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August 29, 2001

VIA HAND DELIVERY

Honorable Michael K. Powell
Chairman
Federal Communications Commission
445 12th Street, S.W.
Room 8-B201
Washington, D.C. 20554

Dear Chairman Powell:

We are writing to clarify the position of the Catholic Television Network ("CTN") and the National ITFS Association ("NIA") regarding the possibility of designating the 2500 – 2690 MHz band for flexible use. We have not asked, and are not now asking, for a flexible use designation. Indeed, in our written comments, CTN and NIA emphasized their commitment to fixed broadband deployment, and expressed serious concern with a flexible use designation in this band (see Attachments A and B). The most critical issue for CTN and NIA is the prompt removal of the cloud of uncertainty that hangs over the 2500 – 2690 MHz band by eliminating the band from further consideration as a candidate for 3G mobile services.

Nonetheless, if the Commission wants to designate the 2500 – 2690 MHz band for flexible use, CTN and NIA would not oppose such a designation subject to two conditions. First, all fixed uses of the band (including, for example, existing and planned fixed two-way broadband systems) must be protected from interference from any new flexible use of the band. Second, any new use of the band must be subject to a formal rulemaking process to determine if such use is feasible and, if so, what new rules are needed to accommodate any new use. These conditions should assure that the fixed broadband deployment plans of CTN and NIA's members can continue without further disruption.

In accordance with Section 1.1206 of the Commission's rules, an original and a copy of this letter and the associated attachments are being submitted with the Secretary's Office.

66500.1

Sincerely yours,

THE CATHOLIC TELEVISION NETWORK

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RECOMMENDATION ITU-R M.1141-1* **

SHARING IN THE 1-3 GHz FREQUENCY RANGE BETWEEN NON-GEOSTATIONARY SPACE STATIONS OPERATING IN THE MOBILE-SATELLITE SERVICE AND STATIONS IN THE FIXED SERVICE

(Questions ITU-R 201/8 and ITU-R 118/9)

(1995-1997)

Summary

Levels of power flux-density (pfd) and fractional degradation in performance are presented as thresholds for coordination of frequency assignments for non-geostationary orbit (non-GSO) space station transmitters in the mobile-satellite service MSS and receiving stations in the fixed service (FS) in frequency bands shared between these services in the 1-3 GHz frequency range. In the annexes, the methodology for sharing between constellations of non-GSO space station transmitters and receiving fixed stations is described and a summary of studies of frequency sharing between transmitting fixed stations and non-GSO space station receivers is presented.

The ITU Radiocommunication Assembly,

considering

a) that Resolution 46 (Rev.WRC-95) of the World Radiocommunication Conference (Geneva, 1995), 113 (WARC-92) and 703 (WARC-92) of the World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum (Malaga-Torremolinos, 1992) and Recommendation 717 (Rev.WRC-95) invited the ITU-R to study criteria for sharing and coordination between systems in the mobile-satellite service (MSS) and the fixed service (FS) and mobile service;

b) that Recommendation 717 (Rev.WRC-95) invited the ITU-R to continue these studies of criteria for sharing and coordination between systems in the MSS and the fixed and mobile services;

c) that the bands 2170-2200 MHz, 2483.5-2500 MHz and 2500-2535 MHz are allocated to the MSS (space-to-Earth) and fixed service (FS) on a co-primary basis;

d) that the bands 1492-1525 MHz, 1525-1530 MHz and 2160-2170 MHz are allocated to the MSS (space-to-Earth) and FS in some regions or by some administrations, on a co-primary basis;

e) that for several decades, systems in the FS have been operated by many administrations in the bands newly allocated to the MSS;

f) that broadcasters in many countries operate ancillary services which have both fixed and mobile characteristics in certain bands shared with the MSS;

g) that the performance of FS systems (analogue point-to-point, digital point-to-point, digital point-to-multipoint including local access systems) needs to be considered when evaluating sharing situations in the 1-3 GHz range;

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* This Recommendation applies only for sharing in the space-Earth direction. No specific criteria have been developed for sharing in the Earth-to-space direction.

** The revision of this Recommendation was jointly prepared by Radiocommunication Study Groups 8 and 9 and any future revision will also be undertaken jointly.

h) that the performance of non-GSO MSS systems need to be considered for sharing in the 1-3 GHz range;

j) that a specific value of pfd produced by different non-GSO MSS satellite constellations gives rise to different values of fractional degradation of performance (FDP) (Recommendation ITU-R F.1108);

k) that multiple non-GSO MSS systems employing code division multiple access (CDMA) techniques have been proposed to share the frequency spectrum in the space-to-Earth direction, in the 2483.5-2500 MHz band, on a co-frequency basis;

l) that analyses performed with the methodology outlined in Recommendation ITU-R F.1108 indicate that it is feasible for non-GSO MSS systems to share the spectrum with analogue radio-relay systems in the 2483.5-2500 MHz band (see Annex 1) and 2160-2200 MHz band even when using higher pfd values for coordination threshold than those in Radio Regulations (RR) No. S21.16 (3400-4200 MHz);

m) that analyses performed with the methodology outlined in Recommendation ITU-R F.1108 for currently designed digital radio-relay systems indicate that the FDP protection criteria would be exceeded in the 2483.5-2500 MHz band where non-GSO MSS systems use pfd values as set forth in RR No. S21.16 (3400-4200 MHz) (see Annex 1);

n) that the presence of interference from industrial, scientific and medical equipment and radio local area network (RLAN) transmitters in the band 2483.5-2500 MHz makes this band unattractive in many countries for digital radio-relay systems;

o) that Recommendation ITU-R F.1246 establishes the reference bandwidth of systems in the FS to be used in specifying the coordination threshold levels,

recommends

1 that the criteria expressed as FDP values for a 1 MHz reference bandwidth, presented in Table 1, should be used as coordination threshold values between non-GSO MSS (space-to-Earth) and digital systems in the FS, in the bands listed, except as noted in § 3 (see Note 2);

