

The 3rd Annual CIS and CEE Spectrum Management Conference

Broadband Spectrum for Market

dr. Mindaugas Žilinskas

Communications Regulatory Authority Republic of Lithuania

*8 April 2019
Minsk, Belorussia*





Subject

- Scope of analysis of radio frequencies-5G pioneer bands in EU;
- Survey of latest auctions for 5G and developments in EU;
- Governmental and Commercial interests in 5G (PPDR);
- Technical Proposals for 5 G pioneer bands;
- Issues on synchronization of 5G networks;
- Cross- border coordination issues;
- Timing, coverage, data throughput obligations,
- Conclusions.

Pioneer bands for 5G in Europe

Radio Spectrum Policy group

Strategic roadmap towards 5G for Europe (RSPG16-032)

Opinion on spectrum related aspects for next generation wireless systems (5G)

1. 3.4-3.8 GHz primary band before 2020.
2. Harmonized below 1 GHz, particularly 700 MHz for nation wide and indoor coverage.
3. Sufficiently large portion (e.g. 1 GHz) of the 26 GHz band made available (locally) in response to market demand by 2020;
4. Insure all technical conditions for harmonized band for mobile are fit for 5G use.



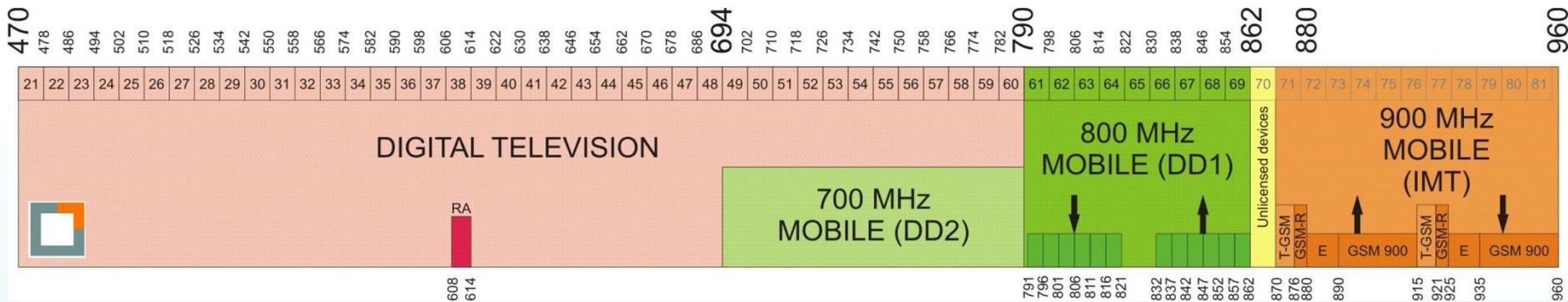
Q2-2
end of
migration
in 700 MHz

RSPG19-010 final

- completed
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022
- no date

**F* - Former Yugoslav
Republic
of Macedonia**

Pioneer 700 MHz frequency band (694-790 MHz) Geneva -06 Agreement



Decision EU 2017(899) of the European Parliament and the Council of 17 May 2017 on the use of 470-790 MHz frequency band in the Union:
 release 700 MHz band 2020 ±2
 until 2030 broadcasting in UHF band
 Review – 2025

Protection of other primary services ITU Radio
 Regulation: ARNS v.s. IMT and Broadcasting

Metod C4: Base stations transmit only in 758–788 MHz and receive signals in the frequency band 703–733 MHz (derived from Study A.3)

ARNS station	System type code	Coordination distances for the receiving MS base stations (km)**	Coordination distances for the transmitting MS base stations (km)
RSBN	AA8	50	125/175*
RLS 2 (type 1) (airborne receiver)	BD	410	432
RLS 2 (type 1) (ground receiver)	BA	50	250/275*
RLS 2 (type 2) (airborne receiver)	BC	150	432
RLS 2 (type 2) (ground receiver)	AA2	50/75*	300/325*
RLS 1 (types 1 и 2) (ground receiver)	AB	125/175*	400/450*
Other ARNS ground stations	Not applied	125/175*	400/450*
Other ARNS airborne stations	Not applied	410	432

* $50\% \leq \text{land path} \leq 100\%$ / $0\% \leq \text{land path} < 50\%$.

** Coordination distances for the receiving MS base stations are based on protection of ARNS stations from the stations in the mobile service and do not ensure protection for receiving base stations of MS from ARNS stations.

ARNS protection (800 MHz & 700 MHz)



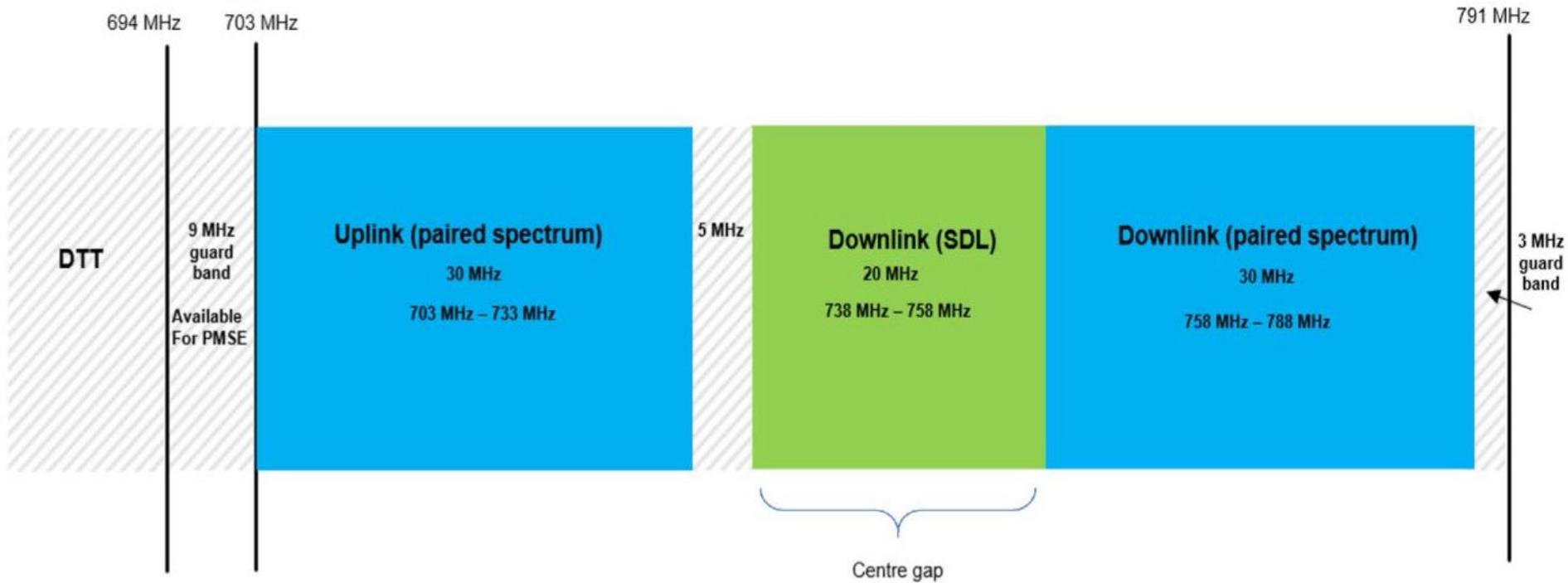
Agenda Item 1.2 IMT v.s. ARNS

Coordination agreements signed in Geneva 3 th of November 2015 with administrations of Russian Federation and Belorussia

