RECOMMENDATION ITU-R F.1763

Radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz

(Question ITU-R 236/9)

(2006)

1 Introduction

This Recommendation recommends specific standards for broadband wireless access (BWA)[1] systems in the fixed service for international use. These standards are composed of common specifications developed by standardization bodies with broad international participation. Using these standards, manufacturers, operators, and device suppliers should be able to design interoperable, cost-effective equipment and systems or devices. It is also noted that some standards for systems operating in the mobile service can be utilized to provide fixed BWA.

The standards support a wide range of fixed and nomadic broadband applications, in urban, suburban and rural areas, for both generic Internet-type data and real-time data, including applications such as voice and videoconferencing.

2 Scope

This Recommendation identifies specific radio interface standards for BWA systems in the fixed service operating below 66 GHz, addressing profiles for the recommended interoperability standards. It provides references to the standards for interoperability between BWA systems.

The interoperability standards referenced in this Recommendation include the following specifications:

– system profiles;
– physical layer parameters, i.e. channelization, modulation scheme, data rates;
– medium access control (MAC) layer messages and header fields;
– conformance testing methods.

This Recommendation is not intended to deal with the identification of suitable frequency bands for BWA systems, nor any regulatory issues.

3 References

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

Recommendation ITU-R F.1401: Considerations for the identification of possible frequency bands for fixed wireless access and related sharing studies.

Recommendation ITU-R F.1499: Radio transmission systems for fixed broadband wireless access based on cable modem standard.

ITU-R Handbook on Fixed Wireless Access: (Volume 1 of the Land Mobile (including Wireless Access)).

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1 “Wireless access” and “BWA” are defined in Recommendation ITU-R F.1399.

Recommendation ITU-R M.1450: Characteristics of broadband radio local area networks.

Recommendation ITU-R M.1457: Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000).

ITU-T Recommendation J.122: Second-generation transmission systems for interactive cable television services – IP cable modems.

4 Acronyms and Abbreviations

ATM	Asynchronous transfer mode
ATS	Abstract test suite
BRAN	Broadband radio access network (ETSI)
BWA	Broadband wireless access
CL	Convergence layer
DLC	Data link control
ETSI	European Telecommunications Standards Institute
FDD	Frequency division duplex
FEC	Forward error correction
HA	HiperACCESS (ETSI)
HiperACCESS	High PERformance Radio ACCESS network
HiperMAN	High PERformance Radio Metropolitan Area Network
HM	HiperMAN (ETSI)
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
LAN	Local area network
LoS	Line of sight
MAC	Medium access control (OSI layer)
MAN	Metropolitan Area Network
MIB	Management information base
MIMO	Multiple input multiple output
NLoS	Non-line of sight
OFDM	Orthogonal frequency-division multiplexing
OFDMA	Orthogonal frequency-division multiple access
OSI	Open systems interconnection
PHY	PHYsical (OSI layer)
PICS	Protocol implementation conformance statement
QoS	Quality of service
RCT	Radio conformance test
SC	Single carrier
SDO	Standards Development Organization
SME	Small Medium Enterprise
SNMP	Simple network management protocol

SOHO	Small Office Home Office
TDD	Time division duplex
TS	Technical specification (ETSI)
TSS&TP	Test suite structure and test purposes
WirelessMAN	Wireless Metropolitan Area Network (IEEE)

The ITU Radiocommunication Assembly,

noting

a) Recommendation ITU-R F.1499, which specifies radio transmission systems for fixed broadband wireless access (BWA) based on cable modem standards;

b) the Handbook on Fixed Wireless Access (Volume 1 of the Land Mobile (including Wireless Access)), which also includes a number of proprietary solutions for fixed BWA;

c) Recommendation ITU-R F.1401, which provides considerations for the identification of possible frequency bands for fixed wireless access and related sharing studies;

d) Recommendation ITU-R M.1450, which recommends broadband radio local area networks standards;

e) Recommendation ITU-R M.1457, which recommends IMT-2000 radio interface standards, some of which may also be used to provide fixed BWA,

recommends

1 that the specific radio interface standards in Annex 1 may be used for BWA systems in the fixed service operating below 66 GHz (see Note 1).

