

## RECOMMENDATION ITU-R S.1527

**Procedure for the identification of non-geostationary-satellite orbit satellites causing interference into an operating geostationary-satellite orbit earth station**

(Question ITU-R 231/4)

(2001)

The ITU Radiocommunication Assembly,

*considering*

- a) that the World Radiocommunication Conference (Istanbul, 2000) (WRC-2000) adopted a combination of single-entry validation, single-entry operational and, for certain antenna sizes single-entry additional operational downlink equivalent power-flux density ( $\text{epfd}_{\downarrow}$ ) limits contained in Article 22 of the Radio Regulations (RR), along with the aggregate limits in Resolution 76 (WRC-2000), which apply to non-geostationary-satellite orbit (non-GSO) fixed-satellite service (FSS) systems to protect GSO networks in parts of the frequency range 10.7-30 GHz;
- b) that Resolution 137 (WRC-2000) invites ITU-R to develop, with the aim of completion by 2003, methodologies to assess the interference levels (through measurement for operational limits) that would be produced by a non-GSO FSS system in the frequency bands specified in Tables 22-4A, 22-4B and 22-4C which may be used by administrations to verify compliance of an individual non-GSO FSS system with the operational limits contained in Tables 22-4A, 22-4B and 22-4C. This necessitates identification of the system concerned;
- c) that Resolution 137 (WRC-2000) further recognizes that, taking into account RR Nos. 22.5H and 22.5I, it is important to discourage violations of the operational  $\text{epfd}_{\downarrow}$  limits by a non-GSO FSS system, but that, if a violation occurs, it should be corrected in the most expeditious manner;
- d) that a procedure is needed to identify a non-GSO FSS satellite close to or within the main beam of an operational GSO earth station where it may generate interference,

*noting*

- a) that up-to-date ephemeris data for non-GSO constellations are required to conduct an accurate identification procedure;
- b) that ephemeris data may be usually publicly available;
- c) that a separate Recommendation is under development to enable the measurement of peak  $\text{epfd}_{\downarrow}$  levels generated by the non-GSO satellite identified into the operational GSO earth station,

*recommends*

- 1 that the methodology given in Annex 1 could be used to calculate the time that a non-GSO satellite would be close to or within the main beam of a GSO FSS earth station antenna and thus with the aid of the ephemeris data, to identify the non-GSO constellation causing interference;

2 that the non-GSO satellite system operator should provide assistance to the GSO FSS network operator to obtain the most current ephemeris data, if necessary to identify the source of interference.

## ANNEX 1

### 1 Introduction

This Annex provides a procedure which could be followed by a GSO earth station operator, to identify non-GSO systems causing sync-loss or severe degradation in operating GSO downlinks.

This Annex is divided into three parts. The first part intends to show that through a simple observation of a signal interfering with a GSO earth station, it is possible to establish a list of the possible existing non-GSO constellations that may be responsible for interference. The second part provides a description of the test bench that can be used to identify a non-GSO constellation. Finally, the last part provides an example of use of this procedure for identification of the HIBLEO-4FL constellation.

This procedure defines an essential step towards the measurement of the power flux-density (pfd) levels generated by a non-GSO constellation into a GSO earth station in operation.

### 2 Pre-measurement analysis

This part intends to show that through a simple observation of a signal interfering with a GSO earth station, it is possible to establish a list of the possible existing non-GSO constellations that may be responsible for interference.

#### 2.1 Observation of the interference

When receiving interference, a GSO FSS network operator first has to identify the source of interference and, most of all, has to determine whether the interference it receives is internal to its network or external.

A non-GSO interfering system can be identified using some or all of the following set of elements:

- any repeatability of the interference and its associated period;
- the time duration of the interference;
- the frequency of the interference;
- a knowledge of the interference level (which causes synchronization loss, or a severe degradation of the GSO signal reception);
- the date and accurate time of appearance of the performance degradation;
- the characteristics of the interfering signal transmitted;
- spectrum analyser plots of the nominal and interference conditions, if any.

Knowing these characteristics of the interfering signal, it is possible to draw up a list of the non-GSO systems filed at ITU, whose signatures may possibly correspond to the one observed.