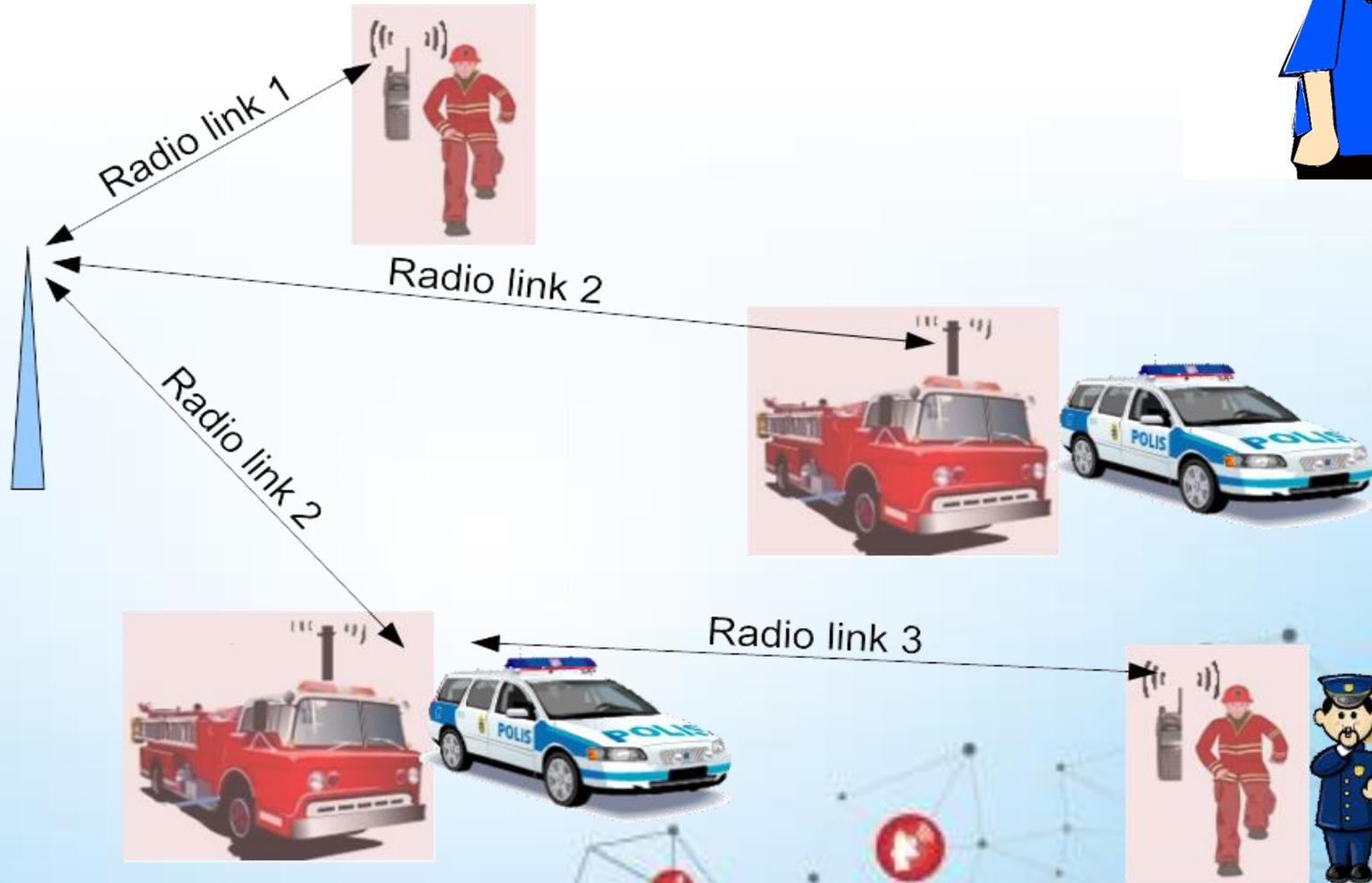
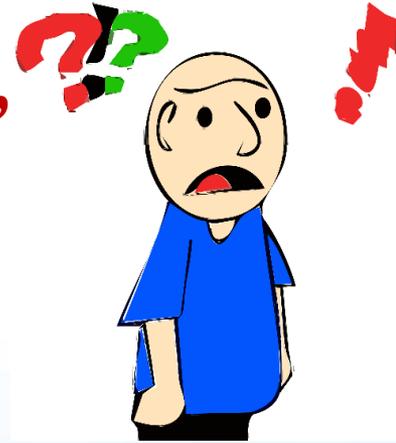


Protection of ARNS according the Rec.1830 – with Russia;
Protection of ARNS according the Rec.1830 and ECC Rec 11(04) for
LTE – with Belorussia

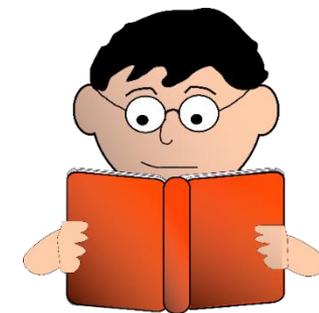
700 MHz frequency band (694-790 MHz)



Interest for PPDR in 5G bands, *(Broadband Public Protection and Disaster Relief)*



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PPDR FREQUENCY ARRANGEMENTS according ECC Report 239

470-694	694-698	698-703	703-733	733-736	736-753	753-758	758-788	788-791	791-821	
DTT		PPDR UL	UPLINK Band #28	PPDR UL		PPDR DL	DOWNLINK Band #28	PPDR DL	DOWNLINK Band #20	
4 MHz	5 MHz	30 MHz			3 MHz	17 MHz	5 MHz	30 MHz		3 MHz

2x3+2x5 MHz option 1
(deployment in France, Finland);
(Sweden, Switzerland- cases different)

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ECC DECISION (16)02 OF 17 JUNE 2016 ON HARMONISED TECHNICAL CONDITIONS AND FREQUENCY BANDS FOR THE IMPLEMENTATION OF BROADBAND PUBLIC PROTECTION AND DISASTER RELIEF (BB-PPDR) SYSTEMS, AMENDED ON 8 MARCH 2019

