

SECTION 4D: FREQUENCY SHARING BETWEEN NETWORKS OF THE FIXED-SATELLITE SERVICE
– EFFICIENT USE OF THE SPECTRUM AND GEOSTATIONARY-SATELLITE ORBIT

4D1: Permissible levels of interference

RECOMMENDATION ITU-R S.735-1*

**MAXIMUM PERMISSIBLE LEVELS OF INTERFERENCE IN A GEOSTATIONARY-SATELLITE
NETWORK FOR AN HRDP WHEN FORMING PART OF THE ISDN
IN THE FIXED-SATELLITE SERVICE CAUSED BY OTHER NETWORKS
OF THIS SERVICE BELOW 15 GHz**

(Question ITU-R 50/4 (1990))**

(1992-1993)

The ITU Radiocommunication Assembly,

considering

- a) that emissions from the earth stations as well as from the space station of a geostationary-satellite network in the fixed-satellite service (FSS) may result in interference to another such network when both networks operate in the same bands;
- b) that it is desirable that the interference in networks in the FSS caused by transmitters of different networks in that service should be such, as to give a reasonable orbit utilization;
- c) that the system designer should control the overall performance of a network and be entitled to provide a quality of service that meets ITU recommended performance criteria which are expressed in terms of a bit error ratio (BER);
- d) that it is necessary to protect a network of the FSS from interference by other such networks;
- e) that to allow an operator to exercise control over the quality of service there needs to be a limit on the aggregate interference a network must be able to tolerate from emissions of all other networks;
- f) that to limit the aggregate interference from all other networks, there needs to be a limit on the interference a network should be expected to tolerate from any one other network;
- g) that it is desirable that the increase in interference from other satellite networks should be a controlled fraction of the total noise that would give rise to a bit error ratio, as set out in Recommendation ITU-R S.614***;
- h) that the levels of interference between geostationary-satellite networks in the FSS below 10 GHz are not expected to exhibit a large variation with time, and under these conditions it is preferable to define the permissible interference limit as a fraction of the pre-demodulator noise power, as this allows multiple interference entries to be superimposed on each other on the basis of RF power addition;
- j) that in frequency bands between 10 and 15 GHz where very high propagation attenuation may occur for short periods of time, it may be desirable for systems to make use of some form of fade compensation to counteract signal fading;
- k) that interference between networks in the FSS may exhibit a non-uniform spectral distribution containing narrow-bandwidth peaks and that narrow-bandwidth carriers are more sensitive to this type of interference,

* New version of CCIR Recommendation 735.

** Former CCIR Question 50/4.

*** Former CCIR Recommendation 614.

recommends

1. that a geostationary network in the FSS operating in the frequency bands below 15 GHz should be designed and operated in such a manner that in any satellite hypothetical reference digital path which forms part of a 64 kbit/s ISDN connection the provisions of § 1 of Recommendation ITU-R S.614* can be met when the aggregate interfering power from the earth and space station emissions of all other networks operating in the same frequency band or bands, assuming clear-sky conditions on the interference paths, does not exceed at the input to the demodulator:

1.1 25% of the total system noise power under clear-sky conditions when the network does not practice frequency re-use;

1.2 20% of the total system noise power under clear-sky conditions when the network does practice frequency re-use;

2. that for a geostationary network in the FSS as mentioned in § 1, the inter-network interference caused by the earth and space station emissions of any one other network operating in the same frequency band or bands should be limited to 6% of the total system noise power under clear-sky conditions;

3. that the maximum level of interference noise power caused to that network should be calculated on the basis of the following values for the receiving earth station antenna gain, in a direction at an angle ϕ (in degrees) referred to the main beam direction:

$$G = 32 - 25 \log \phi \quad \text{dBi} \quad \text{for} \quad 1^\circ \leq \phi < 48^\circ$$

$$G = -10 \quad \text{dBi} \quad \text{for} \quad 48^\circ \leq \phi \leq 180^\circ$$

4. that the following Notes should be regarded as part of this Recommendation:

Note 1 – For the calculation of the limits quoted in § 1.1, 1.2 and 2 it should be assumed that the total system noise power at the input to the demodulator is of thermal nature and includes all inter-system noise contributions as well as interference noise from other systems.