## 2.2 Hypothesis on the possible interfering system

In order to identify the non-GSO systems candidate to be responsible for the interference received by the GSO earth station, it is first necessary to draw up a complete list of the existing non-GSO systems operating in the band of concern for the GSO operator.

Such a list can be set up using the radio-frequency data on file at ITU, which provides information on the non-GSO constellations of interest in the identification of the non-GSO system, such as:

- period of the non-GSO constellation;
- the frequency range used by the constellation;
- the emission designators of the constellation (i.e. the bandwidth and frequency designators);
- the power levels expected on the ground, etc.

Given this information and the limited number of in orbit non-GSO systems that will eventually coexist, the list of candidate interferers will be relatively short.

The peak of  $\text{epfd}_{\downarrow}$  generated by a non-GSO system can occur in two configurations:

- when a non-GSO satellite is in-line with a GSO pointing direction if the non-GSO satellite keeps transmitting through its side lobes;
- when a satellite is about to switch off all its transmissions as it gets close to the GSO arc.

In both cases, the peak of  $\text{epfd}_{\downarrow}$  corresponds to clear geometrical configurations.

Therefore, the second element that will help with the identification of a non-GSO system is the time coincidence of an interference event with the particular geometrical situation of the non-GSO satellite with regard to the GSO network.

To determine the location of a non-GSO satellite with respect to a GSO earth station at a particular time, reference ephemeris data along with orbit predicting software are required. Such orbit predicting software packages are widely available on the Internet, and provide information such as:

- the elevation and azimuth of the non-GSO satellites when passing through a GSO earth station main beam;
- whether satellites of a non-GSO constellation are visible from the location of a particular GSO earth station;
- the position of the satellites in the sky of the GSO earth station at the time of an interference problem.

If non-GSO ephemeris data is not available from other sources then the non-GSO satellite system operator should provide assistance to the GSO FSS network operator to obtain the most current ephemeris data.

One difficulty with the identification of a non-GSO satellite in the direction of the GSO satellite orbit is that the non-GSO signal is mixed with GSO satellite signals and therefore may not be readily identifiable.

## 2.3 Tests schedule

The following section explains how to determine the pointing direction towards which the probability of having satellites of the non-GSO systems is high.

If up-to-date ephemeris data and associated orbit prediction software are available, it is possible to determine all satellite passes within  $\pm X^\circ$  of an antenna azimuth and elevations, the name of the satellites, and the time and duration of each pass. Such information can be used to determine a (azimuth  $\times$  elevation) window of  $\pm X^\circ$  on a side for which the probability of having satellite passes is maximum. This exercise will have to be done for each candidate non-GSO system likely to cause interference.

For the planned period of the test, the GSO operator should establish Table 1 for the selected azimuth:

TABLE 1  
Listing of the timetable for test schedule

| Candidate non-GSO systems | Test antenna pointing direction | Best probability (azimuth $\times$ elevation) window | Satellite number pass | Day of pass (m:d:y) <sup>(1)</sup>                                   | Theoretical time pass (h:m:s) <sup>(2)</sup>                         |
|---------------------------|---------------------------------|------------------------------------------------------|-----------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|
| 1                         |                                 |                                                      | $x$<br>$y$<br>$z$     | (m:d:y) <sub>x</sub><br>(m:d:y) <sub>y</sub><br>(m:d:y) <sub>z</sub> | (h:m:s) <sub>x</sub><br>(h:m:s) <sub>y</sub><br>(h:m:s) <sub>z</sub> |
| 2                         |                                 |                                                      |                       |                                                                      |                                                                      |
| 3                         |                                 |                                                      |                       |                                                                      |                                                                      |

(1) (m:d:y): month, day, year.

(2) (h:m:s): hour, minute, second, thousands of a second.

