

RECOMMENDATION ITU-R S.1256

**METHODOLOGY FOR DETERMINING THE MAXIMUM AGGREGATE POWER
FLUX-DENSITY AT THE GEOSTATIONARY-SATELLITE ORBIT IN THE BAND
6 700-7 075 MHz FROM FEEDER LINKS OF NON-GEOSTATIONARY
SATELLITE SYSTEMS IN THE MOBILE-SATELLITE SERVICE
IN THE SPACE-TO-EARTH DIRECTION**

(Question ITU-R 206/4)

(1997)

The ITU Radiocommunication Assembly,

considering

- a) that the band 6 700-7 075 MHz is allocated to the fixed-satellite service (FSS), in the space-to-Earth direction, on a primary basis, for the use by feeder links of non-geostationary satellite networks in the mobile-satellite service (MSS);
- b) that the band 6 700-7 075 MHz is also allocated to the FSS in the Earth-to-space direction, on a primary basis, and the band 6 725-7 025 MHz is subject to the Allotment Plan of Appendix 30B of the Radio Regulations (RR) for geostationary satellite networks;
- c) that, under No. S22.5A of the RR, the maximum aggregate power flux-density (pfd) produced within $\pm 5^\circ$ of the geostationary-satellite orbit (GSO) by a non-geostationary satellite system in the FSS shall not exceed $-168 \text{ dB(W/m}^2\text{)}$ in any 4 kHz band;
- d) that Resolution 115 of the World Radiocommunication Conference (Geneva, 1995) (WRC-95) invites ITU-R to establish a methodology to determine the maximum aggregate power flux-density at the GSO from a non-geostationary satellite network;
- e) that non-geostationary satellite networks of the mobile-satellite service have orbital and transmission parameters available as specified in § A.3 vii) of Annex 1 to Resolution 46 (Rev.WRC-95),

recommends

- 1 that the methodology given in Annex 1 shall be followed to determine the maximum level of aggregate power flux-density ($\text{dB(W/m}^2\text{)}$ in any 4 kHz band), at any location within $\pm 5^\circ$ inclination of the GSO, from the feeder links of a non-geostationary satellite network operating in the band 6 700-7 075 MHz, in the space-to-Earth direction.

ANNEX 1

Methodology

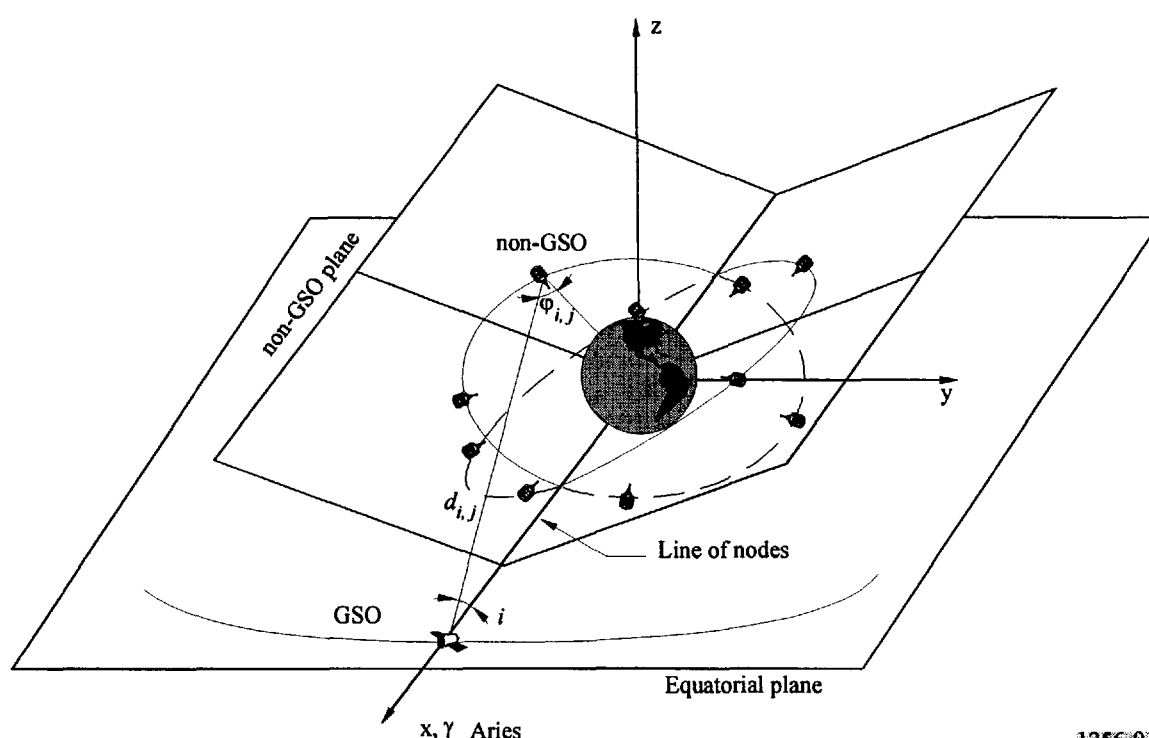
1 Description of methodology

To calculate the aggregate pfd from a non-geostationary orbiting satellite (non-GSO) network to a single test location at the GSO, computer modelling of the full non-GSO constellation and a test location at the GSO is needed.

Basically, noting that in an ordinary situation a GSO satellite will orbit the geostationary orbit with a period of about $T_{\text{GSO}} = 24 \text{ h}$ and that the orbital period of a non-GSO satellite ($T_{\text{non-GSO}}$) is not necessarily a submultiple of T_{GSO} , extensive time-consuming statistical simulations may be needed to assess the worst-case scenario that would lead to the maximum pfd level at the GSO location.