2 that the criteria expressed as pfd values using reference bandwidths of 1 MHz, presented in Table 1, and 4 kHz, presented in Table 2, should be used as coordination threshold values between non-GSO MSS (space-to-Earth) and analogue systems for telephony in the FS in the bands listed (see Note 1); for analogue systems for television in the FS, only the pfd values using the 1 MHz reference bandwidth, presented in Table 1, should apply (see Notes 1, 3, 4, 5 and 6);

3 that in order to accommodate non-GSO MSS systems in the 2483.5-2500 MHz band, new digital point-to-point and point-to-multipoint radio-relay systems may need to be designed and operated to be compatible with the pfd values given in Table 1.

TABLE 1

Coordination threshold values for specific bands used for non-GSO MSS (space-to-Earth) and FS systems (pfd for analogue and FDP for digital)

Frequency band (MHz)	pfd per space station at angle of arrival δ (degrees) (dB(W/(m^2 · MHz)))	FDP (%) (See Note 2)
1 492-1525	−128 for 0° ≤ δ < 5° −128 + 0.5 (δ − 5) for 5° ≤ δ < 25° −118 for 25° ≤ δ < 90°	25
1 525-1 530	−128 for 0° ≤ δ < 5° −128 + 0.5 (δ − 5) for 5° ≤ δ < 25° −118 for 25° ≤ δ < 90°	25
2 160-2 170	−123 for 0° ≤ δ < 5° −123 + 0.5 (δ − 5) for 5° ≤ δ < 25° −113 for 25° ≤ δ < 90° (See Note 3)	25
2 170-2 200	−123 for 0° ≤ δ < 5° −123 + 0.5 (δ − 5) for 5° ≤ δ < 25° −113 for 25° ≤ δ < 90° (See Note 3)	25
2 483.5-2 500	−126 for 0° ≤ δ < 5° −126 + 0.65 (δ − 5) for 5° ≤ δ < 25° −113 for 25° ≤ δ < 90° (See Note 4)	pfd values in the preceding column apply to digital radio-relay systems in this band (See Note 4)
2 500-2 535	−128 for 0° ≤ δ < 5° −128 + 0.5 (δ − 5) for 5° ≤ δ < 25° −118 for 25° ≤ δ < 90°	25

NOTE 1 – In cases involving sharing with analogue systems for telephony in the FS, further coordination is only required when the pfd values are greater than or equal to the coordination threshold values in both Tables 1 and 2.

NOTE 2 – The concept for calculating the FDP for a FS network is contained in Recommendation ITU-R F.1108.

NOTE 3 – The pfd values specified for the 2 160-2 200 MHz band provide full protection for analogue radio-relay systems using the sharing criteria established by Recommendation ITU-R SF.357, for operation with a non-GSO MSS system employing narrow-band time division multiple access/frequency division multiple access (TDMA/FDMA) techniques.

NOTE 4 – The pfd values specified for the 2 483.5-2 500 MHz band provide full protection for analogue radio-relay systems using the sharing criteria established by Recommendation ITU-R SF.357, for operation with multiple non-GSO MSS systems employing CDMA techniques (see Annex 1). The pfd values specified will not provide full protection for existing digital fixed systems in all cases. However, these pfd values are considered to provide adequate protection for digital fixed systems designed to operate in this band, where high power ISM and possible low power applications are expected to produce a relatively high interference environment.

TABLE 2

Coordination threshold values for specific bands used for non-GSO MSS (space-to-Earth) and FS systems (analogue systems for telephony)

Frequency band (MHz)	pfd per space station at angle of arrival δ (degrees) (dB(W/(m^2 · 4 MHz)))		
1 492-1 525	−146	for	$0° \leq \delta < 5°$
	−146 + 0.5 (δ − 5)	for	$5° \leq \delta < 25°$
	−136	for	$25° \leq \delta < 90°$
1 525-1 530	−146	for	$0° \leq \delta < 5°$
	−146 + 0.5 (δ − 5)	for	$5° \leq \delta < 25°$
	−136	for	$25° \leq \delta < 90°$
2 160-2 170	−141	for	$0° \leq \delta < 5°$
	−141 + 0.5 (δ − 5)	for	$5° \leq \delta < 25°$
	−131	for	$25° \leq \delta < 90°$
	(See Note 3)		
2 170-2 200	−141	for	$0° \leq \delta < 5°$
	−141 + 0.5 (δ − 5)	for	$5° \leq \delta < 25°$
	−131	for	$25° \leq \delta < 90°$
	(See Note 3)		
2 483.5-2 500	−144	for	$0° \leq \delta < 5°$
	−144 + 0.65 (δ − 5)	for	$5° \leq \delta < 25°$
	−131	for	$25° \leq \delta < 90°$
2 500-2 535	−146	for	$0° \leq \delta < 5°$
	−146 + 0.5 (δ − 5)	for	$5° \leq \delta < 25°$
	−136	for	$25° \leq \delta < 90°$

NOTES 1 to 4 – See Table 1.

