RECOMMENDATION ITU-R F.1609-1

Interference evaluation from fixed service systems using high altitude platform stations to conventional fixed service systems in the bands 27.5-28.35 GHz and 31-31.3 GHz

(Question ITU-R 212/9)

(2003-2006)

Scope

This Recommendation describes interference evaluation methodologies from the fixed service (FS) using high altitude platform stations (HAPS) to conventional FS systems in the bands 28 GHz (27.5-28.35 GHz) and 31 GHz (31-31.3 GHz). Examples of interference calculations using these methodologies are also provided in Annexes 1 to 3 for both point-to-point and point-to-multipoint fixed wireless access (FWA) stations.

The ITU Radiocommunication Assembly,

considering

a) that new technology utilizing high altitude platform stations (HAPS) in the stratosphere is being developed;

b) that since the 47 GHz bands, stated in *recognizing* a) below, are more susceptible to rain attenuation in those countries listed in Nos. 5.537A and 5.543A of the Radio Regulations (RR), the frequency range 18-32 GHz has been studied in ITU-R for possible identification of additional spectrum;

c) that the bands 27.5-28.35 GHz and 31-31.3 GHz are allocated to the FS on a primary basis,

recognizing

a) that WRC-97 made provisions for operation of HAPS within the fixed service (FS) in the bands 47.2-47.5 GHz and 47.9-48.2 GHz;

b) that RR No. 5.537A states that the allocation to the FS in the band 27.5-28.35 GHz may also be used by HAPS in the listed countries, and the use by HAPS is limited to operation in the HAPS-to-ground direction and shall not cause harmful interference to, nor claim protection from, conventional types of FS systems or other co-primary services;

c) that RR No. 5.543A states that the allocation to the FS in the band 31-31.3 GHz may also be used by HAPS in the ground-to-HAPS direction in the listed countries, and the use by HAPS shall not cause harmful interference to, nor claim protection from, conventional types of FS systems or other co-primary services, taking into account RR No. 5.545;

d) that RR No. 5.543A also states that the use of HAPS in the band 31-31.3 GHz shall not cause harmful interference to the passive services having a primary allocation in the band 31.3-31.8 GHz, taking into account the interference criteria given in Recommendations ITU-R SA.1029 and ITU-R RA.769;

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e) that Resolution 145 (WRC-03) urgently requested studies on technical, sharing and regulatory issues in order to determine criteria for the operation of HAPS in the bands 27.5-28.35 GHz and 31-31.3 GHz,

recommends

1 that the methodologies contained in Annexes 1 and 2 may be used to evaluate interference from a HAPS-based system to a conventional FS system (point-to-multipoint (P-MP) and point-to-point (P-P)) (see Note 1 and Note 2);

2 that the methodology contained in Annex 3 may be used to evaluate interference from a HAPS to a conventional FS system in the 27.5-28.35 GHz band;

3 that the methodologies contained in Annexes 1, 2 and 3 may be used to develop bilateral agreements between administrations.

NOTE 1 – Recommendation ITU-R F.1569 should be referred to for typical parameters regarding a HAPS-based system.

NOTE 2 – The interference evaluation from a HAPS-based system to the fixed wireless access (FWA) system is discussed for the worst interference scenario in Annex 1 and Annex 2. Adopting interference mitigation techniques described in Recommendation ITU-R F.1608 may shorten the required separation distance.

NOTE 3 – In Annexes 1 and 2, the numerical parameter such as transmission output is fixed. For other parameters, it will not be as difficult to calculate on the basis of the results described there. Furthermore, Recommendation ITU-R F.758 lists some system parameters, some of which include the worst case from the viewpoint of the interference issues.

Annex 1

Methodology for interference evaluation from systems in the FS using HAPS to FWA systems (P-MP) in the bands 27.5-28.35 GHz and 31-31.3 GHz

1 Introduction

This Annex provides a methodology for interference evaluation, technical parameters, and operational techniques to be used for sharing studies between systems in the FS using HAPS and FWA systems operating in P-MP in the bands 27.5-28.35 GHz and 31-31.3 GHz. P-MP systems normally consist of one base station and several subscriber stations.

In the FWA system, there is no rule to use these two frequency bands between FWA base station and FWA subscriber station. Therefore, all interference situations have to be considered.

2 Calculation methodology of interference from HAPS-based system to FWA system (P-MP)

2.1 Interference from HAPS airship to FWA station

The interference power from the spot beam of HAPS airship to FWA station, I (dB(W/MHz)), is obtained by equation (1).

