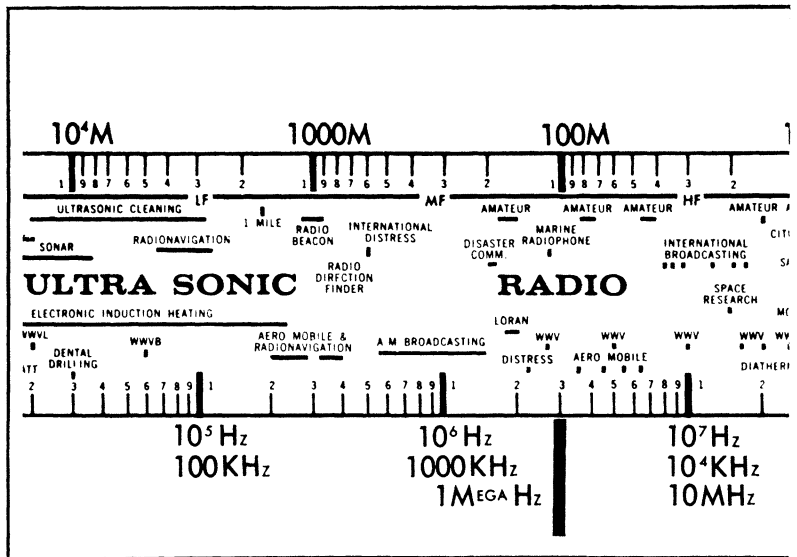


Percentages of the spectrum allotted to users



ASTRONOMY

When pulsars were first discovered, a not entirely facetious hypothesis was that they were signals generated by little green men, intelligent beings in some other solar system.

If they had turned out to be that, it would have been the first time that emissions engineered by intelligent beings had been anything but a nuisance to radio astronomers. The signals produced by the varicolored little men of earth have always been a severe problem to astronomers.

And now the earthmen are venturing into space, further compounding the problem. A profusion of space vehicles now communicates with the earth or helps earthlings communicate with each other. In the future there will be many more.

As these two uses of the radio spectrum grow, their frequency requirements conflict with those of other users, from television broadcasters to garage door openers. The range of frequencies available for transmission is limited.

Since the early days of radio an inter-governmental organization called the International Telecommunications Union has been responsible for dividing up the spectrum and assigning portions of it to different uses. From time to time, as demands on the available frequencies have increased, ITU has adjusted its allocation of bandwidths, often not without considerable controversy among users of the radio spectrum.

It is about to happen again. In view of the rapid growth of radio astronomy and space communications the ITU has scheduled a World Administrative Radio Conference for June 1971 to consider frequency allocations for those two services.

"There have been seven conferences since 1927 that were empowered to allocate frequencies," says S. M. Myers of the Federal Communications Commission. At that rate people expect the decisions of the 1971 conference, whatever they may be, to stand unaltered for a number of years. A decade is the likeliest bet. "Most everyone is looking from now to 1980," says Paul A. Price of the National Aeronautics and Space Administration.

In preparation for the conference, the FCC has asked American astronomers and space communication organizations for information about their needs. Meanwhile the International Scientific Radio Union, an organization of scientists who use radio in their investigations, has put forth a series of proposals to restrict certain frequencies for radio astronomy. The union recommends these to the governments of the world in the hope they will make them part of their negotiating policy at the ITU conference.

The consensus seems to be that, as Price puts it, "there isn't enough spectrum. Additional space is needed." One way to get it is to extend the usable

spectrum into the high-frequency or millimeter-wave range. "Proposals for allocation go clear up to 250 or 300 gigahertz (billion cycles per second)," says Price, "beyond anything now allocated." Present transmitters operate at frequencies up to 40 gigahertz, and that is the highest frequency at which allocations have been made.

Experimental studies as high as 100 gigahertz are being done. The Communications Satellite Corp. and NASA are testing between 15 and 30 gigahertz for use in earth-space systems. "We know they're feasible," says Price. "The question is the efficiency," how much signal comes out for the power that is put in. At these frequencies absorption in the atmosphere, especially by water vapor, is a serious problem. Propagation tests for wavelength bands of 4, 6, 7, 8 and 19 to 30 are planned before the 1971 conference. They will involve Applications Technology Satellites E, F and G.

