RECOMMENDATION ITU-R BO.1597

Methodology for the calculation of the worst-case interference levels between non-geostationary broadcasting-satellite service (sound) systems using highly-elliptical orbit and geostationary orbit satellite networks operating in the band 2 630-2 655 MHz

(Resolution 539 (WRC-2000), Question ITU-R 204/10)

(2002)

The ITU Radiocommunication Assembly,

considering

a) that the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000) established the provisions necessary to implement broadcasting-satellite service (sound) (BSS (sound)) systems using a certain type of non-geostationary (NGSO) satellite operating in the band 2 630-2 655 MHz in certain countries in Region 3, including a minimum elevation angle of not less than 40° over the service area;

b) that satellite technology has now advanced to the stage where NGSO systems in the BSS (sound) are technically and economically feasible when operated with high elevation angles;

c) that satellite systems in the BSS as described in *considering* a) can be used for the delivery of high-quality, spectrally-efficient BSS (sound) to portable and mobile terminals;

d) that Resolution 539 (WCR-2000) calls upon ITU-R to develop calculation methodologies and sharing criteria to be used by administrations;

e) that the 2 520-2 670 MHz band is allocated to the BSS (community reception) in all three Regions, the 2 535-2 655 MHz band is allocated to the BSS (sound) in some countries, and the 2 500-2 690 MHz band is allocated to the fixed-satellite service in Region 2, all of which overlap the band 2 630-2 655 MHz;

f) that a methodology for the calculation of the worst-case interference levels between NGSO BSS (sound) systems using highly-elliptical orbits and geostationary orbit (GSO) satellite networks operating in the band 2 630-2 655 MHz would facilitate coordination,

noting

a) that information relating to NGSO BSS (sound) systems using highly-elliptical orbits in the BSS (sound) in the band 2 630-2 655 MHz in Region 3 have been received by the Radiocommunication Bureau and are expected to be brought into use in the near future;

b) that the type of highly-elliptical orbit NGSO satellite systems referenced in *noting* a) are characterized by the use of operational active arcs that are spatially separated from the geostationary orbit as viewed from the earth station, *recommends*

1 that the methodology in Annex 1 be used by administrations for the calculation of the worst-case interference levels between NGSO BSS (sound) systems using highly-elliptical orbits and GSO satellite networks operating in the frequency band 2 630-2 655 MHz.

NOTE 1 – This methodology will overestimate the interference level due to the worst-case assumptions. A methodology that takes into account the time variant interference levels may become necessary to assess the interference level more precisely.

ANNEX 1

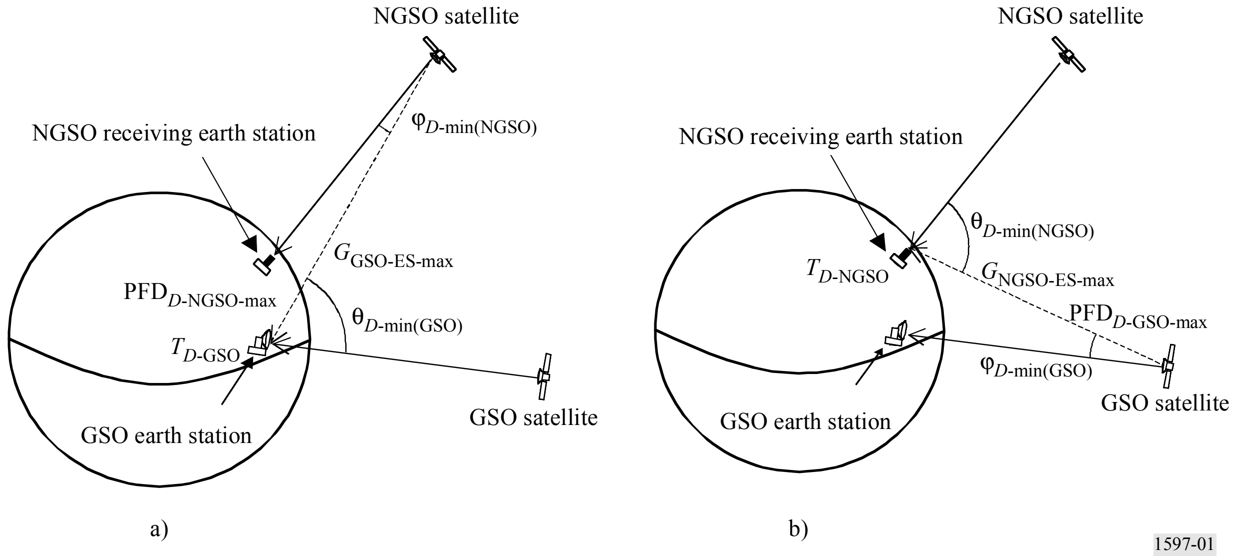
Methodology for the calculation of the worst-case interference levels between NGSO BSS (sound) systems using highly-elliptical orbits and GSO satellite networks operating in the frequency band 2 630-2 655 MHz

This Annex describes a methodology for the calculation of the worst-case interference between NGSO BSS (sound) systems and GSO satellite networks operating in the frequency band 2 630-2 655 MHz resulting from co-frequency operation.

Figure 1 shows the relevant coordinate systems. Figure 1a) shows the coordinate system for the calculation of interference from the NGSO satellite to the GSO receiving earth station. Figure 1b) shows the coordinate system for the calculation of interference from the GSO satellite to the NGSO receiving earth station.

