Radiocommunication Study Groups

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World Broadcasting Unions – Technical Committee

PRELIMINARY DRAFT REVISION OF RECOMMENDATION ITU-R M.1450-5

Characteristics of Broadband Radio Local Area Networks

Introduction

A number of administrations have recently made all or portions of the 6 GHz band (5 925 to 7 125 MHz) available for Wireless Access Systems (WAS), also called Radio Local Area Networks (RLANs). RLAN operations have been allocated in other bands as a mobile service with a number of technical and operational restrictions. [See Res. 229 (Rev. WRC-19)] No RLAN allocation presently exists for the 6 GHz band, however. RLAN operations must be subject to the conditions that no interference is caused to allocated services operating in accordance with the RR and that any interference to RLAN operations must be accepted.

In order to ensure that the performance of allocated systems is not compromised, spectrum sharing rules must be defined. Sharing and compatibility studies of WAS/RLAN systems have been undertaken or are being proposed for protection of a number of allocated services, but there are no apparent sharing studies involving RLANs and Electronic Newsgathering (ENG) systems operating in the 6 GHz band provided for consideration by WP5A.

ENG systems operate in the mobile service and are typically unidirectional, so they include passive receivers that must be protected and may be located far from an associated transmitter. ENG systems also may operate both indoors and outdoors, so sharing with RLAN systems must consider both scenarios. A number of interference mitigation schemes have been required or proposed to protect allocated services including ENG in the 6 GHz band, including Automatic Frequency Coordination (AFC) and Contention-Based Protocols (CBP). The WBU-TC is concerned that the proposed interference mitigation schemes may be inadequate to protect video ENG passive receivers, which operate in accordance with the RR and are a vital component to broadcasting. This concern is based upon historical interference problems between RLAN systems and ENG receivers in the band 2450 – 2483.5 MHz. While most RLAN systems operating in that spectrum incorporate a “listen before talk” CPB, that protocol has proven inadequate to detect ENG operations and the use of that spectrum for ENG has consequentially been limited to exceptional circumstances, such as air-to-ground video feeds.

Some information on the technical parameters and operational characteristics of ENG systems, including cordless video cameras and video links, can be found in ITU-R Recommendation ITU-R M.1824-1 and Report BT.2344-2, both of which reflect the extent of ENG operations in 6 GHz and other spectrum across many countries.

Monte-Carlo simulations of interference to ENG receivers from 6 GHz RLAN transmitters have been conducted and are reported in study of Attachment 1 (in two parts). Three common types of ENG deployments were studied: indoor short-range radio cameras, outdoor short-range radio cameras, and outdoor long-range video links. For each scenario, at least 10,000 Monte Carlo iterations were used to develop statistics of the magnitude and likelihood of interference. A -10 I/N value was used to define the threshold of interference as recommended in ITU-R M.1824-1. Significantly, degradation of ENG receivers was predicted in a substantial number of cases.

In the case of indoor ENG operations, interference was predicted at least 0.9 percent of the time in the "best case" and 95.3 percent of the time in the "worst case." Even the best case represents multiple potential interruptions of video coverage each minute, which falls far short of the broadcast quality demanded by broadcasters and expected by viewers. The level of predicted interference is also much greater than I/N = -10 dB in many cases, with the strength of the RLAN signal being equal to the "noise floor" of the ENG receiver in over one-half of the Monte Carlo "snapshots" in one scenario with out-of-channel emissions also being a significant contributor to the interference in many cases.

As for outdoor ENG operations involving a portable camera, interference was predicted at least 0.4 and up to 66.9 percent of the time. The level of interference was also high in many cases, with the strength of the RLAN signal being equal to that of the noise floor of the ENG receiver in almost 40 percent of the Monte Carlo "snapshots" in a typical scenario.

In the case of ENG operations involving a news truck transmitting to a central receive site, interference was predicted in every single scenario. In many cases, thousands of RLANs, both indoor and outdoor, contributed to the predicted aggregate interference. Significantly, the level of interference was so high in all cases that the RLAN signals were always equal to or greater than the noise floor of the ENG receiver.

On the basis of the attached sharing study, the WBU-TC urges WP5A to recognize and fully consider incumbent ENG operations in the 6 GHz band in considering sharing with RLAN systems. Accordingly, WBU-TC proposes revising ITU-R Rec. M.1450-5 as indicated in Annex A.

Status:

Contact: Robert Weller **E-mail:** rweller@nab.org

Attachment: 1

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ANNEX 12 TO WORKING PARTY 5A CHAIRMAN'S REPORT

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT REVISION OF
RECOMMENDATION ITU-R M.1450-5

Characteristics of broadband radio local area networks

(Questions ITU-R 212/5 and ITU-R 238/5)

(2000-2002-2003-2008-2010-2014)

Summary of the revision

This revision includes additional interference mitigation techniques under frequency sharing environments

Scope

This Recommendation provides the characteristics of broadband radio local area networks (RLANs) including technical parameters, and information on RLAN standards and operational characteristics. Basic characteristics of broadband RLANs and general guidance for their system design are also addressed.

The ITU Radiocommunication Assembly,

considering

a) that broadband radio local area networks (RLANs) are widely used for fixed, semi-fixed (transportable) and portable computer equipment for a variety of broadband applications;

b) that broadband RLANs are used for fixed, nomadic and mobile wireless access applications;

c) that broadband RLAN standards currently being developed are compatible with current wired LAN standards;

d) that it is desirable to establish guidelines for broadband RLANs in various frequency bands;

e) that broadband RLANs should be implemented with careful consideration to compatibility with other radio applications,

noting

a) that Report ITU-R F.2086 provides technical and operational characteristics and applications of broadband wireless access systems (WAS) in the fixed service;

b) that other information on broadband WAS, including RLANs, is contained in Recommendations ITU-R F.1763, ITU-R M.1652, ITU-R M.1739 and ITU-R M.1801,

recommends

1 that the broadband RLAN standards in Table 2 should be used (see also Notes 1, 2 and 3);

2 that Annex 2 should be used for general information on RLANs, including their basic characteristics;

3 that the following Notes should be regarded as part of this Recommendation.

