national circumstances (cybersecurity, confidentiality, other legal requirements, etc.)

## Spectrum sharing at national level

- ❑ To achieve more flexibility and improve spectrum efficiency in 5G networks, spectrum sharing approaches are under investigation in some European countries
- ❑ In France, the national Government and the regulator Arcep issued a joint call for the creation of 5G platform trials that would be open to third parties, using the 26 GHz band.
- ❑ In UK, shared access to spectrum through local licensing is promoted by using mobile technology to support innovation and develop solutions to meet local wireless connectivity needs.
- ❑ In Italy, the 26.5-27.5 GHz band, which has been already awarded to 5G, includes the possibility of shared use of the spectrum.
- ❑ Mobile spectrum for private licensing has been also considered by some European countries in 5G frequency bands

## The Italian scenario: focus on the 26 GHz band

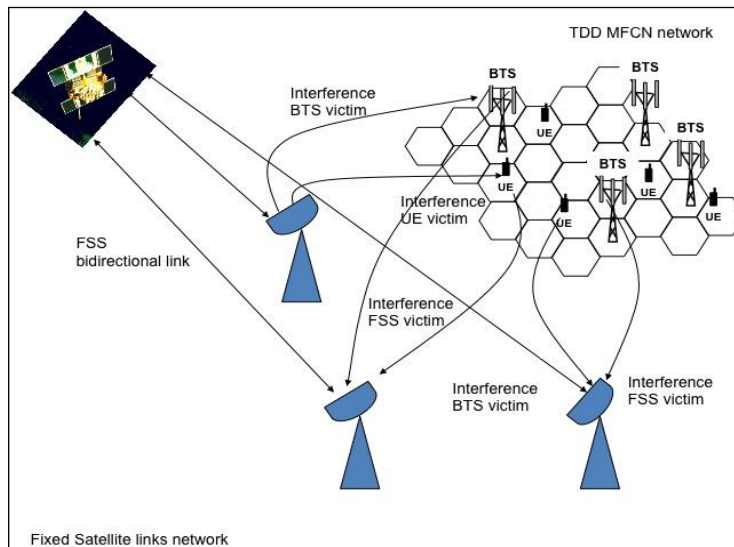
- ❑ Rights of use in the 26.5-27.5 GHz band were assigned (2018) in Italy to five operators who were awarded 200 MHz each
- ❑ According to the provisions of the Italian regulator Agcom's Resolution no. 231/18/CONS and of the Ministry of Economic Development (MiSE) tender specification, in order to achieve a more efficient use of spectrum, also due to the propagation characteristics of band, the frequency blocks can be shared among operators and can be dynamically used in areas where they are not used by the holders of rights of use (this is the so called, club use approach)
- ❑ This approach allows to use larger frequency blocks of up to 1 GHz, bringing benefits for 5G system performance (capacity, peak throughput, latency) even in high density locations (central squares, shopping districts, stadiums, airports, stations, etc.).

## Coexistence and sharing scenarios in the 26 GHz band

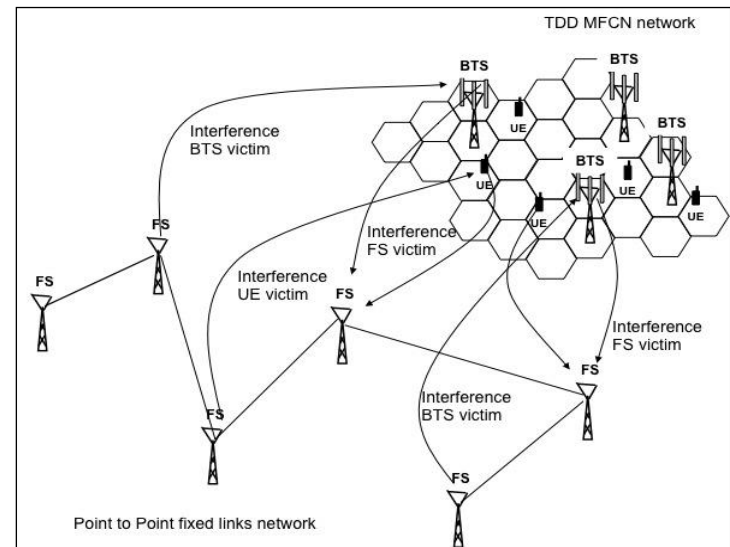
- ❑ The **implementation** of **club use** requires to identify application scenarios and to evaluate the conditions of coexistence to guarantee the dynamic use of frequencies while avoiding possible interference among operators
- ❑ Synchronization aspects at 26 GHz: coexistence between synchronized, unsynchronized and semi-synchronized networks in indoor and outdoor environments
- ❑ Coexistence with incumbent users (FS, FSS)

