Radiocommunication Study Groups

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Annex 30 to Document 4A/343-E
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Annex 30 to Working Party 4A Chair's Report

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R S.[INTERFERENCE-NGSO-NGSO]

Since November of 2020, Working Party 4A (WP 4A) has been working towards developing a methodology for the assessment of interference between non-GSO systems, and between non-GSO systems and GSO networks. Five input contributions were received on this topic to the October 2024 meeting of WP 4A. Based on these input contributions and subsequent discussions during the meeting, an update to the Working Document was created as shown in the Attachment.

During the October 2024 meeting of WP 4A, technical discussions took place on the various elements relevant to assessment of interference during non-GSO-non-GSO coordination.
A summary of the items discussed is provided below:

- consideration of a metric as an alternative/addition to the average degradation in throughput to capture long-term effects of interference (e.g. decrease in capacity delivered by a link over a long period of time/certain percentage(s) of time, additional *C/N* threshold(s));
- consideration of multiple non-collocated interferer earth stations;
- consideration of inclusion of intra-system interference in the noise temperature.

Further contribution on this subject is encouraged.

[Editor's note: any text shown in tracked changes has not been agreed.]

Attachment: 1

ATTACHMENT

~~WORKING DOCUMENT TOWARDS A~~ PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R S.[INTERFERENCE-NGSO-NGSO]

[Methodology to assess average degradation in throughput and increase in unavailability for a non-geostationary system, due to the interference caused by another non-geostationary system operating co-frequency[~~, for frequency ranges between 10.7 GHz and 52.4 GHz~~]]

[~~Possible~~ methodology to be used during coordination ~~when an assignment to a~~between non-geostationary FSS satellite systems for frequency ranges between 10.7 and 52.4 GHz ~~is involved~~]

~~[Editor's Note: Views were expressed that a protection criterion for sharing of spectrum between non-GSO and GSO in the coordination bands is a needed element within WP 4A and many of the principles listed in this document can be applied to the GSO-non-GSO case. Noting that an additional document will create another work stream within WP 4, further contributions on this subject may re-introduce concepts related to sharing between non-GSO to GSO.]~~

~~*[Editor's note: Views were expressed that the NGSO-GSO portion of this recommendation is not needed because RR Article 22 equivalent power flux density (EPFD) limits already provide a means to share spectrum between GSO networks and non-GSO systems, leveraging the unique ability of non-GSO systems to avoid GSO networks and these limits are widely used in coordination agreements.]*~~

The ITU Radiocommunication Assembly,

considering

a) that emissions from the earth stations as well as from the space station(s) of a non-GSO satellite system may cause interference to stations of another non-GSO satellite system operating in the same frequency band(s);

b) that non-GSO satellite systems which use Adaptive Coding and Modulation (ACM) techniques are designed to adapt to degraded link conditions by reducing overall throughput and, therefore, do not provide constant bit rate services;

c) that intra-system interference and inter-system interference contribute to the total system noise power

d) that during the planning and/or coordination stage(s) of a non-GSO satellite system, it may be useful to evaluate the potential impact on the availability (short-term) and throughput (long-term) performance;

e) that in interference situations involving non-GSO systems it is necessary to take into account the time-varying nature of the interference and propagation conditions when determining the availability (short-term) and throughput performance (long-term), respectively~~, of these networks in degraded link conditions~~;

x) that in interference situations involving non-GSO systems, there may be multiple interfering carriers from a single non-GSO system that contribute to the availability (short-term) and

throughput (long-term) performance degradation (e.g. if the Nco for the interfering system is simulated as being greater than 1 or if the simulation contains more than one interfering earth station);

Start from 4A/284

f) ~~that if not limited,~~ taking into account *considering ~~f~~e)*, ~~short-term interference events may cause, for certain systems, loss of synchronization or other unstable conditions even under clear-sky conditions which may cause a degradation or loss of service for periods longer than the interference event~~ and that the availability (short-term) protection criteria given in Recommendation ITU-R S.1323-2 was developed by taking this into consideration that short-term interference events may cause, for certain systems, loss of synchronization or other unstable conditions even under clear-sky conditions which may cause a degradation or loss of service for periods longer than the interference event;

End from 4A/284

Start from 4A/301

f) that ~~if not limited, taking into account *considering f),*~~ short-term interference events may cause, for certain systems, loss of synchronization or other unstable conditions even under clear-sky conditions which may cause a degradation or loss of service for periods longer than the interference event~~, and~~

x) that Recommendation ITU-R S.1323-2 was developed by taking ~~this~~ into consideration short-term interference events;

End from 4A/301

[*g)* that the availability and the throughput performance ~~such calculations referred to in considering f)~~ depend on the expected performance of the satellite link relative to the foreseeable degraded conditions such as time-varying propagation conditions and geometry of the satellite systems involved~~;~~.]

