uk spectrum policy forum

Sub-teraHertz Frequency bands

(bands above 86GHz)

The opportunities and the challenges

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Active applications of >86 GHz

Fixed point-to-point

- W-Band; 92 – 114.25 GHz (commercial availability in perhaps 18 months)
- D-Band; 130 – 174.8 GHz (commercial availability in perhaps 5 years)
- Channel/block arrangements defined in ECC Recommendations (18)01 & 18(02)

IMT

- Vision for use of sub-terahertz spectrum for 6G is still being developed

Space applications

- Particularly for inter-satellite links

Sensing and materials analysis

- High operating frequency (to above 1THz) and low power
- Very high bandwidth to achieve precision of resolution (>1THz not uncommon)
- Generally uses different RF technologies to other applications

Meteorology

- Limited use at 94 GHz and 238 GHz

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Passive applications of >86 GHz

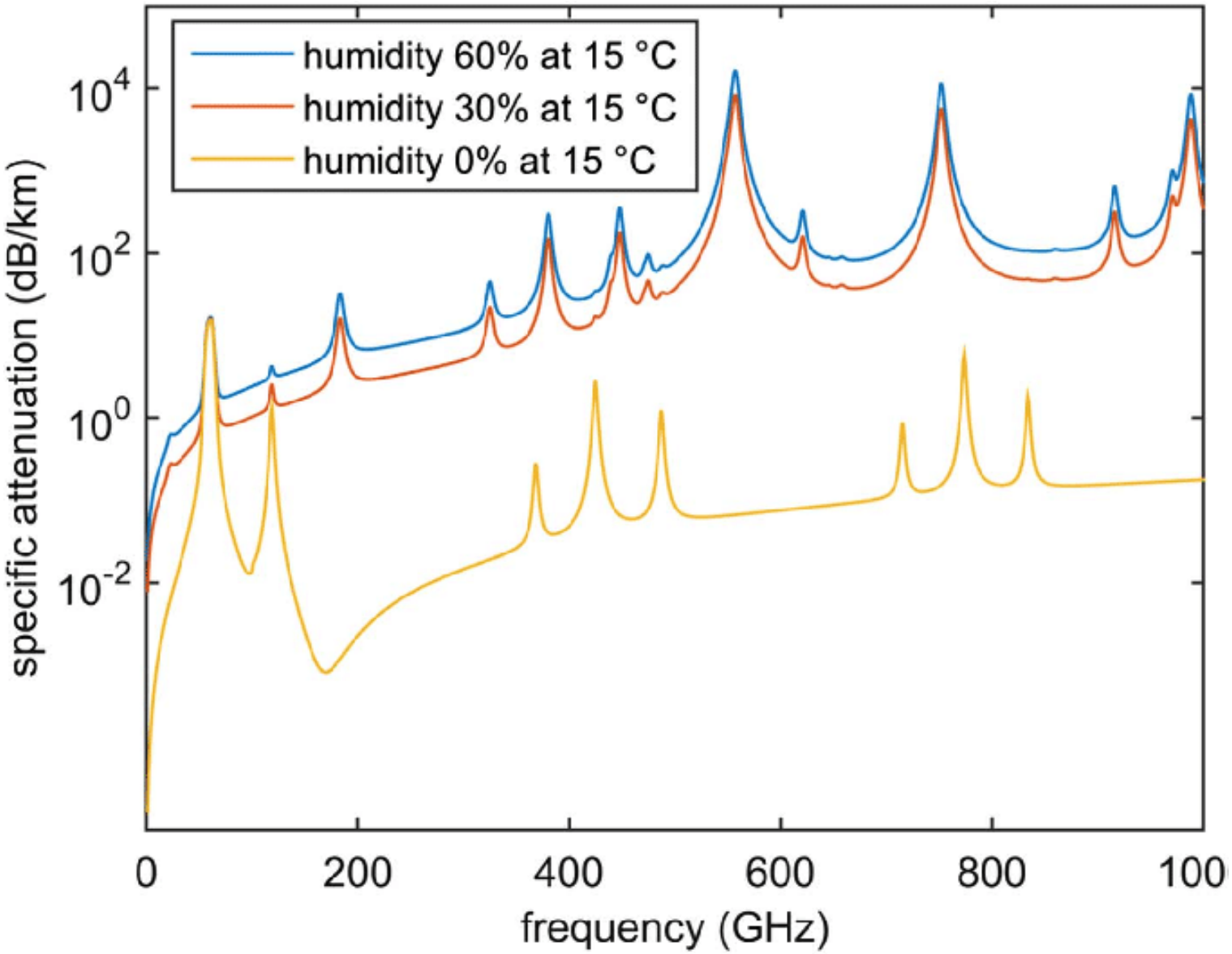
Meteorology

- Requires multiple frequency bands for weather prediction
  - Bands measure different aspects at different heights,
- 175 – 192 GHz band is critical for humidity data
  - Uses separate channels at peak of absorption and to the side for calibration
  - Scans from vertical to around 30 degrees elevation