## Coexistence and sharing with incumbent services (I)

- ❑ In Italy the 26 GHz band is partially allocated to fixed service (FS) links, both Point-to-Point (P-P) and Point-to-Multipoint (P-MP) [20].
- ❑ Also Fixed Satellite Service (FSS) is present in Italy in the 26 GHz band both in-band and in adjacent band



FSS



FS



## Coexistence and sharing with incumbent services (II)

- ❑ FUB performed coexistence evaluations between IMT2020 and FS, FSS incumbent services in the 26 GHz band using a proprietary sharing tool
- ❑ Protection criteria is based on I/N (see ECC Report 303)
- ❑ Sharing conditions are calculated through the identification of minimum separation distance between interferer and victim as a function of angular discrimination
- ❑ Propagation models: ITU-R P. 1411, ITU-R P. 452, ITU-R P. 2108
- ❑ Some results on the impact of IMT-2020 on a victim P-P link are presented

IMT-2020 TECHNICAL CHARACTERISTICS	
Parameter	Outdoor (sub) urban hotspot BS
Channel bandwidth	200 MHz
Antenna height	6 m
Number of sectors	1
Mechanical tilt	10°
Antenna pattern	Beamforming
Antenna gain	5 dBi (per MIMO element)
Frequency	26 GHz

FS P-P TECHNICAL CHARACTERISTICS			
Parameter			
Antenna gain (dBi)	36.6	36.6	42
Antenna height (m)	15	30	60
Channel bandwidth (MHz)	28	28	56
Noise figure (dB)	6.5		
Maximum I/N	-10		
Antenna pattern	ITU-R Rec. F.699		

## Coexistence and sharing with incumbent services (III)

### □ propagation model 26 GHz:

- Rec. ITU-R P.452-16 in combination with Rec. ITU-R P.2108-0 that evaluates supplementary attenuation due to clutter in the propagation path
- Rec. ITU-R P.1411 in urban areas and, for the indoor scenario, Rec. ITU-R P.2109 that defines the additional Building Penetration Loss.