1. 698-703 MHz (uplink) / 753-758 MHz (downlink) those specified in Annex 1;
2. 703-733 MHz (uplink) / 758-788 MHz (downlink) those specified in ECC/DEC/(15)01 [16];
3. 733-736 MHz (uplink) / 788-791 MHz (downlink) those specified in Annex 1;

1. 450.5-456.0 MHz (uplink) / 460.5-466.0 MHz (downlink) those specified in Annex 2;
2. 452.0-457.5 MHz (uplink) / 462.0-467.5 MHz (downlink) those specified in Annex 2;
3. 410.0-415.0 MHz (uplink) / 420.0-425.0 MHz (downlink) those specified in Annex 3;
4. 411.0-416.0 MHz (uplink) / 421.0-426.0 MHz (downlink) those specified in Annex 3;
5. 412.0-417.0 MHz (uplink) / 422.0-427.0 MHz (downlink) those specified in Annex 3;

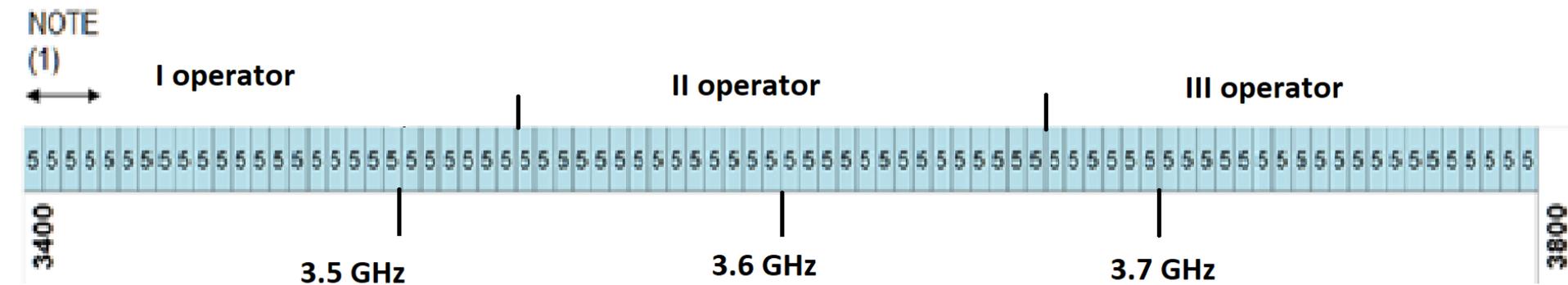
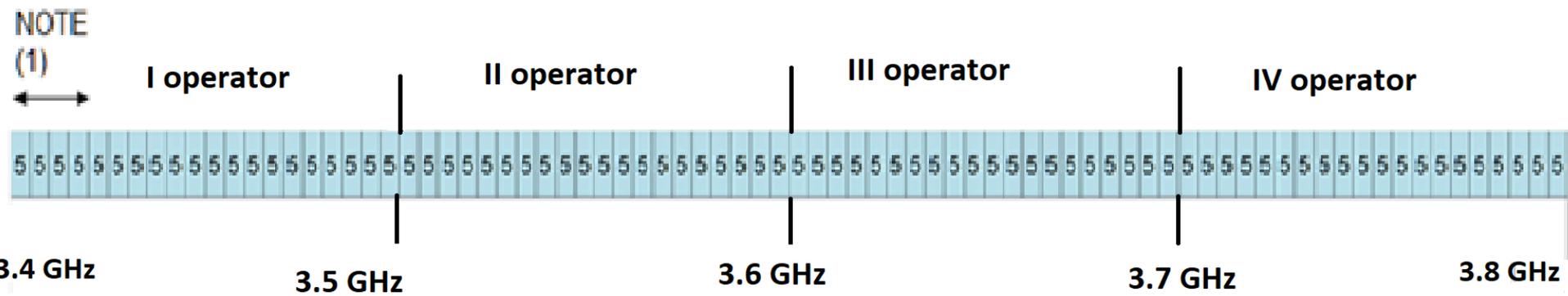
5G pioneer *band 3400-3800 MHz*

RSPG Opinion on 5G implementation challenges
(RSPG 3rd opinion on 5G). RSPG19-007

“there shall be spectrum available providing the opportunity to access sufficiently large portions of contiguous spectrum, **preferably 80-100 MHz**, for wireless broadband electronic communications services”.

ECC Dec. 11(06) Harmonized frequency arrangements and least restrictive technical conditions (LRTC) for mobile/fixed communications networks (MFCN) operating in the band 3400-3800 MHz

Amended 26 October 2018.

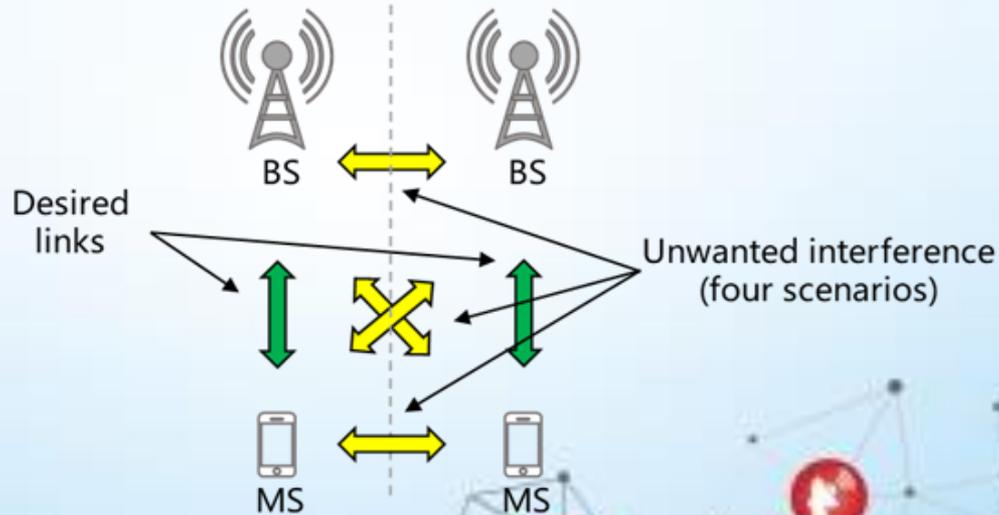
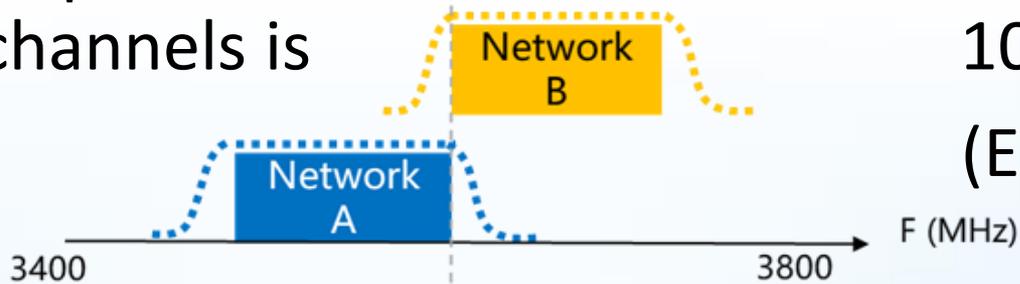