NOTE 1 – Acronyms and terminology used in this Recommendation are given in Table 1.

NOTE 2 – Annex 1 provides detailed information on how to obtain complete standards described in Table 2.

NOTE 3 – This Recommendation does not exclude the implementation of other RLAN systems.

NOTE 4 – The frequency bands listed in Table 2 are for reference only. Administrations wishing to implement RLANS in other frequency bands shall ensure that those systems do not cause interference or claim protection from other radio services of neighbouring countries.

TABLE 1

Acronyms and terms used in this Recommendation

Access method	Scheme used to provide multiple access to a channel
AP	Access point
ARIB	Association of Radio Industries and Businesses
ATM	Asynchronous transfer mode
Bit rate	The rate of transfer of a bit of information from one network device to another
BPSK	Binary phase-shift keying
BRAN	Broadband Radio Access Networks (A technical committee of ETSI)
Channelization	Bandwidth of each channel and number of channels that can be contained in the RF bandwidth allocation
Channel Indexing	The frequency difference between adjacent channel centre frequencies
CSMA/CA	Carrier sensing multiple access with collision avoidance
DAA	Detect and avoid
DFS	Dynamic frequency selection
DSSS	Direct sequence spread spectrum
e.i.r.p.	Equivalent isotropically radiated power
ENG	Electronic News Gathering
ETSI	European Telecommunications Standards Institute
Frequency band	Nominal operating spectrum of operation
FHSS	Frequency hopping spread spectrum
HIPERLAN2	High performance radio LAN 2
HiSWANa	High speed wireless access network – type a
HSWA	High speed wireless access
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
LAN	Local area network
LBT	Listen before talk
MU	Medium utilisation

MMAC	Multimedia mobile access communication
Modulation	The method used to put information onto an RF carrier
MIMO	Multiple input multiple output
OFDM	Orthogonal frequency division multiplexing
PSD	Power spectral density
PSTN	Public switched telephone network
QAM	Quadrature amplitude modulation
QoS	Quality of Service
QPSK	Quaternary phase-shift keying
RF	Radio frequency
RLAN	Radio local area network
SSMA	Spread spectrum multiple access
Tx power	Transmitter power – RF power in Watts produced by the transmitter
TCP	Transmission control protocol
TDD	Time division duplex
TDMA	Time-division multiple access
TPC	Transmit power control
WATM	Wireless asynchronous transfer mode

TABLE 2

Characteristics including technical parameters associated with broadband RLAN standards

Characteristics	**IEEE Std 802.11-2012 (Clause 17, commonly known as 802.11b)**	**IEEE Std 802.11-2012 (Clause 18, commonly known as 802.11a[1])**	**IEEE Std 802.11-2012 (Clause 19, commonly known as 802.11g[1])**	**IEEE Std 802.11-2012 (Clause 18, Annex D and Annex E, commonly known as 802.11j)**	**IEEE Std 802.11-2012 (Clause 20, commonly known as 802.11n)**		**IEEE Std 802.11ad-2012**	**ETSI EN 300 328**	**ETSI EN 301 893**	**ARIB HiSWANa,[1]**	**ETSI EN 302 567**
Access method	**CSMA/ CA, SSMA**	**CSMA/CA**					**Scheduled, CSMA/CA**		**TDMA/TDD**		
Modulation	CCK (8 complex chip spreading)	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 52 subcarriers (see Fig. 1)	DSSS/CCK OFDM PBCC DSSS-OFDM	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 52 subcarriers (see Fig. 1)	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 56 subcarriers in 20 MHz 114 subcarriers in 40 MHz MIMO, 1-4 spatial streams	256-QAM-OFDM 64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 56 subcarriers in 20 MHz 114 subcarriers in 40 MHz 242 subcarriers in 80 MHz 484 subcarriers in 160 MHz and 80+80 MHz MIMO, 1-8 spatial streams	Single Carrier: DPSK, π/2-BPSK, π/2-QPSK, π/2-16QAM OFDM: 64-QAM, 16-QAM, QPSK, SQPSK 352 subcarriers	No restriction on the type of modulation	64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM 52 subcarriers (see Fig. 1)		

TABLE 2 (*CONTINUED*)

Characteristics	**IEEE Std 802.11-2012 (Clause 17, commonly known as 802.11b)**	**IEEE Std 802.11-2012 (Clause 18, commonly known as 802.11a[(1)])**	**IEEE Std 802.11-2012 (Clause 19, commonly known as 802.11g[(1)])**	**IEEE Std 802.11-2012 (Clause 18, Annex D and Annex E, commonly known as 802.11j)**	**IEEE Std 802.11-2012 (Clause 20, commonly known as 802.11n)**		**IEEE Std 802.11ad-2012**	**ETSI EN 300 328**	**ETSI EN 301 893**	**ARIB HiSWANa,[(1)]**	**ETSI EN 302 567**
Data rate	1, 2, 5.5 and 11 Mbit/s	6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s	1, 2, 5.5, 6, 9, 11, 12, 18, 22, 24, 33, 36, 48 and 54 Mbit/s	3, 4.5, 6, 9, 12, 18, 24 and 27 Mbit/s for 10 MHz channel spacing 6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s for 20 MHz channel spacing	From 6.5 to 288.9 Mbit/s for 20 MHz channel spacing From 6 to 600 Mbit/s for 40 MHz channel spacing	From 6.5 to 693.3 Mbit/s for 20 MHz channel spacing From 13.5 to 1 600 Mbit/s for 40 MHz channel spacing From 29.3 to 3 466.7 Mbit/s for 80 MHz channel spacing From 58.5 to 6 933.3 Mbit/s for 160 MHz and 80+80 MHz channel spacing			6, 9, 12, 18, 27, 36 and 54 Mbit/s		