### 3 Test bench presentation

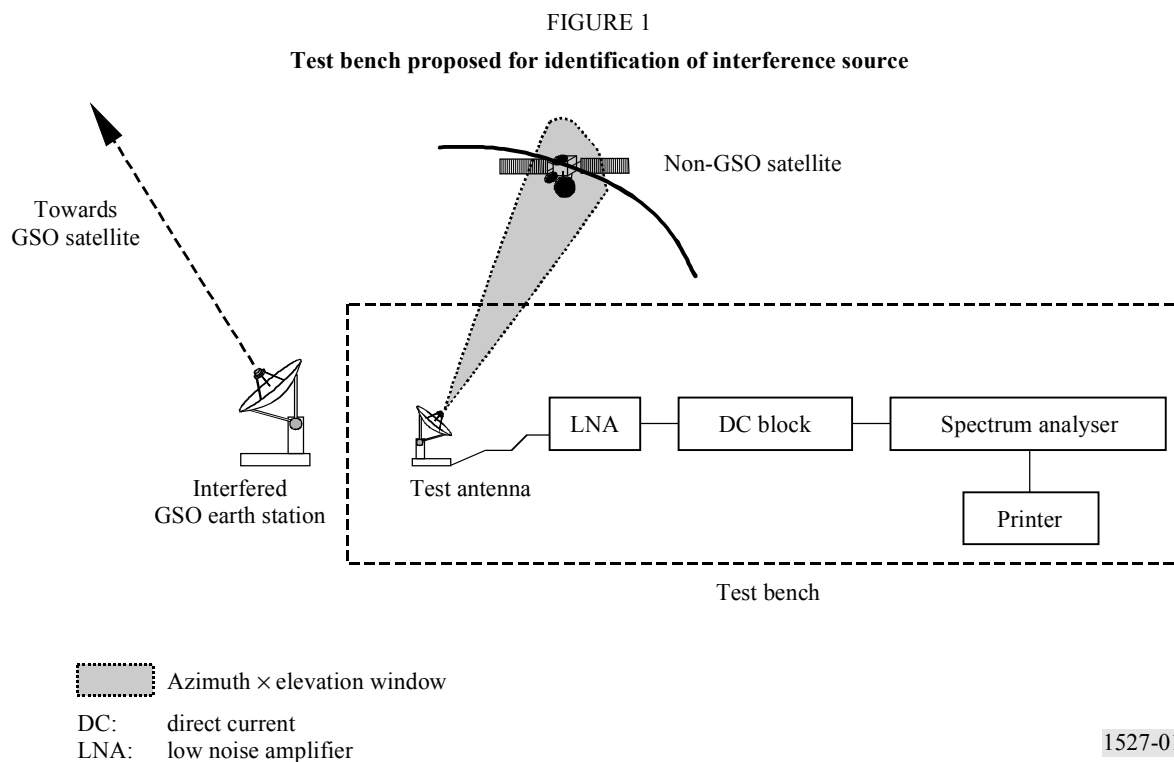
#### 3.1 Test bench set up

The proposed test bench will observe the pfd level received from non-GSO systems into the GSO earth station in the pointing direction with the greatest probability of appearance of their satellites with regard to the GSO earth station location (see § 2.3).

The test antenna that is used is separated from the GSO earth station antenna and may be of small diameter: 1.2 m or 3 m. Indeed, the aim of the analysis is not to measure the interference level generated into the GSO earth station in operation, but rather to detect and observe signals coming from a particular non-GSO satellite, at the frequency at which interference has been detected in a GSO earth station. The test antenna is located close to the GSO earth station.

The signal can also be observed in the telemetry bands. Indeed, most non-GSO FSS systems are not planning to serve all the areas in visibility of the satellite which means that the observed satellite may not be transmitting towards the measurement site. In order to make the first observation of the signal it is therefore necessary to validate the constellation parameters observing the telemetry bands.

The test bench proposed for identification of the non-GSO interference source is the following:



The required information on the test bench elements are given in Table 2.

TABLE 2

| Description           | Required characteristics                                 | Note                                          |
|-----------------------|----------------------------------------------------------|-----------------------------------------------|
| Test antenna and feed | Size<br>Frequency range<br>Antenna gain pattern          | Provided by the manufacturer                  |
| LNA                   | Frequency range<br>Gain and noise temperature            | Measured by the manufacturer                  |
| Coaxial cables        | Low loss cables<br>Loss as a function of the frequency   | Measured during calibration tests (see § 3.2) |
| DC block              | Loss                                                     | Measured                                      |
| Power supply          | Compatible with the LNA voltage                          |                                               |
| Spectrum analyser     | Low noise floor<br>Frequency range compatible with tests |                                               |
| Printer               | Compatible with spectrum analyser                        |                                               |

In order to have accurate results it is necessary to calibrate the test reception chain as described in § 3.2.