International Telecommunication Union

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Recommendation ITU-R M.1739
(03/2006)

Protection criteria for wireless access systems, including radio local area networks, operating in the mobile service in accordance with Resolution 229 (WRC-03) in the bands 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz

M Series

Mobile, radiodetermination, amateur and related satellite services

International Telecommunication Union

Foreword

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RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R M.1739

Protection criteria for wireless access systems, including radio local area networks, operating in the mobile service in accordance with Resolution 229 (WRC-03) in the bands 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz

(2006)

Scope

This Recommendation provides protection criteria for wireless access systems, including radio local area networks (WAS/RLAN), operating in the mobile service in accordance with Resolution 229 (WRC-03), for the purposes of carrying out compatibility studies with services or applications from which WAS/RLAN systems are to be protected.

The ITU Radiocommunication Assembly,

considering

a) that wireless access systems (WAS), including radio local area networks (RLANs) provide effective broadband solutions;

b) that while some administrations do not afford protection for WAS/RLAN stations in their national rules, other administrations afford protection for WAS/RLAN stations in their national rules;

c) that for the purposes of carrying out compatibility studies regarding services or applications from which WAS/RLAN systems are entitled to be protected, the development of a Recommendation defining protection criteria for WAS/RLAN stations operating in accordance with Resolution 229 (WRC-03) is desirable,

recognizing

a) that there are primary allocations to the mobile service in the bands 5 150-5 350 MHz and 5 470-5 725 MHz for the implementation of WAS, including RLANs (WAS/RLAN);

b) that WAS/RLAN systems operating in accordance with Resolution 229 (WRC-03) should not suffer significant data rate and/or range impairments as a result of interference from services or applications from which WAS/RLAN systems are entitled to protection, but may not claim protection from, and shall not cause interference to, certain other primary services as defined in the Radio Regulations;

c) that some limited degree of interference or interference potential from services or applications from which WAS/RLAN systems are entitled to protection must be tolerated by WAS/RLAN stations,

noting

a) that an analysis of the effects of interference on WAS/RLAN systems is contained in Annex 1, *recommends*

1 that, for the purposes of conducting compatibility studies with respect to services or applications from which WAS/RLAN systems are entitled, according to their status, to be protected, the protection criteria for WAS/RLAN systems operating in the mobile service in accordance with Resolution 229 (WRC-03) should be as follows:

– the *I*/*N* ratio at the WAS/RLAN receiver should not exceed –6 dB, assuring that degradation to a WAS/RLAN receiver's sensitivity will not exceed approximately 1.0 dB as described in Annex 1.

Annex 1

Development of the protection criteria for WAS/RLAN systems operating in the mobile service in accordance with Resolution 229 (WRC-03) in the bands 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz

1 Analysis of typical WAS/RLAN range/data rate performance without interference

For typical WAS/RLAN system deployments, an appropriate path-loss model is free space (r^2) up to a breakpoint of 5 m, and r^4 after that. This model offers a simple, but reasonably realistic approximation of propagation at the frequencies in question in a typical modern indoor office environment consisting primarily of relatively open "cubicle" space with a variety of moderate obstructions and reflective surfaces.

For WAS/RLAN systems operating under the provisions of Resolution 229 (WRC-03) the frequency of operation is in the 5 GHz range.

As a representative system, for the sake of analysis, a system with 20 dBm transmit power, a 20 MHz bandwidth, a 5 dB noise figure, and 0 dBi antennas at both ends of the link between the WAS/RLAN transmitter and the intended receiver is modelled.

Given these basic system parameters, and the required *S*/*N* ratio to achieve various standard data rates, the achievable ranges at those various standard data rates without interference are given in Table 1.

TABLE 1

Achievable range vs. data rate without interference

Data rate (Mbit/s)	Required *S*/*N* (dB)	Range (m)
54	25	29.1
48	22	34.6
36	19	41.1
24	16	48.8
18	13	58.0
12	10	68.9
9	8	77.4
6	5	91.9

2 Analysis of typical WAS/RLAN range and/or data rate degradation with interference

A 5% reduction in the range at which a given data rate can be maintained compared to the non-interfered range achievable at the same data rate is considered to be an acceptable level of degradation for WAS/RLAN systems to tolerate from services or applications from which WAS/RLAN systems are entitled to protection. However, larger degradations in range, or reductions in rate at range, would be considered unacceptable because they would represent too large an adverse impact on WAS/RLAN system performance (technically and/or economically).

To determine what level of interference would result in a 5% reduction in range at standard data rates, we can calculate what reduction in signal power (this is equivalent to a rise in the noise floor since both result in a reduced link budget) would produce the required *S*/*N* at this reduced range.