TABLE 2 (*CONTINUED*)

Characteristics	IEEE Std 802.11-2012 (Clause 17, commonly known as 802.11b)	IEEE Std 802.11-2012 (Clause 18, commonly known as 802.11a[(1)])	IEEE Std 802.11-2012 (Clause 19, commonly known as 802.11g[(1)])	IEEE Std 802.11-2012 (Clause 18, Annex D and Annex E, commonly known as 802.11j)	IEEE Std 802.11-2012 (Clause 20, commonly known as 802.11n)		IEEE Std 802.11ad-2012	ETSI EN 300 328	ETSI EN 301 893	ARIB HiSWANa,[(1)]	ETSI EN 302 567
Frequency band	2 400-2 483.5 MHz	5 150-5 250 MHz[(4)] 5 250-5 350 MHz[(3)] 5 470-5 725 MHz[(3)] 5 725-5 825 MHz	2 400-2 483.5 MHz	4 940-4 990 MHz[(2)] 5 030-5 091 MHz[(2)] 5 150-5 250 MHz[(4)] 5 250-5 350 MHz[(3)] 5 470-5 725 MHz[(3)] 5 725-5 825 MHz	2 400-2 483.5 MHz 5 150-5 250 MHz[(4)] 5 250-5 350 MHz[(3)] 5 470-5 725 MHz[(3)] 5 725-5 825 MHz	5 150-5 250 MHz[(4)] 5 250-5 350 MHz[(3)] 5 470-5 725 MHz[(3)] 5 725-5 825 MHz	57-66 GHz	2 400-2 483.5 MHz	5 150-5 350[(5)] and 5 470-5 725 MHz[(3)]	4 900 to 5 000 MHz [(2)] 5 150 to 5 250 MHz [(4)]	57-66 GHz
Channel indexing	5 MHz				5 MHz in 2.4 GHz 20 MHz in 5 GHz	20 MHz	2 160 MHz		20 MHz	20 MHz channel spacing 4 channels in 100 MHz	
Spectrum mask	802.11b mask (Fig. 4)	OFDM mask (Fig. 1)			OFDM mask (Figs. 2A, 2B for 20 MHz and Figs. 3A, 3B for 40 MHz)	OFDM mask (Fig. 2B for 20 MHz, Fig. 3B for 40 MHz, Fig. 3C for 80 MHz, Fig. 3D for 160 MHz, and Fig. 3E for 80+80 MHz)	802.11ad mask (Fig. 5)		Fig. 1x	OFDM mask (Fig. 1)	

TABLE 2 (*END*)

Characteristics	**IEEE Std 802.11-2012 (Clause 17, commonly known as 802.11b)**	**IEEE Std 802.11-2012 (Clause 18, commonly known as 802.11a[(1)])**	**IEEE Std 802.11-2012 (Clause 19, commonly known as 802.11g[(1)])**	**IEEE Std 802.11-2012 (Clause 19, Annex D and Annex E, commonly known as 802.11j)**	**IEEE Std 802.11-2012 (Clause 20, commonly known as 802.11n)**	**IEEE P802.11ac**	**IEEE Std 802.11ad-2012**	**EN 300 328**	**EN 301 893**	**ARIB HiSWANa, [(1)]**	**ETSI EN 302 567**
Transmitter											
Interference mitigation	LBT	LBT/DFS/ TPC	LBT		LBT/DFS/TPC		LBT	DAA/LBT, DAA/non-LBT, MU	LBT/DFS/TPC	LBT	
Receiver											
Sensitivity	Listed in Standard										

(1) Parameters for the physical layer are common between IEEE 802.11a and ARIB HiSWANa.

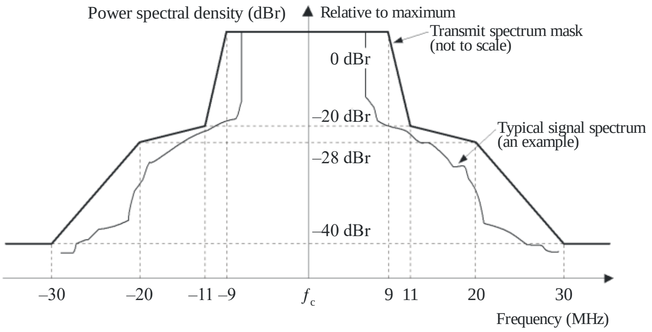
(2) See 802.11j-2004 and JAPAN MIC ordinance for Regulating Radio Equipment, Articles 49-20 and 49-21.

(3) DFS rules apply in the 5 250-5 350 and 5 470-5 725 MHz bands in many administrations and administrations must be consulted.

(4) Pursuant to Resolution **229 (Rev.WRC-12)**, operation in the 5 150-5 250 MHz band is limited to indoor use.

