



# The Frequency Struggle: X-Band SAR vs 5G

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**AIRBUS** <sub>1</sub>

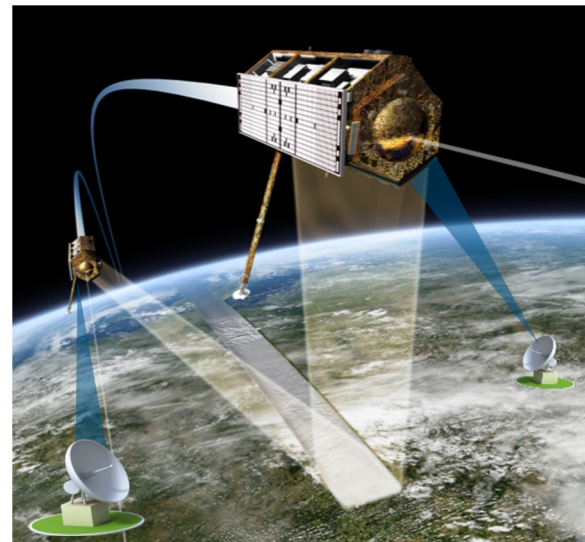
# Context

Radio frequencies are key for carrying out Space-Based Earth Observation and when it comes to Synthetic Aperture Radar (SAR) they contribute as well to the acquisition.

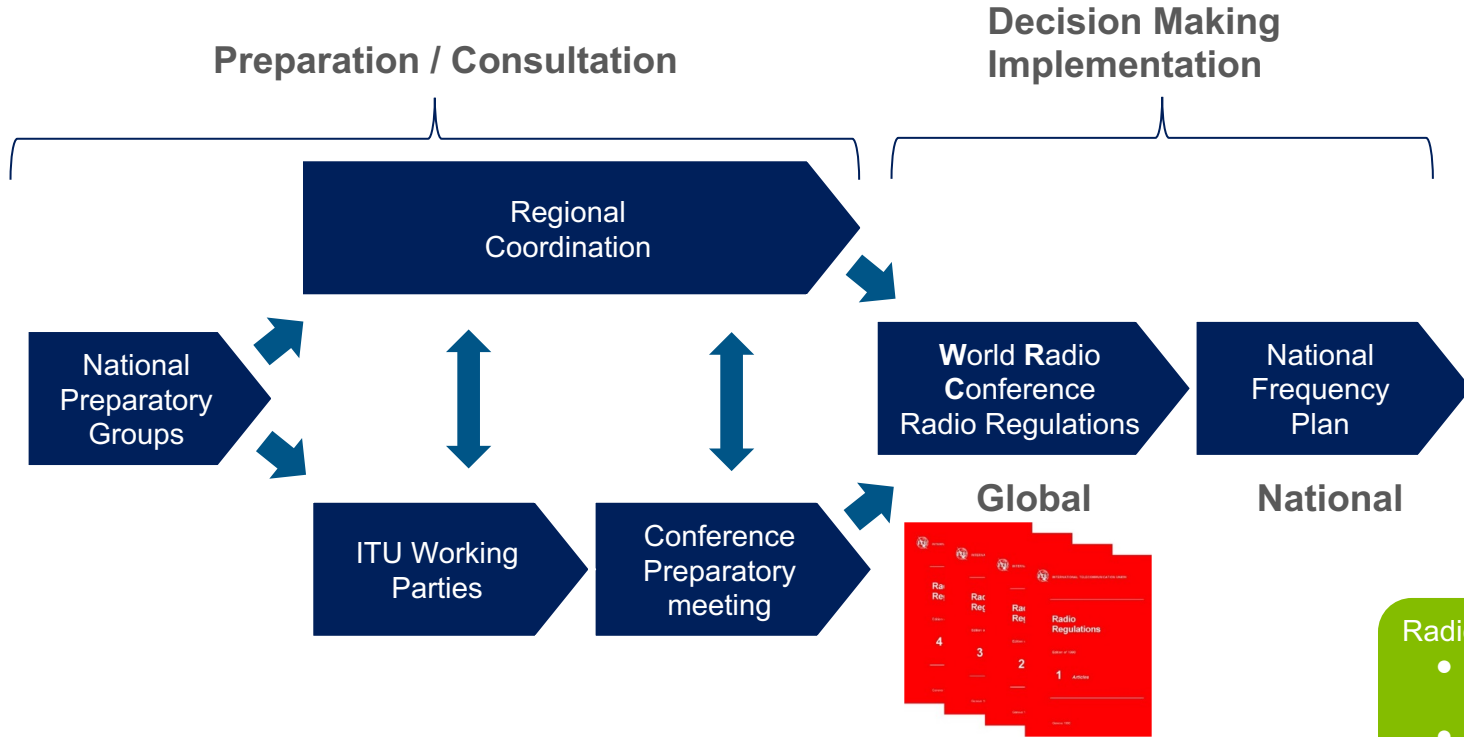
1. Uplink (tasking)
2. Downlink
3. Remote Sensing