### □ Interferer Adaptive Antenna System (AAS): 64-element (8x8) MIMO:

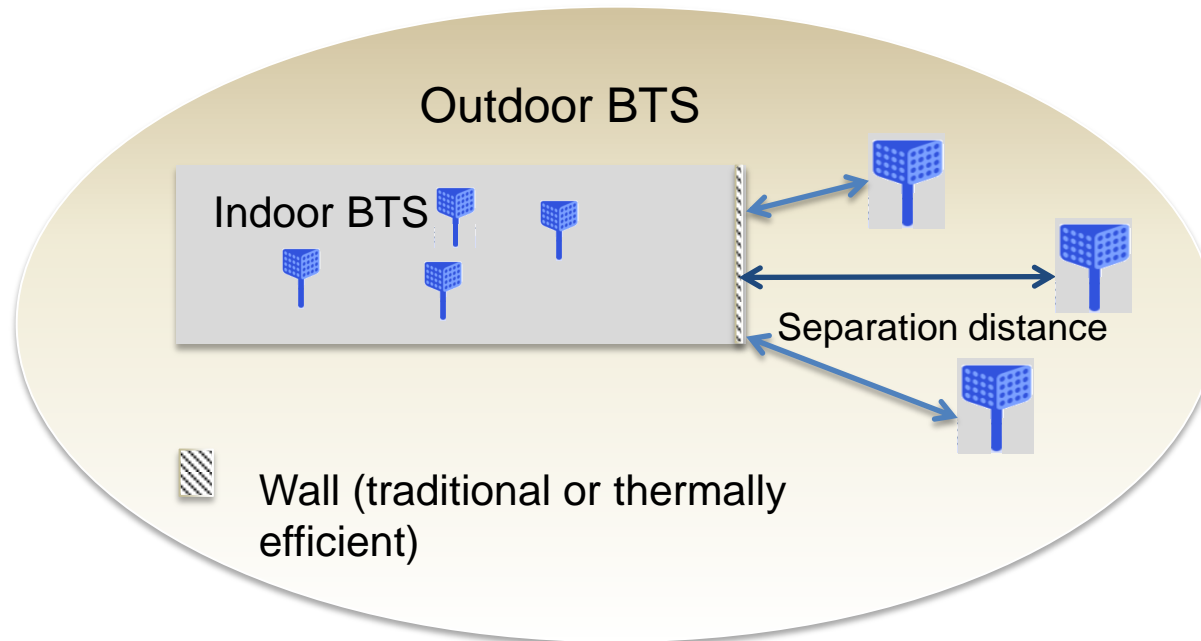
- $G_{TOT}=5 + 10 \log_{10} 64 = 23 \text{ dBi}$ ,  $P_{TOT}=10 + 10 \log_{10} 64 = 28 \text{ dBm}$ ,  $EIRP=P_{TOT} + G_{TOT} - L_C = 48 \text{ dBm}$

IMT 2020 Configuration parameters in different scenarios							
	Config 1	Config 2	Config 3	Config 4	Config 5	Config 6	Config 7
BTS height (m)	6	15	6	6	3	3	6
Azimuth	0	0	0	0	0	0	180
Outdoor/Indoor	Outdoor	Outdoor	Outdoor	Outdoor	Indoor traditional	Indoor thermally efficient'	Outdoor
Co/adjacent/Channel	Co-channel	Co-channel	Adjacent-NFD = -30 dB I	Adjacent-NFD = -45 dB guard band	Co-channel	Co-channel	Co-channel

Protection distance (Km) I/N = -10 dB							
	Config 1	Config 2	Config 3	Config 4	Config 5	Config 6	Config 7
h FS = 15 m	27,05	32,95	2,05	0,65	3,75	0,65	0,85
h FS = 30 m	33,15	39,55	2,05	0,65	3,75	0,65	0,85
h FS = 60 m	45,05	51,65	3,75	0,95	6,75	0,85	0,75

## 5G sharing studies scenarios: 26 GHz band

- ❑ Coexistence scenarios between 5G networks deriving from the implementation of **the club use approach**:
  - spectrum sharing 5G outdoor – 5G outdoor
  - **spectrum sharing 5G outdoor – 5G indoor**
  - spectrum sharing 5G indoor – 5G indoor



## 5G sharing studies simulation parameters: 26 GHz band

### IMT-2020 SIMULATION PARAMETERS (TX SIDE)

	OUTDOOR BS	INDOOR BS
Pc (Conducted power)	10 dBm/200 MHz	5 dBm/200 MHz
Element gain	5 dBi	5 dBi
TRP	25 dBm/200 MHz	23 dBm/200 MHz
Antenna height	15 m	3 m
Tilt values	6°/10°/15°	0°/6°