FIGURE 1a

OFDM transmit spectrum mask for 802.11a, 11g, 11j, and HiSWANa systems



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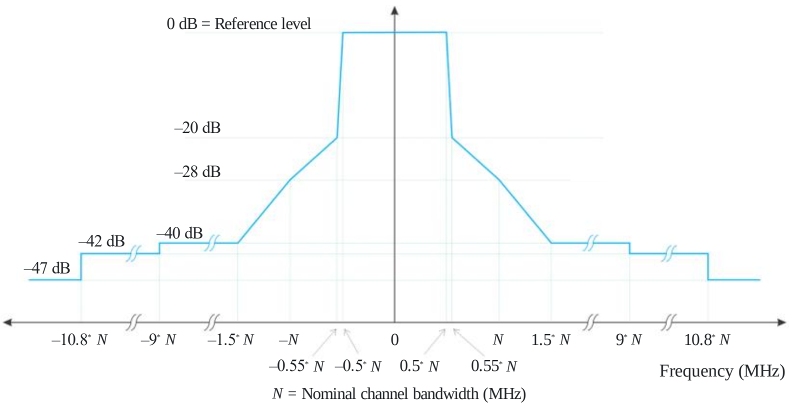
NOTE 1 – The outer heavy line is the spectrum mask for 802.11a, 11g, 11j, HiSWANa and the inner thin line is the envelope spectrum of OFDM signals with 52 subcarriers.

NOTE 2 – The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

NOTE 3 – In the case of the 10 MHz channel spacing in 802.11j, the frequency scale shall be half.

FIGURE 1b

Transmit spectrum mask for EN 301 893



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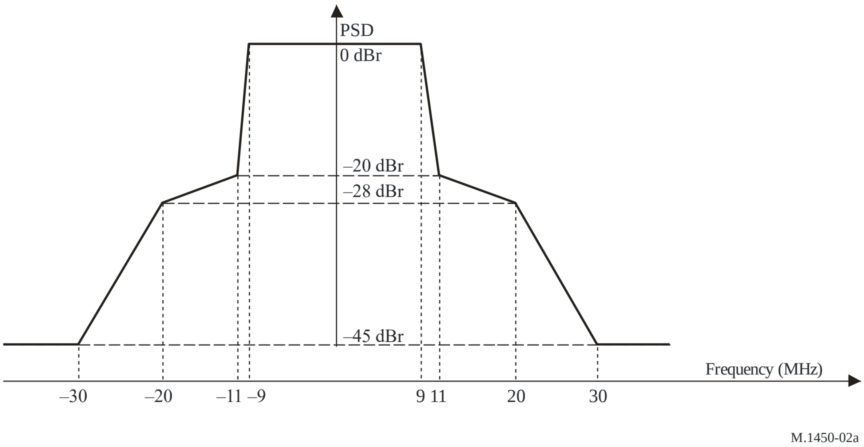
NOTE – dBc is the spectral density relative to the maximum spectral power density of the transmitted signal.

FIGURE 2a

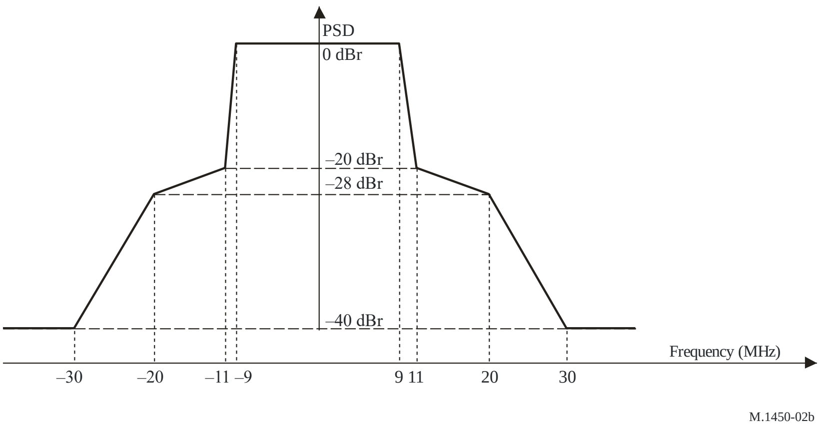
Transmit spectral mask for 20 MHz 802.11n transmission in 2.4 GHz band



NOTE – Maximum of −45 dBr and −53 dBm/MHz at 30 MHz frequency offset and above.

FIGURE 2b

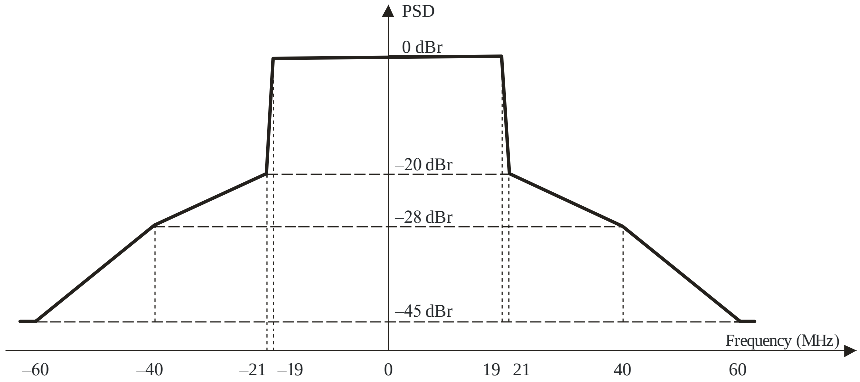
Transmit spectral mask for a 20 MHz 802.11n transmission in 5 GHz band and transmit spectral mask for 802.11ac



NOTE – For 802.11n, the maximum of –40 dBr and –53 dBm/MHz at 30 MHz frequency offset and above. For 802.11ac, the transmit spectrum shall not exceed the maximum of the transmit spectral mask and –53 dBm/MHz at any frequency offset.

