

Consultation: position ASTRON on the RSPG draft report '6G Strategic vision'

ASTRON (www.astron.nl) is the Netherlands Institute for Radio Astronomy, and is part of NWO-i (<https://www.nwo-i.nl/en/>), the Institutes Organisation of NWO (<https://www.nwo.nl/en/contact>), the Dutch Research Council. The response of ASTRON to the draft RSPG report, below, is in the context of protection of radio astronomy services and science.

The frequency ranges under consideration for 6G technologies include, among others, the sub-6 GHz, upper 6 GHz, and the 7-15 GHz bands. This also includes improving network coverage below 1 GHz, and possibly deploying Non-Terrestrial Networks such as HAPS, HIBS and satellites. These bands encompass several ranges protected for radio astronomy (RAS) in ITU Region 1, with varying levels of protection. Part of the radio astronomy bands are protected by footnote 5.149 in Radio Regulations 2024:

" In making assignments to stations of other services to which the bands: 13.360-13.410 kHz ... 252-275 GHz are allocated, administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service (see Nos. 4.5 and 4.6 and Article 29). (WRC 07)"

In the upper 6 GHz range this includes the 6650-6675.2 MHz radio astronomy band.

Additionally, the 2024 Radio Regulations designates RAS primary use and secondary allocations, including:

- The 10.6-10.68 GHz, 10.68-10.7 GHz, and 15.35-15.40 GHz bands are allocated to RAS as primary use.
- The 14.47-14.5 GHz band is assigned to RAS under a secondary allocation.

At the Westerbork Synthesis Radio Telescope (WSRT) site, several telescopes are equipped with receivers capable of observing within these bands up to 8.6 GHz. Looking further ahead, we are considering expanding the RAS capability at the site with new GHz range systems (SKA dishes, large N - small D array) in the frequency range up to 15.5 GHz.

We urge regulatory bodies across ITU Region 1 to ensure that the electric field strength in the 6650-6675.2 MHz, 10.6-10.68 GHz, 10.68-10.7 GHz, 14.47-14.5 GHz, and 15.35-15.4 GHz bands at RAS sites, resulting from transmissions by other users, remains below the thresholds specified in ITU-R Recommendation RA.769. This includes both intended emissions and unintended ones, such as spectral leakage through bandpass filters with insufficient roll-off. This includes RAS bands below 6 GHz and below 1 GHz should 6G be deployed in those frequency ranges.

Outside these protected bands, spectrum-sharing possibilities must be approached carefully. For RAS, the priority is the fraction of time the dynamic spectrum (time-frequency space) remains unoccupied. At these frequency ranges, the distribution of this unused time is less critical. Time Division Duplexing (TDD) may be moderately preferred over Frequency Division Duplexing (FDD) if the average bandwidth occupied is smaller. If TDD is allowed dynamic bandwidth allocation, it must be ensured

that the protections for the above-mentioned bands remain strictly observed. Dynamic bandwidth allocation can support spectrum sharing, provided bandwidth use is not only expanded as needed but also reduced when feasible.

To safeguard RAS operations, the following measures should be considered:

- Refusing permits for transmissions in the protected bands and implementing a safe guard band around them to account for poor transmitter bandpass filter performance.
- Enforcing geographic restrictions on transmitters.

As non-terrestrial networks (HAPs, HIBS, satellites) are considered, measures must be taken to avoid increasing the (low-level) background interference levels throughout the radio spectrum. For HAPS and HIBS this may be due to e.g. transmitter signal reflections from terrestrial transmitters or from space-based transmitters. For both (LEO) satellites and HAPS/HIBS, there is a risk of unwanted emissions (UEMR) well exceeding the ITU-R-RA769 levels for the RAS protected bands, as is shown in [DiVruno 2023, doi: 10.1051/0004-6361/202346374]. This can relatively easy be solved by careful EMC design of the systems involved, for example including proper shielding of power converters. Although UEMR typically is strongest below 1 GHz, it may occur also at higher frequencies. This problem is worsened by the rapid increase in the number of space-based systems. ITU Working Party 7D is currently drafting a report 'Unintended electromagnetic radiation (UEMR) from space systems into RAS frequency bands' addressing these issues.