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Studies on the use of frequency bands above 275 GHz by land-mobile and fixed service applications

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In the Radio Regulations ([RR](#)) there are no frequency allocations above 275 GHz. RR No. 5.565 identifies certain frequency bands in the range 275–1000 GHz for use by administrations for passive service applications, without precluding the use of this range by active services and urging administrations to take all practicable steps to protect the passive services from harmful interference. Thus, in the RR there is already an implicit identification for land-mobile and fixed service applications above 275 GHz. RR No. 5.565 also indicates that all frequencies in the range 1000–3000 GHz may be used by both active and passive services.

WRC-19 agenda item 1.15 is to consider the identification of frequency bands for use by administrations for the land-mobile and fixed service applications operating in the frequency range 275–450 GHz, in accordance with Resolution 767 (WRC-15). This range of spectrum is expected to play an important role in providing connectivity for the increasing population in countries.

“The technological development of active services above 275 GHz is in its infancy and is expected to evolve over a long period of time.”

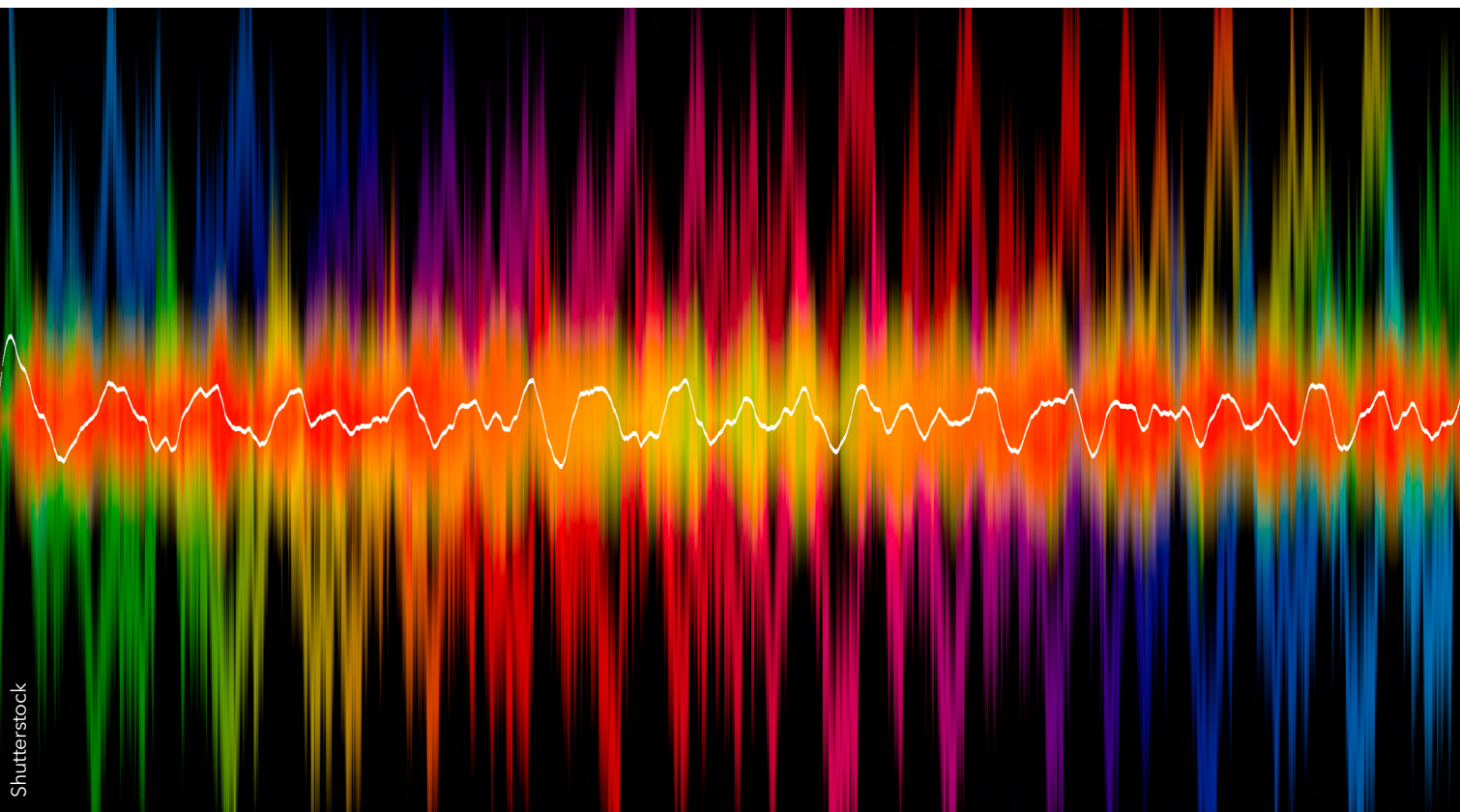
José Costa

ITU-R studies to date

Recent advances in microwave technology make possible the use of frequencies above 275 GHz by active services for communications and other uses (cf. Reports ITU-R [F.2416](#), [M.2417](#), [RA.2189](#), [RS.2194](#), [RS.2431](#), [SM.2352](#) and [SM.2450](#)).

The studies conducted in the ITU Radiocommunication Sector ([ITU-R](#)) in support of WRC-19 agenda item 1.15 include the characterization of the land-mobile and fixed service applications that use and/or aim to use this frequency range, due to increasing interest. They were developed in a relatively short time to provide timely input for the sharing and compatibility studies:

- Report ITU-R [F.2416](#) (11/2017) “Technical and operational characteristics and applications of the point-to-point fixed service applications operating in the frequency band 275–450 GHz”, provides fixed service applications and their technical and operational characteristics operating in the frequency range 275–450 GHz for sharing and compatibility studies between fixed service applications and passive services, as well as among active services in the frequency range 275–450 GHz.