### IMT-2020 SIMULATION PARAMETERS (RX SIDE)

Channel bandwidth (MHz)	200
Noise power	-91 dBm
Maximum I/N	-6 dB

## 5G sharing studies methodology : 26 GHz band

- ❑ **Propagation model: ITU-R P.452-16.** In addition for the indoor scenario, **ITU-R P.2109** is used to evaluate the additional Building Penetration Loss.
- ❑ The impact of AAS antenna systems has been considered for both outdoor and indoor Base Transceiver Station (BTS) sites according to the **ITU-R M.2101** model
- ❑ The interferer has an **Adaptive Antenna System** (AAS) constituted by a 64-element (8x8) MIMO array. Each element has a gain of 5dBi, therefore the total gain is:

$$G_{TOT} = 5 + 10 \log_{10} 64 = 23 \text{ dBi}$$

- ❑ The assumed Tx power is 10 dBm per array element, so the total power over the total bandwidth of 200 MHz is:

$$P_{TOT} = 10 + 10 \log_{10} 64 = 28 \text{ dBm}$$

- ❑ Therefore the EIRP, considering a 3 dB coupling loss  $L_C$  is:

$$\text{EIRP} = P_{TOT} + G_{TOT} - L_C = 48 \text{ dBm}$$

- ❑ that corresponds to a spectral power density of:

$$\text{EIRP (dBm/MHz)} = 48 + 10 \log_{10} (1/200) = 25 \text{ dBm/MHz}$$

- ❑ In this analysis we used the **Minimum Coupling Loss** (MCL) method.

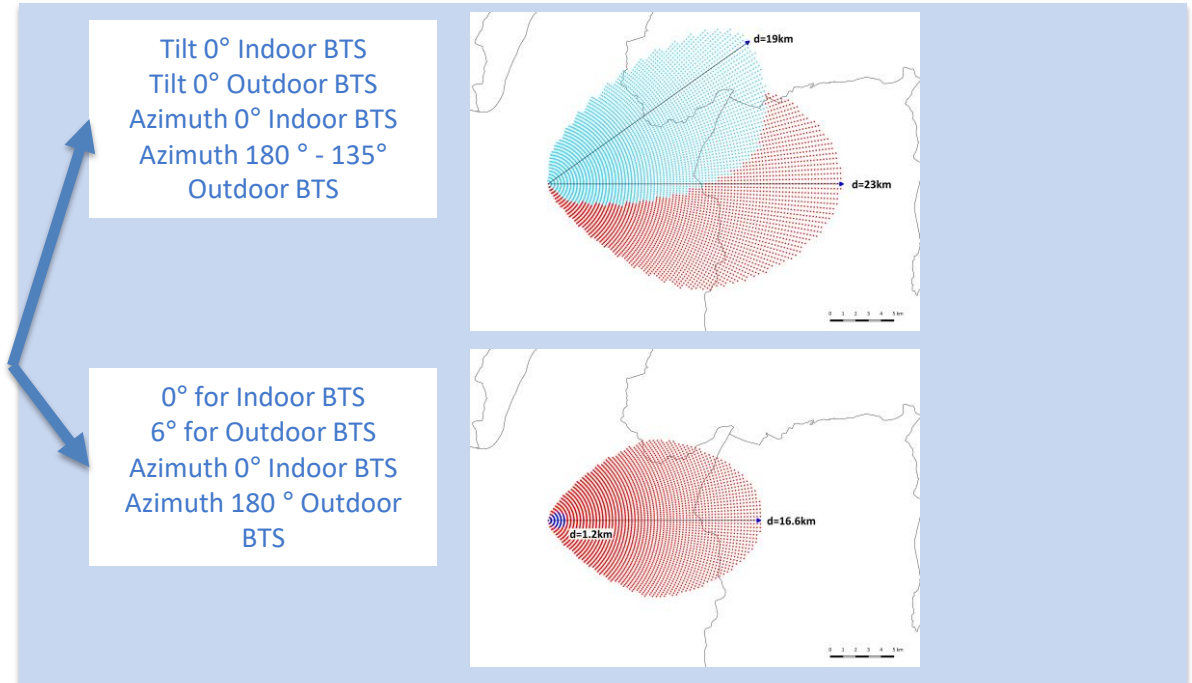
## 5G sharing studies simulation results : 26 GHz band (I)