~~*h)* that, given that non-GSO satellites are constantly in motion, the time element is an important factor when assessing the availability (short-term) and throughput (long-term) performance degradation due to an interference event involving non-GSO systems;~~

~~*i)* that Recommendation ITU-R S.2131 contains methodologies to determine the performance objectives for satellite systems using ACM and may be used to calculate throughput performance;~~

~~*j)* that Recommendation ITU-R S.1323-2 provides methodologies for determining maximum aggregate permissible levels of interference when non-GSO FSS systems are involved for frequency bands below 30 GHz, among other things;~~

~~*k)* that Recommendation ITU-R S.1323-2, *recommends* 12, Note 3, states that "the total system noise power at the input to the demodulator is of thermal nature and includes all intra-system noise contributions as well as interference noise from other systems" and that "in the event that the interference cannot be assumed to be thermal in nature the permissible level of interference into a digital carrier should be based upon the degradation of the BER (or C/N) performance",~~

noting

Start from 4A/266

a) that studies have identified the potential blocking effect of non-GSO systems with large number of satellites and have suggested that sharing information on active satellites that are transmitting or receiving may be a solution and may increase efficient use of spectrum among involved systems~~.~~;

b) that concerns have separately been raised that sSharing information on active satellites may be either impractical, not feasible or processable, or would require sharing confidential information, and, therefore, sharing such information would be left to agreement between parties in coordination.;

End from 4A/266

Start from 4A/301

that agreement among the involved parties in bilateral discussions to share information on active satellites may improve the efficiency of the use of the spectrum by their respective systems,

End from 4A/301

recognizing

a) that alternative methods and permissible interference levels as agreed between the administrations concerned may be used to assess the impact on the link performance of their satellite networks or systems;

b) that Recommendations ITU-R S.1431 and ITU-R S.1595 contain mitigation techniques, such as avoidance of inline events, which could be used to assist in achieving sharing frequency assignments between non-GSO satellite systems.;

c) that Recommendation ITU-R S.2131 contains methodologies to determine the performance objectives for satellite systems using ACM and may be used to calculate throughput performance;

d) that Recommendation ITU-R S.1323 provides methodologies for determining maximum aggregate permissible levels of interference for non-GSO FSS systems operating in frequency bands below 30 GHz,

recommends

1 that the methodology given in Annex 1 could be used for the calculation of average degradation in throughput and increase in unavailability for a non-geostationary GSO system, due to the interference caused by another non-geostationary GSO system operating co-frequency, to assist administrations conducting technical studies and/or frequency coordination under RR No. **9.12**.;

2 that in coordination discussions, by agreement between the administrations concerned, administrations may address the need to protect non-GSO satellite systems from interference events that may cause loss of synchronization, taking into account *considering gf)* above and any interference mitigation based on the application of *recommends* 1.

[NOTE – The methodologies and permissible interference levels accepted by operational non-GSO satellite systems, which have successfully achieved co-existence in the same frequency bands, could serve as a reference for coordination discussions between other concerned administrationsparties.]

ANNEX 1

Methodology to assess average degradation in throughput and increase in unavailability for a non-geostationary system, due to the interference caused by another non-geostationary system operating co-frequency~~, for frequency ranges between 10.7 GHz and 52.4 GHz~~

This Annex provides the methodology which can be used to compute the ~~average~~ degradation in throughput and both relative and absolute increase in unavailability.

The short-term protection criterion compares link availability under time-varying propagation conditions to link availability under time varying propagation conditions with interference. The long-term protection criterion compares throughput under time-varying propagation conditions to throughput under time varying propagation conditions with interference.