Radio astronomy

- There are only two observatories in Europe operating above 86 GHz
  - In the French Alps (2550m ASL) and the Spanish Sierra Nevada (2850m ASL)
  - There are more than 400 molecular resonance lines between 86 GHz and 1 THz
    - 47 of which are considered ‘most important’
  - Most are used to observe line radiation in our galaxy
    - so the maximum Doppler shift is low

Atmospheric attenuation



Relative humidity rarely drops below 50% in UK

- But the absolute density of moisture in air drops at low temperature
- At -10° saturated water vapour density is 18% of +15°

Attenuation by other atmospheric gases is not significant

- Except at 60 GHz and 120 GHz (due to oxygen)

Attenuation due to Rainfall is 12-15dB/km for 30mm/hour at >80 GHz

- Typical for 0.01% time in UK

Three regimes of ITU spectrum regulation

86 – 275 GHz

- Table of allocations in Radio Regulations
- 11 bands with No. 5.340 “All emissions are prohibited”

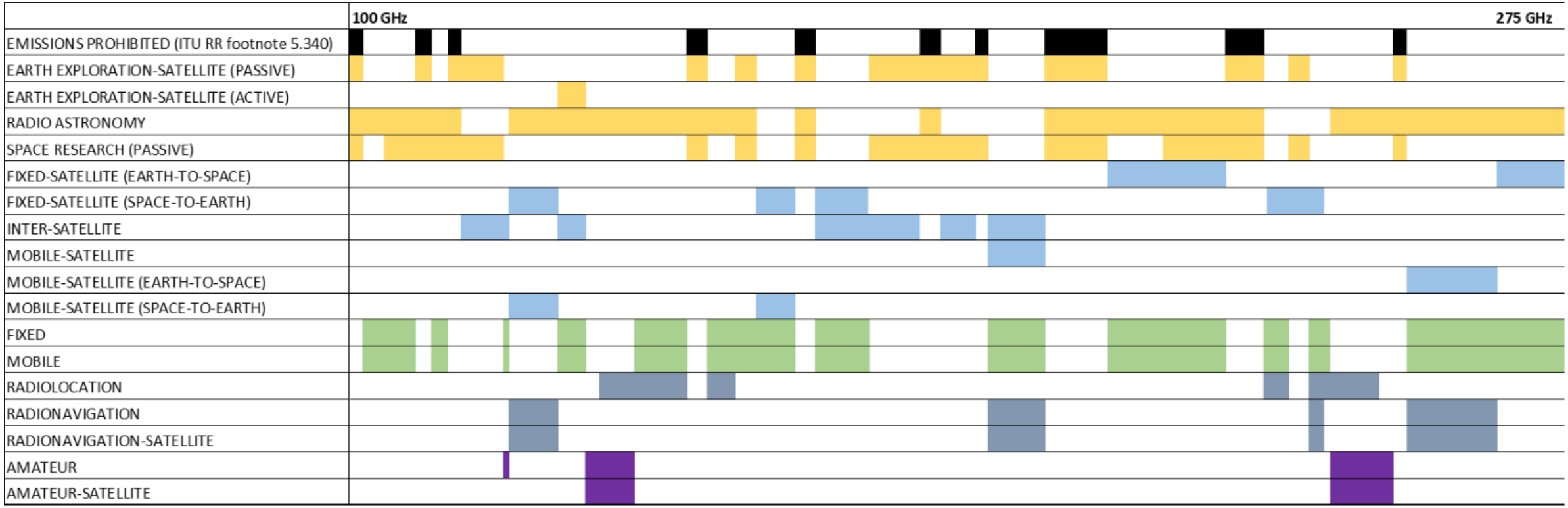
275 – 1000 GHz

- No allocations, but bands are ‘identified’ for passive services in No. 5.565
  - There are eight bands for Radio astronomy and 27 bands for EESS/SRS
- Only 160 GHz bandwidth is not identified for RA or EESS/SRS
- The widest band above 510 GHz not identified is 30 GHz

275 – 450 GHz

- No. 5.564A: Identification of spectrum for land mobile and fixed services
  - For 139 GHz of this frequency range, “no specific conditions are necessary to protect EESS (passive) applications”
    - There is no mention of other active services

UK Table of allocations between 100 GHz and 275 GHz



Source: Ofcom

All spectrum allocated to mobile is also allocated to the fixed service

- And most of this below 175 GHz is within the W and D band channel arrangements
- The widest contiguous mobile/fixed bands are 23 GHz and 17 GHz
  - These are both above 200 GHz

