

RECOMMENDATION ITU-R F.1402*, **

FREQUENCY SHARING CRITERIA BETWEEN A LAND MOBILE WIRELESS ACCESS SYSTEM AND A FIXED WIRELESS ACCESS SYSTEM USING THE SAME EQUIPMENT TYPE AS THE MOBILE WIRELESS ACCESS SYSTEM

(Questions ITU-R 215/8 and ITU-R 140/9)

(1999)

1 Introduction

Nowadays, technology of land-mobile systems is used for fixed wireless access (FWA) systems. Such FWA systems are becoming popular and implemented at a remarkable speed, since large demands for mobile communications bring about economical equipment production for this application. In this Recommendation, a land mobile system is called mobile wireless access (MWA) system, and the FWA system that utilizes the same type of equipment as the MWA is called MWA-based FWA system or simply FWA system. These terminologies are based on Recommendation ITU-R F.1399.

In most cases, such FWA systems are designed in the same frequency band as the MWA systems to enhance the manufacturing efficiency. Therefore it is an urgent and critical subject to study the sharing criteria, particularly necessary geographical separation, between both systems.

Such criteria is needed when one administration wishes to utilize the frequency band with dual allocations (i.e. to the fixed and the mobile services) for both FWA and MWA applications in certain geographical separation.

Recommendation ITU-R F.1334 presents a statistical technique for calculating interference conditions for the cases that the land-mobile system and fixed system use different types of equipment from each other. With the purview of providing complementary information, this Recommendation mainly describes interference between an MWA system and an FWA system using the same type of equipment with the same design parameters.

2 Scope

This Recommendation describes the frequency sharing criteria between the FWA and MWA systems on the assumption that both systems use the same frequency and type of equipment. Necessary geographical separations between both systems are calculated for the cases that the systems employ time division duplex (TDD) or frequency division duplex (FDD).

3 References

Recommendation ITU-R F.1334: Protection criteria for systems in the fixed service sharing the same frequency bands in the 1 to 3 GHz range with the land mobile service;

Recommendation ITU-R F.1399: Vocabulary of terms for wireless access;

* This Recommendation was developed jointly by Radiocommunication Study Groups 8 (Working Party 8A) and 9 (Working Party 9B), and any further revision should also be undertaken jointly.

** This draft new Recommendation should be brought to the attention of Radiocommunication Study Groups 3 (Working Party 3K) and 8 (Working Party 8A).

4 Recommendation

4.1 Interference model

The prerequisites for setting an interference model are as follows:

- The MWA and FWA system use equipment with the same specifications.
- The MWA and FWA systems are point-to-multipoint systems.
- The MWA and FWA systems employ either TDD or FDD for duplexing.

Figure 1 shows an interference model, where various interference can be classified into the following eight types:

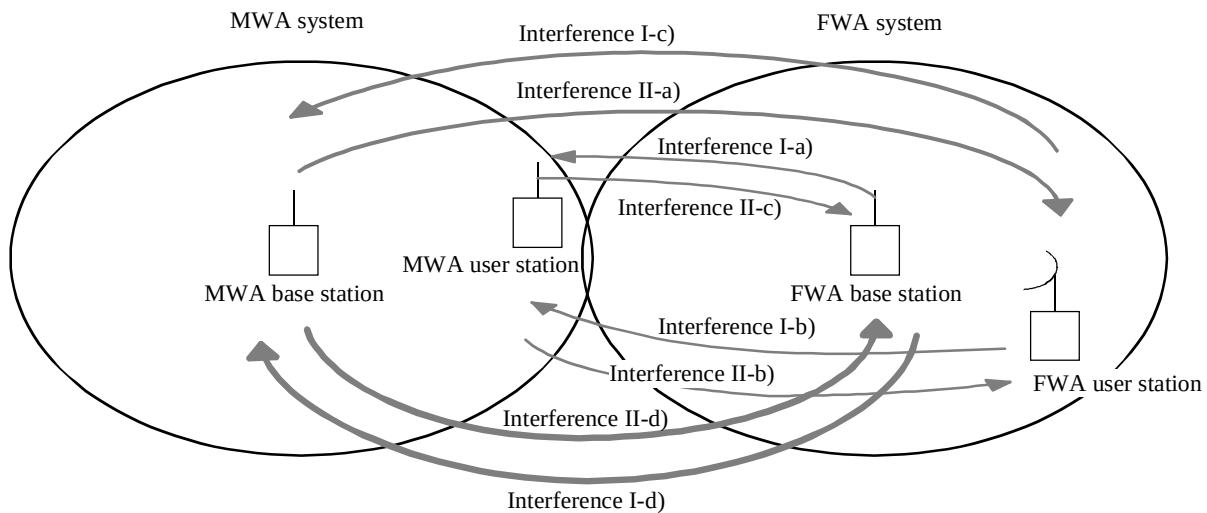
Case I: MWA system is interfered-with side

- I-a) FWA base station $\Rightarrow$ MWA user station
- I-b) FWA user station $\Rightarrow$ MWA user station (TDD system only)
- I-c) FWA user station $\Rightarrow$ MWA base station
- I-d) FWA base station $\Rightarrow$ MWA base station (TDD system only)

Case II: FWA system is interfered-with side

- II-a) MWA base station $\Rightarrow$ FWA user station
- II-b) MWA user station $\Rightarrow$ FWA user station (TDD system only)
- II-c) MWA user station $\Rightarrow$ FWA base station
- II-d) MWA base station $\Rightarrow$ FWA base station (TDD system only).