NOTE 5 – Based on Recommendation ITU-R F.1246 regarding the reference bandwidth, the pfd values specified in Table 2 for a 4 kHz reference bandwidth are 18 dB lower than the pfd values specified in Table 1 for a 1 MHz reference bandwidth. These values are appropriate to protect analogue FS systems of medium and low capacity (960 channels or less), as explained in Recommendation ITU-R F.1246.

NOTE 6 – The approach of employing both 1 MHz and 4 kHz reference bandwidths as adopted in *recommends* 2 is applicable only to the frequency bands in the 1-3 GHz range, shared by the MSS and the FS. This result is based on the fact that the analogue systems in the FS in these bands are generally used for low to medium capacity of 960 channels or less. This approach is not appropriate for other frequency bands where high-capacity analogue radio-relay systems are employed.

Sharing methodology and interference criteria used for the determination of coordination threshold criteria

1 Description of methodology

The methodology for determining the coordination threshold between non-GSO MSS downlinks and the FS is based on Recommendation ITU-R F.1108. This Recommendation provides:

- a method to determine the visibility statistics of non-GSO satellites as seen by terrestrial stations. The method takes into account the orbital parameters of the non-GSO system, the motion of the Earth and the relevant geometrical factors. It is a sufficiently complex method that a computer program is required to determine the visibility statistics;
- a method of relating the interference to a FDP for digital FS networks;
- a method of relating the interference to a degradation in performance for analogue FS networks.

For the digital FS case, the interference objective is a degradation to the error performance objective (increase in outage) and it is a single value (e.g. 10%).

For the analogue FS case, a two point interference objective mask, consisting of a long-term and a short-term interference objective, is used.

1.1 Simulation methodology

A computer program was used to simulate the interference into the FS network from the non-GSO satellite constellation(s) operating in the 2483.5-2500 MHz band. The program calculates the satellite orbital positions at each time instance, and the aggregate interference from all satellites visible to the FS station(s) is determined using equation (1):

$$I = \sum_{i=1}^{N} \sum_{j=1}^{M} \rho(\delta_{ij}) \; A_{iso} \; G(\theta_{ij}) \qquad (1)$$

where:

- i: 1 of N visible satellites
- j: 1 of M stations on a route
- $\rho(\delta_{ij})$: pfd received at station j from the i^{th} satellite
- δ_{ij}: elevation angle from station j to the i^{th} satellite
- A_{iso}: area of an isotropic antenna $= \lambda^2/4\pi$
- $G(\theta_{ij})$: j^{th} station's antenna gain in the direction of the i^{th} satellite
- θ_{ij}: angle between the j^{th} station's antenna pointing vector and the range vector from the j^{th} station and the i^{th} satellite.

The pfd incident on the station's receiving antenna as a function of the elevation angle can be assumed to be of the form:

$$\rho(\delta) = \begin{cases} \rho(5) & \text{for } 0° \le \delta < 5° \quad (2a) \\ \dfrac{\rho(25) - \rho(5)}{20}(\delta - 5) + \rho(5) & \text{for } 5° \le \delta < 25° \quad (2b) \\ \rho(25) & \text{for } 25° \le \delta < 90° \quad (2c) \end{cases}$$

where:

- δ: elevation angle (degrees)
- ρ: pfd (dB(W/m^2)) in a reference bandwidth

$\rho(5)$: pfd value at $\delta \leq 5°$

$\rho(25)$: pfd value at $\delta \geq 25°$.

Alternatively, satellite beam parameters can be assumed and the associated pfd values at various angles of arrival can be derived.

The point-to-point FS station antenna gain conforms to the antenna pattern having averaged side-lobe levels as defined in Note 6 of Recommendation ITU-R F.699. A suitable antenna radiation pattern for point-to-multipoint systems can also be used.

1.2 Analogue FS systems

It was assumed that there are 51 analogue stations on a route centred at a given latitude. The routes span a distance of 2 500 km with stations spaced exactly 50 km apart. The azimuth angle for each station is specified by a given trendline angle and a variable angle that is uniformly distributed between ±12.5° The analysis considers trendline angles that vary between 10° and 170° in 20° steps. Each station is assumed to use a high gain antenna pointed at the next station at an elevation angle of 0°.

The program calculates the interference statistics based on the aggregate interference noise power calculated at each sample point. The interference statistics show the probability that the aggregate received interference noise power exceeds a given interference level. The interference interval is then mapped to the interference noise power in a 4 kHz baseband channel by:

$$N_{ch} = \frac{N_T}{k\,T\,B}\,I \tag{3}$$

where:

- N_T: thermal noise power introduced in a 4 kHz baseband channel at a station = 25 pW psophometrically weighted at a point of zero relative level (pW0p)
- k: Boltzmann's constant
- T: station receiving system noise temperature
- B: reference bandwidth = 4 kHz
- I: aggregate received interference noise power in the reference bandwidth.

1.3 Digital FS systems

Only one digital FS receiver is required for the analysis as opposed to a complete route. The FS station is positioned at a certain latitude and its pointing azimuth is varied between 0° and 180°. Each station is assumed to use a high gain antenna at an elevation angle of 0°.

At each time instance the program calculates the aggregate interference received at the FS station.

It then calculates the FDP for the digital station as:

$$FDP = \sum_{I_i = min}^{max} \frac{I_i\, f_i}{N_T} \tag{4}$$

where:

- I_i: interference noise power level
- f_i: fractional period of time that the interference power equals I_i
- N_T: station receiving system noise power level = $k\,T\,B$
- k: Boltzmann's constant
- T: station receiving system effective noise temperature
- B: reference bandwidth = 1 MHz.

