

IEEE Recommended Practice for Local and metropolitan area networks

Coexistence of Fixed Broadband Wireless Access Systems

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

and the
IEEE Microwave Theory and Techniques Society



Published by
The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

10 September 2001

Print: SH94942
PDF: SS94942

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Approved 6 July 2001
IEEE-SA Standards Board

Approved 1 November 2001
American National Standards Institute



Abstract: This IEEE recommended practice provides guidelines for minimizing interference in fixed broadband wireless access (BWA) systems operating in the frequency range 10 to 66 GHz, with particular focus on the range 23.5 to 43.5 GHz. It analyzes coexistence scenarios and provides guidance for system design, deployment, coordination, and frequency usage.

Keywords: coexistence, fixed broadband wireless access (BWA), interference, local multipoint distribution service (LMDS), millimeter wave, multipoint, point-to-multipoint, radio, wireless metropolitan area network (WirelessMAN™) standard

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Print: ISBN 0-7381-2930-5 SH94942
PDF: ISBN 0-7381-2931-3 SS94942

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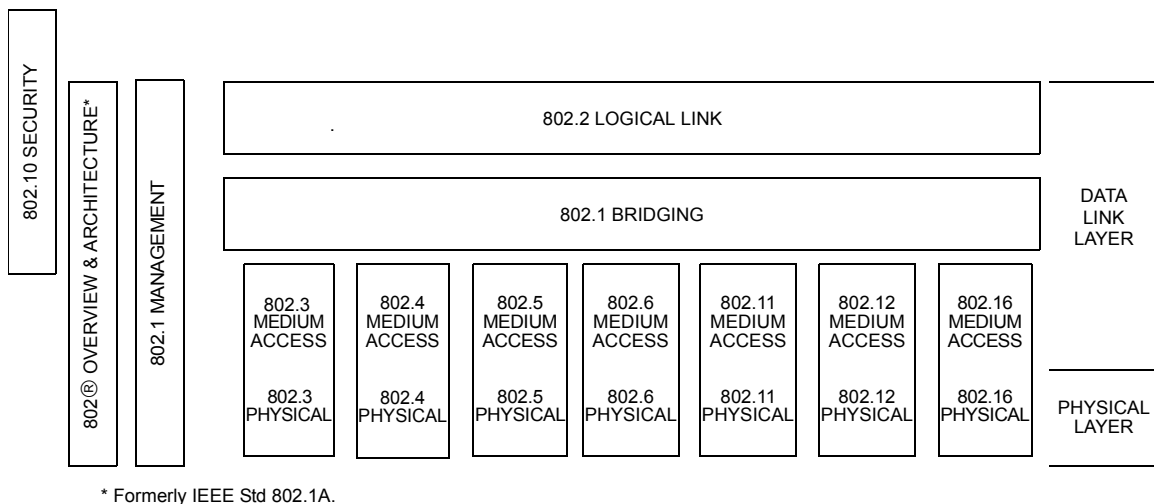
Introduction

(This introduction is not a part of IEEE Std 802.16.2-2001, IEEE Recommended Practice for Local and metropolitan area networks—Coexistence of Fixed Broadband Wireless Access (BWA) Systems.)

This Recommended Practice provides guidelines for minimizing interference in fixed broadband wireless access systems. Pertinent coexistence issues are addressed. Recommended engineering practices provide guidance for system design, deployment, coordination, and frequency usage. This document covers frequencies of 10 to 66 GHz frequencies in general, but it is focused on 23.5 to 43.5 GHz. If followed by manufacturers and operators, it should allow a wide range of equipment to coexist in a shared environment with acceptable mutual interference.

Other non-IEEE standards committees and regulatory bodies have done similar studies and developed guidelines or rules. In Annex D, work from some of these bodies has been summarized.

This Recommended Practice is intended as a companion to the IEEE 802.16 Standard Air Interface for Fixed Broadband Wireless Access Systems, which is part of a family of standards for local and metropolitan area networks. The relationship between the IEEE 802.16 standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.)



This family of standards deals with the Physical and Data Link Layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection Basic Reference Model (ISO/IEC 7498-1:1994). The access standards define several types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining the technologies noted above are as follows:

- IEEE Std 802¹: *Overview and Architecture*. This standard provides an overview to the family of IEEE 802® Standards. This document forms part of the IEEE 802.1 scope of work.
- ANSI/IEEE Std 802.1B and 802.1K [ISO/IEC 15802-2]: *LAN/MAN Management*. Defines an Open Systems Interconnection (OSI) management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ANSI/IEEE Std 802.1D: *Medium Access Control (MAC) Bridges*. Specifies an architecture and protocol for the [ISO/IEC 15802-3]: interconnection of IEEE 802 LANs below the MAC service boundary.
- ANSI/IEEE Std 802.1E [ISO/IEC 15802-4]: *System Load Protocol*. Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- ANSI/IEEE Std 802.1F: *Common Definitions and Procedures for IEEE 802 Management Information*.
- ANSI/IEEE Std 802.1G [ISO/IEC 15802-5]: *Remote Media Access Control (MAC) Bridging*. Specifies extensions for the interconnection, using non-LAN systems communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.
- ANSI/IEEE Std 802.1H [ISO/IEC TR 11802-5]: *Recommended Practice for Media Access Control (MAC) Bridging of Ethernet V2.0 in IEEE 802 Local Area Networks*.
- ANSI/IEEE Std 802.1Q: *Virtual Bridged Local Area Networks*. Defines an architecture for Virtual Bridged LANs, the services provided in Virtual Bridged LANs, and the protocols and algorithms involved in the provision of those services.
- ANSI/IEEE Std 802.2 [ISO/IEC 8802-2]: *Logical Link Control*.
- ANSI/IEEE Std 802.3 [ISO/IEC 8802-3]: *CSMA/CD Access Method and Physical Layer Specifications*.
- ANSI/IEEE Std 802.4 [ISO/IEC 8802-4]: *Token Bus Access Method and Physical Layer Specifications*.
- ANSI/IEEE Std 802.5 [ISO/IEC 8802-5]: *Token Ring Access Method and Physical Layer Specifications*.
- ANSI/IEEE Std 802.6 [ISO/IEC 8802-6]: *Distributed Queue Dual Bus Access Method and Physical Layer Specifications*.
- ANSI/IEEE Std 802.10: *Interoperable LAN/MAN Security*. Currently approved: Secure Data Exchange (SDE).

¹The IEEE 802 Architecture and Overview Specification, originally known as IEEE Std 802.1A, has been renumbered as IEEE Std 802. This has been done to accommodate recognition of the base standard in a family of standards. References to IEEE Std 802.1A should be considered as references to IEEE Std 802.

- ANSI/IEEE Std 802.11: *Wireless LAN Medium Access Control (MAC) Sublayer and [ISO/IEC 8802-11]Physical Layer Specifications.*
- ANSI/IEEE Std 802.12: *Demand Priority Access Method, Physical Layer and Repeater Specification.*
[ISO/IEC 8802-12]
- IEEE Std 802.15: *Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for: Wireless Personal Area Networks.*
- IEEE Std 802.16: *Standard Air Interface for Fixed Broadband Wireless Access Systems.*
- IEEE Std 802.17: *Resilient Packet Ring Access Method and Physical Layer Specifications.*

In addition to the family of standards, the following is a recommended practice for a common physical layer technology:

- IEEE Std 802.7: *IEEE Recommended Practice for Broadband Local Area Networks.*

The reader of this standard is urged to become familiar with the complete family of standards.

Conformance test methodology

An additional standards series, identified by the number 1802, has been established to identify the conformance test methodology documents for the IEEE 802 family of standards. Thus the conformance test documents for IEEE 802.3 are numbered IEEE 1802.3, the conformance test documents for IEEE 802.5 will be IEEE 1802.5, and so on. Similarly, ISO will use IEEE 18802 to number conformance test standards for IEEE 8802 standards.

Interpretations and errata

Interpretations and errata associated with this standard may be found at one of the following Internet locations:

- <http://standards.ieee.org/reading/ieee/interp/>
- <http://standards.ieee.org/reading/ieee/updates/errata/>

One such interpretation, on the topic of out-of-block unwanted emissions, exists at the time of publication.

