

RECOMMENDATION ITU-R SA.1015-1

Bandwidth requirements for deep-space research

(Question ITU-R 209/7)

(1994-2007)

Scope

This Recommendation presents bandwidth requirements for the space research service (deep space), to be taken into account in band allocations to space research service (deep space) in the future. The technical basis for these bandwidth requirements is also explained.

The ITU Radiocommunication Assembly,

considering

- a) that maximum symbol rates required for deep-space telecommunications in both space-to-Earth and Earth-to-space directions, have been well established (see Annex 1) for the foreseeable future;
- b) that, utilizing currently practicable techniques, the corresponding required bandwidths have been established;
- c) that the required width of allocated bands is influenced by the requirements of individual links and by the number of links that are simultaneous within the beamwidth of a deep-space research earth station antenna;
- d) that, in the future, the bandwidth required for some telecommunication functions of deep-space research may be reduced by utilizing newer techniques,

recommends

- 1 that band allocations for deep-space research should take into account the bandwidth requirements listed in Annex 1;
- 2 that all feasible steps that will reduce the required bandwidth should be considered for future telecommunication systems for deep-space research.

Annex 1**Bandwidth requirements for deep-space research****1 Introduction**

The total bandwidth suitable for deep-space telecommunications is a function of the required symbol rates, the number of spacecraft links in each mission, the number of missions, and the extent to which frequencies may be shared without mutual interference.

2 Link bandwidth

Earth-to-space and space-to-Earth bandwidths are governed by the required telemetering symbol rates, and by the required precision of angular and ranging measurements.

Needed symbol rates and corresponding bandwidths for the different functions projected to be used in deep-space research are summarized in Table 1.

TABLE 1
**Maximum required symbol rates and bandwidths
for a deep-space mission**

Direction and function	Symbol rate (Msymbol/s)	RF bandwidth (MHz)
Earth-to-space		
Telecommand	0.002	0.040 ⁽¹⁾
Computer programming	0.2	0.8
Voice	0.045	0.18
Television	30	120
Ranging	100 ⁽²⁾	400
Space-to-Earth		
Maintenance telemetering	1.2 ⁽³⁾	4.8
Scientific data	600 ⁽⁴⁾	1 200 ⁽⁵⁾
Voice	0.27 ⁽³⁾	1.08
Television	60 ⁽⁴⁾	240
Ranging	100 ⁽²⁾	400

⁽¹⁾ Typically a sub-carrier will be used.

⁽²⁾ The unit is MHz for sinewave ranging and Mchip/s (mega chips per second) for pseudo-noise (PN) ranging.

⁽³⁾ Assuming rate 1/6 error correction code will be used.

⁽⁴⁾ Assuming rate 1/2 error correction code will be used.

⁽⁵⁾ Assuming QPSK modulation will be used.

The extremely precise navigation technique using very long baseline interferometry (VLBI) requires the transmission of tones widely spaced from the carrier. Typically the spacing may vary from 1/200 to 1/600 of the spacecraft transmitted frequency and the relative power of these tones to the carrier is typically –15 dB. Transmission of these tones will not be continuous. Therefore, spectral line separation of frequency tones used in VLBI need not be considered a determinant of required bandwidth.

Spacecraft design simplicity, reliability and optimum performance of the telecommunications links have led to the use of bi-phase modulation with residual carrier as the traditional deep-space technique for the transmission of information. To pass a periodic square modulation waveform with no more than 0.3 dB loss, the bandwidth must include the fifth harmonic of the modulating square wave. For the telemetering signal, the radio-frequency bandwidth must be wide enough to pass the fifth harmonic of the sub-carrier frequency plus two and half times the symbol rate. With present