The fade margin loss (FML) is given by:

$$FML = 10 \log (1 + FDP) \quad \text{dB}$$

A 10% FDP equates to about a 0.4 dB loss in fade margin. 25% FDP equates to about 1 dB loss in fade margin, and a 100% FDP corresponds to a 3 dB loss in fade margin.

1.4 Multiple non-GSO constellations

1.4.1 Analogue FS systems

When analysing the impact on the FS from multiple non-GSO constellations, the computer program generates the discrete probability density function (pdf) of the interference noise power into an FS channel for each non-GSO MSS system. If the interference intervals are small enough, the discrete pdf will closely approximate the continuous pdf for interference to line-of-sight radio-relay systems from a particular type non-GSO MSS system. Specifically, the pdf of the interference power I_j, from the j^{th} non-GSO MSS system may be written as:

$$p_j\,(I_j) \tag{5}$$

The next step is to obtain the pdf of the interference noise power for two or more non-GSO MSS systems. The pdf of the sum of two uncorrelated random variables may be obtained as the convolution of the individual pdfs. In general, if:

$$z = x + y \tag{6}$$

where x and y are uncorrelated random variables, and the pdfs of x and y are given by $p_x(x)$ and $p_y(y)$, then the pdf of z is given by the convolution integral:

$$p_z(z) = \int_{-\infty}^{\infty} p_x(z - y)\; p_y(y)\,\mathrm{d}y \tag{7}$$

The key assumption associated with the convolution integral is that the random variables x and y are uncorrelated. It is asserted that this is the case for non-GSO MSS systems because of the differences in the orbital parameters of the different systems, although this should be confirmed. Thus, the convolution integral may be used to obtain the pdf of the total interference $p(I)$ to line-of-sight radio-relay systems caused by two non-GSO MSS systems j and k:

$$p(I) = \int_{-\infty}^{\infty} p_j(I - I_k)\; P_k\,(I_k)\,dI_k \tag{8}$$

Equation (8) may be used iteratively (the n-fold convolution) to obtain the pdf of the total interference for n independent non-GSO MSS systems.

The cumulative distribution function (cdf) is obtained from:

$$P(I > x) = \int_{x}^{\infty} p(I)\,\mathrm{d}I = \sum_{x}^{\infty} p(I) \tag{9}$$

where:

$P(I > x)$: cdf of the interference power in the telephony channel

$p(I)$: either the discrete or continuous pdf.

1.4.2 Digital FS systems

The calculation of the FDP described in § 1.3 is equal to the first moment of the interference power normalized to the noise at the receiver input in the reference bandwidth. Thus, the FDP due to interference from several independent constellations is the sum of the degradations produced by each.

Two types of antennas are used for the digital systems: relatively high gain, circularly symmetric antennas; and, low-to-moderate gain antennas with constant gain in the azimuth plane and a directional pattern in the elevation plane. All digital line-of-sight radio-relay systems and local-access systems using sector antennas are assumed to use antennas that are circularly symmetric. The radiation pattern of this type of antenna is assumed to conform to the antenna pattern having averaged side-lobe levels as defined in Note 6 of Recommendation ITU-R F.699.

2 Results

Several computer simulations using a common methodology have been performed to determine pfd values which ensure that the relevant FS interference objectives are met. This section contains the results of those simulations.

Analogue FS systems

Values of pfd to protect 2 500 km analogue radio-relay routes centred at 15°, 40° and 60° latitude from the emissions of non-GSO MSS systems were evaluated. Values were determined by assuming combinations of three non-GSO MSS constellations selected from four representative systems.

The analyses used a base pfd value of -150 dB(W/(m^2 · 4 kHz)) for elevation angles less than 5°, linearly increasing to -137 dB(W/(m^2 · 4 kHz)) at 25° and remaining at that level for elevation angles up to 90°. It was shown that, except for one or two route trend lines centred in the higher latitudes, the $-150/-137$ dB(W/(m^2 · 4 kHz)) template provided protection to analogue radio-relay systems consistent with the values contained in Recommendation ITU-R SF.357.

It was assumed that the four non-GSO systems used CDMA techniques and that they were all designed such that they could share on a co-frequency, co-coverage basis.

Digital FS systems

For multiple non-GSO MSS systems interfering, with a digital point-to-point station employing a high-gain receiving antenna, it was shown that the pfd template needed to realize an average FDP on the order of 10% with peaks not much greater than 15% to 20% was -162 dB(W/(m^2 · 4 kHz)) in the 0-5° range of elevation angle, linearly escalating to -149 dB(W/(m^2 · 4 kHz)) at 25° elevation angle and remaining at that value up to 90° of elevation angle. At values of pfd sufficient to protect the operation of analogue point-to-point radio-relay systems, i.e., -150 dB(W/(m^2 · 4 kHz)) escalating to -137 dB(W/(m^2 · 4 kHz)), digital point-to-point radio-relay stations would experience an average FDP on the order of 160%, with peaks to 240% and 320% and troughs as low as 80% depending on the latitude of the station. An FDP of 160% is equivalent to a decrease in fade margin of about 4 dB.

2.1 Trends

Several trends arising from the results can be observed.

The received interference can vary rapidly with the FS pointing azimuth for some non-GSO constellations. Constellations with polar or near polar orbits also impact various FS pointing azimuths differently, but the effect is much less pronounced.

FS stations at higher latitudes generally experience more interference over time than FS stations located at lower latitudes. This is more true for constellations with polar orbits, however actual operational requirements may include turning off outer beams due to coverage overlap and hence the interference effect will be reduced.