Participants

This document was developed by the IEEE 802.16 Working Group on Broadband Wireless Access, which is responsible for Wireless Metropolitan Area Network (WirelessMAN™) Standards and Recommended Practices. Primary development was carried out by the Working Group's Task Group 2. When the draft of this standard passed Working Group Letter Ballot and Sponsor Ballot, Task Group 2 was Chaired by Philip Whitehead. J. Leland Langston was the original Task Group 2 Chair, from May 1999 until July 2000. Subsequently, Andy McGregor served in that capacity until November 2000.

Roger B. Marks served as Technical Editor of this standard, with contributions from Paul Beastall. Earlier editors were Muya Wachira, who edited the draft that passed Working Group Letter Ballot; Vito Scaringi, who edited the draft first presented for Working Group Letter Ballot; and Rebecca Chan. Comment

resolutions were developed by a Comment Resolution Committee chaired by Philip Whitehead, and included Rémi Chayer, Jack Garrison, Barry Lewis, Paul Thompson, and Robert Whiting.

At the time the draft of this standard passed Working Group Letter Ballot, the IEEE 802.16 Working Group on Broadband Wireless Access had the following officers:

Roger B. Marks, *Chair*
Brian G. Kiernan, *Vice Chair*
Carl J. Bushue, *Secretary*

Louis Olsen served as Vice Chair during the initial development of this document, until September 2000. J. Scott Marin served as Working Group Secretary during the draft's development until December 2000.

The following members of the IEEE 802.16 Working Group on Broadband Wireless Access participated in the Working Group Letter Ballot in which the draft of this standard was approved:

Song An	Phil Guillemette	Andrew Middleton
Reza Arefi	Zion Hadad	Anton Monk
Jori Arrakoski	Baruch Halachmi	William Myers
Arun V. Arunachalam	Michael Hamilton	Uzi Padan
Eli Avivi	Srinath Hosur	Yunsang Park
Ian Baragar	Coleman Hum	Brian Petry
C. R. Baugh	Wayne Hunter	Moshe Ran
Carlos Belfiore	Eric Jacobsen	Stanley Reible
Anader Benyamin-Seeyar	Hamadi Jamali	Guy Resheff
Tom Bilotta	Jacob Jorgensen	David Ribner
Baruch Buskila	Inchul Kang	Eugene Robinson
Dean Chang	Mika Kasslin	Walt Roehr
Naftali Chayat	Brian Kiernan	Durga Satapathy
Rémi Chayer	Itzik Kitroser	Glen Sater
Mary Condie	Allan Klein	Vito Scaringi
José Costa	Jay Klein	David Schafer
Bruce Curriuan	Tom Kolze	Menashe Shahar
Amos Dotan	Demosthenes Kostas	Chet Shirali
Brian Eidson	John Langley	George Stamatelos
Carl Eklund	Yigal Leiba	Ken Stanwood
David Falconer	Barry Lewis	Paul Thompson
George Fishel	John Liebetreu	David Trinkwon
Adrian Florea	Lars Lindh	Nico van Waes
Robert Foster	Fred Lucas	Muya Wachira
Avraham Freedman	J. Scott Marin	Philip Whitehead
G. Jack Garrison	Roger Marks	Chaoming Zeng
Richard Germon	Andy McGregor	Juan-Carlos Zuniga
	Ronald Meyer	

The following members of the balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Jim Carlo	Vic Hayes	Roderick McMullin
Jose M. Costa	Robert Heile	Robert O'Hara
Guru Dutt Dhingra	Charles Jackson	Roger Pandanda
Thomas Dineen	Hamadi Jamali	Ken Peirce
Vern Dubendorf	Brian Kiernan	Walt Roehr
Mary DuVal	Gregory Luri	Jon Rosdahl
Richard Eckard	James Scott Marin	Jaideep Roy
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Avraham Freedman	Peter Martini	Don Wright
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**IEEE Recommended Practice for
Local and metropolitan area networks**

Coexistence of Fixed Broadband Wireless Access Systems

1. Overview

This document provides recommended practice for the design and coordinated deployment of fixed Broadband Wireless Access (BWA) systems to control interference and promote coexistence. This Recommended Practice is divided into nine clauses. Subclause 1.1 provides the scope of the Recommended Practice. Clause 2 lists references to other standards that are useful in applying this Recommended Practice. Clause 3 provides definitions and abbreviations that are either not found in other standards or have been modified for use with this Recommended Practice. Clause 4 provides a summary of fixed BWA coexistence recommendations and guidelines. Clause 5 provides an overview of fixed BWA systems including system architecture and medium overview. Clause 6 deals with equipment design parameters, including radiated power, spectral masks and antenna patterns, and includes limits for both in-band and out-of-band fixed BWA system emissions. Also included in Clause 6 are recommended tolerance levels for certain receiver parameters, including noise floor degradation and blocking performance, for interference received from other fixed BWA systems as well as from other systems. Clause 7 provides the methodology to be used in the deployment and coordination of fixed BWA systems, including band plans, separation distances, and power spectral flux density limits to facilitate coordination and enable successful deployment of fixed BWA systems with tolerable interference. Clause 8 consists of interference and propagation evaluation examples of coexistence in a point-to-multipoint (PMP) environment, indicating some of the models, simulations and analyses used in the preparation of this Recommended Practice. Clause 9 describes some of the mitigation techniques that could be employed in case of co-channel interference between systems operating in adjacent areas or in case of undesired signals caused by natural phenomena and other unintentional sources.

1.1 Scope

The intent of this document is to define a set of consistent design and deployment recommendations that promote coexistence for fixed BWA systems. The recommendations have been developed and substantiated by analyses and simulations specific to the deployment and propagation environment appropriate to terrestrial fixed BWA intersystem interference experienced between operators licensed for fixed BWA. These recommendations, if followed by manufacturers and operators, will facilitate a wide range of equipment to coexist in a shared environment with acceptable mutual interference.

The scope of this Recommended Practice includes the examination of interference between systems deployed across geographic boundaries in the same frequency blocks and systems deployed in the same geographic area

in adjacent frequency blocks. This document emphasizes coexistence practices for point-to-multipoint systems. This Recommended Practice does not cover coexistence issues due to intrasystem frequency reuse within the operator's authorized band, and it does not consider the impact of interference created by fixed BWA systems on non-BWA terrestrial and satellite systems.

This document is not intended to be a replacement for applicable regulations, which would take precedence.

2. Normative references

This Recommended Practice shall be used in conjunction with the following:

ETSI EN 301 390 V1.1.1. (2000-12), Fixed Radio Systems; Point-to-Point and Point-to-Multipoint Systems; Spurious Emissions and Receiver Immunity at Equipment/Antenna Port of Digital Fixed Radio Systems.¹

IEEE P802.16/D3, Draft Standard for Local and Metropolitan Area Networks—Part 16: Standard Air Interface for Fixed Broadband Wireless Access Systems.²

Recommendation ITU-R F.1509: Technical and Operational Requirements that Facilitate Sharing between Point-to-Multipoint Systems in the Fixed Service and the Inter-Satellite service in the band 25.25–27.5 GHz.³

3. Definitions and abbreviations

For the purposes of this Recommended Practice, the following terms and definitions apply. The Authoritative Dictionary of IEEE Standards Terms [B9]⁴ should be referenced for terms not defined in this clause.

Other standards documents (e.g., [B19]) employ comparable definitions and abbreviations to those that follow. However, while comparable, they differ in a number of cases.

3.1 Definitions

3.1.1 authorized band: The range of frequencies over which an operator is permitted to operate radio transmitters and receivers.

3.1.2 automatic transmit power control (ATPC): A technique used in BWA systems to adaptively adjust the transmit power of a transmitter to maintain the received signal level within some desired range.

3.1.3 base station (BS): A generalized equipment set providing connectivity, management, and control of the subscriber station.

3.1.4 broadband: Having instantaneous bandwidths greater than around 1 MHz and supporting data rates greater than about 1.5 Mbit/s.

¹ETSI publications are available from The European Telecommunications Standards Institute, 650, route des Lucioles, 06921 Sophia Antipolis, France (<http://www.etsi.org/>).

²This IEEE draft had not been approved by the IEEE-SA Standards Board at the time this publication went to press. For information about obtaining a draft, contact the IEEE.

³ITU-T publications are available from the International Telecommunications Union, Place des Nations, CH-1211, Geneva 20, Switzerland/Suisse (<http://www.itu.int/>).