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$$I = P_{Tx_H_mB_n} + G_{Tx_H_mB_n}(\theta_{H_mB_n_F}) - L_S - L_{AtmHm_F} + G_{Rx_FWA}(\theta_{F_H_m}) - L_{fRx_FWA} \quad (1)$$

where:

$P_{Tx_H_mB_n}$: transmission power density of spot beam (B_n) of HAPS (H_m) (dB(W/MHz))

$G_{Tx_H_mB_n}(\theta_{H_mB_n_F})$: antenna gain of spot beam of HAPS airship toward the direction of FWA station (dBi)

L_S: free space pass loss between HAPS airship and FWA station (dB) shown in the following:

$$L_S = 20 \log\left(\frac{4\pi d \times 1\,000}{\lambda}\right)$$

d: distance between HAPS airship and FWA station (km)

λ: wave length (m)

L_{AtmHm_F}: atmospheric absorption loss between HAPS airship and FWA station (dB) (for details, refer to Appendix 1 to Annex 1 and Annex 2 which is based on Recommendation ITU-R F.1404, where absorption is denoted by $A(h,\theta)$)

$G_{Rx_FWA}(\theta_{F_H_m})$: receive antenna gain of FWA station toward the direction of HAPS airship (dBi)

L_{fRx_FWA}: feeder loss of FWA station in the receive side (dB).

The ratio of the interference power to the receiver thermal noise, I/N, is obtained by equation.

$$I/N = I - 10 \log(293 \times k \times 10^{NF/10} \times 10^6) \quad \text{dB} \quad (2)$$

where:

k: Boltzmann's constant = 1.38×10^{-23}(J/K)

NF: noise figure of FWA station (dB).

2.2 Interference from HAPS ground station to FWA station

The interference power from HAPS ground station to FWA station, I (dB(W/MHz)), is obtained by equation (3).

$$I = P_{Tx_GS} - L_{fTx_GS} + G_{Tx_GS}(\theta_{H_F}) - L_s - L_{Atm} - L_{Obs} + G_{Rx_FWA}(\theta_{F_H}) - L_{fRx_FWA} \quad (3)$$

where:

P_{Tx_GS}: transmission power density from HAPS ground station (dB(W/MHz))

L_{fTx_GS}: feeder loss of HAPS ground station (dB)

$G_{Tx_GS}(\theta_{H_F})$: antenna gain of HAPS ground station toward the direction of FWA station (dBi)

L_S: free space pass loss between HAPS ground station and FWA station (dB)

L_{Atm}: atmospheric absorption loss between HAPS ground station and FWA station (dB), which is calculated by using Recommendation ITU-R P.676

L_{Obs}: shielding loss between HAPS ground station and FWA station (it is not included in the calculation of required separation distance) (dB)

$G_{Rx_FWA}(\theta_{F_H})$: receiving antenna gain of FWA station toward the direction of HAPS ground station (dBi)

L_{fRx_FWA}: feeder loss in FWA station (dB).

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The ratio *I*/*N* is obtained by equation (2).

3 Assumptions for interference evaluation

3.1 HAPS system

The parameters of HAPS system are described in Recommendation ITU-R F.1569.

3.2 FWA system with P-MP operation

Section 1 in Appendix 2 describes the assumed parameters of the FWA system with P-MP operation to carry out the interference evaluation, which includes base station and subscriber station.

As for the FWA base station, the following three cases are considered from the viewpoint of antenna beam pattern and scheme of frequency reuse. Herein, it is assumed that the base stations are geographically installed every 2 km.

Case a): Assumed antenna beam pattern is based on Recommendation ITU-R F.1336 and frequency reuse is seemed to be comparatively realistic (segmented 4×4 frequency bands are used by four base stations and its antenna beam is 90° sector: a group of four stations is repeatedly installed).

Case b): Assumed antenna beam pattern is based on Recommendation ITU-R F.1336 and all base stations use same frequency assigned for the base station (therefore, omni pattern is assumed in azimuth direction).

Case c): Assumed antenna beam pattern is a reasonably realistic one, which many service providers would adopt (not listed in Recommendation), and frequency reuse scheme is the same as in Case a).

4 Examples of calculation result in the case of FWA system with P-MP operation

This section shows examples of calculated *I*/*N* characteristics and required separation distance. Regarding the system parameters of the FWA system with P-MP operation, three Cases a), b) and c) are considered for the base station. It is also supposed that the same type of FWA subscriber station is used for three base stations.