1 Evaluation of the impact on link performance due to inter-system interference conditions

The procedures outlined in this Annex rely on the following principles:

Principle 1: The two time-varying sources of link performance degradation considered in the verification are link fading ~~(~~from rain~~) using the characteristics of the reference link~~ and inter-system interference. The total *C*/*N* in the reference bandwidth for a given carrier is:

$$C/N = C/(N_T + I) \quad (1)$$

where:

C: wanted signal power (W) in the reference bandwidth, which varies as a function of fades and of transmission configuration and also as a function of link geometry (as appropriate)

N_T: total system noise power (W) in the reference bandwidth

I: time-varying interference power (W) in the reference bandwidth.

Principle 2: The calculation of spectral efficiency is focused on satellite systems utilizing adaptive coding and modulation (ACM) by calculating the throughput degradation as a function of *C*/*N*, which varies depending on the propagation and interference impacts on the satellite link over the long term.

[*Principle 3:* During a fading event in the downlink direction, the rain rate for the interfering carrier(s) is(are) considered ~~attenuated by~~ the same ~~amount~~ as for the wanted carrier when the interfering space station is within [X°] of the main beam of the victim link. [This principle results in ~~slight~~ underestimation of the impact of the downlink interference.] For the other interfering carriers, a random rain rate (p={0:100%}) should be assumed. For the unavailability assessment, the interfering path should be considered in clear sky.]

[*Principle 4*: During a fading event in the uplink direction the interfering carrier(s) may not necessarily be attenuated by the same amount as the wanted carrier. Note: Further studies may be needed on Principle 4]

[Editor's note: Principles 3 and 4 should be reviewed once the algorithm in the section below is finalized.]

To assist administrations in seeking coordination between non-GSO systems, the approach described in this section provides a methodology to evaluate levels of permissible interference between the two non-GSO systems considered. To evaluate whether or not conditions of permissible interference are satisfied when a non-GSO system is involved, ~~data inputs~~characteristics of both the interfering and victim system should be taken into account. Consideration should also be given to the link type when evaluating whether or not conditions of permissible interference are satisfied as different link types have different availability requirements i.e. Gateway links vs user links. In some cases it may also be useful to consider alternative methods to assess the impact on link performance as agreed upon between administrations.

For an analysis of the interference environment, the ~~Data~~ data needed should~~to be considered in an interference evaluation would preferably~~ be ~~provided by~~exchanged between administrations ~~but in the case where data is not or cannot be provided by administrations such as in the case of predicting the interference environment for planning purposes~~ noting that the filing information of non-GSO systems may not contain all the necessary information for a representative analysis.~~could be taken into account.~~

The input parameters listed in Table ~~2~~1, or a subset of them, are to be determined , for each non-GSO link to be evaluated, in order to compute the interference statistics~~:~~. Those input parameters used for evaluating potential for interference heavily dictate the resultant interference statistics should remain within the envelope of the notified information.

TABLE 1

Input parameters

Parameter	Unit
Latitude, longitude and altitude of the ~~collocated~~ earth stations of the interfering and interfered-with satellite system/network	(°N, °E, m)
Orbital parameters of interfering satellite system/network	-
Orbital parameters of interfered-with satellite system/network	-
EIRP or PFD of interfering satellite system/network	dB(W/Hz) or dB(W/m^2/Hz)
EIRP or PFD of interfered-with satellite system/network	dB(W/Hz) or dB(W/m^2/Hz)
Antenna pattern of transmit antenna of interfering satellite system/network	-
Antenna pattern of receive antenna of interfered-with satellite system/network	-
Peak gain of transmit antenna of interfering satellite system/network	dBi
Peak gain of receive antenna of interfered-with satellite system/network	
Carrier frequency	GHz
Receiver system noise temperature of interfered-with satellite system/network	K
[C/I_Intra to characterized the Intra system noise of interfered-with satellite system/network]	dB
Tracking strategy[1] employed by the interfering satellite system/network	-
Tracking strategy[1] employed by the interfered-with satellite system/network	-
Minimum elevation of the interfering satellite system/network	deg

批注 **[4A2661]:** Proposed to be retained by some and proposed to be deleted by some

~~[1] The tracking strategy used by a non-GSO system could be in the form of a logical rule describing the pointing direction of the wanted earth station~~

Parameter	Unit
Minimum elevation of the interfered-with satellite system/network	deg
GSO avoidance angle of the interfering satellite system/network, if applicable	deg
GSO avoidance angle of the interfered-with satellite system/network, if applicable	deg
Option 1: *C/N* threshold for verifying compliance with the unavailability increase criteria Option 2: *C/N* unavailability threshold~~(s)~~[2] for verifying compliance with the unavailability increase and spectral efficiency decrease criteria	dB

批注 [4A2662]: The options shown here are each proposed to be deleted by some and retained by others.