⁴The numbers in brackets correspond to those of the bibliography in Annex G.

3.1.5 broadband wireless access (BWA): Wireless access in which the connection(s) capabilities are broadband.

3.1.6 cross-polar discrimination (XPD): The XPD of an antenna for a given direction is the difference in dB between the peak co-polarized gain of the antenna and the cross-polarized gain of the antenna in the given direction.

3.1.7 digital modulation: Digital modulation is the process of varying one or more parameters of a carrier wave (e.g., frequency, phase, amplitude, or combinations thereof) as a function of two or more finite and discrete states of a signal.

3.1.8 downlink: The direction from a base station to the subscriber station.

3.1.9 DS-3: A North American Common Carrier Multiplex level having a line rate of 44.736 Mbit/s.

3.1.10 fixed wireless access: Wireless access application in which the location of the SS and the BS are fixed in location.

3.1.11 frequency block: A contiguous portion of spectrum within a sub-band or frequency band, typically assigned to a single operator.

NOTE—A collection of frequency blocks may form a sub-band and/or a frequency band.

3.1.12 frequency division duplex (FDD): A duplex scheme in which uplink and downlink transmissions use different frequencies but are typically simultaneous.

3.1.13 Frequency Range 1: For purposes of this document, Frequency Range 1 refers to 10–23.5 GHz.

3.1.14 Frequency Range 2: For purposes of this document, Frequency Range 2 refers to 23.5–43.5 GHz.

3.1.15 Frequency Range 3: For purposes of this document, Frequency Range 3 refers to 43.5–66 GHz.

3.1.16 frequency re-use: A technique for employing a set of frequencies in multiple, closely-spaced cells and/or sectors for the purpose of increasing network traffic capacity.

3.1.17 harmonized transmissions: The use, by multiple operators, of a compatible transmission plan so that the base stations from different operators can share an antenna site and minimize interference. For FDD systems, this implies that each operator's base station transmits in the same frequency sub-block (typically on a different channel) and that their terminals transmit in the corresponding paired sub-block. For TDD systems, harmonization implies frame, slot, and uplink/downlink synchronization.

3.1.18 intercell link: Intercell links interconnect two or more BS units, typically using wireless, fiber, or copper facilities.

3.1.19 mesh: A wireless network topology, known also as multipoint-to-multipoint, in which a number of subscriber stations within a geographic area are interconnected and can act as repeater stations. This allows a variety of routes between the core network and any subscriber station. Mesh systems do not have base stations in the conventional point-to-multipoint sense.

3.1.20 multicarrier system: A system using two or more carriers to provide service from a single transmitter.

3.1.21 multipoint (MP): A generic term for point-to-multipoint and multipoint-to-multipoint and variations or hybrids of these. Multipoint is a wireless topology in which a system provides service to multiple,

geographically distributed, subscriber stations. The sharing of resources may occur in the time domain, frequency domain, or both.

3.1.22 multipoint-to-multipoint (MP-MP): See **mesh**.

3.1.23 OC-3: One hierarchical level in the Synchronous Optical Network transmission standard. The line rate for this level is 155.52 Mbit/s.

3.1.24 occupied bandwidth (B_o): For a single carrier, B_o is the width of a frequency band such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5% of the total mean power radiated by a given emission. This implies that 99% of the total mean emitted power is within this band, and hence this bandwidth is also known as the 99% bandwidth.

When a multicarrier transmission uses a common amplifier stage, the occupied bandwidth of this composite transmission is defined by the following relationship:

$$B_{OM} = 1/2 B_{OU} + 1/2 B_{OL} + (F_{OU} - F_{OL})$$

where:

B_{OM} = Occupied bandwidth of the multicarrier system

B_{OU} = Single-carrier Occupied Bandwidth of the uppermost sub-carrier

B_{OL} = Single-carrier Occupied Bandwidth of the lowermost sub-carrier

F_{OU} = Center frequency of the uppermost sub-carrier

F_{OL} = Center frequency of the lowermost sub-carrier

NOTE 1—This multicarrier definition will give a bandwidth which is slightly wider than the multicarrier 99% power bandwidth. For example, for six identical, adjacent carriers, B_o will contain 99.5% of the first carrier, 99.5% of the last carrier and 100% of the four middle carriers and therefore 99.8333% of total mean power.

NOTE 2—This definition applies to most analog and simple digital emissions (QAM, QPSK, etc.), but its applicability to other more complex modulation structures (e.g., OFDM, CDMA) is still to be determined.

3.1.25 out-of-block emissions (OOB emissions): Emissions from the edge of the authorized bandwidth up to 200% of the occupied bandwidth from the edge of the authorized bandwidth. These emissions occur both above and below the authorized bandwidth.

3.1.26 point-to-multipoint (PMP): In wireless systems, a topology wherein a base station simultaneously services multiple, geographically separated subscriber stations and each subscriber station is permanently associated with only one base station.

3.1.27 point-to-point: A topology in which a radio link is maintained between two stations.

3.1.28 power flux density (pfd): The radiated power flux per unit area.

3.1.29 power spectral flux density (psfd): The radiated power flux per unit bandwidth per unit area.

3.1.30 radiation pattern envelope (RPE): The RPE is a graph that represents the maximum sidelobe levels of an antenna over the specified band.

3.1.31 repeater station (RS): A station other than the BS that includes radio communication equipment facing two or more separate directions. Traffic received from one direction may be partly or wholly retransmitted in another direction. Traffic may also terminate and originate at the repeater station.

3.1.32 service area: A geographic area in which an operator is authorized to transmit.

3.1.33 spectrum disaggregation: Segregation of spectrum to permit several operators access to subportions of a licensee's authorized band.

3.1.34 spurious emissions: Emissions greater than 200% of the occupied bandwidth from the edge of the authorized bandwidth.

While this definition is specific to this Recommended Practice, International Telecommunications Union (ITU) Radio Regulation S.145 defines spurious emission as follows:

“Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.”

3.1.35 subscriber station (SS): A generalized equipment set providing connectivity between subscriber equipment and a base station.

3.1.36 synchronized transmissions: Harmonized time-division duplex (TDD) transmissions.

3.1.37 terminal equipment: Terminal equipment encompasses a wide variety of apparatus at customer premises, providing end user services and connecting to subscriber station equipment (SS) via one or more interfaces.

3.1.38 time-division duplex (TDD): A duplex scheme where uplink and downlink transmissions occur at different times but may share the same frequency.

3.1.39 uplink: The direction from a subscriber station to the base station.

3.1.40 unwanted emissions: Out-of-band emissions, spurious emissions, and harmonics.

3.1.41 virtual block edge: A reference frequency used as a block edge frequency for testing of unwanted emissions so as to avoid effects of radio frequency (RF) block filters.

3.1.42 wireless access: End-user radio connection(s) to core networks.

3.2 Abbreviations

AdjCh	adjacent channel
ATPC	automatic transmit power control
AZ	azimuth
BER	bit error ratio
BFWA	broadband fixed wireless access
B _o	occupied bandwidth
BRAN	broadband radio access networks (an ETSI Project)
BS	base station
BW	bandwidth
BWA	broadband wireless access
CDF	cumulative distribution function
CDMA	code division multiple access
CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications (European Conference of Postal and Telecommunication Administrations)

C/I	carrier-to-interference ratio
C/N	carrier-to-noise ratio
C/(N+I)	carrier-to-noise and interference ratio
CoCh	co-channel
CS	central station (used in Annexes only); or channel separation (in 6.1.3 only)
CW	continuous wave
dBc	decibels relative to the carrier level
dBi	gain relative to a hypothetical isotropic antenna
DRS	data relay satellite
DS-3	44.736 Mbit/s line rate
D/U	desired carrier-to-undesired carrier ratio
EL	elevation
EIRP	effective isotropic radiated power
EN	European norm
ERC	European Radiocommunications Committee
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission (USA)
FDD	frequency division duplex
FDMA	frequency division multiple access
FSPL	free space path loss
FWA	fixed wireless access
GSO	geostationary orbit
IA	interference area
IC	Industry Canada
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers, Inc.
I/N	interference-to-thermal noise ratio
ISOP	interference scenario occurrence probability
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union – Radiocommunication Sector
LMCS	local multipoint communication system
LMDS	local multipoint distribution service
LOS	line of sight
MAN	metropolitan area network
MCL	minimum coupling loss
MP	multipoint
MP-MP	multipoint-to-multipoint
MWS	multimedia wireless systems
NFD	net filter discrimination
OC-3	155.52 Mbit/s line rate
OFDM	orthogonal frequency division multiplexing
OOB	out-of-block
PCS	personal communication service
pdf	power flux density
PMP	point-to-multipoint
psd	power spectral density
psfd	power spectral flux density
PTP	point-to-point
QAM	quadrature amplitude modulation
QPSK	quadrature phase shift keying
RA	Radiocommunications Agency
RABC	Radio Advisory Board of Canada
RF	radio frequency