FIGURE 1

The coordinate systems for calculation of interference between the NGSO BSS (sound) system and the GSO network in the frequency band 2 630-2 655 MHz



1 Information required for the calculation of interference

a) The following information is required to calculate interference from the NGSO BSS (sound) system into GSO satellite networks (see Fig. 1a)):

– **Space-to-Earth transmissions of the NGSO BSS (sound) system**

$\theta_{D\text{-min(GSO)}}$: Minimum angular separation of the active transmitting NGSO satellites from the line-of-sight between the GSO earth station and its associated GSO satellite (degrees).

$\varphi_{D\text{-min(NGSO)}}$: Minimum angular separation of the active transmitting NGSO satellites from the line-of-sight between the GSO earth station and the boresight of the antenna of NGSO satellites (degrees).

For the transmitting space station antenna, Recommendation ITU-R S.672 provides reference in this respect.

$\text{PFD}_{D\text{-NGSO-max}}$: Maximum power-flux density (pfd) at the Earth's surface caused by transmissions from each NGSO satellite in the constellation (dB(W/(m^2 · Hz))).

N_D: Maximum number of co-frequency NGSO satellites transmitting towards the same geographic region of the Earth, as well as an indication of the number of such satellites as a function of the percentage of time.

– **Receiving earth station sensitivity of the GSO network**

$G_{\text{GSO-ES-max}}$: The assumed maximum off-axis gain of the GSO receiving earth station in a direction corresponding to the minimum angular separation ($\theta_{D\text{-min(GSO)}}$) of the NGSO satellite when it is actively transmitting (dBi).

$T_{D\text{-GSO}}$: Assumed clear-sky receiving system noise temperature (including receiving antenna noise) of the GSO downlink (K). To err on the conservative side this need not include degradations caused to the overall link resulting from the uplink.

b) The following information is required to calculate interference from the GSO networks into a NGSO BSS (sound) system (see Fig. 1b)):

– **Space-to-Earth transmissions of the GSO network**

$\theta_{D\text{-min(NGSO)}}$: Minimum angular separation of the GSO satellites from the line-of-sight between the NGSO BSS (sound) receiving earth station and its associated NGSO BSS (sound) satellite (degrees).

$\varphi_{D\text{-min(GSO)}}$: Minimum angular separation of the GSO satellite from the line-of-sight between the NGSO earth station and the boresight of the antenna of the GSO satellite (degrees).

$\text{PFD}_{D\text{-GSO-max}}$: Maximum pfd at the Earth's surface caused by transmissions from the GSO satellite (dB(W/(m^2 · Hz))).

– **Receiving earth station sensitivity of the NGSO BSS (sound) system**

$G_{\text{NGSO-ES-max}}$: The assumed maximum off-axis gain of the NGSO BSS (sound) receiving earth station in a direction corresponding to the GSO satellite (dBi).

For the receiving earth station of NGSO BSS (sound) system, Recommendation ITU-R M.1091 provides reference in this respect.

$T_{D\text{-NGSO}}$: Assumed clear-sky receive system noise temperature (including receiving antenna noise) of the NGSO BSS (sound) receiving earth station (K). To err on the conservative side this need not include degradations caused to the overall link resulting from the uplink.

2 Calculation of interference

a) Calculation of downlink interference into the GSO satellite network

Step D_GSO1: Calculate the maximum interfering signal power spectral density from a single NGSO satellite at the GSO earth station antenna output:

$$I_{0-GSO-ES} = PFD_{D-NGSO-max} + G_{GSO-ES-max} + 10\log\left(\frac{\lambda^2}{4\pi}\right) \quad \text{dB(W/Hz)} \qquad (1)$$

where λ is the wavelength.

Step D_GSO2: Calculate the noise power spectral density at the GSO earth station antenna output:

$$N_{0-GSO-ES} = 10\log\left(k\,T_{D-GSO}\right) \quad \text{dB(W/Hz)} \qquad (2)$$

where k is Boltzmann's constant.

Step D_GSO3: Calculate the degradation to downlink receive system noise temperature from the constellation of NGSO satellites:

$$\Delta T / T_{D-GSO} = N_D \; 10^{\left(\frac{I_{0-GSO-ES} - N_{0-GSO-ES}}{10}\right)} \times 100\% \qquad (3)$$

b) Calculation of downlink interference into the NGSO BSS (sound) system

Step D_NGSO1: Calculate the maximum interfering signal power spectral density from a GSO satellite at the NGSO BSS (sound) receiving earth station antenna output:

$$I_{0-NGSO-ES} = PFD_{D-GSO-max} + G_{NGSO-ES-max} + 10\log\left(\frac{\lambda^2}{4\pi}\right) \quad \text{dB(W/Hz)} \qquad (4)$$

where λ is the wavelength.

Step D_NGSO2: Calculate the noise power spectral density at the NGSO receiving earth station antenna output:

$$N_{0-NGSO-ES} = 10 \log \left(k\, T_{D-NGSO} \right) \qquad \text{dB(W/Hz)} \qquad (5)$$

where k is Boltzmann's constant.

Step D_NGSO3: Calculate the degradation to downlink receiving system noise temperature from the GSO satellite:

$$\Delta T / T_{D-NGSO} = 10^{\left(\frac{I_{0-NGSO-ES} - N_{0-NGSO-ES}}{10} \right)} \times 100\% \qquad (6)$$