- **ITU** is a specialised **agency of the United Nations** responsible for matters related to information and communication Technology.
- ITU's radio communication sector (**ITU-R**) **manages the international radio-frequency spectrum** and satellite orbit resources.
- **Radio Regulations (RR)** is the **international treaty governing the use of the radio-frequency spectrum** and the GSO and NGSO satellite orbits
- **World Radiocommunication Conferences (WRC)** review/revise RR based of an agenda determined by taking into account recommendations made by previous WRC. WRC are are held every 3/4 years.



# Context - Regulatory Environment



**Radio Regulations:**

- have the value of an international treaty
- baseline regulations
- revised every 4 years

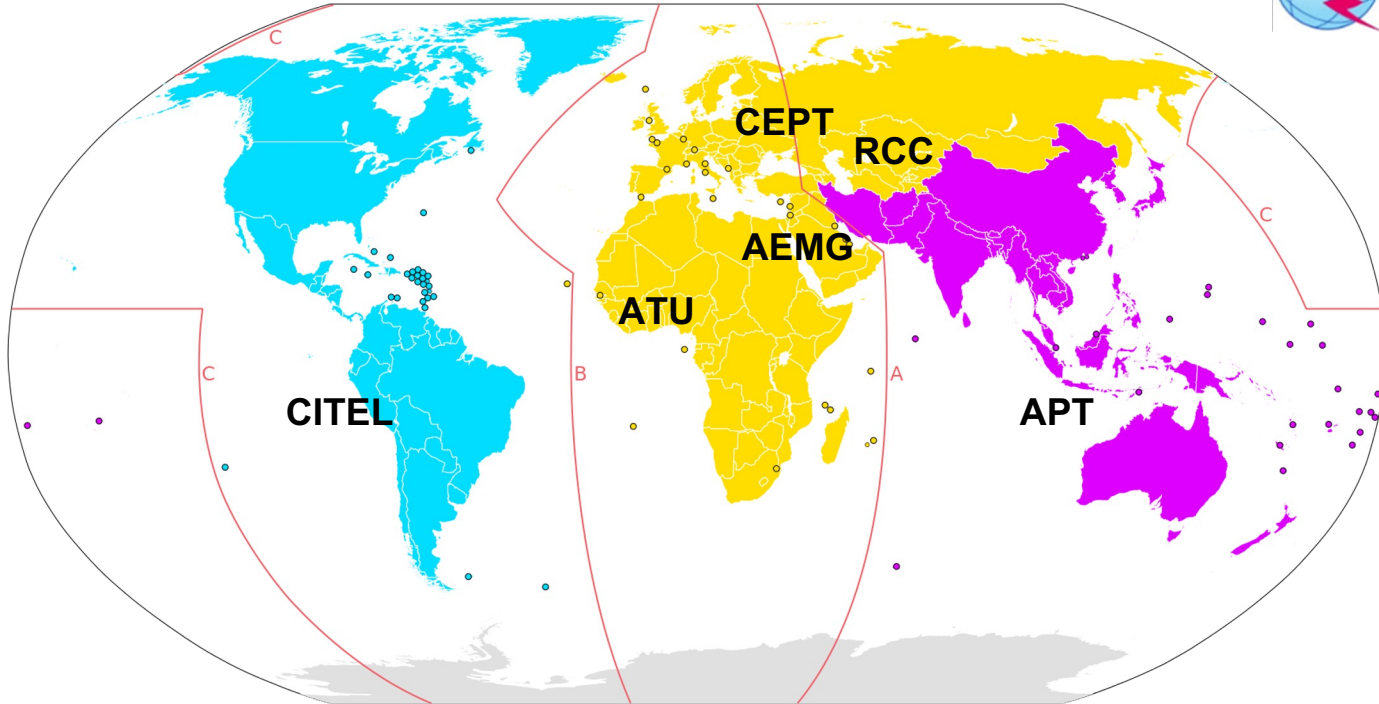


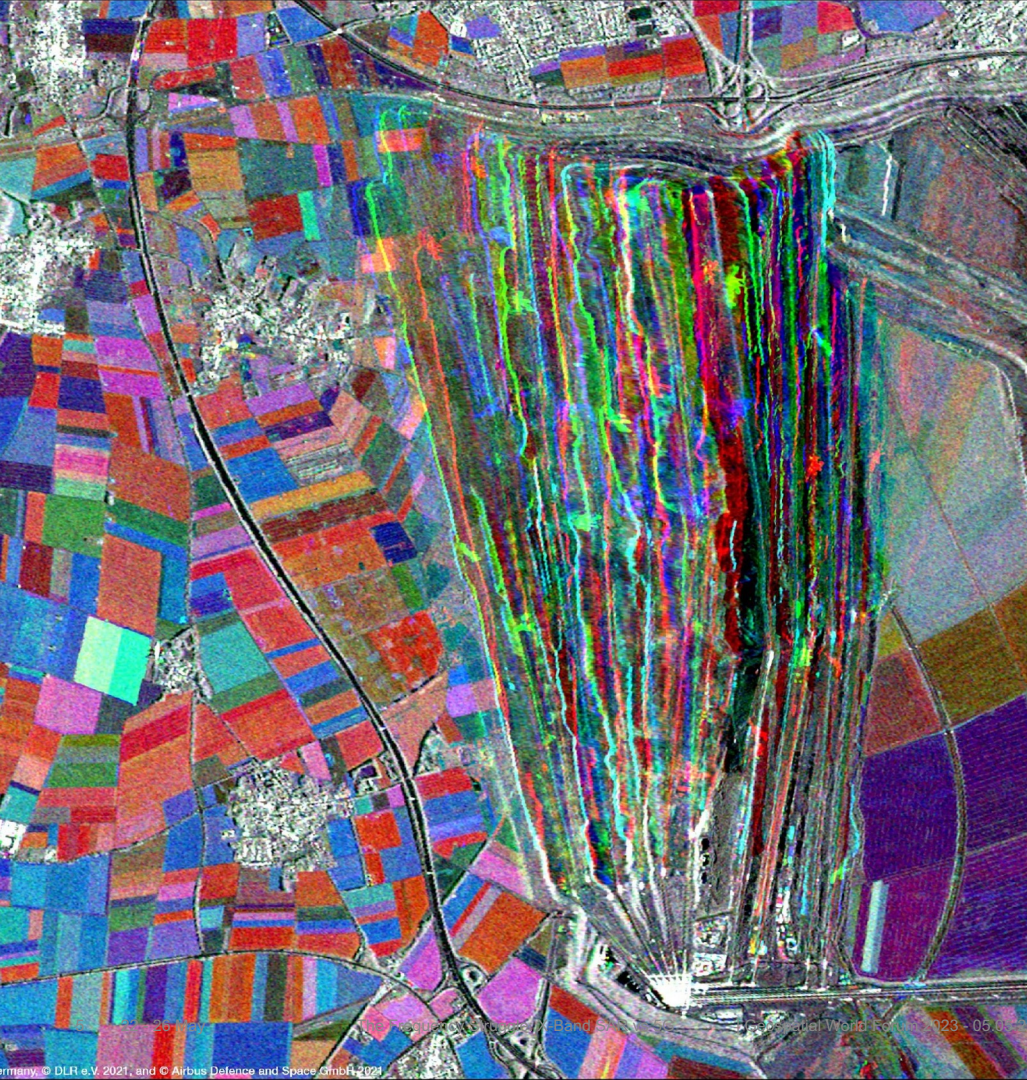
# Context - Regions and Coordination



Regions

- 1
- 2
- 3





# The Frequency Struggle

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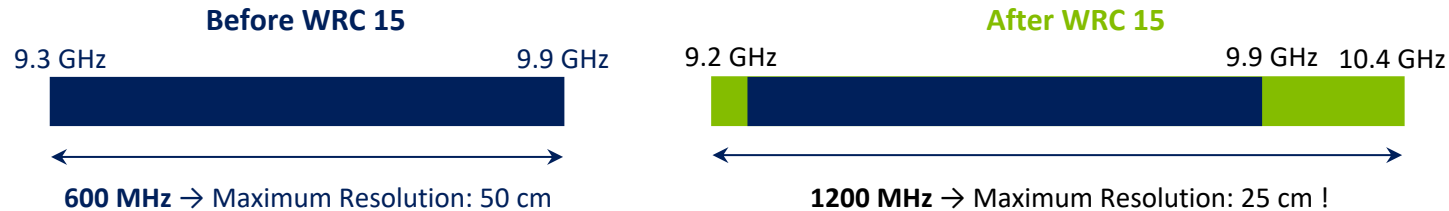
SAR X-BAND VS 5G

Rotterdam, NL

**AIRBUS**

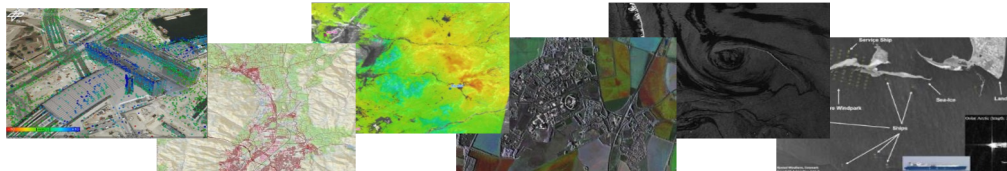
## 2015 - Extending the SAR X-Band

In 2015, the World Radio Conference (WRC) extended the X-Band Earth Observation SAR acquisition bandwidth, from 600 MHz to 1200 MHz between 9 200 MHz to 10 400 MHz. The objective was to achieve very high-resolution imaging capability, comparable to current optical Earth Observation data.