Satellite constellations operating at lower altitudes require different pfd masks to protect the FS than those constellations operating at higher altitudes.

As a first order estimate, the levels of interference over time decrease inversely with the square of the operating frequency.

2.2 Conclusions

The selection of a single pfd mask which ensures protection of the FS and which does not simultaneously penalize other non-GSO constellations, is difficult. Selection of a particular pfd mask based on one constellation can result in inadequate protection to the FS, as another constellation which could meet those pfd levels could still exceed the FS interference objectives. In other words, two different non-GSO constellations can operate with different pfd masks which both protect the FS equally. The above does not hold true for a pfd mask derived from several non-GSO constellations which have been designed to share on a co-frequency, co-coverage basis and which use CDMA techniques.

The pfd required to protect 2500 km hypothetical reference circuit (HRC) analogue FS systems from the simultaneous emissions of three non-GSO MSS constellations was found to be –150 dB(W/(m^2 · 4 kHz)) at elevation angles between 0° and 5°, linearly escalating to –137 dB(W/(m^2 · 4 kHz)) at an elevation angle of 25°. The pfd remained constant at this value for elevation angles above 25°. Interference to the HRC was consistent with the values given in Recommendation ITU-R SF.357.

The pfd required to ensure that the FDP as defined in Recommendation ITU-R F.1108, of digital FS systems, did not exceed about 10% was found to be some 9 dB to 10 dB more stringent than the values of pfd required to protect the performance of analogue FS systems. These lower values, if adopted, will inhibit the introduction of viable non-GSO MSS systems.

It was concluded that sharing with these systems would be most readily accomplished by establishing pfd values that, while resulting in an FDP in excess of 10%, for example, would not unduly penalize the design and operation of either FS or non-GSO MSS systems in the 2483.5-2500 MHz band.

ANNEX 2

Sharing of frequency bands in the 1-3 GHz range between transmitting stations in the FS and non-GSO space stations operating in the MSS (Earth-to-space)

1 Introduction

Studies were required for the sharing scenario between transmitting stations in the FS and non-GSO MSS space station receivers in the MSS Earth-to-space frequency bands between 1-3 GHz, i.e. 1610-1626.5 MHz, 1675-1710 MHz, 1970-2010 MHz and 2655-2690 MHz. However, the sharing studies were limited to the 1610-1626.5 MHz and 1970-2010 MHz bands, since these bands are of immediate interest for the implementation of non-GSO MSS systems. No inputs were received for the other bands. A study on the specific sharing scenario of FS troposcatter links with non-GSO systems was also considered. In addition to the sharing studies, the possible regulatory options for FS systems are discussed.

Sharing studies have shown that co-channel operation of the transmitting stations of the new FS and receivers of non-GSO MSS space stations in the 1980-2010 MHz band would not in general be possible.

Sharing studies in the 1610-1626.5 MHz band (see RR No. S5.359) found that the loss of traffic capacity may be acceptable in the case of very low FS density (e.g. one in 230000 km^2).

One option to improve the sharing conditions would be to reduce considerably the permissible e.i.r.p. limits in RR Article S21 for FS transmitters. Any such limits are highly dependent on the assumptions regarding new FS transmitter density and would be based on the assumption of a high FS density. This would lead to extremely stringent limits on new FS stations which may not be practical for their operation.

In view of the above. no specific criteria to facilitate sharing from a technical viewpoint have been developed.

2 Simulation of interference from FS links into MSS satellite receiver

2.1 Point-to-point FS links

Studies on the interference from typical multiple FS transmitters (circa 6000 worldwide) into non-GSO/MSS (medium-Earth orbit) space station receivers in the band 1980-2010 MHz found that unacceptable interference to non-GSO/MSS space station receivers would occur. The assumed target equivalent interference *C/I* criterion was not met for close to 100% of the time. Based on this study, it can be concluded that co-channel sharing of MSS uplinks to non-GSO MSS satellites in frequency band segments in the 1980-2010 MHz band, which are or remain heavily used by, the FS would not be possible. It is noted that a preliminary assessment based on interpolations of actual FS utilisation data in a number of countries has indicated that the number of point to point FS transmitters could be greater than that assumed in the above study and would only further increase the level of interference.

Further studies on the interference from typical multiple FS transmitters (between 700 and 3000 worldwide) into non-GSO/MSS (low-Earth orbit) space station receivers in the band 1610-1626.5 MHz found that the loss of traffic capacity may be acceptable only in the case of very low FS density (e.g. one in 230000 km^2).

2.2 Troposcatter FS links

In the case of sharing between FS troposcatter systems and the non-GSO MSS (medium-Earth orbit) system, one study showed that co-channel sharing would not be feasible. In the main beam of a troposcatter transmitter operating at its maximum output power, the MSS satellite receiver could experience interference levels of up to 60 dB higher than is tolerable. In the side lobe region tolerable interference levels are still exceeded. Thus it would be necessary to phase out these systems if the non-GSO MSS is to be implemented in portions of the bands where troposcatter systems operate.

3 Conclusions

3.1 Co-channel operation of the transmitting stations of the FS in the band 1980-2010 MHz will cause unacceptable interference to the non-GSO MSS space station receivers.

3.2 For systems in FS in the band 1610-1626.5 MHz (RR No. S5.359), loss of traffic capacity for a non-GSO MSS system may be acceptable only in the case of very low FS density (e.g. one in 230000 km^2).

