RECOMMENDATION ITU-R S.1419

INTERFERENCE MITIGATION TECHNIQUES TO FACILITATE COORDINATION BETWEEN NON-GEOSTATIONARY-SATELLITE ORBIT MOBILE-SATELLITE SERVICE FEEDER LINKS AND GEOSTATIONARY-SATELLITE ORBIT FIXED-SATELLITE SERVICE NETWORKS IN THE BANDS 19.3-19.7 GHz AND 29.1-29.5 GHz

(Question ITU-R 206/4)

(1999)

The ITU Radiocommunication Assembly,

considering

a) that the World Radiocommunication Conference (Geneva, 1997) (WRC-97) confirmed the use of the bands 19.3-19.7 GHz (downlink) and 29.1-29.5 GHz (uplink) for use by non-geostationary-satellite orbit mobile-satellite service (non-GSO MSS) feeder links;

b) that the use of these bands will be in accordance with Nos. S5.523C, S5.523D, S5.523E and S5.535A of the Radio Regulations (RR);

c) that the networks using these bands are to coordinate their use of frequencies in accordance with RR No. S9.11;

d) that there are a limited number of non-GSO MSS feeder-link earth stations expected to operate in these bands;

e) that Recommendation ITU-R S.1323 – Maximum permissible levels of interference in a satellite network (GSO/FSS; non-GSO/FSS; non-GSO/MSS feeder links) for a hypothetical reference digital path, in the fixed-satellite service caused by other codirectional networks below 30 GHz, identifies the short-term interference from non-GSO fixed-satellite service (FSS) feeder links in the frequency range below 30 GHz and recommends that this short-term interference should be responsible for at most 10% of the time allowance for given bit-error rates specified in short-term performance objectives and should not lead to loss of synchronization in the desired network more than once per *x* days;

f) that mitigation techniques are available to achieve satisfactory coordination of non-GSO MSS feeder links with other users of the MSS feeder-link allocation in the 20/30 GHz bands,

recommends

1 that the mitigation techniques described in Annex 1 to this Recommendation can be used to achieve satisfactory coordination between non-GSO MSS feeder-links and co-frequency GSO FSS satellite networks;

2 that adaptive uplink power control (Recommendation ITU-R S.1325) or other methods of fade compensation should be considered for use to facilitate coordination on both non-GSO MSS feeder links and GSO FSS networks using the allocations of the 20/30 GHz bands.

ANNEX 1

Mitigation techniques

Paragraph 4.3.5.1.2 of the Conference Preparatory Meeting (Geneva, 1997) (CPM-97) Report to WRC-97 provides a useful summary of mitigation techniques that may be used by non-GSO MSS feeder links to achieve shared use of spectrum with GSO FSS networks. Five primary techniques for mitigating interference between feeder links for non-GSO MSS networks and GSO FSS networks in the bands 20/30 GHz have been studied. These interference mitigation techniques are useful in different degrees in facilitating sharing between GSO FSS networks and non-GSO MSS feeder-link networks in the bands 20/30 GHz.

1 Adaptive power control

The studies to date have shown that the use of adaptive uplink power control will ease overall coordination between FSS networks. Adaptive uplink power control may be used to maintain system performance during times of increased levels of interference. Recommendation ITU-R S.1255 recommends that networks employing adaptive uplink power control should transmit signals at the lowest possible power levels to mitigate interference between GSO FSS networks and feeder links of non-GSO MSS networks.

2 Use of high gain antennas

A study addressing sharing on both downlinks and uplinks between a single GSO FSS network (employing small aperture earth station terminals) and co-located non-GSO MSS feeder links (low-Earth orbits (LEO) or medium-Earth orbits (MEO)) investigated the effects of varying the antenna sizes of either the GSO FSS earth station or of the non-GSO space station. The study showed that restricting the GSO earth station minimum antenna size to 1 m results in interference levels below the currently proposed aggregate criteria for the LEO A MSS network feeder links. The interference level is generally higher for the MEO case than the LEO case. For a 1.8 m GSO earth station antenna the interference criteria are exceeded in all links.

3 Geographic isolation between earth stations

A study confirmed that geographic isolation of earth stations is an effective interference mitigation method. As indicated in the CPM-97 Report to WRC-97, maintaining a minimum latitudinal separation of 2° between competing GSO/LEO earth stations is required to reduce the interference to acceptable levels. In the GSO/MEO case, separations greater than 2° in latitude (225 km) are required to reduce the interference to acceptable levels.

Further, it has been shown that the geographic separation of the earth stations of the two systems, combined with the use of high gain antennas, would be more effective in mitigating interference than either of the two techniques separately. Geographic isolation down to 60 km is possible with these techniques.

4 Satellite diversity

The use of satellite diversity has been considered as a mitigation technique to avoid mainbeam-to-mainbeam interference by switching traffic to an alternative satellite. This technique has a number of system design and network operational implications which network operators have to consider before implementing it. The constellation design is determined by how best to accommodate the service links and may not provide visibility statistics such that satellite diversity is possible.

5 Site diversity

Site diversity is the use of an alternate earth station located far enough away from the primary site to provide sufficient antenna discrimination to maintain acceptable interference levels. Its use as an interference mitigation technique depends on the non-GSO MSS space station antenna beamwidth. For example, to be effective in mitigating interference between a LEO B feeder-link network and a GSO FSS network (GSO-13) in the 20/30 GHz bands, earth station diversity would require that the LEO B satellite antennas be so large as to be impractical. For such a case a satellite antenna diameter of 13 m would be required to achieve earth station separations of 40 km assuming perfect pointing. With the actual LEO B satellite antenna, large separations on the order of 500 km between primary and a diversity earth station site would be required. As both the primary and the diversity site would have to be coordinated with other non-GSO MSS feeder-link network earth stations operating in the same frequency bands, the technique could have a substantial negative effect on co-frequency sharing between non-GSO MSS feeder-link earth stations.

Results of another study show that use of site diversity to mitigate interference is possible for the case of one GSO network and one non-GSO MSS feeder-link network sharing the same frequency where this feature was incorporated into the non-GSO feeder-link design at conception. For this case a LEO A-type system was designed to accommodate a 2° site separation distance. This results in a 10 dB reduction in the interference into the LEO A uplink and the interference criteria is met in all links. Results similar to those of the preceding paragraph indicate that larger site separation distances, which are not operationally practical for the LEO B MEO MSS feeder-link system, are required to reduce the interference between GSO and MEO systems to acceptable levels.

Although both site diversity and geographic separation of earth stations can, in theory, reduce interference levels, the required separation distances (and the operational feasibility thereof) need to be evaluated on a case-by-case basis and for a greater range of system characteristics.

6 Link balancing

The concept of link balancing refers to the design of non-GSO MSS feeder links to reflect the need to mitigate the effects of uplink transmissions from GSO FSS earth stations. In the case of uplink transmissions from non-GSO MSS earth stations, the GSO receive signal is protected because of the distance involved. However, this is not the case for the uplink of the non-GSO MSS network vis-à-vis interfering transmissions from the GSO FSS. To balance the transmission environment, the non-GSO MSS feeder link carries larger fixed uplink margins to protect itself from the GSO.

7 Coordination methods

To date the studies conducted by ITU-R indicate that geographic isolation provides the best solution to coordination between non-GSO MSS feeder links and the GSO FSS systems. Typically, there are relatively few non-GSO MSS feeder-link earth stations in a system dispersed over a wide area. Within such an area, the non-GSO MSS earth station will require less spectrum than the GSO FSS, thus permitting the additional use of either frequency isolation and/or polarization isolation to achieve satisfactory coordination.