- Report ITU-R [M.2417](#) (11/2017) “Technical and operational characteristics of land-mobile service applications in the frequency range 275–450 GHz”, covers close proximity mobile systems operating in the frequency range 275–450 GHz, including a description of the applications and characteristics of kiosk downloading mobile systems, ticket gate downloading mobile systems, inter-chip communication systems, intra-device communications, and wireless links for data centers. These are all high-capacity mobile applications over short distances, generally operating indoors.

The sharing and compatibility studies between land-mobile, fixed and passive services in the frequency range 275–450 GHz are documented in Report ITU-R [SM.2450](#) (06/2019) “Sharing and compatibility studies between land-mobile, fixed and passive services in the frequency range 275–450 GHz”. The report contains several studies to assess frequency sharing between passive service applications (radio astronomy and Earth exploration satellite) and the fixed and land-mobile service applications in the 275–450 GHz range.

The compatibility studies, based on the technical information available in Reports ITU-R M.2417-0 and ITU-R F.2416-0, seek spectrum that can be used by these applications without the need for specific constraints to protect passive service applications. The passive service studies are based on Reports ITU-R [RA.2189-1](#) and ITU-R [RS.2431-0](#):

- Report ITU-R [RA.2189-1](#) (09/2018) “Sharing between the radio astronomy service and active services in the frequency range 275–3000 GHz” concluded that, at the emission powers considered there, sharing between radio astronomy and active services in the band 275–3000 GHz is possible if atmospheric characteristics as a function of height above sea level, as well as transmitter antenna directivity, are taken into account.

Harmful interference to radio astronomy facilities can be avoided using geographic exclusion zones surrounding radio astronomy facilities. Direct illumination of radio astronomy observatories, primarily at altitudes comparable to or above those of the observatories, could cause interference to radio astronomy systems.

Apart from exclusion zones, two basic strategies are possible for protecting the radio astronomy in these bands from fixed service emissions. The first involves lower powers and narrow beam antennas, and the second involves avoiding pointing towards radio astronomy facilities.

While this should be straightforward for most fixed service point-to-point uses, it is not applicable to some other terrestrial applications such as mobile use.

This report highlights the importance of sharing studies at specific geographic locations on a case-by-case basis.