FIGURE 3a

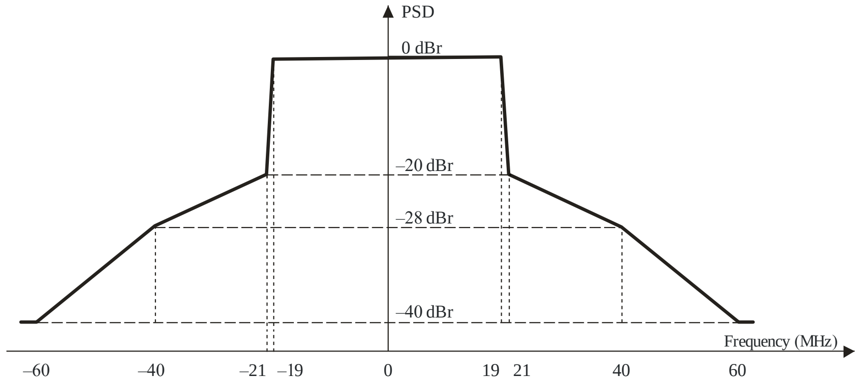
Transmit spectral mask for a 40 MHz 802.11n channel in 2.4 GHz band



NOTE – Maximum of −45 dBr and −56 dBm/MHz at 60 MHz frequency offset and above.

FIGURE 3b

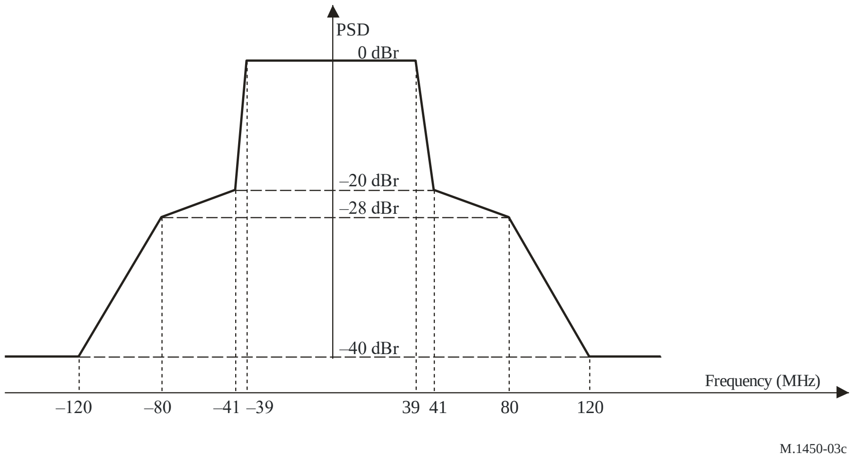
Transmit spectral mask for a 40 MHz 802.11n channel in 5 GHz band and transmit spectral mask for 802.11ac



NOTE – For 802.11n, maximum of –40 dBr and –56 dBm/MHz at 60 MHz frequency offset and above. For 802.11ac, the transmit spectrum shall not exceed the maximum of the transmit spectral mask and –56 dBm/MHz at any frequency offset.

FIGURE 3c

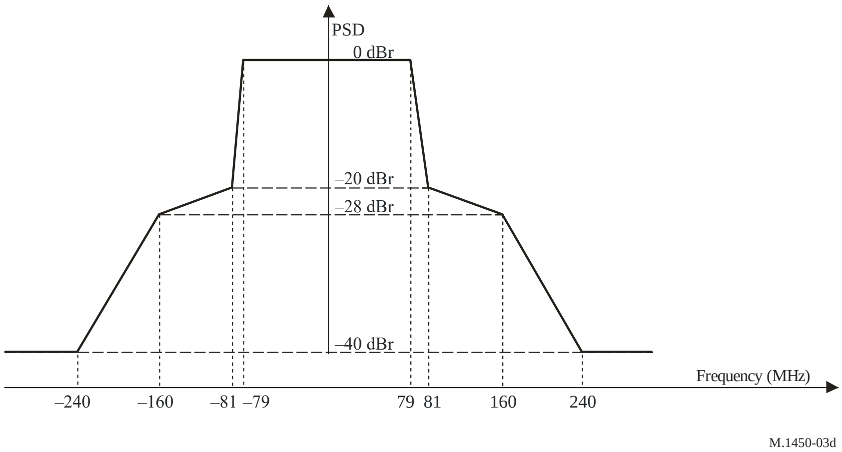
Transmit spectral mask for an 80 MHz 802.11ac channel



NOTE – The transmit spectrum shall not exceed the maximum of the transmit spectral mask and –59 dBm/MHz at any frequency offset.

FIGURE 3d

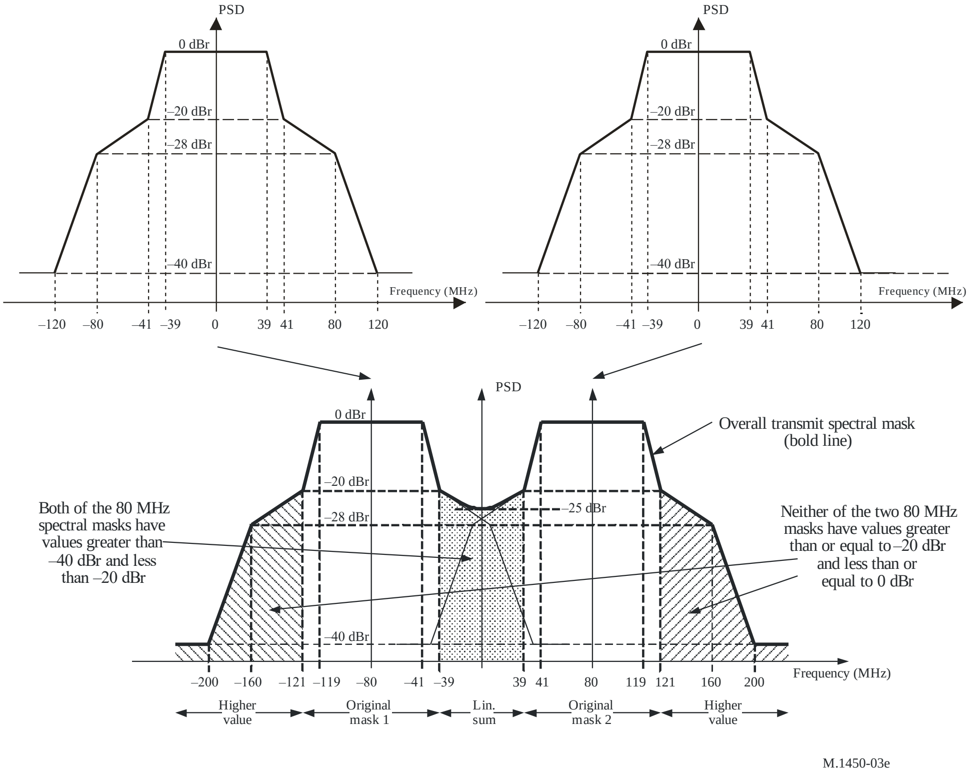
Transmit spectral mask for a 160 MHz 802.11ac channel