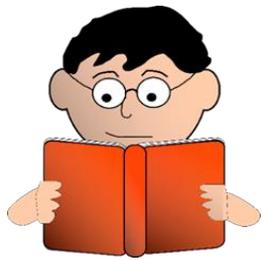
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Conditions for 5G use in 3.5 GHz band, synchronization of TDD networks

separation distance between BS in adjusted channels is 10-15 km

(ECC Rep.296)



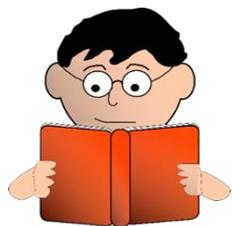


Conditions for 5G use in 3.5 GHz band, synchronization

Synchronised: **avoids** any BS-BS and MS-MS interferences, no need for guard bands or additional filters.

Simplifies the **network deployment** relatively to interference mitigation.

Leads to the selection of a **common frame structure**, which determines a **specific DL / UL transmission ratio** and **frame length** and has an impact on network performance (latency, spectral efficiency, throughput, coverage).



Conditions for 5G use in 3.5 GHz band, synchronization (Rep.296)

TDD mobile operators need to reach agreement on:

- **A common phase clock reference** (e.g. UTC) and accuracy/performance constraints that depend on the underlining technology (e.g. +/- 1.5 μ s for LTE-TDD and 5G-NR), either using their own equipment to provide the clock, or sharing the same phase/time clock infrastructure;
- **Permanent monitoring of the agreed clock source.** If this is lost for some period, the system may start interfering other channels;
- **A compatible frame structure** (including TDD DL / UL ratio and frame length).

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Conditions for 5G use in 3.5 GHz band, coordination contour of one earth station's

Diagram 1: 2.1 TABLES. RECEIVING GSO ES in FIXED-SATELLITE SERVICE W.R.T. TRANSMITTING TERRESTRIAL STATIONS. TS: Fixed, mobile

Notice ID: 110505580

Administration/Geographical area: RUS/RUS

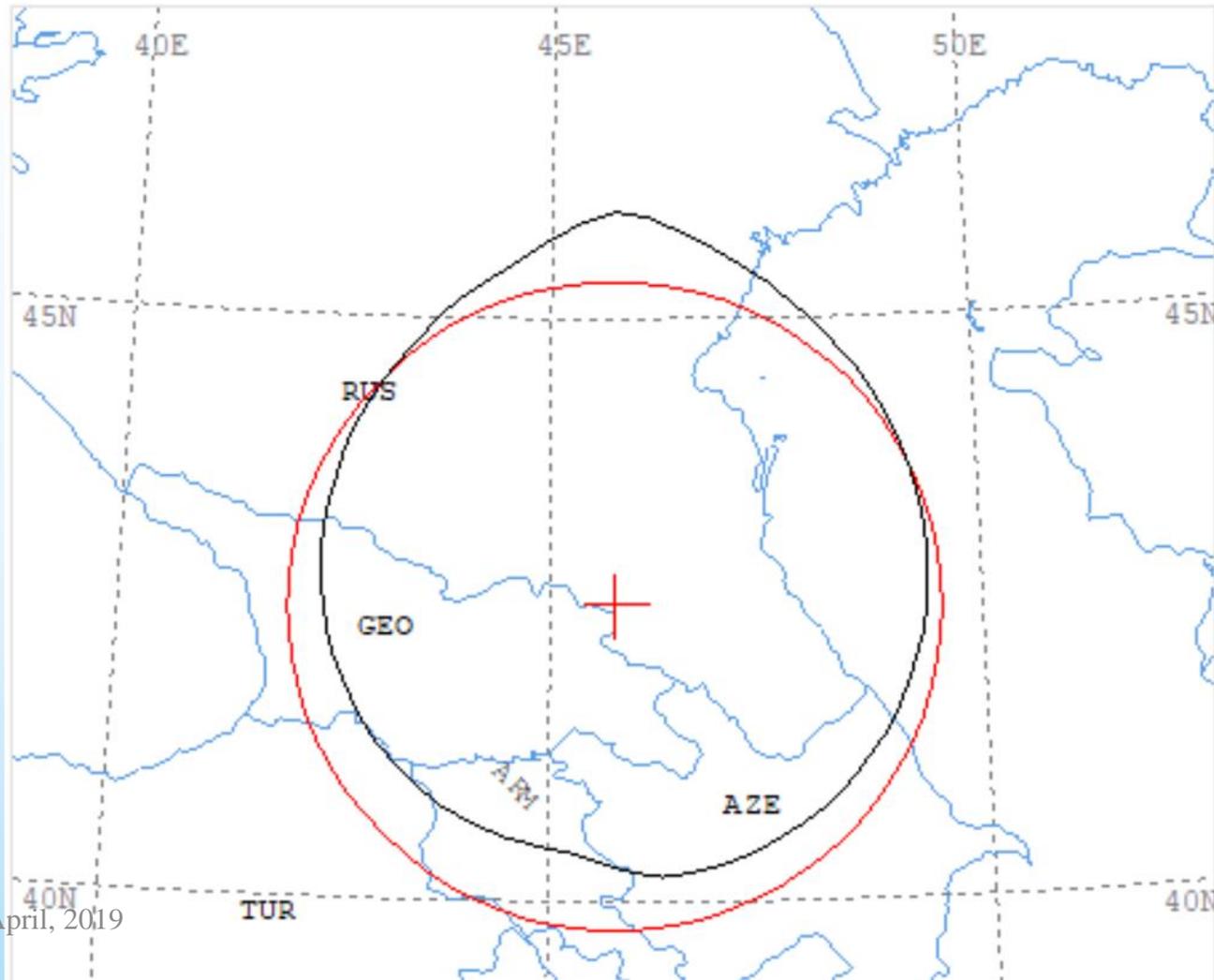
Satellite orbital position: 53.00

Frequency band: 3407.0000-4193.0000 MHz

Earth station name: KHULANDQ/GSPC

Earth station position: 045E450042M3300

Satellite name: EXPRESS-5



Conditions for 5G use in 3.5 GHz band

*Provisions 5.430A of RR “ The allocation of the frequency band 3 400-3 600 MHz to the mobile, except aeronautical mobile, service is subject to agreement obtained under No. 9.21. This frequency band is identified for International Mobile Telecommunications (IMT)... Before an administration brings into use a (base or mobile) station of the mobile service in this frequency band, it shall ensure that the power flux-density (pfd) produced at 3 m above ground does not exceed **-154.5 dB(W/(m² 4 kHz))** for more than **20%** of time at the border of the territory of any other administration. This limit may be exceeded on the territory of any country whose administration has so agreed...”*