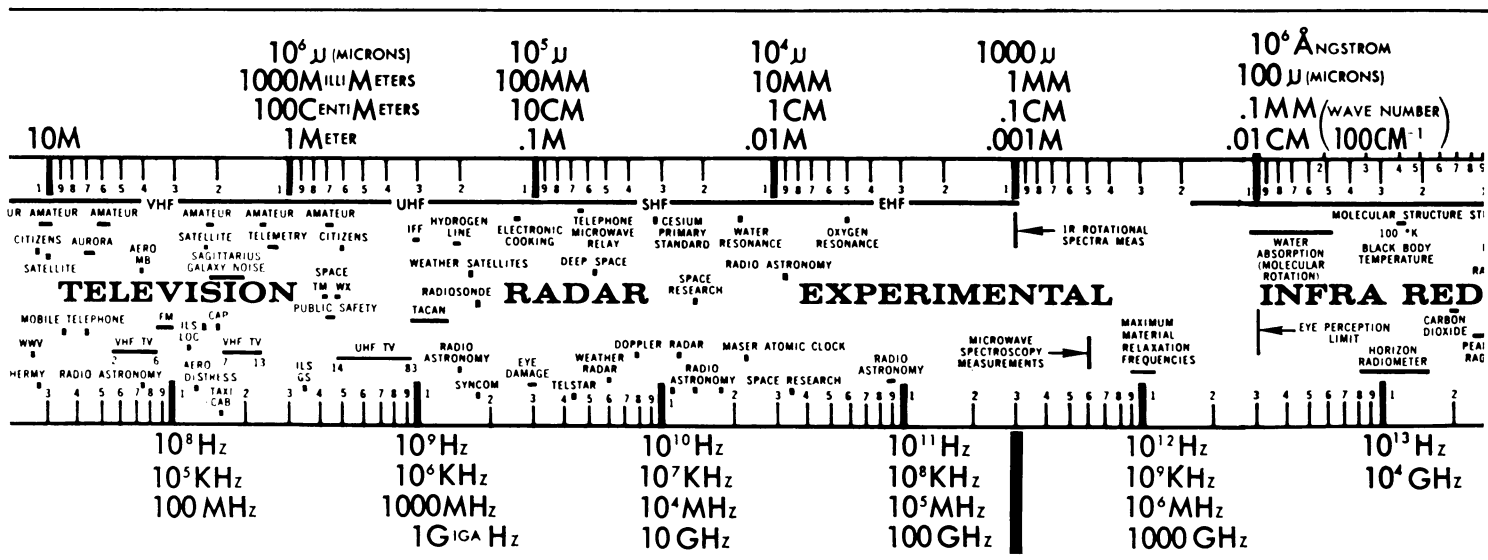
Extending the usable spectrum may relieve some of the pressure, but it will not by itself resolve the difficulty: The space people and other broadcasters want frequencies to transmit signals

Frequencies in a squeeze

More and more users for a limited spectrum are creating an allocation jam

by Dietrick E. Thomsen





N. Amer. Rockwell

Radio spectrum with user allocations. Radio astronomy windows are at 7 megahertz, and 1, 10 and 100 gigahertz.



Price: Just not enough spectrum.

on, while the astronomers want protection from transmissions on certain frequencies.

Astronomers can listen on any frequency they can build receiving equipment for. But on any frequency where artificial emissions are allowed any astronomical signals will be drowned out as long as the transmitting stations are on. Therefore since the beginning of radio astronomy certain frequency bands spaced across the spectrum have been forbidden to transmitters, and astronomers have done most of their looking through these windows.

But as radio astronomy has developed, more and wider bands have been requested. Sometimes this has led to fights with commercial interests. For example, when various countries first began to use UHF television channels, astronomers requested protection for channel 37 because it happened to be a conveniently located window. The ITU

responded by recommending, but not ruling, that national regulatory agencies give channel 37 as much protection as they could.

The University of Illinois, believing that the FCC would follow the recommendation, built a telescope to observe on this frequency. When it was about to start observing, the university found that the FCC had received applications to license broadcasting stations on channel 37. A battle ensued with scientific organizations and the university, which stood to lose an investment of millions of dollars, on one side, and commercial television organizations on the other. Finally the FCC, reasoning that it could satisfy the license applicants elsewhere in the spectrum, put channel 37 under protection until 1974.

Now the astronomers complain that this hard-won channel is too narrow. The Committee on Frequency Allocation of the National Academy of Sciences says, "some important U.S. observatories are unable to use this band for any observations, because nearby transmitters on channels 36 and 38 produce excessive out-of-band radiation."

Generally, spurious signals and spillover lead the astronomers to desire the widening of most of their bands.

Some astronomy bands are dictated by nature rather than by the arbitrary judgment of allocating agencies. More and more, astronomers have discovered that certain substances in space emit certain precise frequencies, the so-called line spectra. In some cases protection for bands containing these line frequencies could be granted; the band 1400-1427 megahertz that surrounds a line of atomic hydrogen is an example. In other cases preexisting allocations have led to trouble.

For instance, the astronomers would like to extend protection to the ranges

1611.75-1612.75 megahertz and 1720-1721 megahertz. These are emission frequencies of the substance hydroxyl, which has been found in large clouds in interstellar space. But the FCC replies that the lower of these lies in a band "which is currently allocated on an exclusive basis to the aeronautical radio-navigation service" and is "within the portion of the band currently being considered for use by an aeronautical collision avoidance system." Similar reasons preclude protection of the 1720 frequency.

In another part of the spectrum the NAS committee recommended shifting a radio astronomy assignment, 31.3 to 31.5 gigahertz, up toward 33 and 34 gigahertz to avoid conflict with a satellite communications frequency at 31.5 to 31.8 gigahertz. But, says the FCC, "present investments in the band 31.8 to 33.4 gigahertz exceed \$50 million and existing and programmed equipment will exceed \$80 million by 1972. . . . A shift as requested does not appear practicable."

The attitude of the astronomers and space people toward each other is friendly, and they are trying to work out their differences in discussions. "We're hoping to get together in the radio astronomy committee," says Price. The FCC is also friendly and seems disposed to give the astronomers as much of what they want as other considerations allow. In a number of cases the FCC is willing to grant protection to the whole of the frequency bands the astronomers ask; in others it would give them only part.

Discussion, however, continues and is likely to go on until the ITU meets. Most recently the FCC has put out a fifth notice of inquiry, as it calls the requests for proposals that it sends to interested parties. ◇