RPE	radiation pattern envelope
RS	repeater station
RSS	Radio Standards Specifications
Rx	receive
SRSP	Standard Radio Systems Plan
SS	subscriber station
TDD	time division duplex
TDMA	time division multiple access
TS	terminal station
Tx	transmit
XPD	cross-polar discrimination

4. Summary of fixed BWA coexistence recommendations and guidelines

4.1 Document philosophy

Radio waves permeate through legislated (and even national) boundaries and emissions spill outside spectrum allocations. Coexistence issues between multiple operators are therefore inevitable.

The resolution of coexistence issues is an important factor for the fixed BWA industry. The Recommendations in 4.2 are provided for consideration by operators, manufacturers, and administrations to promote coexistence. Practical implementation within the scope of the current recommendations will assume that some portion of the frequency spectrum (at the edge of the authorized bandwidth) may be unusable. Furthermore, some locations within the service area may not be usable for deployment. Coexistence will rely heavily on the good-faith collaboration between spectrum holders to find and implement economical solutions.

The document analyzes coexistence using two scenarios:

- A co-channel (CoCh) scenario in which two operators are in either adjacent territories or territories within radio line of sight of each other and have the same spectrum allocation, and
- An adjacent Channel (AdjCh) scenario in which the licensed territories of two operators overlap and they are assigned adjacent spectrum allocations.

Coexistence issues may arise simultaneously from both scenarios as well as from these scenarios involving multiple operators.

As a starting point for the consideration of tolerable levels of interference into fixed BWA systems, ITU-R Recommendation F.758-2 [B16] details two generally accepted values for the interference-to-thermal noise ratio (I/N) for long-term interference into fixed service receivers. When considering interference from other services, it identifies an I/N value of -6 dB or -10 dB matched to specific requirements of individual systems. This approach provides a method for defining a tolerable limit that is independent of most characteristics of the victim receiver, apart from noise figure, and has been adopted for this Recommended Practice. The acceptability of any I/N value needs to be evaluated against the statistical nature of the interference environment. In arriving at the Recommendations in this document this evaluation has been carried out for an I/N value of -6 dB.

Clause 9 provides interference mitigation measures that can be utilized to solve coexistence problems. Because of the wide variation in subscriber station and base station distribution, radio emitter/receiver parameters, localized rain patterns, and the statistics of overlapping emissions in frequency and time, it is impossible to prescribe in this document which of the mitigation measures are appropriate to resolving a particular coexistence problem. In the application of these mitigation measures, identification of individual terminals or groups of terminals for modification is preferable to the imposition of pervasive restrictions.

Implementing the measures suggested in Recommendations 8–10 in 4.2 using the suggested equipment parameters in Clause 6 will, besides improving the coexistence conditions, have a generally positive effect on intrasystem performance. Similarly, simulations performed in the preparation of this Recommended Practice suggest that most of the measures undertaken by an operator to promote intrasystem performance will also promote coexistence.

It is outside the scope of this document to make recommendations that touch on intrasystem matters such as frequency plans, frequency reuse patterns, etc.

4.2 Recommendations

4.2.1 Recommendation 1

Adopt a criterion of 6 dB below receiver thermal noise (i.e., $I/N \leq -6$ dB) in the victim receiver as an acceptable level of interference from a transmission of an operator in a neighboring area. The document recommends this value in recognition of the fact that it is not practical to insist upon an “interference-free” environment. Having once adopted this value, the following are some important consequences:

- Each operator accepts a 1 dB degradation [the difference in dB between C/N and $C/(N + I)$] in receiver sensitivity. In some regard, an I/N of -6 dB becomes the fundamental criterion for coexistence. The very nature of the MP system is that receivers must accept interference from intrasystem transmitters. Although a good practice would be to reduce the intrasystem interference level to be well below the thermal noise level (see Recommendation 6 in 4.2.6), this is not always feasible. The actual level of external interference could be higher than the limit stated above and still be not controlling, or comparable to the operator’s intrasystem interference. Thus, there is some degree of interference allocation that could be used to alleviate the coexistence problem.
- Depending upon the particular deployment environment, an operator’s receiver may have interference contributions from multiple CoCh and AdjCh operators. Each operator should include design margin capable of simultaneously accepting the compound effect of interference from all other relevant operators. The design margin should be included preemptively at initial deployment, even if the operator in question is the first to deploy in a region and is not experiencing interference. All parties should recognize that, in predicting signal levels that result in the -6 dB interference value, it is difficult to be precise in including the aggregating effect of multiple terminals, the effect of uncorrelated rain, etc. Therefore, all parties should be prepared to investigate claims of interference even if the particular assessment method used to substantiate the -6 dB value predicts that there should not be any interference.

4.2.2 Recommendation 2

Each operator should take the initiative to collaborate with other known operators prior to initial deployment and prior to every relevant system modification. This recommendation should be followed even if an operator is the first to deploy in a region. To encourage this behavior for co-channel interference, this document introduces the concept of using power spectral flux density values to “trigger” different levels of initiatives taken by an operator to give notification to other operators. The specific trigger values and their application to the two deployment scenarios are discussed in Recommendation 5 (4.2.5) and Recommendation 6 (4.2.6) and in Clause 7

4.2.3 Recommendation 3

In the resolution of coexistence issues, in principle, incumbents and first movers should coordinate with operators who deploy at a later time. In resolving coexistence issues, it is legitimate to weigh the capital investment an incumbent operator has made in his or her system. It is also legitimate to weigh the capital

investment required by an incumbent operator for a change due to coexistence versus the capital investment costs that the new operator will incur.

The logic behind this Recommendation is that some coexistence problems cannot be resolved simply by modifying the system of a new entrant into a region. Rather, they require the willingness of an incumbent to make modifications as well. It is recognized that this Recommendation is especially challenging in the AdjCh scenario where overlapping territories imply that the incumbent and the late-comer may be competing for the same clients. The reality of some spectrum allocations are such that AdjCh operators will be allocated side-by-side frequency channels. As is seen below, this is an especially difficult coexistence problem to resolve without co-location of the operator's cell sites.

4.2.4 Recommendation 4

No coordination is needed in a given direction if the transmitter is greater than 60 km from either the service area boundary or the neighbor's boundary (if known) in that direction. Based on typical fixed BWA equipment parameters and an allowance for potential LOS interference couplings, subsequent analysis indicates that a 60 km boundary distance is sufficient to preclude the need for coordination. At lesser distances, coordination may be required, but this is subject to a detailed examination of the specific transmission path details that may provide for interference link excess loss or blockage. This coordination criteria is viewed to be necessary and appropriate for both systems that conform to this Recommended Practice and those that do not.

4.2.5 Recommendation 5

(This Recommendation applies to co-channel cases only.)

Recommendation 2 above introduced the concept of using power spectral flux density "triggers" as a stimulus for an operator to take certain initiatives to collaborate with his or her neighbor. It is recommended that regulators specify the applicable trigger values for each frequency band, failing which the following values may be adopted:

The coordination trigger values (see Annex B) of -114 (dBW/m²)/MHz (24, 26, and 28 GHz bands) and -111 (dBW/m²)/MHz (38 and 42 GHz bands) are employed in the initiative procedure described in Recommendation 6 (4.2.6). The evaluation point for the trigger exceedance may be at either the victim operator's licensed area boundary, the interfering operator's boundary, or at a defined point in between depending to some extent on the specific geographic circumstances of the BWA licensing. These values were derived as that power spectral flux density values which, if present at a typical point-to-multipoint base station antenna and typical receiver, would result in approximately the -6 dB interference value cited in Recommendation 1. It should be emphasized that the trigger values are useful only as thresholds for taking certain actions with other operators; they do not make an absolute statement as to whether there is, or is not, interference potential. In cases of significant deployment of point-to-point systems alongside point-to-multipoint systems where protection of the point-to-point systems is mandated, tighter psfd trigger levels may be appropriate. For example, -125 (dBW/m²)/MHz at 38 GHz band is applied by some administrations to protect point-to-point links.