For interference not of a thermal nature the permissible level of interference into a digital carrier should be based upon the degradation of the long-term performance objective as given in Annex 1 to Recommendation ITU-R S.614*.

Note 2 – For this interference calculation, as applied to satellite networks operating in a fading environment, it should be assumed that the carrier power level is reduced, until the system performance coincides with the above BER and percentage of month (see Annex 1 for clarification).

Note 3 – It is assumed in this Recommendation that the interference from other satellite networks is of a continuous nature at frequencies below 10 GHz: further study is required with respect to cases where interference is not of a continuous nature above 10 GHz.

Note 4 – When interference is characterized by a non-uniform spectral distribution there may be cases where, for design purposes, a greater interference allocation of total system noise may be made to narrow-bandwidth carriers by the system designer. One model developed to address this is presented in detail in Annex 2.

Note 5 – For networks using 8 bit PCM encoded telephony see Recommendation ITU-R S.523*.

Note 6 – In some cases it may be necessary to limit the single entry interference value to less than the value quoted in § 2 above in order that the total value recommended in § 1 may not be exceeded. In other cases, particularly in congested arcs of the geostationary-satellite orbit, administrations may agree bilaterally to use higher single entry interference values than those quoted in § 2 above, but any interference noise power in excess of the value recommended in § 2 should be disregarded in calculating whether the total value recommended in § 1 is exceeded.

Note 7 – There is an urgent need for study of the acceptability of an increase in the maximum total interference noise values recommended in § 1.

* Former CCIR Recommendations 614 and 523.

Note 8 – Although this Recommendation has an upper frequency limit of 15 GHz, in the frequency range from 10 to 15 GHz short-term propagation data are not available uniformly throughout the world and there is a continuing need to examine such data to confirm an appropriate interference allowance to meet § 1.2 and 1.3 of Recommendation ITU-R S.614*.

Note 9 – There is a need for urgent study to be given to the interference noise allowances appropriate to systems operating at frequencies above 15 GHz.

Note 10 – The interference criteria of this Recommendation apply only to the transmission of digital services that fall under the provisions of Recommendation ITU-T G.821** and Recommendation ITU-R S.614*. Further study by radiocommunication Study Group 4 is required regarding the performance objectives and appropriate interference criteria for other than 64 kbit/s digital transmissions within an ISDN connection as information on the performance requirements for such services becomes available to it.

Note 11 – The principles of this Recommendation may also be applied to digital-satellite networks providing long-term performance objectives different from those in Recommendation ITU-R S.614*. This is a subject for further study.

Note 12 – Special attention may have to be given to digital carriers with narrow bandwidths when they are being interfered with by analogue TV transmissions. For such cases with artificial energy dispersal at the frame rate the protection ratios given in Recommendation ITU-R S.671* apply. This is a subject for further study.

Note 13 – Attention should also be drawn to the interference from TDMA systems when, due to burst overlapping at the transponder input of an interfered-with system, the BER is increased relative to that of a synchronous burst allocation.

Note 14 – In order to promote orbit efficiency, satellite networks operating in heavy rain environments are encouraged to use some form of fade compensation.

Note 15 – This Recommendation is closely related to Recommendation ITU-R S.614*, a fact that needs to be considered in any future revisions to either of these two Recommendations.

Note 16 – Annexes 1 and 2 provide information on the permissible level of interference into an ISDN satellite digital path.

ANNEX 1

Considerations on the permissible level of interference into an ISDN satellite digital path

The development of a Recommendation on the permissible level of interference into an ISDN satellite digital path is essential if satellite networks are to have some basis on which to undertake coordination, or for system designers to include some margin for interference in their link calculations.

It was noted in the preparation of this Recommendation that there were two ways of interpreting the noise level referred to in Recommendation ITU-R S.523* which is dealing with maximum permissible levels of interference in an FSS 8 bit PCM telephony system.

The expression used in § 1.1 of Recommendation ITU-R S.523* is:

“the interference power level should not exceed 25% of the total noise power level at the input to the demodulator which would give rise to a bit error ratio of 1×10^{-6} ”.

* Former CCIR Recommendations 614, 671 and 523.

** Former CCITT Recommendation G.821.