Conditions for 5G use in 3.5 GHz band (2)

RoP Part B, section B6

„ „3.8 For the protection of the fixed and fixed-satellite services in the frequency bands between 3 400 MHz and 3 700 MHz from the mobile, except aeronautical mobile, service in the context of the provisions of Nos. 5.430A, 5.431A and 5.432B, and from IMT in the context of the provisions of Nos. 5.431B and 5.434, the power flux density of **-154.5 dB(W/m²·4 kHz)²** produced at the height of 3 m above ground level is used. Based on the above pfd value the coordination distances are calculated using Recommendation **ITU-R P.452-16 for 20%** of time with smooth Earth terrain profile.“

Methodology for compatibility analysis

Report ITU-R S.2368-0
(06/2015)

Sharing studies between International Mobile
Telecommunication-Advanced systems and geostationary
satellite networks in the fixed-satellite service
in the 3 400-4 200 MHz and
4 500-4 800 MHz frequency bands
in the WRC study cycle leading to WRC-15

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Methodology for compatibility analysis

Long-term interference criterion

- Based on Recommendation ITU-R S.1432
 $I/N = -10$ dB ($DT/T = 10\%$) corresponding to the aggregate interference from co-primary allocation for 20% of any month.

Short-term interference criterion

- Based on Recommendation ITU-R SF.1006.
- In-band sharing studies: $I/N = -1.3$ dB that may be exceeded by up to 0.001667% time (single entry).- Propagation model ITU R P 452-14 and 452-15.

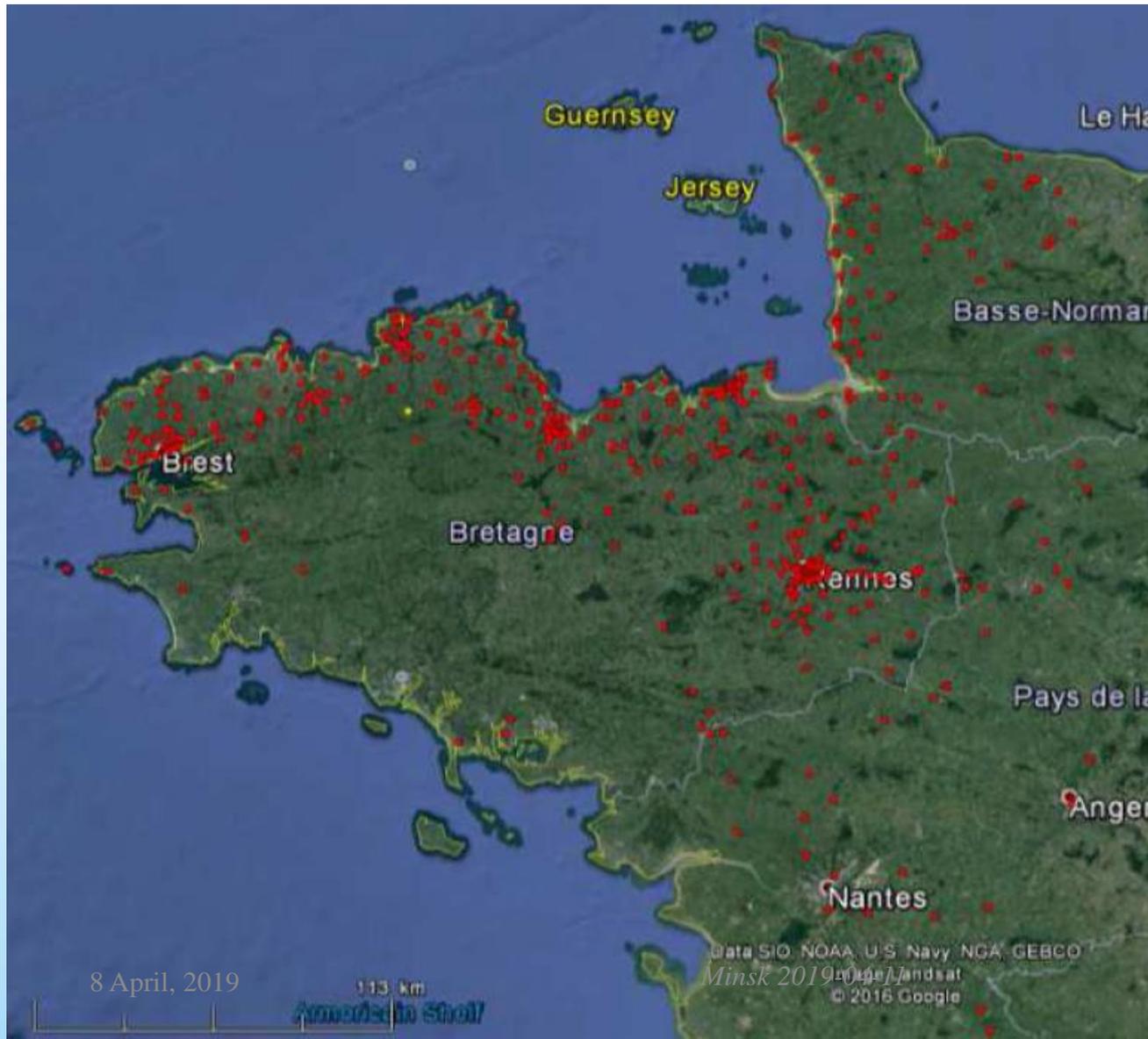
Methodology for compatibility analysis, results

TABLE 7 (Report ITU-R S.2368-0)

Required separation distances to protect FSS earth stations associated with in-band emissions
Cases 1,2 – no specific, without terrain, 3-5 specific with terrain

Study #	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
Scenario			IMT-Advanced networks using suburban macro-cell deployment								
Long-term interference	61-84 km (FSS antenna elevation angle of 5°)	56-61 km (FSS antenna elevation angle from 48° to 5°)	30-40 km / 10-20 km (FSS antenna elevation angle of 6.5/36° with mountain terrain profile)	Single entry: 58.1 km Aggregate: 63.0 km (FSS antenna elevation angle of 5°)	57.1-87.1 km (FSS antenna elevation angle of 5°)	N/A	N/A	About 100 km (FSS antenna elevation angle of 9.4°)	N/A	27-50 km (FSS antenna elevation angle of 5°)	N/A
Short-term interference	486-628 km (FSS antenna elevation angle of 5°)	44-224 km, main lobe 2-62.7 km, side lobe (FSS antenna elevation angle from 48° to 5°)	30-70 km/ 10-26 km (FSS antenna elevation angle of 6.5/36° with mountain terrain profile)	525 km (FSS antenna elevation angle of 5°)	312.2-487.6 km (FSS antenna elevation angle of 5°)	N/A	N/A	About 450 km on partly over-sea path; about 300 km on overland path (FSS antenna elevation angle of 9.4°)	N/A	N/A	N/A

EMC of earth station in Lannion (FR) and IMT according the ITU Report 2368



Short term
interference
0,00166% of time
(8,76 min/year)

and long term
interference 20%
of time,
Propagation mode
452-14.

