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RESOLUTION 681 (WRC-23)

**Studies of technical and regulatory provisions necessary to protect radio astronomy operating in specific Radio Quiet Zones and, in radio astronomy service primary allocated frequency bands globally, from aggregate radio-frequency interference caused by systems in the non-geostationary-satellite orbit**

The World Radiocommunication Conference (Dubai, 2023),

*considering*

- a) that radio astronomy is a pivotal scientific discipline that plays a crucial role in unravelling the mysteries of the cosmos;
- b) that the number of non-geostationary-satellite orbit (non-GSO) satellite launches has increased in recent years and even more launches are planned for the next decade;
- c) that for the purpose of this Resolution, a Radio Quiet Zone (RQZ) is any recognized geographic area within which the usual spectrum management procedures are modified for the specific purpose of reducing or avoiding interference with radio telescopes, thereby maintaining the required standards for quality and availability of observational data, as defined in Report ITU-R RA.2259;
- d) that aggregate emissions from single and multiple non-GSO satellite systems may cause interference to the radio astronomy service (RAS), even in RQZs, which may be challenging to resolve with only national regulation;
- e) that non-GSO satellite systems are being considered for future use as part of terrestrial networks under the mobile-satellite service (MSS);
- f) that a number of administrations have implemented regulations to establish RQZs which may not be applicable to satellite operations;
- g) that the 2023 Radiocommunication Assembly instructed ITU Radiocommunication Sector (ITU-R) Study Group 7 to facilitate information sharing to enable better coordination between satellite operators and RAS sites, including, for example, the creation of a database of RQZs;
- h) that the potential impact of non-GSO satellite systems on astronomy has been recognized and is currently being discussed in the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) under the name “Dark and Quiet Skies”;
- i) that the impact of non-GSO satellite systems on radio astronomy has been recognized by the International Astronomical Union by creating the Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference;

*j)* that a small number of remote RAS stations are of the utmost importance as they are designed to make observations of significance, resulting in new knowledge of astronomical phenomena, which may require observations of objects not previously studied, or observing objects with increased precision;

*k)* that, for the purpose of this Resolution, the facilities which fall into the category defined in *considering j)* are:

- the Square Kilometre Array Observatory in South Africa;
- the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile;

*l)* that the RAS stations in *considering k)* must be able to operate in much larger frequency ranges than those currently allocated to the RAS in order to meet their scientific goals;

*m)* that the RAS stations in *considering k)* are afforded a national RQZ, while only a small fraction of other RAS stations are surrounded by RQZs;

*n)* that current approaches and procedures may not be sufficient to ensure protection of the RAS from emissions produced by the increasing number of non-GSO satellite systems,

*noting*

*a)* that Recommendation ITU-R RA.769 provides thresholds for the non-GSO satellite interference received through the far side lobes of radio astronomy telescopes;

*b)* that Recommendation ITU-R RA.1031 addresses the protection of radio astronomy in shared bands;

*c)* that Recommendation ITU-R RA.1513 provides the acceptable levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the RAS on a primary basis;

*d)* that Recommendation ITU-R M.1583 provides the calculations for interference between non-GSO MSS or radio navigation-satellite service (RNSS) and radio astronomy telescope sites;

*e)* that Recommendation ITU-R S.1586 provides the method for calculating unwanted emission levels produced by a non-GSO FSS at radio astronomy sites;

*f)* that Report ITU-R RA.2259 contains characteristics of national RQZs and measures to establish them,

*recognizing*

*a)* that No. **29.12** highlights the susceptibility of radio astronomy to harmful interference from space-borne transmitters;

*b)* that the spectrum requirements for radio astronomy stations in *considering k)* are fulfilled by the primary and secondary allocations, as well as by national arrangements;

- c) that there are no examinations currently performed by the Bureau with regard to RAS protection from satellite systems under Articles **9** or **11**;
- d) that the compatibility issues between the RAS and non-GSO systems may be addressed by technical mitigation measures before satellites are launched and operational;
- e) that for non-GSO systems the equivalent power flux density (epfd) method, which is developed in Recommendations ITU-R M.1583 and ITU-R S.1586, provides a sufficiently accurate estimate of the total power that is introduced into RAS receivers and can be used to incorporate the effects of other technical parameters;
- f) that national regulations for radio astronomy in the RQZ may be different for each administration, leading to varying protection measures;
- g) that some non-GSO systems currently operate in frequency bands adjacent to RAS primary allocations;
- h) that the specific protection measures for the RAS agreed between administrations are outside the scope of this Resolution,

*resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference*

- 1 studies on how the interference from unwanted emissions from a single non-GSO satellite system operating in the adjacent and nearby frequency bands in Table 1 affects the operation of RAS stations in frequency bands allocated to the RAS on a primary basis in Table 1;
- 2 studies on how the aggregate interference from unwanted emissions from multiple non-GSO satellite systems operating in the adjacent and nearby frequency bands in Table 1 affect the operation of RAS stations in frequency bands allocated to the RAS on a primary basis in Table 1;
- 3 studies on the possible recognition of the RQZs specified in *considering k)* above, based on their characteristics and existing ITU-R studies;
- 4 studies on how the aggregate interference from single and multiple non-GSO satellite systems affects the operation of RAS stations in the RQZs specified in *considering k)*;
- 5 studies on new coexistence measures between non-GSO satellite systems and RAS stations in the RQZs specified in *considering k)*;
- 6 studies of methods to calculate the necessary separation distances between gateways of non-GSO systems operating in bands adjacent to or near RAS allocations and RAS stations protected by the RQZs specified in *considering k)*,

*invites administrations*

to participate actively in the studies and provide the technical and operational characteristics of the systems involved and other information required for the studies by submitting contributions to the ITU-R,

*invites the 2027 world radiocommunication conference*

1 to consider appropriate technical and/or regulatory measures based on the results of the studies mentioned in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference 1*;

2 to consider, if deemed appropriate, based on the studies mentioned in *resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference 3, 4, 5 and 6*, potential solutions to characterize the RQZs in *considering k)* in the Radio Regulations and/or in a WRC Resolution,

*instructs the Secretary-General*

to bring this Resolution to the attention of COPUOS and other international and regional organizations concerned.

TABLE 1

**RAS frequency bands to be studied and corresponding active services to be included**

<b>Radio astronomy frequency band</b>	<b>Active space service operating in adjacent or nearby frequency band</b>	<b>Active space service (space-to-Earth)</b>	<b>Scope</b>
10.6-10.7 GHz	10.7-10.95 GHz	FSS	<i>Resolves etc. 1 and 2</i>
42.5-43.5 GHz	42-42.5 GHz	FSS	<i>Resolves etc. 2</i>
76-77.5 GHz	74-76 GHz	FSS, MSS	<i>Resolves etc. 2</i>
94.1-95 GHz	95-100 GHz	RNSS, MSS	<i>Resolves etc. 2</i>
100-102 GHz	95-100 GHz	RNSS, MSS	<i>Resolves etc. 1 and 2</i>
114.25-116 GHz	116-119.98 GHz	ISS	<i>Resolves etc. 1 and 2</i>
130-134 GHz	123-130 GHz	FSS, MSS, RNSS	<i>Resolves etc. 2</i>