

To the Spectrum Policy Task Force,

Greetings.

As a radio astronomer, I welcome the FCC's broad review of spectrum policy, particularly in the areas of interference protection and spectral efficiency. I am a principal scientist at NASA's Jet Propulsion Laboratory and Lead Radio Astronomer for NASA's Deep Space Network. I was a member of the Committee on Radio Frequencies of the National Academy of Sciences from 1996 to 2001. I participate in the US National Committee of Working Party 7D (Radio Astronomy) of the International Telecommunications Union. I was a participant at the 1997 World Radio Communications Conference as a delegate with the Inter-Union Committee on Astronomical Frequencies. My comments, however, are mine alone and do not necessarily represent the policies of my employer (the California Institute of Technology) or the other agencies mentioned above.

Before commenting on some of the issues raised in the Public Notice, let me remind the Task Force that the social importance of astronomy is, literally, invaluable. From Ptolemy to Copernicus to Galileo to Einstein to Hawking, Humankind's conception of the universe has formed a basis for our understanding of how we came to be, who we are, and what potentially the future holds in store for us. Radio astronomy, though only half a century old, has proven to have an important role in that tradition. This account, because of its length, I will file as a separate comment. I would like the Task Force to consider that because we cannot forecast the outcome of scientific exploration, it is not possible to (as is suggested in Question 16 of the Notice) to balance the economic values of radio astronomy and, say, cellular telephone service.

Question 4:

An appropriate analogies for the Task Force to consider are:

- a) regulations which limit environmental pollution, and,
- b) wilderness areas set aside to ensure species survival and biodiversity.

In the case of the spectrum, these translate into

- a) stricter limits on emissions not necessary to achieve the spectrum user's goal, and
- b) spectrum preserves (such as the bands currently assigned to the scientific services) and geographical preserves (such as the National Radio Quiet Zone).

Question 7:

ITU RA.769 sets forth, band by band, the levels of interference considered harmful to radio astronomy. However, these levels were established when radio astronomy was in its infancy. Technologies have vastly improved, and many observations are conducted below the levels set forth in RA.769. Radio telescopes now probe deeper into the universe and thus farther back in time, tracing the evolution of the universe. By reviewing these standards and setting stricter limits, the USA would likely trigger an international review by the ITU.

Question 8:

Different active services have different standards for emissions generated outside their allocated bands. In making spectrum assignments, this has been taken into account. If the nature of services in bands were allowed to change in response to economic needs, then perhaps the unwanted

emission standards should be applied to the bands rather than the services.

Question 9:

ITU RA.769 has the status of a recommendation, though it is generally observed as if it were a regulation. In the U.S., footnotes to the regulations add to and subtract from the protection given to the passive services. The harmful interference standards for passive service bands, based on an update of ITU RA.769, should be made binding in the U.S. on all active services.

Question 10:

The active services, quite naturally, prefer power limits to be specified at the transmitter. However, what matters ultimately to the passive service users are power levels received at the sensor. I suggest that the latter should ultimately be the decisive criterion. The former can be derived from calculations and field testing, but should only be considered as advisory.

Question 11:

It is quite possible that power limits to protect against harmful interference will spur innovation, for example, by stimulating research into more efficient coding methods and better band-limiting filters.

Question 12:

Yes. In particular, interference mitigation techniques are now being investigated. It is quite possible that certain specific types of interference can, in future, be effectively excised. Limits on such types of interference could then be relaxed. On the other hand, other types of interference may become increasingly damaging as the sensitivity of radio astronomy receivers increases.

Question 14:

Yes. However, this should only be done in the context of a method for redefining the standards as technology changes (see Question 12).

- 14a. One consideration should be cost. For example, interference excising receivers may depend heavily on computation, which might not be affordable now but would be in the future.
- 14b. Existing receivers should have at least as much protection in the future as they do now.
- 14c. Yes. The passive services are much more sensitive than receivers of most active services, and generally more severely affected.

Question 15:

One concern I would have about using litigation as a method of handling interference disputes is the potential inequality of the parties. For example, the National Radio Astronomy Observatory, the largest radio astronomy institution in the country, would be hard pressed to bear the cost of a dispute with, say, Motorola.

Question 19:

I believe that there are more efficient coding methods and more effective techniques for band-limiting filtering. I do not know to what extent their lack of use is a chicken-and-egg problem, i.e., they are not used because the required ICs are not available at low enough cost because there is not a market for them. New regulations could provide the incentive.

Question 21:

Stronger standards for unwanted emissions would help increase efficiency of spectrum use.

Question 25:

Radio astronomy is a global activity. Radio telescopes exist on all continents, and telescopes on many continents operate jointly in array configurations. It is essential that U.S. frequency assignments for radio astronomy are aligned with those of other countries, and that U.S. standards for harmful interference match or exceed those of other countries.

Respectfully yours,

T. B. H. Kuiper