Methodology for compatibility analysis

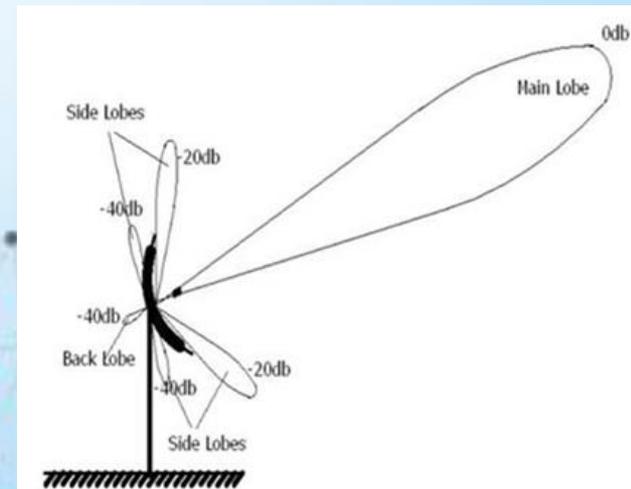
Is based on: REC. ITU-R S.1432-1, REC. ITU-R SF.558-2*, REC. ITU-R SF.1006* and...

Interference between an earth station and a terrestrial station can be considered as negligible when the interference power level for great-circle propagation mechanisms does not exceed the maximum permissible level of interference **for 20% of the time**, and also when the interference power level for all propagation mechanisms combined (i.e., great-circle and rain-scatter propagation mechanisms) **does not exceed the maximum permissible level of interference for a small agreed percentage of the time.**

and agreement between **FSS and IMT operators.**

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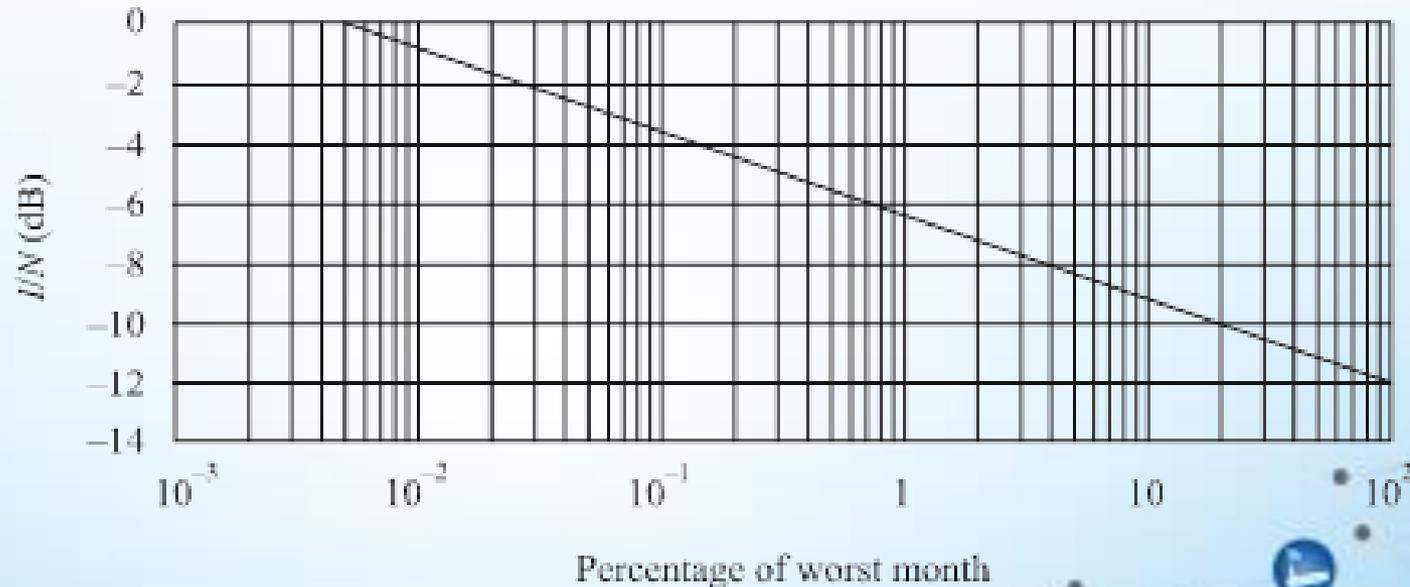
8 April, 2019



Methodology for compatibility analysis (REC. ITU-R S.1432-1)