NOTE – The transmit spectrum shall not exceed the maximum of the transmit spectral mask and –59 dBm/MHz at any frequency offset.

FIGURE 3e

Transmit spectral mask for a 80+80 MHz 802.11ac channel



NOTE – The transmit spectrum shall not exceed the maximum of the transmit spectral mask and –59 dBm/MHz at any frequency offset.

FIGURE 4

Transmit spectrum mask for 802.11b

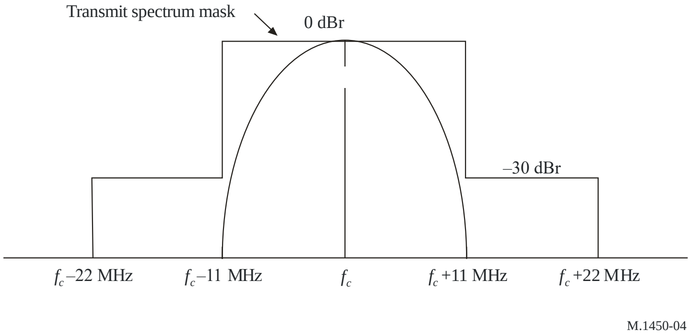
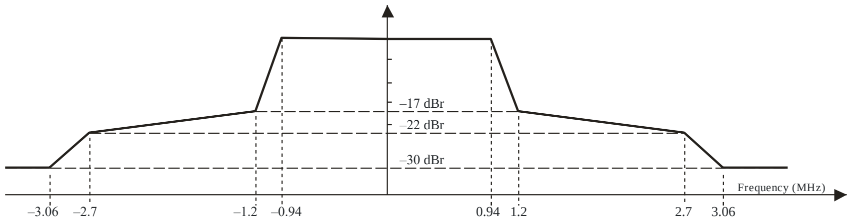


FIGURE 5

Transmit spectrum mask for 802.11ad



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Annex 1

Obtaining additional information on RLAN standards

The ETSI EN 300 328, EN 301 893 and EN 302 567 standards can be downloaded from http://pda.etsi.org/pda/queryform.asp. In addition to these standards, the Hiperlan type 2 standards can still be downloaded from the above link.

The IEEE 802.11 standards can be downloaded from: http://standards.ieee.org/getieee802/index.html.

IEEE 802.11 has developed a set of standards for RLANs, IEEE Std 802.11 – 2012, which has been harmonized with IEC/ISO[1]. The medium access control (MAC) and physical characteristics for wireless local area networks (LANs) are specified in ISO/IEC 8802-11:2005, which is part of a series of standards for local and metropolitan area networks. The medium access control unit in ISO/IEC 8802-11:2005 is designed to support physical layer units as they may be adopted dependent on the availability of spectrum. ISO/IEC 8802-11:2005 contains five physical layer units: four radio units, operating in the 2 400-2 500 MHz band and in the bands comprising 5 150-5 250 MHz, 5 250-5 350 MHz, 5 470-5 725 MHz, and 5 725-5 825 MHz, and one baseband infrared (IR) unit. One radio unit employs the frequency-hopping spread spectrum (FHSS) technique, two employ the direct sequence spread spectrum (DSSS) technique, another employs the orthogonal frequency division multiplexing (OFDM) technique, and another employs a multiple input multiple output (MIMO) technique.

1 ISO/IEC 8802-11:2005, Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications.

Annex 2

Basic characteristics of broadband RLANs and general guidance for deployment

1 Introduction

Broadband RLAN standards have been designed to allow compatibility with wired LANs such as IEEE 802.3, 10BASE-T, 100BASE-T and 51.2 Mbit/s ATM at comparable data rates. Some broadband RLANs have been developed to be compatible with current wired LANs and are intended to function as a wireless extension of wired LANs using TCP/IP and ATM protocols. Recent spectrum allocations by some administrations promote development of broadband RLANs. This allows applications such as audio/video streaming to be supported with high QoS.

Portability is a feature provided by broadband RLANs but not wired LANs. New laptop and palmtop computers are portable and have the ability, when connected to a wired LAN, to provide interactive services. However, when they are connected to wired LANs they are no longer portable. Broadband RLANs allow portable computing devices to remain portable and operate at maximum potential.

Private on-premise, computer networks are not covered by traditional definitions of fixed and mobile wireless access and should be considered. The nomadic users are no longer bound to a desk. Instead, they are able to carry their computing devices with them and maintain contact with the wired LAN in a facility. In addition, mobile devices such as cellular telephones are beginning to incorporate the ability to connect to wireless LANs when available to supplement traditional cellular networks.