4.1 Interference from HAPS airship to FWA system

In examination of the interference from the HAPS airship to the FWA base station, it is supposed that 11×21 HAPS airships are deployed in the area of 500 km × 1 000 km. The *I*/*N* characteristics are evaluated as a function of distance between the FWA station and the nadir point of the HAPS airship locating in the middle of the 1 000 km side.

Through the calculation, it is assumed that the main beam of the FWA base station always directs toward the horizontal direction. On the other hand, it is supposed herein for the sake of the worst-case analysis that the FWA subscriber station directly points the HAPS airship up to 60° in elevation.

4.1.1 Interference from HAPS airship to FWA base station

Figures 1 and 2 show the *I*/*N* characteristics of the FWA base station of Cases a) and b) respectively, when it is subject to the interference from 11×21 multiple HAPS airships (refer to Fig. 3). The notation “front” in Fig. 1 means that the base stations point toward the centre of multiple HAPS airships face-to-face in azimuth direction. The “side” and “back” indicate the

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conditions that the base station sees the airship on its side and at its back, respectively. The indicated *I*/*N* shows the worst value among all spot beams of HAPS airships using frequency reuse scheme.

From both Figures, it is seen that the maximum *I*/*N* is about −15 dB. Therefore, under the conditions made here, it is said that the multiple HAPS airships may not give serious interference to the FWA base station. It is noted that front is equal to side and back in Fig. 2, because the antenna pattern is assumed to be omni characteristics in azimuth direction.

When the reasonably realistic beam pattern is used for the FWA base station as in Case c), the *I*/*N* is slightly reduced as shown in Fig. 4. In Case c), the maximum *I*/*N* is about −20 dB.