**EESS(Active)**  
Earth Exploration  
Satellite Service  
(Active)  
aka spaceborne SAR

X-Band SAR is used for **environmental monitoring** (e.g. deforestation, pollution, ice monitoring, etc.), **agriculture**, **land management**, **global elevation models**, **precise infrastructure monitoring**, **emergency preparedness and management**, **enhanced maritime monitoring** and **image intelligence**.



Report ITU-R RS.2274 (09/2013)

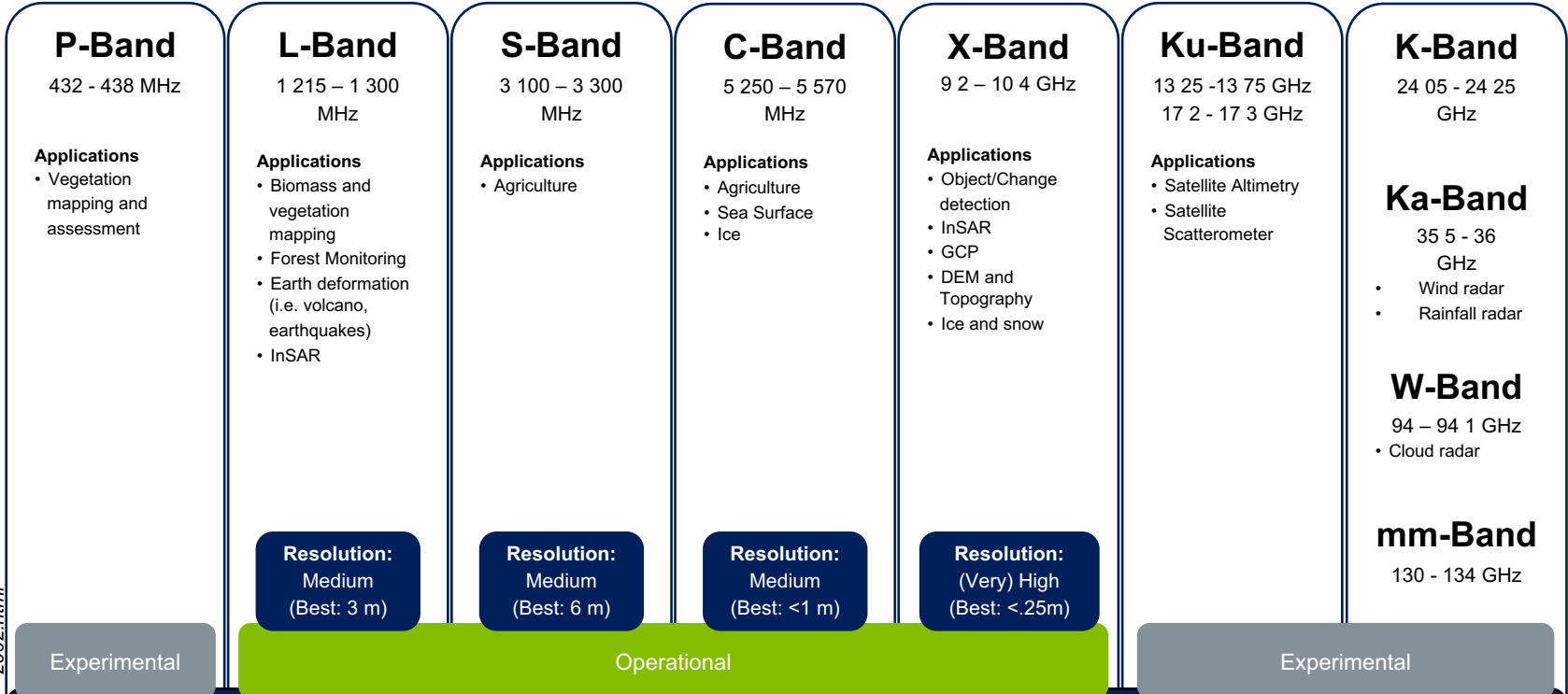
“Spectrum requirements for spaceborne synthetic aperture radar applications planned in an extended allocation to the Earth exploration-satellite service around 9 600 MHz”



# Space-Based Radar Frequencies (EESS Active\*)

\*References: ITU Radio Regulations (RR-2020-00013-Vol.I-EA5);

IEEE Designation: <https://standards.ieee.org/standard/521-2002.html>



Because of the difference in wavelength and thus penetration of the electromagnetic waves, frequency bands and applications are closed connected and although some level of overlapping is possible, physical limitations apply.