3.3 In view of the sharing difficulties noted above, no specific criteria to facilitate sharing from a technical viewpoint have been developed.

TSB86

TIA/EIA TELECOMMUNICATIONS SYSTEMS BULLETIN

Criteria and Methodology to Assess Interference Between Systems in the Fixed Service and the Mobile-Satellite Service in the Band 2165-2200 MHz

TSB86

OCTOBER 1999

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

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PREFACE

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Preface

This Telecommunications System Bulletin (TSB-86) was prepared by a Joint Working Group (JWG), comprised of TR-34.2, TR-14.11 and the National Spectrum Managers Association. The JWG, designated JWG TR-34.2/TR-14.11/NSMA, was formed under the auspices of the TIA following a number of informal discussions among representatives of the mobile satellite and terrestrial fixed microwave point-to-point service industries, TIA officials and other interested parties.

The 2165 – 2200 MHz band has been allocated by the FCC for the Mobile Satellite Service (MSS) (space-to-Earth) on a co-primary basis with the Fixed Service (FS) commencing on January 1, 2000. The band is currently used by Common Carrier microwave and Private Operational Fixed Service microwave operators; and, one of the key issues in the FCC's 2 GHz Rulemaking is the extent to which this band can be shared between the MSS and these FS users.

The Satellite Communications Division and Wireless Communication Division of TIA agreed to form the JWG with Terms of Reference as follows:

1. Study the potential for sharing the band 2165-2200 MHz between satellite systems operating in the MSS and microwave systems operating in the FS;

2. Determine the conditions under which sharing may be possible and the arrangements necessary for sharing to occur (if any);

3. Document the essential elements of the study with findings and conclusions that can be assessed by others not directly involved in the study and produce a TSB to be published by the TIA;

4. Follow the prescribed TIA rules of procedure (TIA Chair's Procedures Notebook), Legal Guide, Engineering Manual and other TIA guidance appropriate for the type of product being developed.

This TSB-86 is primarily intended to provide a methodology for evaluating MSS interference into FS receiving stations. In publishing this TSB, the JWG makes no claims or conclusions about the extent to which the 2165-2200 MHz band can be shared between MSS and FS users.

The primary output of the JWG is this TSB-86, which draws upon material in TSB-10F. Consequently, the reader should have access to TIA TSB-10F and refer to that document when necessary. Also, where applicable, references to certain ITU-R Recommendations and citations to the ITU Radio Regulations are made in order to conserve space; these references are available through the internet by consulting the ITU's web site (http://www.itu.int). The reader/user of this document is advised that the methodologies presented in Section 4 of the instant version of TSB-86 are valid only for evaluating MSS interference into FS receive stations *not* operating with Automatic Transmit Power Control (ATPC). A significant percentage of FS stations may operate with ATPC. Finally, terrain scatter is not explicitly considered in this TSB (see Section 1.3).

1. Criteria & Methodology to Assess Interference between Systems in the Fixed Service and the Mobile-Satellite Service in the 2165-2200 MHz Band

1.1 Introduction

This document provides technical background information on systems operating in the FS and the MSS in the 2.1 GHz frequency band (Section 2); delineates methods for evaluating the associated potential interference (Sections 3, 4 and 5); presents example applications for the methodology (Section 6) and discusses possible interference mitigation techniques (Section 7). Effective January 1, 2000, the frequency band 2165-2200 MHz will be allocated in the United States and Canada to both the FS and MSS (space-to-Earth).[1] However, in accordance with the ITU Radio Regulations (RR), the subject frequency sharing situations can also arise in the 2160-2165 MHz band. General background information on international and domestic coordination of proposed 2 GHz MSS systems (with terrestrial FS) is provided in the subsequent sub-sections.

1.2 Frequency Coordination

As of December 15, 1998, the MSS networks listed in Table 1-1 and Table 1-2 have been "Advanced Published" with the International Telecommunication Union (ITU) for operation in the band 2160-2200 MHz. Operators of some, but not necessarily all of these systems have applied to the FCC to serve mobile terminals in the United States. This fact notwithstanding, foreign MSS networks can potentially cause interference to US FS systems whether or not they are providing service within the US.

As illustrated in Figure 1-1, the FCC, on behalf of the US FS operators, can request coordination in cases where either the power flux density (PFD) or fractional degradation in performance (FDP) thresholds for coordination are exceeded and, if applied, the Standard Computation Program (SCP) indicates that the applicable interference thresholds are exceeded. The methodology presented herein for evaluating potential interference is consistent with the RR coordination procedures and will be useful to the US FS community in support of its international frequency coordination endeavors.

In order to accrue US rights to use the 2165-2200 MHz MSS resources, the FCC has Advanced Published with the ITU certain of the MSS systems listed in Tables 1-1 and 1-2 (i.e., the systems for which "USA" is listed as the administration). These systems are representative of anticipated US MSS systems. The methodology presented is for evaluating potential interference between MSS and FS systems. The FCC has received nine applications to use 2165-2200 MHz MSS resources in the United States.

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[1] FCC, ET Docket No. 95-18 (FCC 2 GHz Order), released March 14, 1997. Also see FCC, ET Docket No.95-18, Memorandum Opinion and Order & Third NPRM and Order, released November 25, 1998.

In addition, foreign MSS networks have been "Advanced Published" with the International Telecommunications Union (ITU) that will not provide services in the United States. This notwithstanding, the downlink frequency assignments for these satellites might be capable of causing interference to US FS systems and are subject to the bilateral frequency coordination provision of RR No. S9.11A and Appendix S5 (formerly Annex 2 to RR Resolution 46).