Speeds of notebook computers and hand-held computing devices continue to increase. Many of these devices are able to provide interactive communications between users on a wired network but sacrifice portability when connected. Multimedia applications and services require broadband communications facilities not only for wired terminals but also for portable and personal communications devices. Wired local area network standards, i.e. IEEE 802.3ab 1000BASE-T, are able to transport high rate, multimedia applications. To maintain portability, future wireless LANs will need to transport higher data rates. Broadband RLANs are generally interpreted as those that can provide data throughput greater than 10 Mbit/s.

2 Mobility

Broadband RLANs may be either pseudo fixed as in the case of a desktop computer that may be transported from place to place or portable as in the case of a laptop or palmtop devices working on batteries or cellular telephones with integrated wireless LAN connectivity. Relative velocity between these devices and an RLAN wireless access point remains low. In warehousing applications, RLANs may be used to maintain contact with lift trucks at speeds of up to 6 m/s. RLAN devices are generally not designed to be used at automotive or higher speeds.

3 Operational environment and considerations of interface

Broadband RLANs are predominantly deployed inside buildings, in offices, factories, warehouses, etc. For RLAN devices deployed inside buildings, emissions are attenuated by the structure.

RLANs utilize low power levels because of the short distances inside buildings. Power spectral density requirements are based on the basic service area of a single RLAN, often defined by a circle with a radius from 10 to 50 m. When larger networks are required, RLANS may be logically concatenated via bridge or router function to form larger networks without increasing their composite power spectral density.

One of the most useful RLAN features is the connection of mobile computer users to a wireless LAN network. In other words, a mobile user can be connected to his own LAN subnetwork anywhere within the RLAN service area. The service area may expand to other locations under different LAN subnetworks, enhancing the mobile user's convenience.

There are several remote access network techniques to enable the RLAN service area to extend to other RLANs under different subnetworks. The ~~International~~ Internet Engineering Task Force (IETF) has developed a number of the protocol standards on this subject.

To achieve the coverage areas specified above, it is assumed that RLANs require a peak power spectral density of e.g. approximately 10 mW/MHz in the 5 GHz operating frequency range (see Table 3). For data transmission, some standards use higher power spectral density for initialization and control the transmit power according to evaluation of the RF link quality. This technique is referred to as transmit power control (TPC). The required power spectral density is proportional to the square of the operating frequency. The large scale, average power spectral density will be substantially lower than the peak value. RLAN devices share the frequency spectrum on a time basis. Activity ~~ratio~~ Factor will vary depending on the usage, in terms of application and period of the day.

Broadband RLAN devices are normally deployed in high-density configurations and may use an etiquette such as listen before talk and dynamic channel selection (referred to here as dynamic frequency selection, DFS) or~~,~~ TPC to facilitate spectrum sharing between devices.

4 System architecture including fixed applications

Broadband RLANs are often point-to-multipoint architecture. Point-to-multipoint applications commonly use omnidirectional, down-looking antennas. The multipoint architecture employs several system configurations:

– point-to-multipoint centralized system (multiple devices connecting to a central device or access point via a radio interface);

– point-to-multipoint non-centralized system (multiple devices communicating in a small area on an ad hoc basis);

– RLAN technology is sometimes used to implement fixed applications, which provide point-to-multipoint (P-MP) or point-to-point (P-P) links, e.g. between buildings in a campus environment. P-MP systems usually adopt cellular deployment using frequency reuse schemes similar to mobile applications. Technical examples of such schemes are given in Report ITU-R F.2086 (see § 6.6). Point-to-point systems commonly use directional antennas that allow greater distance between devices with a narrow lobe angle. This allows band sharing via channel and spatial reuse with a minimum of interference with other applications;

– RLAN technology is sometimes used for multipoint-to-multipoint (fixed and/or mobile mesh network topology, in which multiple nodes relay a message to its destination). Omnidirectional and/or directional antennas are used for links between the nodes of the mesh network. These links may use one or multiple RF channels. The mesh topology enhances the overall reliability of the network by enabling multiple redundant communications paths throughout the network. If one link fails for any reason (including the introduction of strong RF interference), the network automatically routes messages through alternate paths.

5 Interference mitigation techniques under frequency sharing environments

RLANs are generally intended to operate in unlicensed or license-exempt spectrum and must allow adjacent uncoordinated networks to coexist whilst providing high service quality to users. In the 5 GHz bands, sharing with primary services must also be possible. Whilst multiple access techniques might allow a single frequency channel to be used by several nodes, support of many users with high service quality requires that enough channels are available to ensure access to the radio resource is not limited through queuing, etc. One technique that achieves a flexible sharing of the radio resource is DFS.

In DFS all radio resources are available at all RLAN nodes. A node (usually a controller node or access point (AP)) can temporarily allocate a channel and the selection of a suitable channel is performed based on interference detected or certain quality criteria, e.g. received signal strength, *C*/*I*. To obtain relevant quality criteria both the mobile terminals and the access point make measurements at regular intervals and report this to the entity making the selection.

In the 5 250-5 350 MHz and 5 470-5 725 MHz bands, DFS must be implemented to ensure compatible operation with systems in the co-primary services, i.e. the radiolocation service.

DFS can also be implemented to ensure that all available frequency channels are utilized with equal probability. This maximizes the availability of a channel to node when it is ready to transmit, and it also ensures that the RF energy is spread uniformly over all channels when integrated over a large number of users. The latter effect facilitates sharing with other services that may be sensitive to the aggregated interference in any particular channel, such as satellite-borne receivers.

TPC is intended to reduce unnecessary device power consumption, but also aids in spectrum reuse by reducing the interference range of RLAN nodes.

Many administrations have authorized broadband RLANs in the band 5 925-7 125 MHz (or portions thereof) to respond to increased demand for wireless connectivity. The authorizations are intended to allow RLANs to share this spectrum with incumbent services under rules that are crafted to protect the licensed services and to enable both unlicensed and incumbent licensed operations to continue to thrive throughout the band.