# Space-Based Radar Systems

IEEE Designation: <https://standards.ieee.org/standard/521-2002.html>

P-Band	L-Band	S-Band	C-Band	X-Band	Ku-Band	K-Band
432 - 438 MHz	1 215 – 1 300 MHz	3 100 – 3 300 MHz	5 250 – 5 570 MHz	9.2 – 10.4 GHz	13.25 - 13.75 GHz 17.2 - 17.3 GHz	24.05 - 24.25 GHz
<ul style="list-style-type: none"> <li>Biomass</li> </ul>	<ul style="list-style-type: none"> <li>SAOCOM-1</li> <li>SAOCOM-2</li> <li>ALOS-2</li> <li>ALOS-4</li> <li>NISAR-L</li> <li>ROSE-L</li> <li>TanDEM-L</li> <li>SAR XL</li> </ul>	<ul style="list-style-type: none"> <li>NovaSAR-S</li> <li>NISAR-S</li> </ul>	<ul style="list-style-type: none"> <li>Sentinel-1</li> <li>Radarsat-2</li> <li>RCM</li> <li>EOCS</li> <li>Chorus-C</li> <li>CHEOS</li> <li>HiSea</li> <li>MicroSAR</li> </ul>	<ul style="list-style-type: none"> <li>TerraSAR / TanDEM / PAZ</li> <li>PAZ-2</li> <li>Kompsat-6</li> <li>CSK / CSG</li> <li>ICEYE</li> <li>Chorus-X</li> <li>Capella Space</li> <li>Synspective</li> <li>iQPS</li> <li>NEC</li> <li>TecSAR</li> <li>PredaSAR</li> <li>UMBRA</li> <li>York Space</li> <li>NOX</li> <li>PLATiNO</li> <li>NimBUS SAR</li> <li>SAR XL</li> <li>[...]</li> </ul>	<ul style="list-style-type: none"> <li>Ka-Band</li> <li>35.5 - 36 GHz</li> <li>W-Band</li> <li>94 - 94.1 GHz</li> <li>mm-Band</li> <li>130 - 134 GHz</li> </ul>	

Due to the large bandwidth available, the consequent application potential (coupling good swath and high-res) and leveraging opportunities offered by tech miniaturisation, X-Band SAR has imposed as the dominant band for commercial space-based radar systems



## 2019 - The Struggle Begins

At WRC-19, Agenda Item 1.2 proposed to consider additional spectrum identification for IMT in the band the 10 – 10.5 GHz over the American continent. The request is to be decided upon at WRC-23.

### Resolution 245 (WRC-19)

[...] to conduct and complete in time for WRC-23 the sharing and compatibility studies, with a view to **ensuring the protection of services to which the frequency band is allocated on a primary basis, without imposing additional regulatory or technical constraints on those services**, and also, as appropriate, on services in adjacent bands, for the frequency bands:

- 3 600-3 800 MHz and 3 300-3 400 MHz (Region 2);
- 3 300-3 400 MHz (amend footnote in Region 1);
- 7 025-7 125 MHz (globally);
- 6 425-7 025 MHz (Region 1);
- **10.0-10.5 GHz (Region 2) [...]**