FIGURE 1

Digital satellite path I/N due to fixed service interference

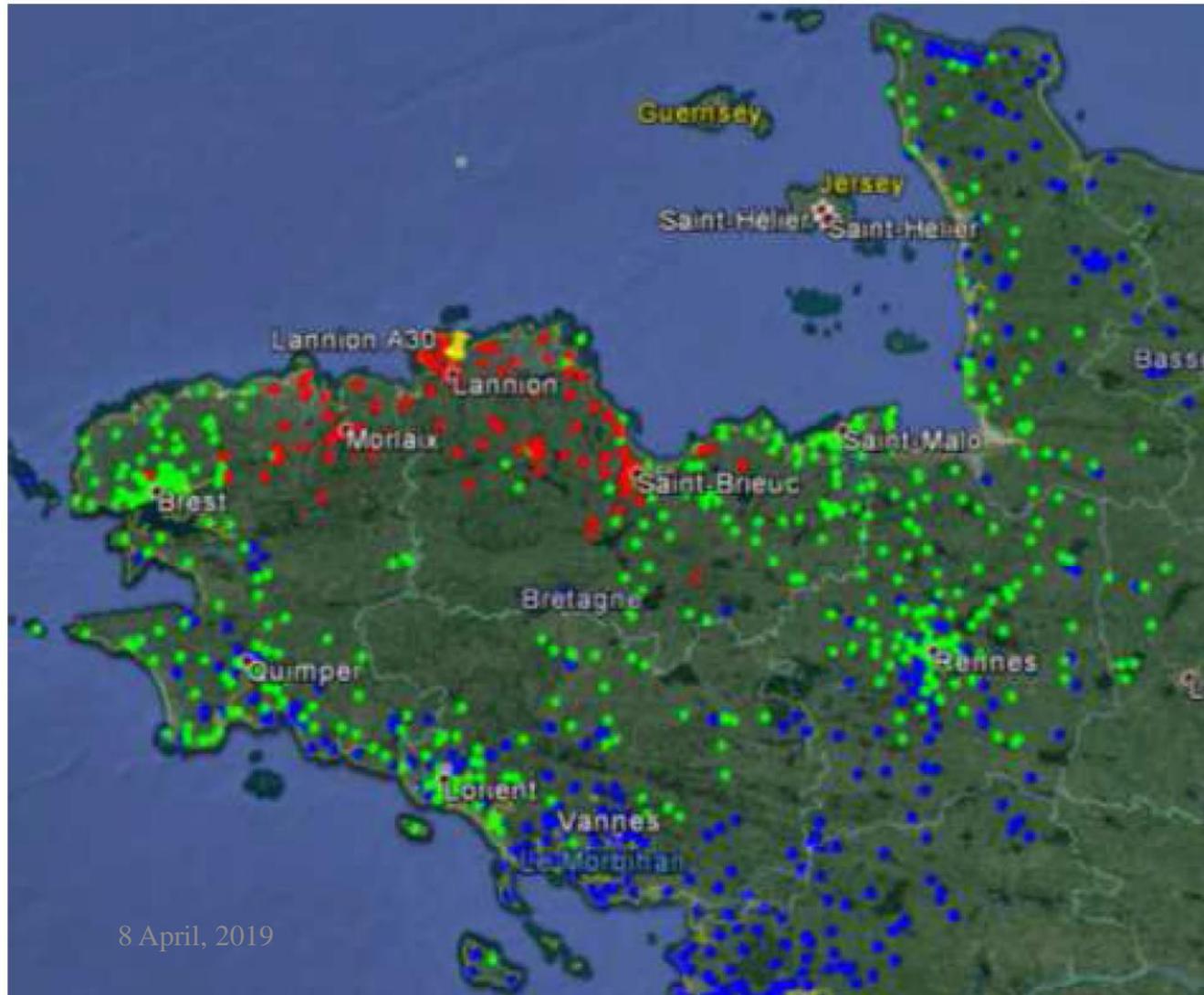


Agreed on: interference 5% of time, $I/N = -8.2$ dB

This I/N corresponds to 6% of the satellite system noise

Co-channel EMC of earth station in Lannion and IMT.

Secteurs dépassant le critère de protection (rouge)	Secteurs initialement agrégés (bleu)	Puissance agrégée reçue par la station SFS (dBm)	Limite de brouillage de la station SFS (dBm)	Marge (dB)	Secteurs exclus pour respecter le critère de protection (vert)
286	2966	-101.3	-119	-17.7	874



Eirp = 74 dBm/20 MHz. (71 dBm/20 MHz)

Antennas of BS ITU-R F1336; tilt = -3, 4, 8 for rural, suburban, urban



Spectrum sharing workload of earth stations

HANDBOOK ON SATELLITE COMMUNICATIONS

(Third Edition) 2002 ITU, Geneva

AN2.1 a) satellite transponder and earth station parameters...

Frequency bands 3625-4095 MHz; Earth stations

Antenna gain receive 61 dBi; Minimum G/T(clear sky) =40.7 dB/K; (C/N) clear sky =14,5 dB.

“This result indicates that an INTELSAT –VI 72 MHz hemi-zone transponder can accommodate, as example, up to approximately 1000 channels:

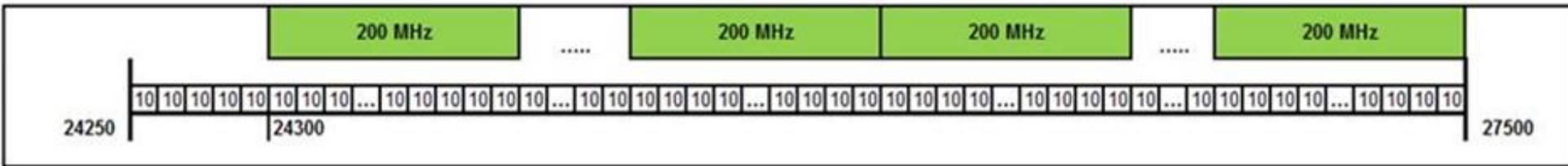
4 (252 channels/15 MHz) carriers, or” ...

Cross-border Coordination frequencies for 5G , according Rec 15(01) for 3400-3800 MHz band:

For the co-channel case - separation distance between BSs is **50 - 60 km** (ECC Rep. 296)

- for the preferential blocks, a value of **67 dB μ V/m/5 MHz** at a height of 3 m above ground level at the borderline between concerned countries and a value of **49 dB μ V/m/5 MHz** at a height of 3 m above ground level at a distance of 6 km inside the neighboring country;*
- for non-preferential blocks, a value of **32 dB μ V/m/5 MHz** at a height of 3 m above ground level **at the borderline between concerned countries.***

ECC Decision (18) 06 “Harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 24.25-27.5 GHz”, corrected 2018 October



MFCN BS additional baseline requirement: maximum emissions into the 23.6-24.0 GHz band

Frequency range	Maximum Total Radiated Power (TRP) (see note)	Measurement bandwidth
23.6-24.0 GHz	-42 dBW	200 MHz

Note: This level requirement applies for BS for all foreseen modes of operation (i.e. maximum in-band power, electrical pointing, carrier configurations)



5G in 26 GHz frequency band



Brussels, XXX
[...] (2019) XXX draft

COMMISSION IMPLEMENTING DECISION

of XXX

on harmonisation of the 24.25-27.5 GHz frequency band for terrestrial systems capable of providing wireless broadband electronic communications services in the Union

(Text with EEA relevance)

[...]

5G in 26 GHz frequency band, obligations and restrictions

... at least 1 GHz of the 26 GHz frequency band by 31 December 2020 in order to facilitate 5G rollout.

The use of unmanned aerial vehicles ('UAVs') such as drones with terrestrial wireless broadband electronic communications networks is allowed just in one direction due to a possible interference to FSS and ISS.

5G in 26 GHz frequency band, restrictions

Article 3

...the terrestrial systems referred to in Article 1 appropriately protect:

- a) systems in adjacent bands, in particular in the Earth Exploration Satellite Service (passive) and in the Radio Astronomy Service in the 23.6-24.0 GHz frequency band;
- b) earth stations in the Earth Exploration Satellite Service and in the Space Research Service for space-to-earth communications operating within the 25.5-27.0 GHz frequency band;
- c) satellite systems for earth-to-space communications in the Fixed Satellite Service operating within the 24.65-25.25 GHz frequency band;
- d) satellite systems for inter-satellite communications operating within the 24.45-24.75 GHz and 25.25-27.5 GHz frequency bands.