4.2.6 Recommendation 6

(This Recommendation applies to co-channel cases only.)

The "triggers" of Recommendation 5 and Recommendation 6 should be applied prior to deployment and prior to each relevant system modification. Should the trigger values be exceeded, the operator should try to modify the deployment to meet the trigger or, failing this, the operator should coordinate with the affected operator. Three existing coordination procedures are described in D, E, and F.

4.2.7 Recommendation 7

For same area/adjacent channel interference cases, analysis and simulation indicate that deployment may require an equivalent guard frequency between systems operating in close proximity and in adjacent frequency blocks. It is convenient to think of the “guard frequency” in terms of “equivalent channels” related to the systems operating at the edges of the neighboring frequency blocks. The amount of “guard frequency” depends on a variety of factors such as “out of block” emission levels and in some cases is linked to the probability of interference in given deployment scenarios. Clause 8 provides insight into some methods that can be employed to assess these situations, while Clause 9 describes some possible interference mitigation techniques. These mitigation techniques include frequency guard bands, recognition of cross-polarization differences, antenna angular discrimination, spatial location differences, and frequency assignment substitution.

In most co-polarized cases, where the transmissions in each block are employing the same channel bandwidth, the guard frequency should be equal to one equivalent channel. Where the transmissions in neighboring blocks employ significantly different channel bandwidths, it is likely that a guard frequency equal to one equivalent channel of the widest bandwidth system will be adequate. However, analysis suggests that, under certain deployment circumstances, this may not offer sufficient protection and that a guard frequency equal to one channel at the edge of each operator’s block may be required. Where administrations do not set aside guard channels, the affected operators would need to reach agreement on how the guard channel is apportioned between them. It is possible that, with careful and intelligent frequency planning, coordination, and/or use of orthogonal polarization or other mitigation techniques, all or partial use of this guard channel may be achieved. However, in order to minimize interference conflicts and at the same time maximize spectrum utilization, cooperative deployment between operators will be essential. This recommendation strongly proposes this.

4.2.8 Recommendation 8

Utilize antennas for the base station and subscriber stations at least as good as the Class 1 antennas described in 6.2. The coexistence simulations which led to the Recommendations contained herein revealed that a majority of coexistence problems are the result of main-beam interference. The sidelobe levels of the base station antennas are of a significant but secondary influence. The sidelobe levels of the subscriber antenna are of tertiary importance. In the context of coexistence, therefore, antennas such as those presented in 6.2 are sufficient. It should be emphasized that utilizing antennas with sidelobe (and polarization) performance better than the minimum will not degrade the coexistence performance and, in fact, is an effective mitigation technique for specific instances. In many cases, intrasystem considerations may place higher demands on antenna performance than those required for intersystem coordination.

4.2.9 Recommendation 9

Utilize an emission mask at least as good as that described in 6.1.3. The utility of emission masks for controlling adjacent channel coexistence issues is strongly dependent upon the separation of the two emitters in space and in frequency. In case of large spatial separation between emitters, the opportunity exists for an interfering emitter to be much closer to a receiver than the desired emitter. This unfavorable range differential can overwhelm even the best emission mask. Likewise, emission masks are most effective when at least one guard channel exists between allocations. The emission mask presented in 6.1.3 is most appropriate for the case in which a guard channel separates allocations and emitters are modestly separated. For cases with no guard band, it is recommended that co-location of harmonized base station emitters be considered before trying to improve emission masks.

4.2.10 Recommendation 10

Limit maximum EIRP in accordance with recommendations in 6.1.1 and use SS power control in accordance with recommendations in 6.1.1.5. The interests of coexistence are served by reducing the

amount of EIRP emitted by base, SS, and repeater stations. The proposed maximum EIRP spectral density values are significantly less than allowed by some regulatory agencies but should be an appropriate balance between constructing robust fixed BWA systems and promoting coexistence.

4.2.11 Recommendation 11

In conducting analyses to predict power spectral flux density and for coordination purposes, the following should be considered:

- a) Calculations of path loss to a point on the border should consider:
 - 1) Clear air (no rain) plus relevant atmospheric absorption
 - 2) Intervening terrain blockage
- b) For the purpose of calculating psfd trigger compliance level, the psfd level at the service area boundary should be the maximum value which occurs at some elevation point up to 500 m above local terrain elevation. Equations (B.2) and (B.3) in Annex B should be used to calculate the psfd limits.
- c) Actual electrical parameters (e.g., EIRP, antenna patterns, etc.) should be used.
- d) Clear sky propagation (maximum path length) conditions should be assumed. Where possible, use established ITU-R Recommendations relating to propagation (e.g., Recommendation ITU-R P.452 [B20]).

4.3 Suggested guidelines for geographical and frequency spacing

This subclause and Clause 8 indicate some of the models, simulations, and analysis used in the preparation of this Recommended Practice. While a variety of tools may be used, the scenarios studied below should be considered when coordination is required.

Guidelines for geographical and frequency spacing of fixed BWA systems that would otherwise mutually interfere are given in 8.1 for each of a number of interfering mechanisms. This subclause summarizes the overall guidelines, taking into account all the identified interference mechanisms.

The two main deployment scenarios are as follows:

- Co-channel systems that are geographically spaced
- Systems that overlap in coverage and (in general) require different frequencies of operation

The most severe of the several mechanisms that apply to each case determines the guideline spacing, as shown in Table 1:

The guidelines are not meant to replace the coordination process described in Clause 7. However, in many (probably most) cases, these guidelines will provide satisfactory psfd levels at system boundaries. The information is therefore valuable as a first step in planning the deployment of systems.

5. System overview

BWA generally refers to fixed radio systems used primarily to convey broadband services between users' premises and core networks. The term "broadband" is usually taken to mean the capability to deliver significant bandwidth to each user. In ITU terminology, and in this document, broadband transmission refers to transmission rate of greater than around 1.5 Mbit/s, though many BWA networks support significantly

Table 1—Summary of the guidelines for geographical and frequency spacing

Dominant interference path (note 1)	Scenario	Spacing at which interference is below target level (generally 6 dB below receiver noise floor)
PMP BS to PMP BS	Adjacent area, same channel	60 km (note 5)
Mesh SSs to PMP BS	Adjacent area, same channel	12 km (note 2)
PMP BS to PMP BS	Same area, adjacent channel	1 guard channel (notes 3 and 5)
Mesh SSs to PMP SS	Same area, adjacent channel	1 guard channel (note 4)
NOTES 1—The dominant interference path is that which requires the highest guideline geographical or frequency spacing. 2—The 12 km value is based on a BS at a typical 50 m height. For other values, the results change to some extent, but are always well below the 60 km value calculated for the PMP – PMP case. 3—The single guard channel spacing is based on both interfering and victim systems using the same channel size. Where the transmissions in neighboring blocks employ significantly different channel bandwidths then it is likely that a guard frequency equal to one equivalent channel of the widest bandwidth system will be adequate. However analysis suggests that, under certain deployment circumstances, this may not offer sufficient protection and that a guard frequency equal to one channel at the edge of each operator's block may be required. 4—The single guard channel spacing for mesh to PMP is based on both interfering and victim systems using the same channel size. This may be reduced in some circumstances. Where the transmissions in neighboring blocks employ significantly different channel bandwidths, it is likely that a guard frequency equal to one equivalent channel of the widest bandwidth system will be adequate. However, analysis suggests that under certain deployment circumstances this may not offer sufficient protection and that a guard frequency equal to one channel at the edge of each operator's block may be required. 5—In a case of harmonized FDD band plans and/or frequency reassignable TDD systems, the BS-to-BS case ceases to be dominant.		

higher data rates. The networks operate transparently, so users are not aware that services are delivered by radio. A typical fixed BWA network supports connection to many user premises within a radio coverage area. It provides a pool of bandwidth, shared automatically among the users. Demand from different users is often statistically of low correlation, allowing the network to deliver significant bandwidth-on-demand to many users with a high level of spectrum efficiency. Significant frequency reuse is employed.