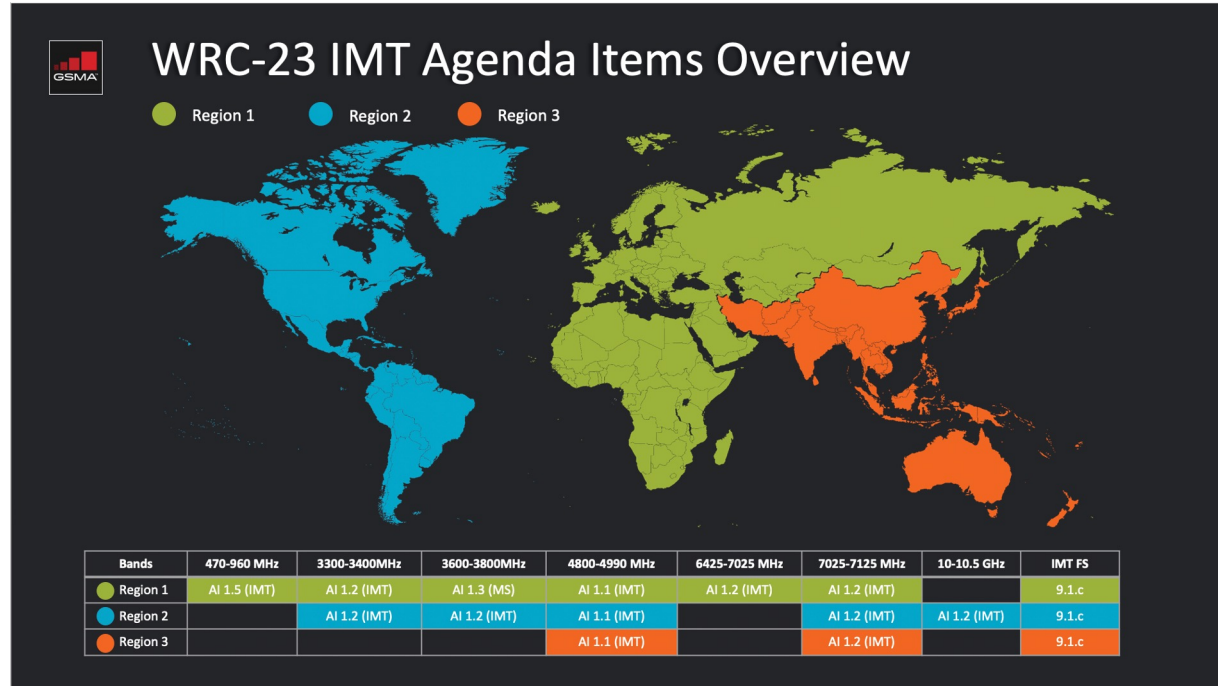


Stakeholders have collaborated within ITU working groups to evaluate, if and how frequency sharing is viable.



Within WP-5D, a number of sharing studies has been performed and presented;  
Results have shown the sharing of the frequency is not possible without impacting EESS (Active).

# The IMT's plan at WRC-23



*“10-10.5 GHz provides valuable additional capacity in between mid-band and mmWave. This spectrum is being studied as a **potential supplement** to provide capacity in Region 2”*

Source: GSMA

## 2023 - Will the struggle end?

- In the framework of ITU-R WP5D, 5 studies looking at the interaction between the SAR emission and the 5G signal were carried out.
- The studies have different scenarios and assumptions leading to variations in the results (see CPM Report, link in QR code).
- However, **all of them show that the protection criteria to protect SAR is exceeded** for the baseline scenario.



Study	Exceedance of protection criteria		
	Static aggregate interference		Dynamic interference (dynamic look angle)
	look angle fixed to 18°	look angle fixed to 50°	
Study A	5.31 dB	11.5 dB	N/A
Study B	N/A	11.22 dB	10.55 dB
Study C	0.96 dB	8.15 dB	N/A
Study D	2.56 dB	8.03 dB	5.29 dB
Study E	5 dB	11 dB	8.6 dB



**All studies show that sharing between EESS (active) and IMT is not possible without additional regulatory and technical constraints.**