A simple and very much less time-consuming simulation can be performed to assess the maximum pfd at any GSO location. Instead of a real orbiting GSO satellite, a fixed test location at the GSO is considered whose orbital position is fixed with respect to a 0xyz Cartesian reference system (see Fig. 1) but not with respect to the rotating Earth reference system. With this in mind, since the non-GSO satellites have an orbital period $T_{non-GSO}$, it implies that the position of the non-GSO satellites, as seen from the fixed GSO test location (see Fig. 1), will be repeated at least once every orbital period $T_{non-GSO}$. Moreover, in the case where the non-GSO satellites are uniformly distributed on each orbital plane, the same geometrical disposition of the non-GSO satellites will be repeated with a period equal to $T_{non-GSO}/N_s$ (where N_s is the number of non-GSO satellites uniformly distributed on one plane). With these basic considerations, the aggregate pfd level (aggregated over the visible non-GSO satellites) at the GSO test location will have values that will be repeated within this period.

FIGURE 1
GSO/non-GSO constellation geometry to calculate pfd: $\Delta\Omega = 0^\circ$



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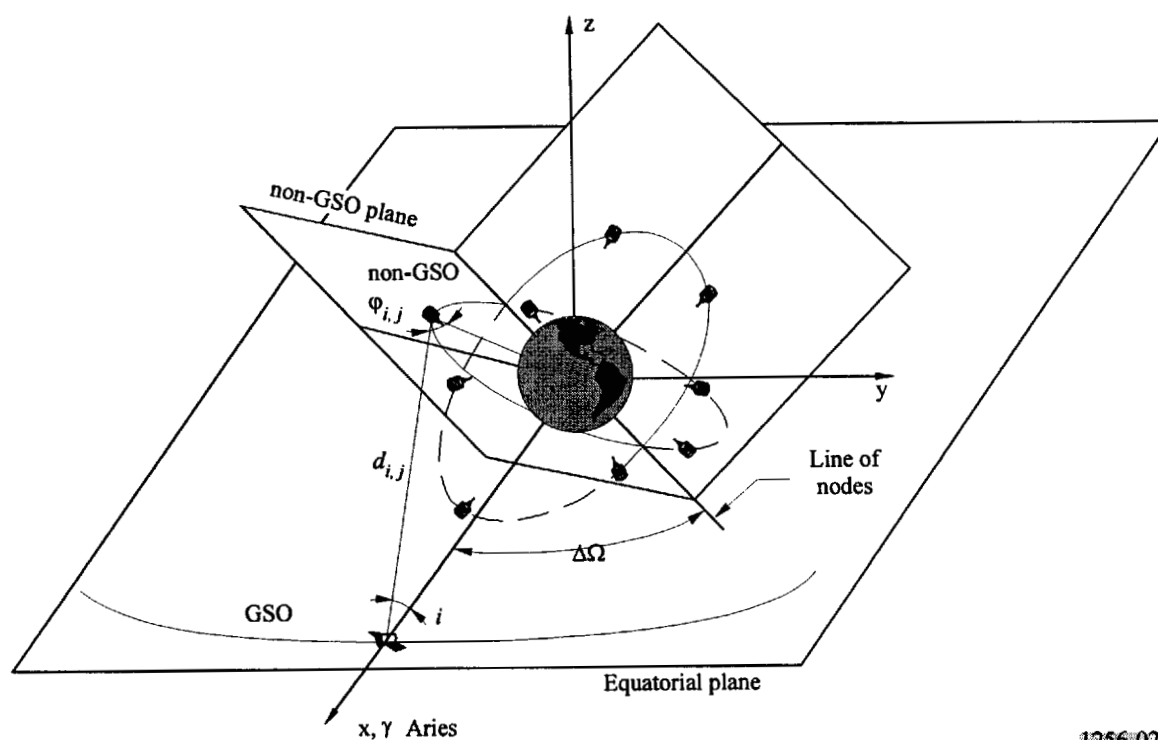
The aggregate pfd can be calculated for each time step and a maximum aggregate pfd, for the chosen GSO test location, can be derived during the simulation period from T_0 to $T_0 + T_{non-GSO}/N_s$.

The value found for the particular GSO test location in Fig. 1 is not necessarily the maximum pfd level. In order to find the highest possible maximum aggregate pfd level, the same procedure must be repeated to the other GSO test locations by incrementing the angle $\Delta\Omega$ (see Fig. 2) between the GSO test location and the non-GSO line of nodes. This second iteration will be done for angles of $\Delta\Omega$ between 0° and $\Delta\Omega_{max} = 360^\circ/N_p$, where N_p is the number of non-GSO satellite orbital planes. In cases where N_p is even (as per LEO-F and LEO-D) then $\Delta\Omega_{max} = 180^\circ/N_p$.

The method can also apply to any non-GSO constellation which does not meet the orbital requirements as stated above (e.g. non-uniform satellite distribution, elliptical orbits). In such cases the time simulation will be performed for a period of time equal to the minimum repeatability period of the constellation configuration, which in many cases is equal to the constellation period $T_{non-GSO}$.

The § 2 reports all the basic equations needed to arrive at the aggregate pfd level from a given non-GSO network to a given test location at the GSO and Fig. 3 shows the flow chart for the software implementation of the methodology here described.

FIGURE 2
GSO/non-GSO constellation geometry to calculate pfd: $\Delta\Omega \neq 0^\circ$



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