To protect the Fixed Satellite Service, one administration allowed fixed outdoor access points to operate at e.i.r.p. levels up to 36 dBm subject to an antenna pointing restriction and an Automatic Frequency Coordination (AFC) system, with limited RLAN e.i.r.p. in 6 875-7 125 MHz. To protect the radio astronomy service in 6 650–6 675.2 MHz, one administration adopted exclusion zones for certain RLAN access points in that band around specific radio astronomy sites. To protect electronic news gathering (ENG) in the mobile service, one administration limited RLAN e.i.r.p. in 6 425–6 525 and restricted operation to indoor locations only. One administration also prohibited low power indoor and standard power access points on oil platforms and aboard ships to protect EESS.

Some enterprise-grade RLAN access points may have the capability of blocking off certain sub-bands to prevent interference to incumbent licensed operations, including nearby ENG receivers. The incorporation of this capability should be considered on a national basis to preserve access to a portion of 5 925-7 125 MHz at indoor and outdoor sports venues and other locations where ENG systems may operate.

6 General technical characteristics

Table 3 summarizes technical characteristics applicable to operation of RLANs in certain frequency bands and in certain geographic areas. Operation in the 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz frequency bands are in accordance with Resolution **229 (Rev.WRC-12)**.

TABLE 3

General technical requirements applicable in certain administrations and/or regions

General band designation	Administration or region	Specific frequency band (MHz)	Transmitter output power (mW) (except as noted)	Antenna gain (dBi)
2.4 GHz band	USA	2 400-2 483.5	1 000	0-6 dBi(1) (Omni)
	Canada	2 400-2 483.5	4 W e.i.r.p.(2)	N/A
	Europe	2 400-2 483.5	100 mW (e.i.r.p.)(3)	N/A
	Japan	2 471-2 497 2 400-2 483.5	10 mW/MHz(4) 10 mW/MHz(4)	0-6 dBi (Omni) 0-6 dBi (Omni)
5 GHz band(5), (6)	USA	5 150-5 250(7) 5 250-5 350 5 470-5 725 5 725-5 850	50 2.5 mW/MHz 250 12.5 mW/MHz 250 12.5 mW/MHz 1 000 50.1 mW/MHz	0-6 dBi(1) (Omni) 0-6 dBi(1) (Omni) 0-6 dBi(1) (Omni) 0-6 dBi(8) (Omni)
	Canada	5 150-5 250(7) 5 250-5 350 5 470-5 725 5 725-5 850	200 mW e.i.r.p. 10 dBm/MHz e.i.r.p. 250 12.5 mW/MHz (11 dBm/MHz) 1 000 mW e.i.r.p.(9) 250 12.5 mW/MHz (11 dBm/MHz) 1 000 mW e.i.r.p.(9) 1 000 50.1 mW/MHz(9)	
	Europe	5 150-5 250(7) 5 250-5 350(10) 5 470-5 725	200 mW (e.i.r.p.) 10 mW/MHz (e.i.r.p.) 200 mW (e.i.r.p.) 10 mW/MHz (e.i.r.p.) 1 000 mW (e.i.r.p.) 50 mW/MHz (e.i.r.p.)	N/A
	Japan(4)	4 900-5 000(11) 5 150-5 250(7) 5 250-5 350(10) 5 470-5 725	250 mW 50 mW/MHz 10 mW/MHz (e.i.r.p.) 10 mW/MHz (e.i.r.p.) 50 mW/MHz (e.i.r.p.)	13 N/A N/A N/A

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General band designation	Administration or region	Specific frequency band (MHz)	Transmitter output power (mW) (except as noted)	Antenna gain (dBi)
57-66 GHz	Europe	57-66 GHz	40 dBm (e.i.r.p.)(12) 13 dBm/MHz (e.i.r.p)	N/A

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Notes to Table 3

(1) In the United States of America, for antenna gains greater than 6 dBi, some reduction in output power required. See sections 15.407 and 15.247 of the FCC's rules for details.

(2) Canada permits point-to-point systems in this band with e.i.r.p. > 4 W provided that the higher e.i.r.p. is achieved by employing higher gain antenna, but not higher transmitter output power.

(3) This requirement refers to ETSI EN 300 328.

(4) See Japan MIC ordinance for Regulating Radio Equipment, Articles 49-20 and 49-21 for details.

(5) Resolution 229 (Rev.WRC-12) establishes the conditions under which WAS, including RLANs, may use the 5 150-5 250 MHz, 5 250-5 350 MHz and 5 470-5 725 MHz.

(6) DFS rules apply in the 5 250-5 350 MHz and 5 470-5 725 MHz bands in regions and administrations and must be consulted.

(7) Pursuant to Resolution 229 (Rev.WRC-12), operation in the 5 150-5 250 MHz band is limited to indoor use.

(8) In the United States of America, for antenna gains greater than 6 dBi, some reduction in output power required, except for systems solely used for point-to-point. See sections 15.407 and 15.247 of the FCC's rules for details.

(9) See RSS-210, Annex 9 for the detailed rules on devices with maximum e.i.r.p. greater than 200 mW: http://strategis.ic.gc.ca/epic/site/smt-gst.nsf/en/sf01320e.html.

(10) In Europe and Japan, operation in the 5 250-5 350 MHz band is also limited to indoor use.

(11) For fixed wireless access, registered.

(12) This refers to the highest power level of the transmitter power control range during the transmission burst if transmitter power control is implemented. Fixed outdoor installations are not allowed.

ATTACHMENT 1

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Field Code Changed

ATTACHMENT 2

437Part 2e.pdf

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