# 5G Spectrum Snapshot

Plenty of frequencies for the different uses and users

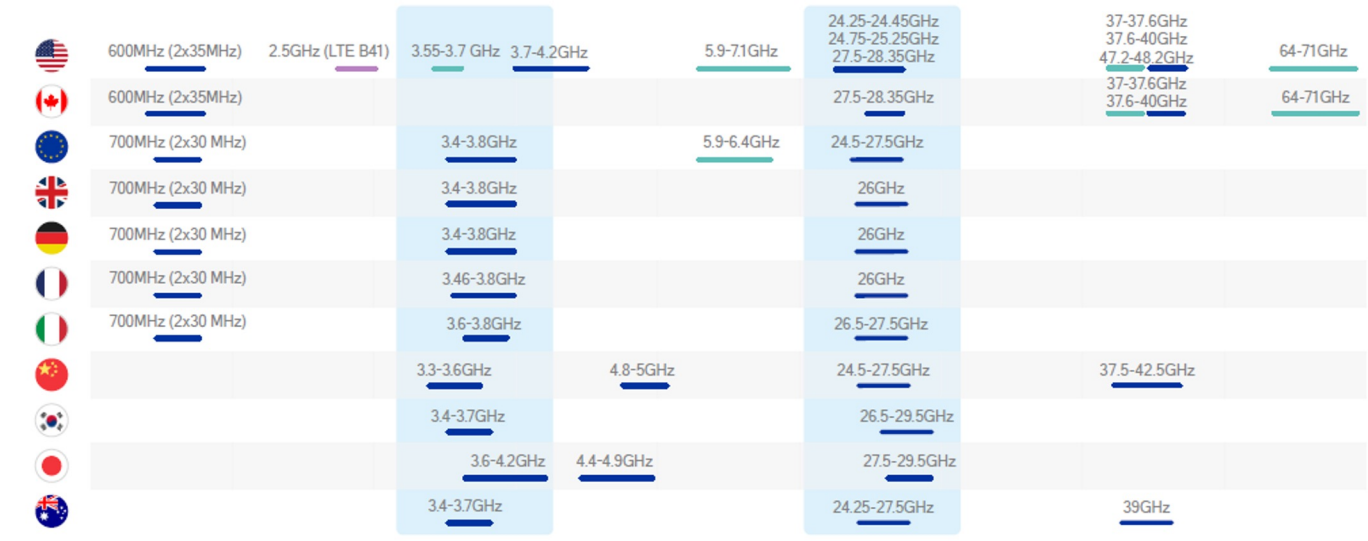


High Throughput Layer  
 Dense Urban / Indoor  
**mmW**

Capacity Layer  
 Metropolitan  
**Mid Band**

**Low Band**

Coverage Layer  
 Nationwide



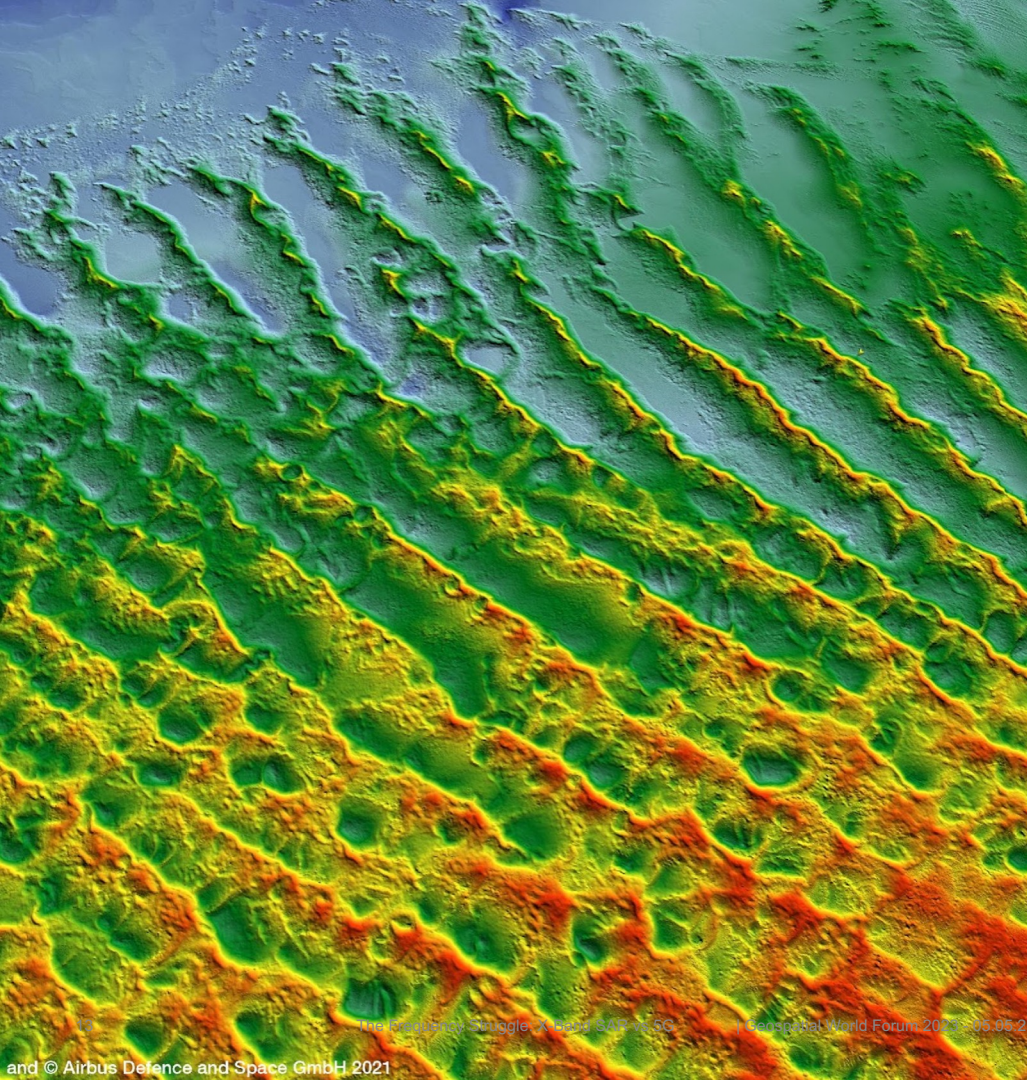
Plenty of frequencies along the entire spectrum have been allocated already to International Mobile Telecommunications (IMT) to enhance mobile broadband, to enable massive M2M communication and ultra-reliable low-latency communications.