- ❑ Co-channel coexistence in the 26 GHz band between outdoor BTS and indoor BTS is evaluated identifying the **exclusion zone** (i.e. the area where IMT interferers are not allowed to operate) around the victim to guarantee a protection level I/N below -6 dB.
- ❑ The blue area refers to the case of **thermally efficient wall** while the red area refers to the **traditional wall** as defined in Rec. ITU-R P.2109.
  - The exclusion zone can be reduced using AAS by adaptively increasing the vertical angular discrimination between outdoor and indoor BTSs.
  - The beam steering of the AAS horizontal pattern which covers 60° for both outdoor and indoor BTS defines the shape of the exclusion area.
  - The worst case is when the interferer is perfectly in line with the victim, separation distance can reach several Km for traditional building if no vertical antenna discrimination is introduced
  - The effect of building penetration loss is more evident in thermally efficient buildings.

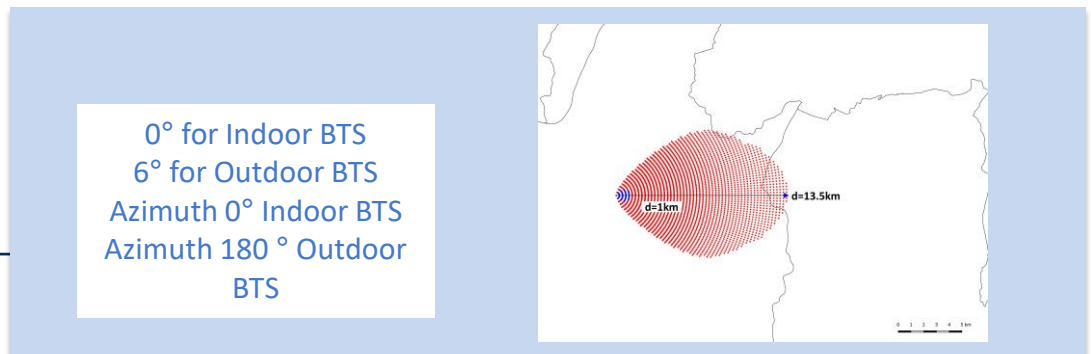
# 5G sharing studies simulation results : 26 GHz band (II)

## Exclusion areas – effect of angular separation

Outdoor-indoor scenario:  
exclusion zone for Outdoor BTS



Indoor-Outdoor scenario:  
exclusion zone for Indoor BTS



## Conclusions and further work

- ❑ Optimal parameters for the efficient use of the spectrum have been identified for sharing and coexistence between **5G systems under the club use approach** and between **5G systems** and **incumbent services in the 26 GHz band**:
  - The **separation distance depends on a lot of variables**: frequency, geometrical and electromagnetic characteristics of transmitters and receivers, etc.
  - **Indoor scenario at 26 GHz allows a considerable reduction of the separation** distance due to the propagation characteristics of this range of frequencies.
  - **Active Antenna Systems (AAS)** can adapt the radiation diagram to minimise the power transmitted in some directions; a proper choice of the active antenna configuration for both indoor and outdoor BS is essential to facilitate spectrum sharing
  
- ❑ Further work:
  - **Analysis of other coexistence scenarios in the new mmwave spectrum that will be identified for mobile service** (including the implementation of proper propagation model).
  - **Experimental activities at mmwave** to characterise the propagation in different scenarios (indoor and outdoor).
  - **Study of interference mitigation techniques**
  
- ❑ Acknowledgement
  - This work has been carried out in the framework of a project between the Ministry of Economic Development and Fondazione Ugo Bordoni, related to Clause 1039 of the Law 205/2017.