The tracking strategy used by a non-GSO system could be in the form of a logical rule describing the pointing direction of the wanted earth station. The tracking strategy used for evaluating potential for interference heavily dictates the resultant interference statistics and hence if a non-GSO operator deviates from the tracking strategy, they must commit to not cause more interference and accept additional interference that may be received.

~~3.~~2 General algorithm

[Note: Further ~~studies will be conducted for non-collocated systems and interference of~~[consideration is needed on how to incorporate the impact from/study with regards to multiple sources of interference from non-colocated earth stations could be included as part of the studies, but in the methodology how to incorporate the impact from] multiple transmitters within a single interfering satellite system requires further discussion at WP 4A. Contributions are invited on this topic.]

批注 [4A2663]: This note is proposed to be retained by some and deleted by others.

~~3.2.1~~*Step 1:* identify whether the analysis is for the uplink or downlink direction

~~3.2.2~~*Step 2:* identify which of the input parameters in Table ~~2~~ 1 are needed

~~3.2.3~~*Step 3:* identify the ~~location of~~ victim link and interfering link(s) to evaluate the interference and their respective locations. Earth stations should be selected in locations with high, medium, and low rain conditions, respectively.

~~3.2.4~~*Step 4:* [select ~~one~~ carrier(s) of the interfering network/system and ~~one~~ carrier(s) of the victim network/system]

~~3.2.5~~*Step 5:* Perform a simulation of the interference environment and generate statistics of the faded C/N and C/N+I. At each simulated time step, carry out the following computations:

[Editor's note: It is to be noted that further work is required, in particular to:

- *Take into account Document 4A/317, in which WP 3M provides clarifications with regards to:*
  - The non-monotonic predicted rain attenuation for exceedance probabilities between 0.01% and 0.001%, and,
  - The non-zero predicted rain attenuation for exceedance probabilities greater than the slant path probability of rain.
    [Canadian view: since the behaviour of the rain attenuation pdf in the two points above is only relevant in cases where a full rain attenuation pdf is to be computed (e.g. in order to convolve it with another set of statistics), and since

[2] The unavailability threshold should be defined as the carrier-to-noise ratio (C/N) at which the wanted signal power is just sufficient to sign onto the network and lock the signal and/or sustain minimum user traffic. Typically, the C/N threshold should not be greater than 0 dB.

the methodology in this section computes the rain attenuation for a specific probability percentage at each time step (i.e. it does not compute the full rain attenuation pdf), these points may not need to be addressed here.]

- *Assess whether the probability used for the rain attenuation in the wanted (pc) and interfering (pi) carriers can be the same.*
[Canadian view: the study carried out in Doc. 3M/251 in 2017 found that there is a difference in the attenuation on the wanted and interfering links in different directions but that it has a limited impact on the total degradation of the link. As such, the study concludes that the attenuation on the wanted and interfering paths can be considered to be correlated, meaning that the same probability can be used for both paths.]
- Assess whether the time correlation for rain attenuation should be taken into account. It could be anticipated that this aspect may be important in particular for interference correlated in time such as between NGSO. In such case, ITU-R Recommendation P.1853 should be used.
[Canadian view: since the evaluation of the interference criteria in Step 3.2.8 does not require a comparison between two specific time steps, a Monte Carlo simulation using randomly generated probability values for rain attenuation would be sufficient.]
- ~~*It was noted that Recommendation P.618 has been revised and we need to ensure that the steps below accurately reflect this.*~~
[Canadian view: it is proposed below not to list the version number associated with Recommendation ITU-R P.618 so that this methodology is not version-specific. See proposed changes below]*]*

For each wanted link for a given wanted earth station location

- *{*

Calculate the wanted signal power:

$$C = eirp - L_{fs} + G_{max}$$

Calculate the thermal noise power using:

$$N_{T\sout{hermal}} = 10log(T \cdot B)\text{-}228.6\ (dBW)$$

[*Calculate the Intra-System noise power using:*

$$I_{Intra} = C - C/I_{Intra}$$

Calculate system noise power using:

$$N_T = 10log(10^{\frac{N_{Thermal}}{10}} + 10^{\frac{I_{Intra}}{10}})]$$

Calculate the rain attenuation (A_{rain_C}) on the wanted signal using the most-recent version of Recommendation ITU-R P.618 based on the location of the wanted earth station, the elevation angle of the wanted satellite as seen from the wanted earth station, and a probability percentage "p". If local measured data is not available, rain attenuation prediction method in section 2.2.1.1 of Recommendation ITU-R P.618-14 can be used.