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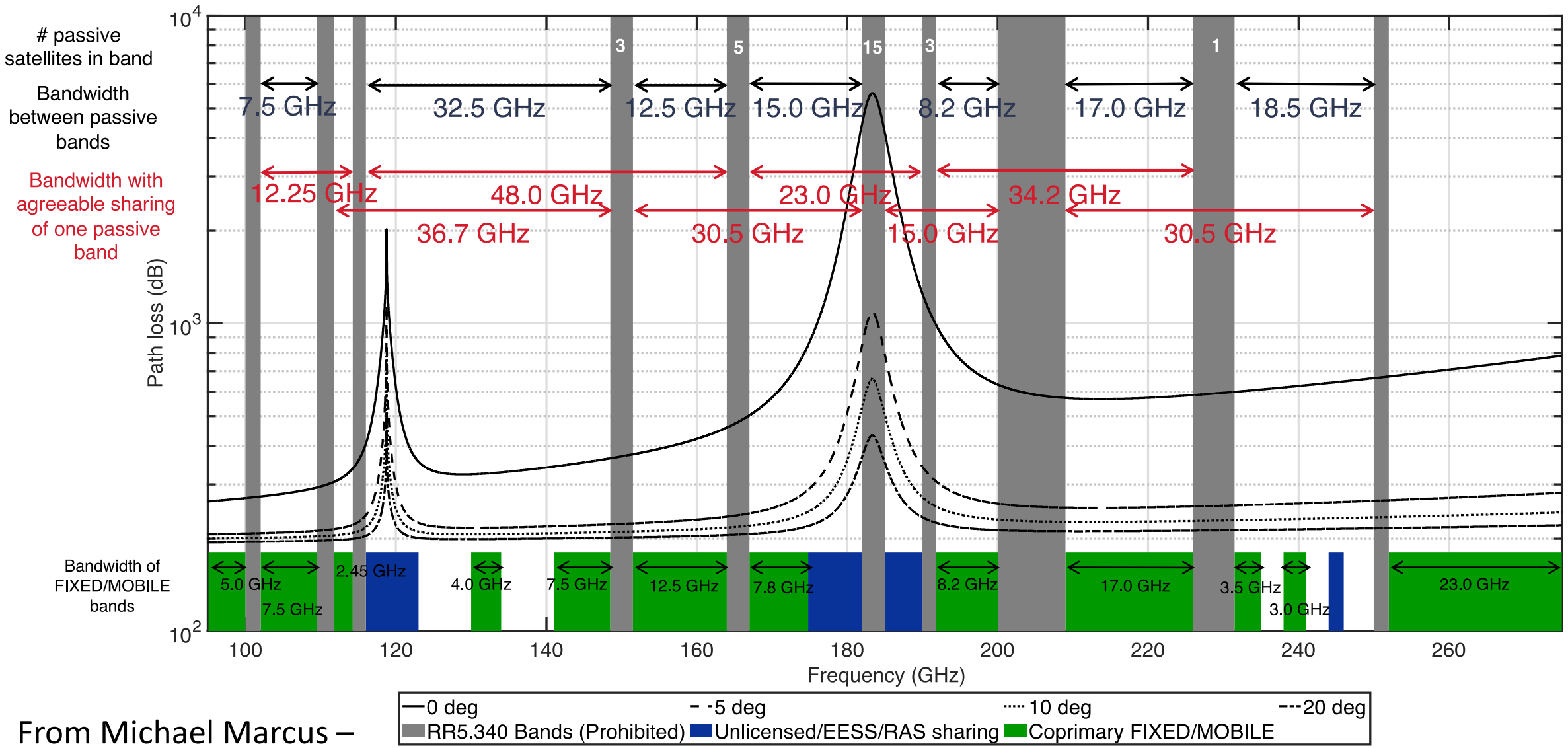
Available bandwidths with and without sharing with passive services



From Michael Marcus – 'Unlicensed' bands are US

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Conclusions

There is not an abundance of spectrum between 86 GHz and 275 GHz

- The spectrum is fragmented by allocations to passive services
- There need to be studies on whether active services can operate in these bands under certain conditions
  - In USA, one technical solution involving null-steering is being considered
- The telecoms industry needs to reach a consensus on the division of spectrum for backhaul/fronthaul (point-to-point), mobile point-to-multipoint and peer-to-peer
  - Or whether these can share spectrum
- The higher the frequency band, the longer the time to commercial availability
  - and the shorter the range
- It is important to distinguish between likely technology advances and ‘wishful thinking’

There appears to be a lack of regulatory certainty for THz sensing applications operating over very wide bandwidths

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Preliminary recommendations and next steps

To Ofcom and terrestrial service stakeholders

- There needs to be an overall view of future use of spectrum up to 275 GHz
  - Before it becomes even more fragmented by ‘early adopters’
- This needs to consider sharing opportunities between active applications
- and the feasibility of active services operating within some ‘No. 5.340’ bands
  - Under specified conditions that do not impair the passive service use

To Government and Ofcom

- UK may be able to take leadership in development of teraHertz applications
  - With help of relatively modest funding and a supportive regulatory regime
  - Possibly under the supplier diversification programme

NEXT STEPS

- I will write a report for SPF on the teraHertz ‘landscape’ in UK
- I would welcome input from interested parties

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