NOTE 1 – Other radio interfaces used for BWA systems that differ from those referenced in Annex 1, including future versions of these standards referenced in Annex 1, could be addressed in the future in ITU-R following the procedures of Resolution ITU-R 1-4.

Annex 1

Radio interface standards for BWA systems in the fixed service

1 Overview of the radio interface

Depending on the frequency band and implementation details, an access system built in accordance with this standardized interoperable radio interface can support a wide range of applications, from enterprise applications to residential applications in urban, suburban and rural areas. This radio interface can also be applied to other applications, such as for backhaul network applications. The specification could easily support both generic Internet-type data and real-time data, including applications such as voice and videoconferencing.

This type of system is referred to as a wireless metropolitan area network (WirelessMAN in IEEE 802.16, HiperACCESS and HiperMAN in ETSI BRAN[2]). The word "metropolitan" refers not to the application but to the scale. The architecture for this type of system is primarily point-to-multipoint (P-MP), with a base station serving subscribers in a cell that can range up to tens of kilometres. Fixed terminals are ideal for providing broadband wireless access to buildings, such as businesses, homes, Internet cafes, telephone shops (telecentres), etc. Also, typically in frequencies below 11 GHz, portable terminals such as laptop computers and bookshelf terminals support nomadic wireless access.

The radio interface includes support for a variety of data rates. At higher frequencies (e.g. above 10 GHz), supported data rates range over 100 Mbit/s per 25 MHz or 28 MHz channel, with many channels available under some administrations. At the lower frequencies (e.g. below 11 GHz), data rates range up to 70 Mbit/s per 20 MHz channel. The radio interface supports both TDD and FDD operation, along with operational use of various advanced antenna processing techniques, such as beamforming, precoding, space-time coding, MIMO, etc.

The radio interface includes a physical layer (PHY) as well as a medium-access control layer (MAC). The MAC is based on demand-assigned multiple access in which transmissions are scheduled according to priority and availability. This design is driven by the need to support carrier-class access to public networks, both Internet protocol (IP) and asynchronous transfer mode (ATM), with full quality of service (QoS) support.

The MAC supports several PHY specifications, depending on the frequency bands of interest and the operational requirements. In particular, the alternatives include, typically:

a) *Below 11 GHz*

- WirelessMAN-OFDM and HiperMAN: this specification, defined in IEEE Standard 802.16 and in ETSI TS 102 177, is based on OFDM.
- WirelessMAN-OFDMA: this specification, defined in IEEE Standard 802.16, is based on OFDMA.
- WirelessMAN-SCa: this specification, defined in IEEE Standard 802.16, uses single-carrier transmission, based on TDD and FDD.

b) *Above 10 GHz*

- WirelessMAN-SC: this specification, defined in IEEE Standard 802.16, uses single-carrier transmission, based on TDD/FDD, time-division multiplexing (TDM)/time-division multiple access (TDMA).
- HiperACCESS: this specification, defined by ETSI BRAN for frequencies above 11 GHz, uses single-carrier TDM and TDMA transmission.

All the above PHYs use the same MAC, with the exception of HiperACCESS. The HiperACCESS standard defines an interoperable P-MP system for fixed BWA above 10 GHz, while using single-carrier TDM downlink and TDMA uplink transmissions for high spectral efficiency and flexibility.

Appendix 1 illustrates pictorially the equivalencies and differences between the IEEE and ETSI standards.