FIGURE 1
Interference model



I-d) and II-d): dominant interference in TDD environment
I-c) and II-c): dominant interference in FDD environment

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4.2 Dominant interference

If the service areas of the FWA and MWA systems are fully separated from each other, the greatest factor determining interference level is not an individual position of the stations, i.e. the distance between the interference source and the interfered-with equipment. Interference level depends on the transmit output power, antenna gain, antenna height and the direction of the antenna main beam.

It is assumed that in the above eight types of interference the line-of-sight path is maintained with no obstacles. Concerning the antenna type only FWA user stations employ directive antennas, while other three kinds of stations use omnidirectional or sectorized type.

In Case I for FDD environment, interference I-c) is considered to be more critical than interference I-a), because FWA user station has directive antenna. Similar consideration is applied in Case II for FDD environment.

In case I for TDD environment, interference I-d) is considered to be more critical than interference I-c), because the FWA base station is located at a higher point so that it covers the area, and the propagation condition between MWA base station and FWA base station is better than that between MWA base station and FWA user station. Similar consideration is applied in Case II for FDD environment.

Consequently, the sharing criteria should be determined by considering the following dominant interference:

a) *Case I:*

- TDD environment: I-d) FWA base station $\Rightarrow$ MWA base station
- FDD environment: I-c) FWA user station $\Rightarrow$ MWA base station.

b) *Case II:*

- TDD environment: II-d) MWA base station $\Rightarrow$ FWA base station
- FDD environment: II-a) MWA base station $\Rightarrow$ FWA user station.

It should be noted that the same combination of interference with opposite direction, i.e. I-d) and II-d), or I-c) and II-a), will result in the same level since MWA and FWA use the same system parameters.

Moreover, it should be noted that if the synchronization of TDD transmission within the system and with the interfering system is achieved in TDD environment, the combination for FDD environment can be applied.

In the above interference a directive antenna at an FWA user station is oriented toward the MWA base station. In addition the worst case is assumed when an FWA user station is located near the FWA base station.

4.3 Protection criteria for MWA systems from FWA system interference

4.3.1 Conditions under TDD environment

The interference level I (dBm) (median value) at the MWA base station can be calculated as follows:

$$I = P_{tC} - L_{fC} - L_{fB} + G_C + G_B - L \quad (1)$$

where:

- L : propagation loss (dB)
- P_{tC} : transmit power of FWA base station (dBm)
- L_{fC} : feeder loss of FWA base station (dB)
- L_{fB} : feeder loss of MWA base station (dB)
- G_C : antenna gain of FWA base station (dBi)
- G_B : antenna gain of MWA base station (dBi).

Then, the maximum allowable interference level for the MWA system can be calculated as follows:

$$I < N_B + X \quad (2)$$

where:

- N_B : thermal noise level at the MWA receiver (dBm)
- X : allowable relative (I/N) ratio at the long term criteria (dB).

X indicates the allowable interference compared with the thermal noise. For the MWA system operating at a threshold related to the thermal noise, it is required that the mutual influence of MWA and FWA is minimal (say, 1 dB); in this case the interference must be approximately 6 dB below thermal noise, and X will be around -6 dB.

In some cases, the mutual influence of MWA and FWA can be the same level as thermal noise to improve the geographically efficient sharing, and in this case X will be around 0 dB.

Another possible approach for the frequency sharing is that some level of interference is accepted for both MWA and FWA, because this system has the interference avoidance functions. Although the traffic capacity may be reduced, the system can be operated even when there is some interference. In this case, X can be greater than 0 dB and the separation distance will become shorter.

In the link design of FWA systems, L is usually calculated from the free-space propagation when sufficient Fresnel radius is obtained. On the other hand, in case of MWA systems a different approach may be adopted. It is very likely that the propagation path with sufficient Fresnel radius is not obtained for each interference path in Fig. 1. In such cases propagation loss greater than the free-space propagation is anticipated. Suppose that the propagation loss at the distance d is expressed by $L(d)$, the minimum distance d_{min} between both stations is given by the following formula derived from formulas (1) and (2):

$$L(d_{min}) = P_{tC} - L_{fC} - L_{fB} + G_C + G_B - (N_B + X) \quad (3)$$

4.3.2 Conditions under FDD environment

Under the FDD environment, the minimum distance d_{min} between both stations can be calculated for different dominant interference but in the same way as follows;

$$L(d_{min}) = P_{tS} - L_{fS} - L_{fB} + G_S + G_B - (N_B + X) \quad (4)$$

where:

P_{tS} : transmit power of FWA user station (dBm)

L_{fS} : feeder loss of FWA user station (dB)

G_S : antenna gain of FWA user station (dBi).

4.4 Protection criteria for FWA systems from MWA system interference

The protection criteria for FWA systems from MWA system interference can be derived from the results in the previous section. As mentioned before, in Case II the interference levels of II-d) and II-a) are equivalent to those of I-d) and I-c) in Case I.

4.5 Examples of the calculation

Examples of the interference calculation based on the actual system are shown in Annexes 1 and 2.

ANNEX 1

Examples of calculation of interference conditions in the 1.9 GHz band

The example below shows how to calculate the conditions between a personal handy-phone system (PHS) and PHS-FWA (or PHS-WLL (wireless local loop)) in the 1.9 GHz band (TDD environment). Even under other environments, similar results will be obtained by changing the parameters.

PHS technology employs dynamic channel assignment (DCA). By using this technology, more than one system, possibly operated by different operators, share the same radio channels avoiding the use of the same frequency at each time slot.