The range of applications is very wide and evolving quickly. It includes voice, data, and entertainment services of many kinds. Each subscriber may require a different mix of services; this mix is likely to change rapidly as connections are established and terminated. Traffic flow may be unidirectional, asymmetrical, or symmetrical, again changing with time. In some territories, systems delivering these services are referred to as multimedia wireless systems (MWS) in order to reflect the convergence between traditional telecommunications services and entertainment services.

These radio systems compete with other wired and wireless delivery means for the “first mile” connection to services. Use of radio or wireless techniques result in a number of benefits, including rapid deployment and relatively low “up-front” costs.

5.1 System architecture

Fixed BWA systems often employ multipoint architectures. The term multipoint includes point-to-multipoint (PMP) and multipoint-to-multipoint (MP-MP). The IEEE 802.16 Working Group on Broadband Wireless Access (see Clause 2) is developing standards for PMP systems with base stations and subscriber stations communicating over a fully specified air interface. A similar PMP standard is being developed within the “HIPERACCESS” topic within ETSI Project BRAN 7. Coexistence specifications for MWS (which includes

the requirements for HIPERACCESS) are being prepared by the ETSI TM4 committee 3. In addition, a number of proprietary fixed BWA systems exist for which the air interface is not standardized.

5.1.1 PMP systems

PMP systems comprise base stations, subscriber stations and, in some cases, repeaters. Base stations use relatively wide-beam antennas, divided into one or several sectors providing up to 360-degrees coverage with one or more antennas. To achieve complete coverage of an area, more than one base station may be required. The connection between BSs is not part of the fixed BWA network itself, being achieved by use of radio links, fiber optic cable, or equivalent means.

Links between BSs may sometimes use part of the same frequency allocation as the fixed BWA itself. Routing to the appropriate BS is a function of the core network. Subscriber stations use directional antennas, facing a BS and sharing use of the radio channel. This may be achieved by various access methods, including frequency division, time division, or code division.

5.1.2 MP systems (Mesh)

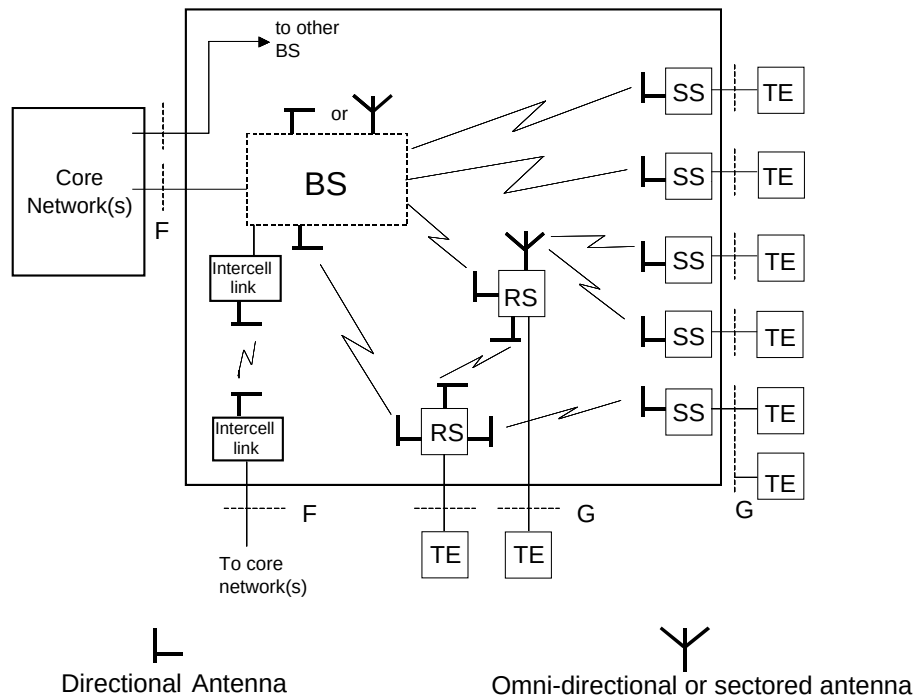
Multipoint-to-multipoint (MP-MP) systems have the same functionality as PMP systems. Base stations provide connections to core networks on one side and radio connection to other stations on the other. A subscriber station may be a radio terminal or (more typically) a repeater with local traffic access. Traffic may pass via one or more repeaters to reach a subscriber. Antennas are generally narrow-beam directional types, with means for remote alignment.

5.2 System components

Fixed broadband wireless access systems typically include base stations (BS), subscriber stations (SS), subscriber terminal equipment, core network equipment, intercell links, repeaters, and possibly other equipment. A reference fixed BWA system diagram is provided in Figure 1. This diagram indicates the relationship between various components of a BWA system. BWA systems may be much simpler and contain only some elements of the network shown in Figure 1.⁵ A fixed BWA system contains at least one BS and a number of SS units. In the figure, the wireless links are shown as zigzag lines connecting system elements.

Intercell links may use wireless, fiber, or copper facilities to interconnect two or more BS units. Intercell links may, in some cases, use in-band point to point (PTP) radios that provide a wireless backhaul capability between base stations at rates ranging from DS-3 to OC-3. Such PTP links may operate under the auspices of the PMP license.

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SOURCE: ETSI EN 301 390 V1.1.1. (2000-12), Fixed Radio Systems; Point-to-Point and Point-to-Multipoint Systems; Spurious Emissions and Receiver Immunity at Equipment/Antenna Port of Digital Fixed Radio Systems.

Figure 1—Interference sources to a fixed BWA BS

Antennas with a variety of radiation patterns may be employed. In general, a subscriber station utilizes a highly directional antenna. Some systems deploy repeaters. In a PMP system, repeaters are generally used to improve coverage to locations where the BS(s) have no line of sight within their normal coverage area(s), or alternatively to extend coverage of a particular BS beyond its normal transmission range. A repeater relays information from a BS to one or a group of SSs. It may also provide a connection for a local subscriber station. A repeater may operate on the same downlink frequencies as those frequencies that it uses, facing the BS, or it may use different frequencies (i.e., demodulate and remodulate the traffic on different channels). In MP-MP systems, most stations are repeaters that also provide connections for local subscribers.

The boundary of the fixed BWA network is at the interface points F and G of Figure 1. The F interfaces are points of connection to core networks and are generally standardized. The G interfaces, between subscriber stations and terminal equipment, may be either standardized or proprietary.

5.3 Medium overview

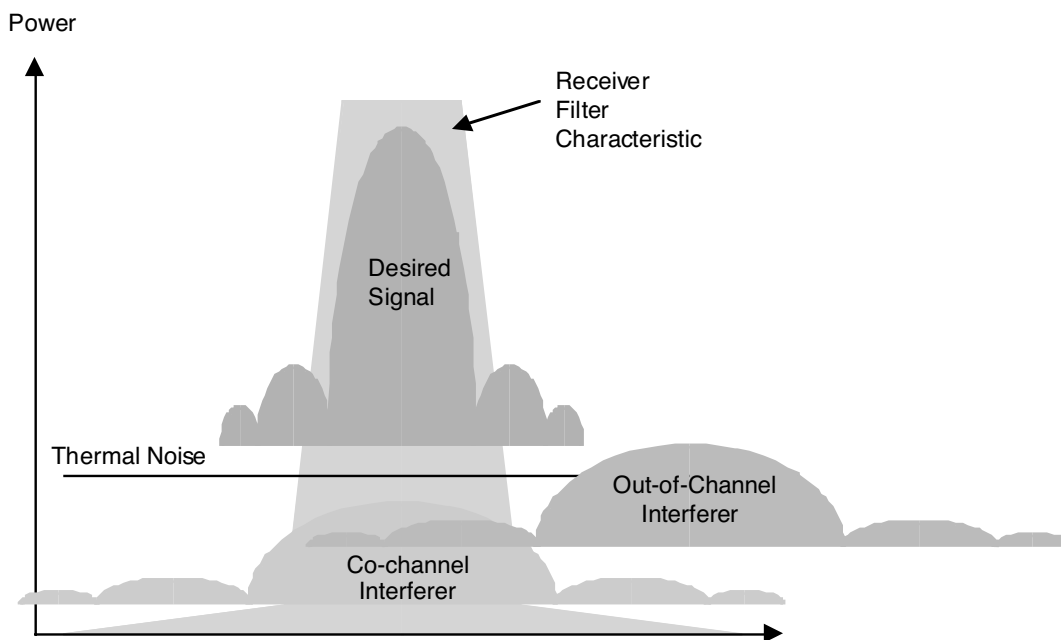
Electromagnetic propagation over Frequency Ranges 1–3 (10–66 GHz) is relatively nondispersive, with occasional but increasingly severe rain attenuation as frequency increases. Absorption of emissions by terrain and human-generated structures is severe, leading to the normal requirement for optical line-of-sight between transmit and receive antennas for satisfactory performance. Radio systems in this frequency regime are typically thermal or interference noise-limited (as opposed to multipath-limited) and have operational ranges of a few kilometers due to the large free-space loss and the sizable link margin which has to be