FIGURE 1

***I*/*N* characteristics in FWA base station of Case a) when interfered from 11 × 21 multiple HAPS airships**

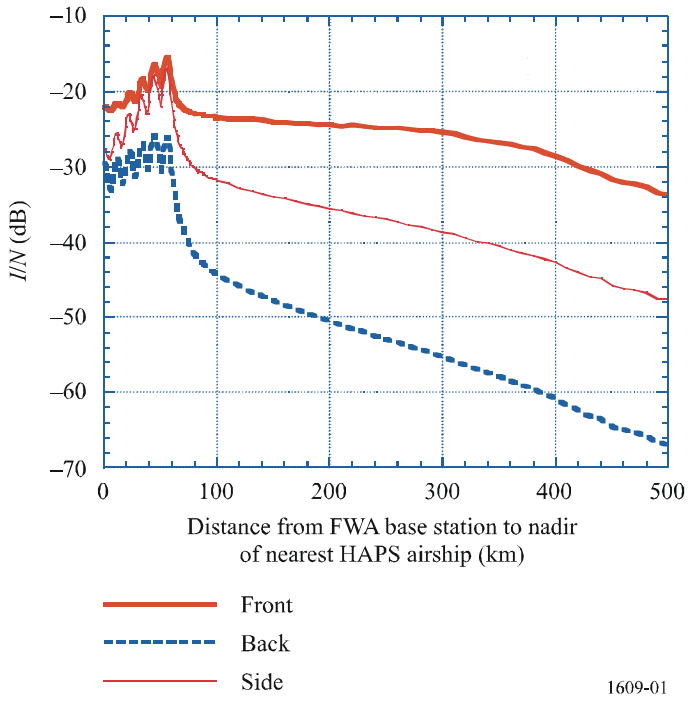

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FIGURE 2

***I/N* characteristics in FWA base station of Case b) when interfered from 11 × 21 multiple HAPS airships**

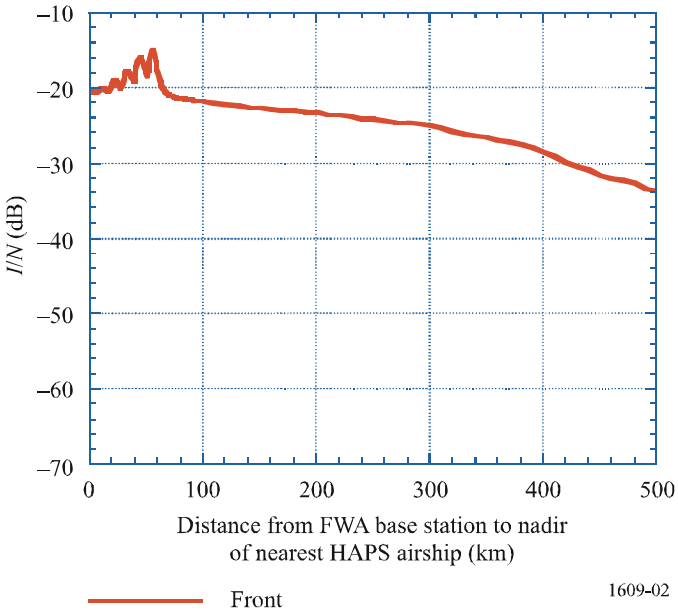

FIGURE 3

HAPS airships located in 500 × 1 000 km area

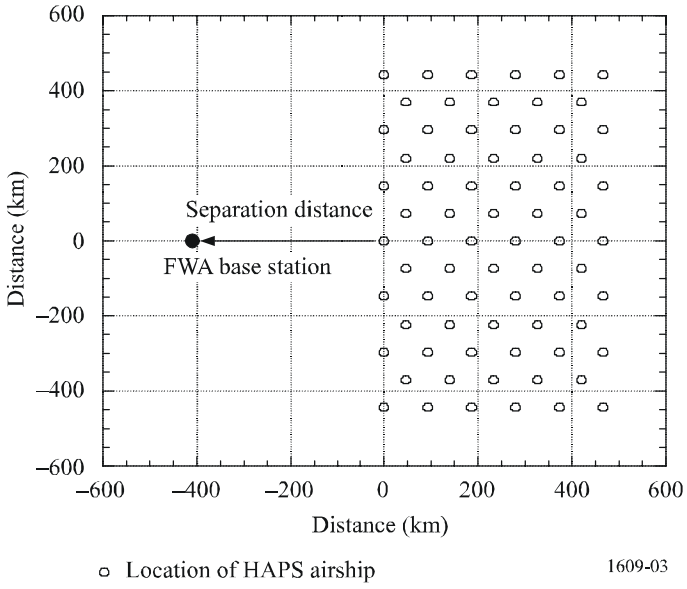

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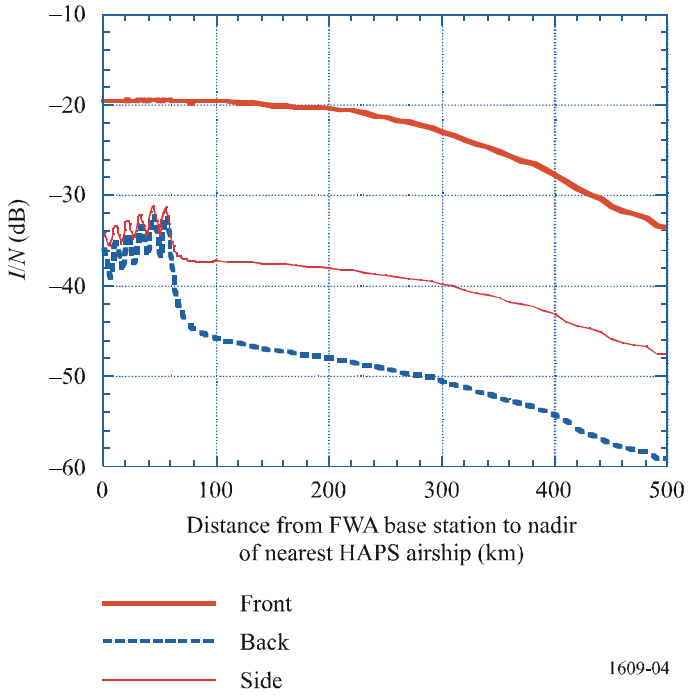
FIGURE 4
***I*/*N* characteristics in FWA base station of Case c) when interfered from 11 × 21 multiple HAPS airships**



4.1.2 Interference from HAPS airship to FWA subscriber station

Concerning the *I*/*N* characteristic of the FWA subscriber station, when interfered from a single HAPS airship, the worst *I*/*N* becomes a large value of about 30 dB as shown in Fig. 5. It is due to larger antenna gain of the FWA subscriber station than that of the base station and to the assumption that the FWA subscriber antenna directly points the HAPS airship with limitation of maximum elevation angle of 60°. Therefore, the HAPS airship will induce large interference to the subscriber station when the same frequency is used. It is noted in Fig. 5 that the distance of 200 km corresponds to the transition point for the use of 30 cm diameter antenna to that of 60 cm diameter antenna (refer to Note 1 of Table 2).

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