Tables 1-1 and 1-2 provide a listing of the MSS networks that have been Advanced Published with the ITU for operation in the band 2160-2200 MHz as of December 15, 1998.

Table 1-1 Non-GSO MSS Systems Advanced Published with the ITU at 2 GHz (as of 15 December 1998)

NETWORK	ADMININISTRATION
QUASIGEO-L3	Germany
F-SAT ICO	France
F-SAT LEO	France
F-SAT LEO-A	France
ICO-P	United Kingdom
PETALRING 60E-S	Netherlands
PETALRING 30C-S	Netherlands
MEASAT-LEO	Malaysia
MEASAT-MEO	Malaysia
SIGNAL	Russia
TONGASAT-LEO-10000	Tonga
TONGASAT-LEO-1200	Tonga
TONGASAT-LEO-1300	Tonga
TONGASAT-ELL-1	Tonga
MSS-LEO-1	USA
MSS-LEO-2	USA
MSSLEO-4B	USA
MSSLEO 3	USA
MSSLEO-4A	USA
MSSLEO-2A	USA
MSSLEO-5	USA

Table 1-2 GSO MSS Systems Advanced Published with the ITU at 2 GHz (as of 15 December 1998)

NETWORK	ADMINISTRATION	LOCATION
INTERSPUTNIK-6W	Belarus/IK	6W
INTERSPUTNIK-16W	Belarus/IK	16W
INTERSPUTNIK-17E	Belarus/IK	17E
INTERSPUTNIK-27E	Belarus/IK	27E
INTERSPUTNIK-64.5E	Belarus/IK	64.5E
INTERSPUTNIK-67.5E	Belarus/IK	67.5E
INTERSPUTNIK-114.5E	Belarus/IK	114.5E
INTERSPUTNIK-3W	Belarus/IK	3W
INTERSPUTNIK-23W	Belarus/IK	23W
INTERSPUTNIK-32.5W	Belarus/IK	32.5W
INTERSPUTNIK-153.5E	Belarus/IK	153.5E
INTERSPUTNIK-97W	Belarus/IK	97W
INTERSPUTNIK-83W	Belarus/IK	83W
INTERSPUTNIK-59.5E	Belarus/IK	59.5E
INTERSPUTNIK-75E	Belarus/IK	75E
CANSAT-M3	Canada	106.5W
KYPROS-SAT-L1	Cyprus	27.5E
KYPROS-SAT-L2	Cyprus	30E
KYPROS-SAT-L3	Cyprus	37E
KYPROS-SAT-L4	Cyprus	39E
SATPHONE-1	Germany	29E
SATPHONE-2	Germany	52E
GARUDA-1	Indonesia	118E
GARUDA-2	Indonesia	123E
GARUDA-3	Indonesia	135E
GARUDA-4	Indonesia	80.5E
DACOMSAT-11LSC	Korea	155E
DACOMSAT-8LSC	Korea	107E
DACOMSAT-9LSC	Korea	109E
HYUNDAI-AS	Korea	120E
HYUNDAI-BS	Korea	126E
ST-2A	Singapore	88E
ST-2B	Singapore	98.5E
EMARSAT-1A/M	UAE	24E
EMARSAT-1B/M	UAE	54E
EMARSAT-1F	UAE	44E

EMARSAT-1G	UAE	51.5E
EMARSAT-1J	UAE	33.5E
EMARSAT-1K	UAE	38.5E
EMARSAT-1L	UAE	28.5E
AGRANI-1	UK	11.5E
AGRANI-1A	UK	29E
AGRANI-2	UK	52E
AGRANI-2A	UK	46E
AGRANI-3	UK	120E
AGRANI-3A	UK	80E
EAST-10E	UK	10E
EAST-13E	UK	13E
EAST-16E	UK	16E
EAST-22E	UK	22E
EAST-6E	UK	6E
EAST-1	UK	32E
INMARSAT-GSO-2A	UK/Inmarsat	90W
INMARSAT-GSO-2B	UK/Inmarsat	88W
INMARSAT-GSO-2C	UK/Inmarsat	21.5E
INMARSAT-GSO-2D	UK/Inmarsat	20E
INMARSAT-GSO-2E	UK/Inmarsat	109E
INMARSAT-GSO-2F	UK/Inmarsat	110E
INMARSAT-GSO-2G	UK/Inmarsat	166W
INMARSAT-GSO-2H	UK/Inmarsat	170W
UKRSAT-4S-64.5E	Ukraine	64.5E
UKRSAT-5 S 38.2W	Ukraine	38.2W
USASAT-27B	USA	76W
USASAT-27C	USA	96W
USASAT-27D	USA	116W
USASAT-27E	USA	101W
USASAT-27G	USA	100W
USASAT-27H	USA	170W
USASAT-27I	USA	76W
USASAT-27K	USA	116W
USASAT-27J	USA	76W
USASAT-27F	USA	10E

1.3 Nature of Interfering Signals from Mobile-Satellite Service Networks

As can be seen from Tables 1-1 and 1-2, MSS systems planning to operate downlinks in the band 2160-2200 MHz utilize either geostationary (GSO) or non-geostationary (non-GSO) satellites. Signals from a GSO satellite produce a PFD that has a nominally fixed angle of arrival at an FS antenna, and the magnitude of the PFD may vary as a result of changing downlink traffic channel assignments (loading), the effect of power control on individual channels, and channel activity (e.g., if voice activated carriers are used). Additionally, for non-GSO satellites, the motion of the satellites introduces a major cause of variation in the interfering signal power received by an FS station. Although interfering emissions from satellites may enter FS receivers through scatter or reflection from terrain features, this mechanism has not been considered in the past in determining the interference potential of emissions from geostationary satellites, nor has it been found to be a problem in bands currently shared between the FS and GSO satellites. It is expected that energy coupled by this mechanism would contribute to the variability of the interference, rather than to an increase in the interference power level. Consequently, terrain scatter is not explicitly considered in this issue of this Bulletin.