reserved for rain loss. At the same time, the desire to deliver sizable amounts of capacity promotes the use of higher-order modulation schemes with the attendant need for large C/I for satisfactory operation. Consequently, the radio systems are vulnerable to interference from emissions well beyond their operational range. This is compounded by the fact that the rain cells producing the most severe rain losses are not uniformly distributed over the operational area. This creates the potential for scenarios in which the desired signal is severely attenuated but the interfering signal is not.

5.3.1 Interference scenarios

5.3.1.1 Forms of interference

Interference can be classified into two broad categories: co-channel interference and out-of-channel interference. These manifest themselves as shown in Figure 2.⁶



SOURCE: ETSI EN 301 390 V1.1.1. (2000-12), Fixed Radio Systems; Point-to-Point and Point-to-Multipoint Systems; Spurious Emissions and Receiver Immunity at Equipment/Antenna Port of Digital Fixed Radio Systems.

Figure 2—Forms of interference

Figure 2 illustrates the power spectrum of the desired signal and co-channel interference in a simplified example. Note that the channel bandwidth of the co-channel interferer may be wider or narrower than the desired signal. In the case of a wider co-channel interferer (as shown), only a portion of its power will fall within the receive filter bandwidth. In this case, the interference can be estimated by calculating the power arriving at the receive antenna and then multiplying by a factor equal to the ratio of the filter's bandwidth to the interferer's bandwidth.

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An out-of-channel interferer is also shown. Here, two sets of parameters determine the total level of interference as follows:

- A portion of the interferer's spectral sidelobes or transmitter output noise floor falls co-channel to the desired signal; i.e., within the receiver filter's passband. This can be treated as co-channel interference. It cannot be removed at the receiver; its level is determined at the interfering transmitter. By characterizing the power spectral density of sidelobes and output noise floor with respect to the main lobe of a signal, this form of interference can be approximately computed in a manner similar to the co-channel interference calculation, with an additional attenuation factor due to the suppression of this spectral energy with respect to the main lobe of the interfering signal. The main lobe of the interferer is not completely suppressed by the receiver filter of the victim receiver. No filter is ideal, and residual power, passing through the stopband of the filter, can be treated as additive to the co-channel interference present. The level of this form of interference is determined by the performance of the victim receiver in rejecting out-of-channel signals, sometimes referred to as "blocking" performance. This form of interference can be simply estimated in a manner similar to the co-channel interference calculation, with an additional attenuation factor due to the relative rejection of the filter's stopband at the frequency of the interfering signal.

Quantitative input on equipment parameters is required to determine which of the two forms of interference from an out-of-channel interferer will dominate.

5.3.1.2 Acceptable level of interference

A fundamental property of any millimeter-wave fixed BWA system is its link budget, in which the range of the system is computed for a given availability, with given rain fading. During the designed worst-case rain fade, the level of the desired received signal will fall until it just equals the receiver thermal noise, $kTBF$, (where k is Boltzmann's constant, T is the temperature, B is the receiver bandwidth, and F is the receiver noise), plus the specified signal-to-noise ratio of the receiver. A way to account for interference is to determine $C/(N + I)$, the ratio of carrier level to the sum of noise and interference. For example, consider a receiver with 6 dB noise figure. The receiver thermal noise is -138 dBW/MHz. Interference of -138 dBW/MHz would double the total noise, or degrade the link budget by 3 dB. Interference of -144 dBW/MHz, 6 dB below the receiver thermal noise, would increase the total noise by 1 dB to -137 dBW/MHz, degrading the link budget by 1 dB.

For a given receiver noise figure and antenna gain in a given direction, the link budget degradation can be related to a received power flux density tolerance. In turn, this tolerance can be turned into separation distances for various scenarios.

5.3.1.3 Interference paths

5.3.1.3.1 Victim BS

Figure 3 shows main sources of interference where the victim receiver is a fixed BWA base station, with a sectoral-coverage antenna.

The victim BS is shown as a black triangle on the left, with its radiation pattern represented as ellipses. The desired SS transmitter is shown on lower right of figure. In the worst case, the desired signal travels through a localized rain cell, and is received at minimum signal strength. Thus, interference levels close to the thermal noise floor are significant.

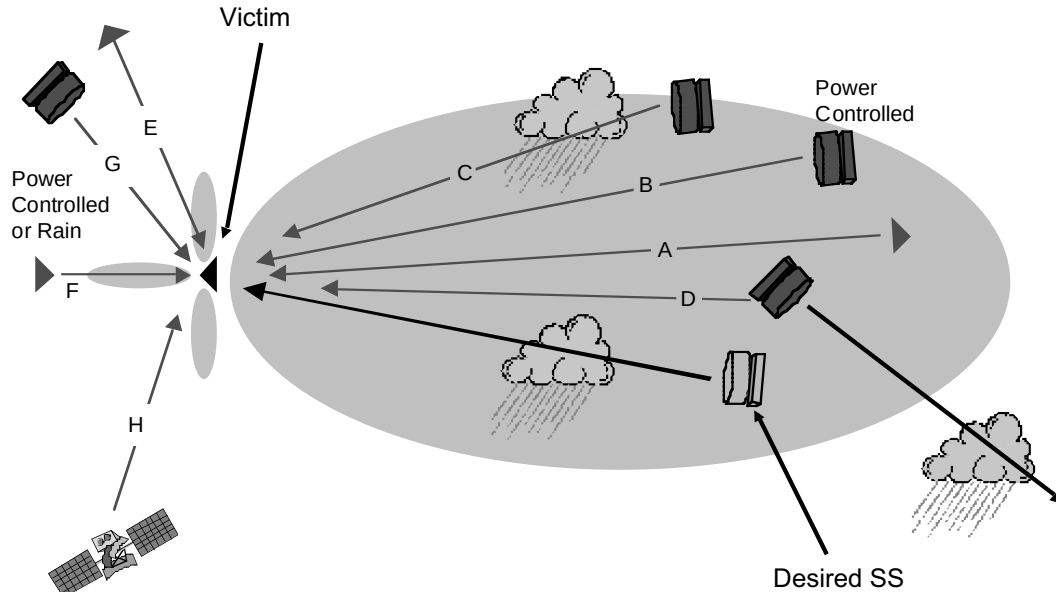


Figure 3—Interference sources to a fixed BWA BS

The letters in Figure 3 illustrate several cases of interference to a base station.

Case A shows BS-to-BS interference in which each BS antenna is in the main beam of the other. This case could occur commonly, as sector coverage angles tend to be wide—up to 90°. In fact, a victim BS could tend to see the aggregate power of several BSs. In addition, BS antennas tend to be elevated, with a high probability of a line-of-sight path to each other. As rain cells can be very localized, it is quite conceivable that the interferer travels on a path relatively unattenuated by rain, while the desired signal is heavily attenuated. BS-to-BS interference can be reduced by ensuring that there is no co-channel BS transmission on frequencies being used for reception at other BSs. This is possible with FDD through cooperative band planning, whereby vendors agree to use a common sub-band for BS transmissions and another common subband for BS reception.