- Report ITU-R [RS.2431-0](#) (09/2018) “Technical and operational characteristics of EESS (passive) systems in the frequency range 275–450 GHz” provides the technical and operational characteristics of Earth observation (passive) sensors in the frequency range 275–450 GHz, to be used for sharing and compatibility studies between Earth exploration satellite (passive) remote sensing, and land-mobile and fixed service applications.

Most of the studies in Report ITU-R [SM.2450](#) concluded that in the bands 275–296 GHz, 306–313 GHz, 320–330 GHz, and 356–450 GHz, no specific conditions to protect the Earth exploration satellite service (EESS) applications are necessary, for systems operating within the parameters given in the referenced [ITU-R Reports](#).

These studies did not seek to develop conditions (such as power limits, shielding requirements and/or elevation angle restrictions, etc.) that could facilitate sharing with EESS in other frequency bands. Therefore, it is possible that active terrestrial service applications may very well share spectrum with EESS applications in other bands with conditions yet to be determined.

Thus, in the remaining frequency bands, 296–306 GHz, 313–320 GHz, 330–356 GHz, specific conditions are necessary, such as shielding, to ensure the protection of EESS (passive) applications from fixed and land mobile service applications, by using the latest relevant [ITU-R Recommendations](#).

What’s at stake?

The availability of enough spectrum for mobile backhaul applications will be critical for advanced and innovative mobile access operations as 5G, 6G, and beyond systems develop and traffic grows, while the traditional fixed service bands for backhaul run out of capacity. Indeed, there are other articles in this special issue covering the importance of WRC-19 agenda item 1.13 on the identification of spectrum for IMT. Furthermore, it is still to be determined the use of the frequencies above 275 GHz for fixed and mobile wireless access for 6G and beyond. Thus, it is necessary to keep all options open, and avoid adding anything in the RR that would curtail the use of this band for mobile backhaul and access in the future; particularly since the studies for this agenda item were unavoidably rather hurried.

It is necessary to enable the use of very large contiguous bandwidths to support high capacity and extreme peak data rates for mobile backhaul and access links. For example, as explained in Report ITU-R [F.2416](#), the overall propagation conditions in the range 275–320 GHz band are similar to the frequency range 252–275 GHz that already has an allocation to the fixed service, thus the range 252–320 GHz would enable 68 GHz for backhaul systems capable of fulfilling the demands for very high capacity transmissions. Therefore, this frequency range may very well be used for outdoor point-to-point fixed service applications over several hundred metres, making it suitable for short distance and very high capacity fixed backhaul services, as an alternative to wireline applications in villages, suburban and dense metro areas.

The ITU-R studies on the compatibility of passive and active services have shown that, depending on the specific sub-band of the 275–450 GHz frequency range and the combined use of active and passive service applications, coexistence can be achieved either without needing specific conditions, or with the implementation of mitigation techniques such as minimum separation distances and avoidance angles. Adequate shielding has not been ruled out as an effective mitigation technique to protect EESS. ITU-R Recommendations and Reports on coexistence between active and passive service applications are expected to evolve over time to reflect technological developments.

Thus, it should be plausible and vital to have access to the 275–450 GHz frequency range for use by terrestrial fixed and land mobile service applications, while protecting EESS (passive) and the required terrestrial-based radio astronomy applications using the evolving guidance of ITU-R Recommendations and Reports. This would enable the use of the whole range, some parts without conditions and other parts with conditions, to be specified in the future. Further studies are needed in ITU-R to analyse the feasibility of using all the frequencies above 275 GHz, including the associated required conditions.

Summary

Since the use of the frequencies above 275 GHz offers many opportunities in the medium to long term for land-mobile and fixed service applications, it is important to continue studying the use of these frequencies in a coordinated and sincere manner.

The technological development of active services above 275 GHz is in its infancy and is expected to evolve over a long period of time. Further studies are therefore required to facilitate the use of frequencies above 275 GHz by all service applications. Such studies should address the evolving technical and operational characteristics, requirements, performance, and benefits associated with the use of the frequencies above 275 GHz by all service applications, and include the need to protect the EESS (passive) and radio astronomy applications.