The influence of MSS loading, power control, and channel activity in GSO and non-GSO systems depends on the MSS modulation and multiple access technique and the reference bandwidth used in the analysis. Numerous narrow-band MSS channels overlapping an FS channel may produce an average level of interfering signal power that has a low variance over time periods of tens of seconds in accordance with the central limit theorem of statistics. However, there is a large variation in this signal level over much longer time periods as a result of variations in loading, and, in the case of non-GSO MSS satellites, as a result of varying antenna discrimination at the satellite and FS station. Thus, the average interfering signal power level from narrow-band MSS systems is determined based on the number of overlapping MSS channels and their individual power levels. These two considerations encompass the effects of channel guard bands as well as loading and channel activity. Wide-band MSS systems (e.g., those using spread spectrum modulation and CDMA) produce an average interfering signal level that exhibits low variance over small time intervals but substantial variation over larger time intervals due to varying traffic loading (and varying antenna discrimination in the case of non-GSO satellites).

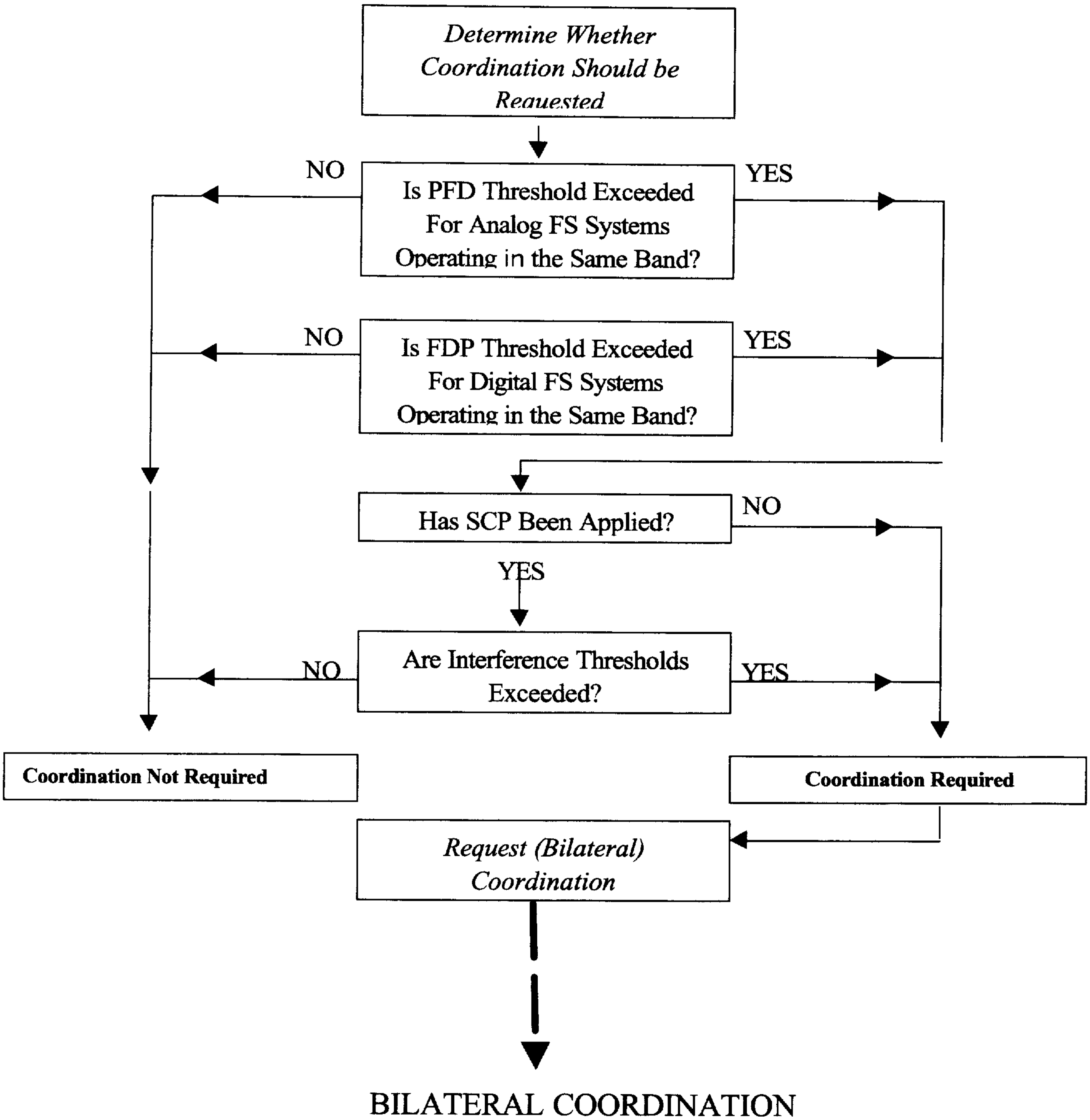

Figure 1-1. Technical Elements of ITU RR Provisions Relevant to International Coordination of Assignments for MSS Systems in the 2160-2200 MHz Band