Case B shows SS-to-BS interference in which each antenna is in the main beam of the other. As SS antenna gain is much higher than the BS antenna gain, this might appear to be the worst possible case. However, fixed BWA PMP systems can safely be assumed to employ uplink adaptive power control at subscriber stations. (Power control is required to equalize the received signal strength arriving at a BS from near and far SSs on adjacent channels. Note that active control of downlink power from BS transmitters is usually not employed, as the BS signal is received by a variety of SSs, both near and far, and power control would tend to create an imbalance in the level of signals seen from adjacent sectors.) Assuming that the subscriber station in Case B sees clear air, it can be assumed to have turned its power down, roughly in proportion to the degree of fade margin of its link. Note, however, that power control is imperfect, so the degree of turndown may be less than the fade margin. The turn-down compensates for the fact that the SS antenna has such high gain, so the net effect is that Case B may not be more severe than Case A. In addition, the narrow beamwidth of a SS antenna ensures that Case B is much less common an occurrence than Case A. However, Case B interference cannot be eliminated by band planning. Case B also covers interference generated by terrestrial point-to-point transmitters.

Case C is similar to Case B, except the interferer is assumed to see a rain cell and therefore does not turn down its power. However, as the interferer's beamwidth is narrow, the interference must also travel through this rain cell on the way to the victim receiver; hence, the net result is roughly the same as Case B. Because power control tracks out the effect of rain, interference analysis can be simplified: we need consider either Case B or Case C but not both. Thus Case B is more conservative with imperfect power control; i.e., the turn-down will tend to be less than the fade margin, so the net received power at the victim receiver is several dB higher than Case C.

Case D is similar to Case C, except the interference is stray radiation from a sidelobe or backlobe of the SS antenna. In the worst case, the SS antenna sees rain towards its intended receiver and therefore does not turn down its power. Modeling of this case requires assumptions of the sidelobe and backlobe suppression of typical SS antennas. These assumptions need to take into account scattering from obstacles in the mainlobe path appearing as sidelobe emissions in real-world installations of SS antennas; an antenna pattern measured in a chamber is one thing while the effective pattern installed on a rooftop is another. If effective sidelobe and backlobe suppression exceeds the power turn down assumption for clear skies, then Case B dominates and Case D need not be considered. The only exception is where Case D models a source of interference that is not a fixed BWA system but a point-to-point transmitter or a satellite uplink. In these cases, the transmit parameters may be so different from a fixed BWA subscriber station that the interference could be significant.

Case E is another case of BS-to-BS interference. In this case, the interfering BS's main beam is in the victim's sidelobe or backlobe. In a related scenario, (not shown), the interfering BS's sidelobe is in the victim's main lobe. As fixed BWA systems tend to employ intensive frequency reuse, it is likely that Case A concerns will dominate over Case E.

Case F covers BS-to-BS backlobe-to-backlobe or sidelobe-to-sidelobe. The low gains involved here ensure that this is a problem only for co-deployment of systems on the same rooftop. Like all sources of BS-to-BS interference, this can be virtually eliminated in FDD via a coordinated band plan.

Case G covers interference from an SS antenna to the victim BS's sidelobe or backlobe. Referring to the commentary concerning Cases B and C, we need only consider the clear air case and assume the interferer has turned down its power. As BS antennas see wide fields of view, Case B is expected to dominate and Case G need not be considered.

Finally, **Case H** covers interference from a satellite downlink or stratospheric downlink. This case is not included in this Recommended Practice. With the above simplifying assumptions, the dominant sources of interference which require detailed modeling are shown in Figure 4.

Case A will tend to dominate unless there is a harmonized band plan for the use of FDD. It will be of concern for unsynchronized TDD or unharmonized FDD. Case B is always a concern. Case D is probably of less concern than Case B when the interferer is a fixed BWA system, but could be significant if the interferer is a higher-power point-to-point transmitter or satellite uplink. Case F is a concern only for co-sited BSs and can be largely mitigated by the use of a harmonized band plan with FDD.

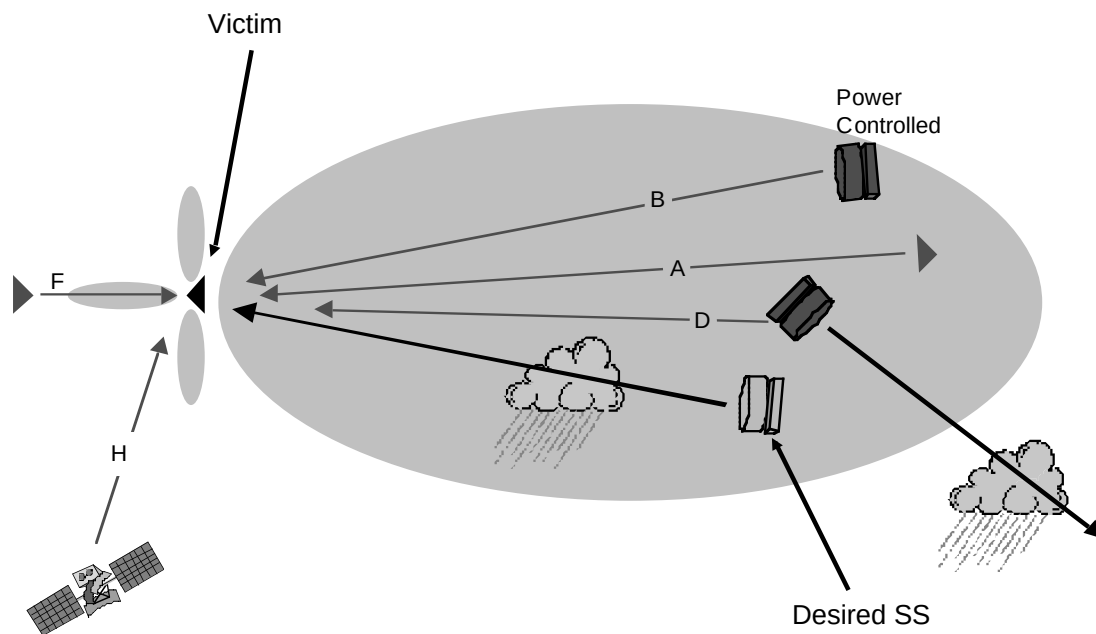


Figure 4—Simplified model for interference to a fixed BWA BS

5.3.1.3.2 Victim subscriber station

Figure 5 shows the main sources of interference to a subscriber station having a narrow beamwidth antenna.

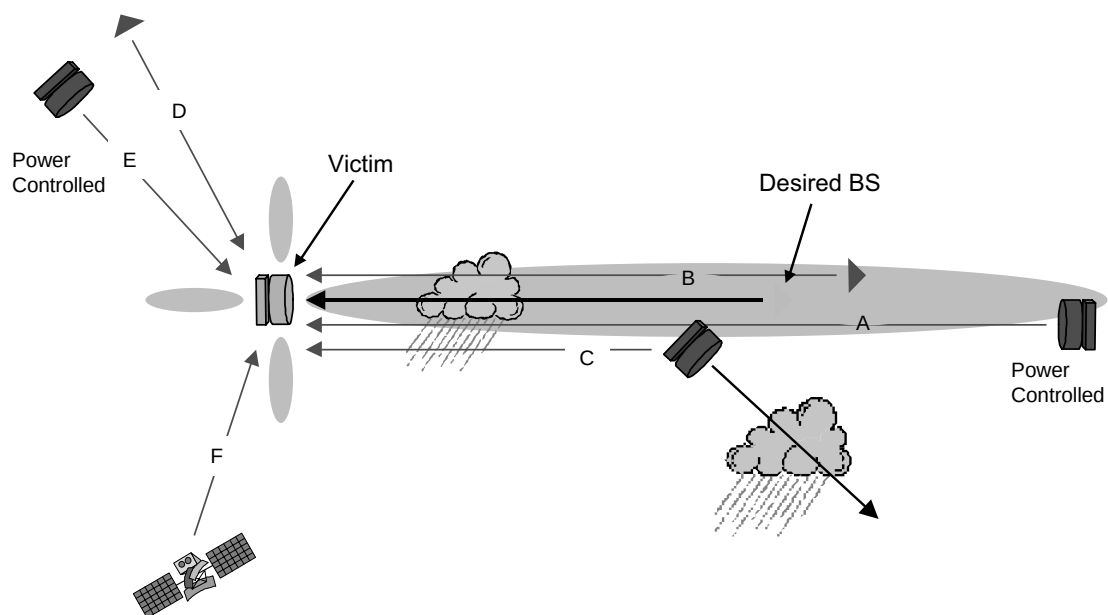


Figure 5—Interference sources to a fixed BWA subscriber station