Note:

Option 1: The probability percentage "p" should be assigned based on uniformly distributed random values of "p" between 0% and 100%. The rain attenuation should

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批注 [4A2664]: Proposed to be retained by some and proposed to be deleted by some.

be set to 0dB if p_max < p ≤ 100%, and it should be set equal to the rain attenuation corresponding to p=0.001% if p<0.001%. The rain attenuation prediction method in section 2.2.1.1 of Recommendation ITU-R P.618-14 can be used for exceedance probabilities between 0.001% and p_max. Here, p_max is the minimum value of a) 10% and b) the probability of rain attenuation on a slant path calculated from Section 2.2.1.2 of Recommendation ITU-R P.618-~~13~~14.

Option 2: The probability percentage "p" should be assigned based on uniformly distributed random values of "p" between 0% and p_max. Here, p_max is the minimum value of a) 10% and b) the probability of rain attenuation on a slant path calculated from section 2.2.1.2 of Recommendation ITU-R P.618-14. The rain attenuation prediction method in section 2.2.1.1 of Recommendation ITU-R P.618-14 can be used for exceedance probabilities between 0.001% and p_max. The rain attenuation should be set equal to the rain attenuation corresponding to p=0.001% if p<0.001%.

Option 3: The probability percentage "p" should be a value agreed upon by concerned parties.

Calculate the faded wanted signal power using:

$$C_f = C - A_{rain\_C}$$

Calculate the faded C/N using:

$$\frac{C}{N} = C_f - N_T$$

For each possible interference source within an interferer non-GSO system

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Calculate the rain attenuation (A_{rain_I}) on the interfering signal using the most-recent version of Recommendation ITU-R P.618 based on the location of the ~~wanted~~ earth station, the elevation angle ~~of the interfering satellite as seen from the wanted earth station~~, and the same probability percentage "p" as was used to compute A_{rain_C}.

Calculate the faded interference signal power using:

$$I = EIRP - A_{rain\_I} + G_{off\text{-}axis} - FSPL$$

}

Calculate aggregated interference I from interfering non-GSO system

$$I_{agg,linear} = \sum_{i=1}^{N} I_{i,linear}$$

Calculate the noise plus interference using:

$$(N_T + I) = 10\log\left(10^{N_T/10} + 10^{I/10}\right)$$

Calculate the faded C/(N+I) using:

$$\frac{C}{N+I} = C_f - (N_T + I)$$

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Compute the CDF of the faded C/N and faded C/N+I

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~~3.2.8~~*~~Step 6:~~* The faded *C*/*N* and faded *C*/(*N*+*I*) distributions should then be used to check against ~~the availability and spectral efficiency sharing criteria as follows~~one of the sets of criteria below:

Set of criteria #1

Step ~~3.2.8.26~~A: Check on unavailability increase

(i) Calculate the unavailability without and with consideration of interference as U_R and U_{RI}, respectively:

Option 1: Using the minimum threshold for the victim link, determine the following:

Option 2: Using the ~~minimum~~ unavailability threshold~~(~~s~~)~~ for the victim link(s), determine the following:

U_R = Sum of the probabilities from all bins for which $\frac{C}{N} < \left(\frac{C}{N}\right)_{Thr}$

U_{RI} = Sum of the probabilities from all bins for which $\frac{C}{N+I} < \left(\frac{C}{N}\right)_{Thr}$

(ii) Check condition to be verified for compliance:

$$U_{RI} \leq (1+X) \times U_R \text{ or } U_{RI} \leq Y + U_R, \text{ when } U_R \text{ is high}$$

$$U_{RI} \leq Y + U_R, \text{ when } U_R \text{ is low}$$

where X and Y are the probability and the sum of probabilities, respectively, of increase in unavailability, to be determined on a case-by-case basis.

Consideration should be given to the link type when determining Y and/or X as different link types may have different availability requirements, for example user terminal links vs gateway links.