Other frequencies applicable for 5G

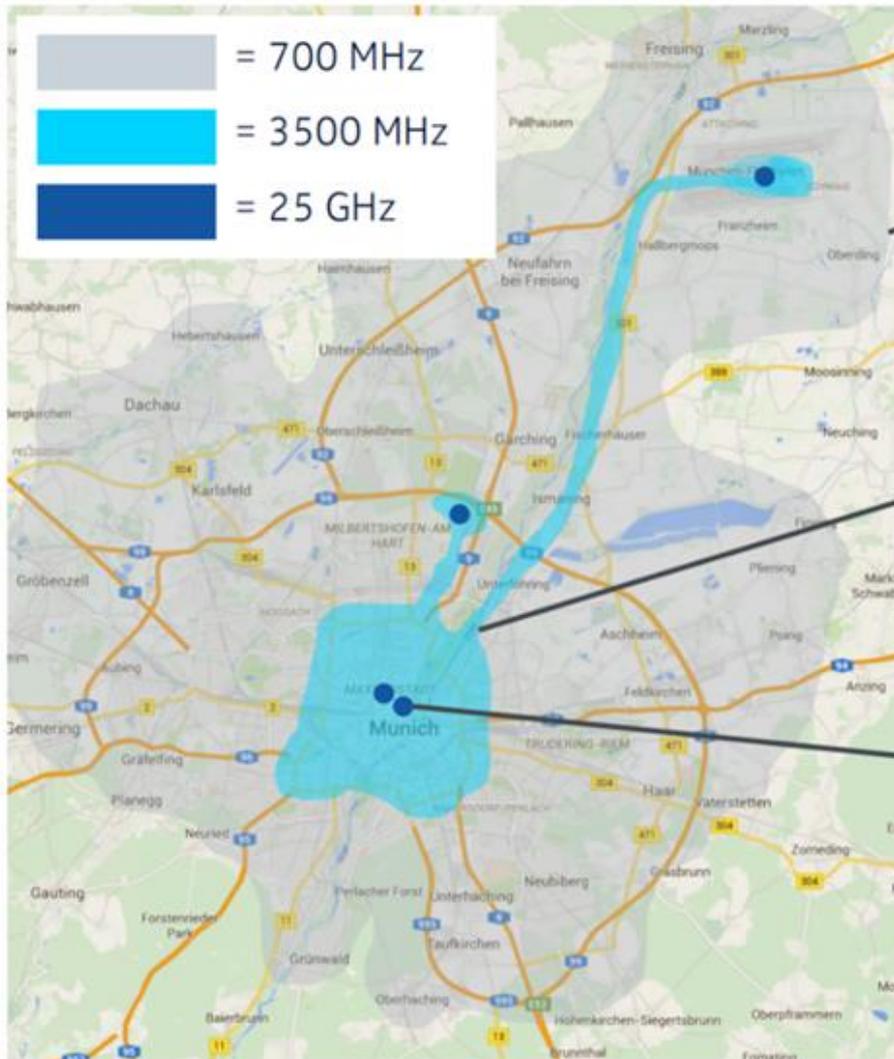
	Frequency band	Used bandwidth	Current use	Future use for 5G
1	790-862 MHz	60 MHz	LTE	?
2	880-915/925-960 MHz	70 MHz	GSM, UMTS, LTE	
3	1710-1785/1805- 1880 MHz	150 MHz	GSM, UMTS, LTE	
4	1920-1980/ 2110-2170 MHz	120 MHz	UMTS, LTE	
5	2300 MHz	100 MHz	LTE	
6	2600 MHz	190 MHz	LTE	
7	3.8 -4.2 GHz	400 MHz	LTE	
8	40.5-43.5 GHz	3 GHz		
9	66-71 GHz	5 GHz		

Coverage and data speed requirements for 5G in EU

EU multiannual radio spectrum policy programme (EU Decision 243/2012/EU) obliges states to bridge the digital divide and contribute to the objectives of the Digital Agenda for Europe, fostering access to broadband at a speed of not less than **30 Mbps** by 2020 for all Union citizens and making it possible for the Union to have the highest possible broadband speed and capacity.

In addition, all European households, rural or urban, should have access to networks offering a download speed of at least **100 Mbps**, which can be upgraded to 1 Gigabit by 2025.

Coverage and data speed requirements for 5G



- 700 MHz layer
- Wide coverage with indoor penetration
 - Massive IoT and ultra reliable low latency
 - Reusing existing sites for 800/900 MHz

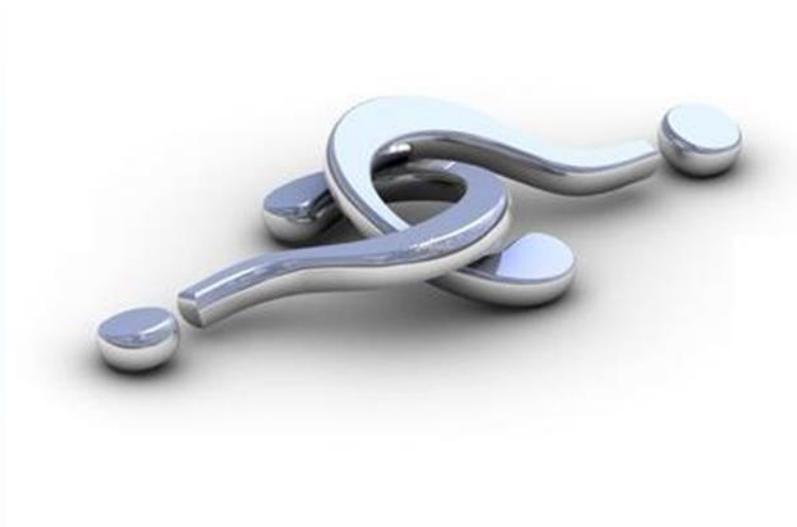
- 3.5 GHz layer
- Dense urban coverage
 - Supports enhanced mobile broadband
 - Reusing existing sites for 2 GHz

- 25 GHz layer
- Hot spots like airports and stadiums
 - Supports full enhanced mobile broadband
 - Data rates exceed 10 Gbps

Conclusion

- to speed up coordination of frequencies with neighboring countries and to conclude cross border coordination agreements for the 5G pioneer bands at first;
- *to start preparation of auction conditions in 5G pioneer band: 700 MHz, 3400-3800 MHz and 26,5-27,5 GHz.*
- to relocate television in 700 MHz band, currently used radio relay links in the bands 3600- 3800 MHz and 26.5-27.5 GHz to other frequency bands.

Thank You



dr. Mindaugas Žilinskas

Communications Regulatory Authority Republic of Lithuania

mindaugas.zilinskas@rrt.lt

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