TABLE 2

Range reduction vs. link budget reduction

Data rate (Mbit/s)	Range reduced by 5% (m)	Link budget reduction (dB)
54	27.6	0.90
48	32.8	0.90
36	39.0	0.90
24	46.4	0.88
18	55.1	0.89
12	65.5	0.89
9	73.5	0.89
6	87.3	0.90

This reduction in the link budget can be related to an interference power in the following way. Consider a receiver with a noise floor (based on the noise bandwidth and thermal noise) of *N* dB. Imagine also that this receiver is subjected to a level of noise within that bandwidth at the level of *I* dB. This interference, *I* dB, will lead to a rise in the noise floor of *R* dB above the thermal noise level of *N* dB.

$$R = 10\log(10^{N/10} + 10^{I/10}) - 10\log(10^{N/10})$$

$$R = 10(\log(10^{N/10} + 10^{I/10}) - \log(10^{N/10}))$$

$$R = 10\left(\log\frac{(10^{N/10} + 10^{I/10})}{10^{N/10}}\right)$$

$$R = 10(\log(1 + 10^{(I-N)/10}))$$

or

$$I - N = 10(\log(10^{R/10} - 1))$$

Using this expression it is possible to relate the rise in the noise floor resulting in the 5% reduction in range to an equivalent amount of interference in the receiver, relative to the noise floor. Those levels are:

TABLE 3

Link budget reduction vs. *I*/*N* ratio

Data rate (Mbit/s)	**Link budget reduction (dB)**	***I*/*N* (dB)**
54	0.90	–6.4
48	0.90	–6.4
36	0.90	–6.4
24	0.88	–6.5
18	0.89	–6.4
12	0.89	–6.4
9	0.89	–6.4
6	0.90	–6.4

Thus, a 5% reduction range reduction at any standard WAS/RLAN data rate will result from an interfering signal about 6.5 dB below the WAS/RLAN receiver's noise floor.

3 Analysis of the effects of different propagation models on the results

This same calculation can be repeated for different propagation models. For instance, instead of r^4 propagation, the effects of $r^{3.2}$ propagation can be evaluated as follows:

TABLE 4

Range/rate degradation of 5% for path loss exponent = $r^{3.2}$

Data rate (Mbit/s)	**Required *S*/*N* (dB)**	**Range (m)**	**Range reduced by 5% (m)**	**Link budget reduction (dB)**	***I*/*N* (dB)**
54	25	45.1	42.9	0.71	–7.5
48	22	56.0	53.2	0.72	–7.4
36	19	69.5	66.0	0.72	–7.4
24	16	86.3	82.0	0.71	–7.5
18	13	107.1	101.7	0.71	–7.5
12	10	132.8	126.2	0.71	–7.5
9	8	153.4	145.7	0.71	–7.5
6	5	190.4	180.9	0.71	–7.5

Note that with the more optimistic propagation model the *I*/*N* ratio requirement has become more stringent by approximately 1 dB.

The effects of using free space (r^2) propagation can be evaluated as follows:

TABLE 5

Range/rate degradation of 5% for path loss exponent = r^2

Data rate (Mbit/s)	Required *S*/*N* (dB)	Range (m)	Range reduced by 5% (m)	Link budget reduction (dB)	*I*/*N* (dB)
54	25	169.0	160.6	0.45	–9.6
48	22	238.8	226.8	0.45	–9.6
36	19	337.3	320.4	0.45	–9.6
24	16	476.4	452.6	0.45	–9.6
18	13	673.0	639.3	0.45	–9.6
12	10	950.6	903.1	0.45	–9.6
9	8	1 196.8	1 136.9	0.45	–9.6
6	5	1 690.5	1 606.0	0.45	–9.6

In the case of the most optimistic propagation model (free space propagation) the required *I*/*N* ratio has become even more stringent.

4 Summary of the results of the interference analysis

It can be seen from these results that if more optimistic (closer to free space) propagation models are assumed, the more the impact of interference sources on WAS/RLAN performance increases and the more negative the *I*/*N* ratio must be to keep the adverse effects on the WAS/RLAN system within acceptable bounds.

Since the model used in the initial example (free space (r^2) up to a breakpoint of 5 m, and r^4 after that) is typical for areas where large numbers of WAS/RLAN devices are being, and will increasingly be, deployed, and offers a less stringent *I*/*N* ratio compared to more optimistic propagation models (approaching free space propagation), it is reasonable to set the protection criteria for WAS/RLAN devices on the basis of the effects of interferers in that propagation environment. Therefore, an *I*/*N* of –6 dB is appropriate for carrying out compatibility studies between WAS/RLAN systems operating under the mobile service and other services or applications in the 5 GHz range from which WAS/RLAN systems are entitled to protection.