There are two possible short-term metrics, a relative unavailability increase or an absolute unavailability increase. ~~When the availability of the interfered-with link in absence of interference from the other non-GSO system is significantly high, it is recommended to use absolute increase in unavailability.~~

~~[Editor's note: further input is required on what defines "high availability"]~~

Step ~~3.2.8.26~~B: Check on the time-weighted average spectral efficiency decrease

(i) Calculate the spectral efficiency without and with consideration of interference as SE_R and SE_{RI}, respectively:

Determine the long-term time-weighted average spectral efficiency, SE_R, assuming precipitation only by:

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Equation 2 or 3 of Recommendation ITU-R S.2131-1 should be used to convert the C/N to a spectral efficiency

Increment SE_R by the spectral efficiency multiplied by the probability associated with this C/N

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Determine the long-term time-weighted average spectral efficiency, SE_{RI}, assuming precipitation and interference by:

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批注 [4A2665]: The options shown here are each proposed to be deleted by some and retained by others.

Equation 2 or 3 of Recommendation ITU-R S.2131-1 should be used to convert the C/(N+I) to a spectral efficiency

Increment SE_{RI} by the spectral efficiency multiplied by the probability associated with this C/(N+I)

}

(ii) Check condition to be verified for compliance:

$SE_{RI} >= SE_R*(1 – Z)$, where Z is to be determined on a case-by-case basis]

Set of criteria #2

Step ~~3.2.8.26~~A: Check on unavailability increase

(i) Calculate the unavailability without and with consideration of interference as U_R and U_{RI}, respectively:

Option 1: Using the minimum threshold for the victim link, determine the following:

Option 2: Using the ~~minimum~~ unavailability threshold~~(s)~~ for the victim link(s), determine the following:

U_R = Sum of the probabilities from all bins for which $\frac{C}{N} < \left(\frac{C}{N}\right)_{Thr}$

U_{RI} = Sum of the probabilities from all bins for which $\frac{C}{N+I} < \left(\frac{C}{N}\right)_{Thr}$

(ii) Check condition to be verified for compliance:

$$U_{RI} \leq (1+X) \times U_R \text{ or } U_{RI} \leq Y+U_R, \text{ when } U_R \text{ is high}$$

$$U_{RI} \leq Y+U_R, \text{ when } U_R \text{ is low}$$

where X and Y are the probability and the sum of probabilities, respectively, of increase in unavailability, to be determined on a case-by-case basis.

Consideration should be given to the link type when determining Y and/or X as different link types may have different availability requirements, for example user terminal links vs gateway links.

There are two possible short-term metrics, a relative unavailability increase or an absolute unavailability increase. ~~When the availability of the interfered-with link in absence of interference from the other non-GSO system is significantly high, it is recommended to use absolute increase in unavailability.~~

~~*[Editor's note: further input is required on what defines "high availability"]*~~

[Editor's note: "time-weighted average" spectral efficiency decrease methodology is unable to protect specific and critical performance objectives of non-GSO systems and should not be considered in this potential recommendation. The spectral efficiency decrease should not be based on total capacity, rather it should be based on the reserve capacity. The concept of reserve capacity, provided in ITU-R S.1323, should be considered. The section below need to be further developed accordingly.]

[*Step ~~3.2.8.26~~B: Check on the ~~time-weighted average~~ spectral efficiency decrease*

(i) Calculate the spectral efficiency without and with consideration of interference as SE_R and SE_{RI} corresponding to a certain percentage of time (between 90% and 99%), respectively:

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批注 [4A2666]: The options shown here are each proposed to be deleted by some and retained by others.

Determine the ~~long-term time-weighted average~~ spectral efficiency, SE_R, assuming precipitation only by:

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Equation 2 or 3 of Recommendation ITU-R S.2131-1 ~~should~~ may be used to convert the C/N to a spectral efficiency

~~Increment~~ Compute the SE_R ~~by the spectral efficiency multiplied by the probability~~ associated with this C/N

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Determine the ~~long-term time-weighted average~~ spectral efficiency, SE_{RI}, assuming precipitation and interference by:

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Equation 2 or 3 of Recommendation ITU-R S.2131-1 ~~should~~ may be used to convert the C/(N+I) to a spectral efficiency

~~Increment~~ Compute the SE_{RI} ~~by the spectral efficiency multiplied by the probability~~ associated with this C/(N+I)

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(ii) Check condition to be verified for compliance:

$SE_{RI} >= SE_R*(1 – Z)$, where Z is to be determined on a case-by-case basis]

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