**Global snapshot of 5G spectrum**  
 Around the world, these bands have been allocated or targeted

Legend:  
 - Blue line: New 5G band  
 - Green line: Licensed  
 - Purple line: Unlicensed/shared  
 - Red line: Existing band

https://www.everythingrf.com/community/5g-frequency-bands





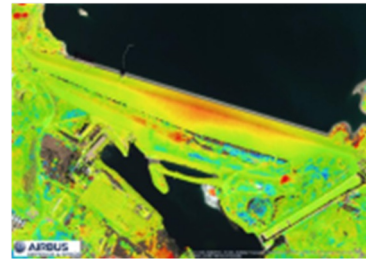
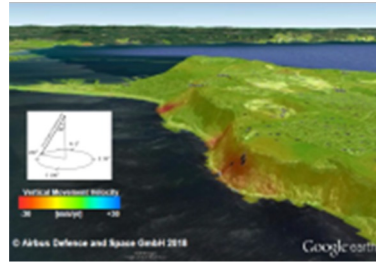
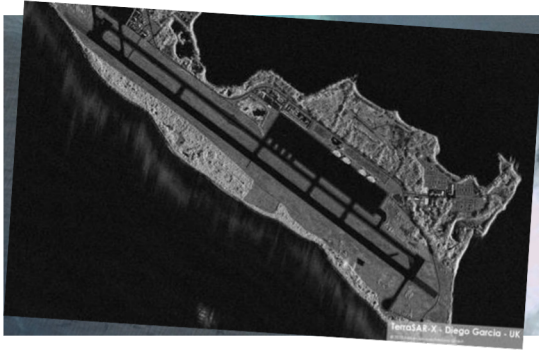
# A Call to Action

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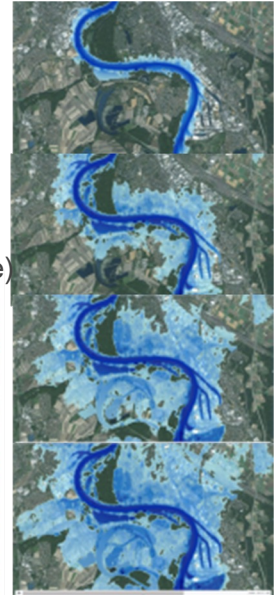
# Many Applications at risk

Weather independent Earth Observation

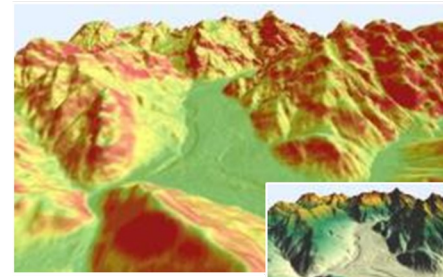
Infrastructure monitoring | Climate change preparedness | Disaster management applications



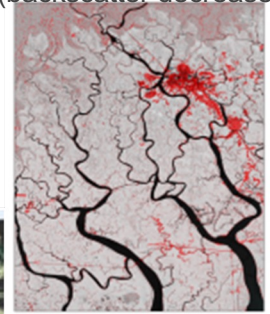
Global Flood Hazard Map (DEM)



Landslide Hazard Mapping (DEM)



Deforestation (backscatter decrease)



## Conclusion

**The band between 9 200 MHz and 10 400 MHz is allocated** on a primary basis to the Earth Exploration Satellite Service (active) **since 2015**, where an extension of 600 MHz was granted.

**The SAR satellites** operating under this service provides unique dataset and measurement capabilities, that are able to fulfill a range of services closely aligned to the needs of commercial, scientific and institutional users, **creating directly an important socio-economic benefit for humanity.**

In our rapidly changing world, both physically and politically with climate change-fuelled crises and conflicts, **X-Band SAR satellites are invaluable instruments, providing data 24/7 and in any weather condition.**

## A Call to Action

- **The RF spectrum is a finite resource.**
- **Earth Observation frequencies are not a given** and all EO stakeholders should be aware the decisions at ITU can have major impacts on all the EO benefits.
- While the issue is now on a portion of band assigned to SAR X-Band, in preparation for WRC-27, **there have been proposals to allocate the full portion X-Band dedicated to SAR and downlink for IMT usage.**
- **Decisions** if such discussions will even take place in 2027, **will happen at WRC-23.**

*If we want to protect SAR and EO frequencies, we need to start NOW!*

- 1) Talk to other Earth Observation stakeholders
- 2) Make them aware of the risks
- 3) Engage with your national frequency regulator
- 4) Make sure that your Nation speak-up at the next WRC-23 and within the ITU in protection of EO

**AIRBUS is fully engaged in protecting Earth Observation frequencies for the benefits of humanity.  
Reach out if you want to know more about your country's position and how to support.**





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