These IEEE and ETSI standards are radio interface interoperability standards. An interoperability standard is a document that establishes engineering and technical requirements that are necessary to be employed in the design of systems, units, or forces and to use the services so exchanged to

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[2] ETSI (European Telecommunications Standards Institute) and IEEE (Institute of Electrical and Electronics Engineers) are standards development organizations (SDOs) responsible for the radio interface standards considered in this Annex.

enable them to operate effectively together. Further relevant definitions describing other types of standards have been published by ISO/IEC[3].

The SDOs, which have developed the above standards, define system profiles for the recommended interoperability parameters. IEEE 802.16 profiles are included in the main standards document. HiperMAN profiles are defined in ETSI TS 102 210, while HiperACCESS profiles are contained in ETSI TS 101 999 and TS 102 000. The profiles are necessary to facilitate interoperability. Further guidance, including references to conformance test specifications, are provided in Appendix 2.

2 Detailed specification of the radio interface

The specifications contained in this section include the following standards for BWA in the fixed service:

2.1 IEEE Standard 802.16-2004

802.16-2004 IEEE Standard for local and metropolitan area networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems.

Abstract: This standard specifies the air interface of fixed BWA systems supporting multimedia services. The MAC layer supports a primarily point-to-multipoint architecture, with an optional mesh topology. The MAC is structured to support multiple PHY specifications, each suited to a particular operational environment. For operational frequencies from 10-66 GHz, the PHY is based on single-carrier modulation. For frequencies below 11 GHz, where propagation without a direct line of sight must be accommodated, three alternatives are provided, using OFDM, OFDMA, and single-carrier modulation. This standard revises and consolidates IEEE Standards 802.16-2001, 802.16a-2003, and 802.16c-2002.

Standard: The IEEE Standard is available in electronic form at the following address: http://standards.ieee.org/getieee802/download/802.16-2004.pdf

Subject to IEEE's Corrigendum 1[4]
http://standards.ieee.org/getieee802/download/802.16e-2005.pdf

2.2 ETSI Standards

The specifications contained in this section include the following standards for BWA in the fixed service:

a) Standards addressing fixed BWA below 11 GHz:

- ETSI TS 102 177 v1.2.1: Broadband Radio Access Networks (BRAN); HiperMAN; Physical (PHY) Layer.
- ETSI TS 102 178 v1.2.1: Broadband Radio Access Networks (BRAN); HiperMAN; Data Link Control (DLC) Layer.
- ETSI TS 102 210 v1.2.1: Broadband Radio Access Networks (BRAN); HiperMAN; System Profiles.
- ETSI TS 102 389 v1.1.1: Broadband Radio Access Networks (BRAN); HiperMAN; Simple Network Management Protocol (SNMP) Management Information Base (MIB).

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[3] "Standardization and related activities – General vocabulary", ISO/IEC Guide 2, Eighth Edition. Geneva, Switzerland, International Organization for Standardization, 2004.

[4] The cited publication includes not only Corrigendum 1 but also additional content that is applicable to the mobile service only and is not part of this Recommendation.

Abstract: The HiperMAN standards addresses interoperability for fixed BWA systems in 2-11 GHz frequencies, while using OFDM downlink and OFDMA uplink, to provide high cell sizes in non-line of sight (NLoS) operation. The standard provides for FDD and TDD support, high spectral efficiency and data rates, adaptive modulation, high cell radius, support for advanced antenna systems, high security encryption algorithms. Its profiles are targeting the 1.75 MHz, 3.5 MHz and 7 MHz channel spacing, suitable for the 3.5 GHz band.

b) Standards addressing fixed BWA above 10 GHz:

- ETSI TS 101 999 v1.1.1: Broadband Radio Access Networks (BRAN); HiperACCESS; Physical (PHY) Layer.
- ETSI TS 102 000 v1.4.1: Broadband Radio Access Networks (BRAN); HiperACCESS, Data Link Control (DLC) Layer.
- ETSI TS 102 115 v1.1.1: Broadband Radio Access Networks (BRAN); HiperACCESS; Cell-based Convergence Layer. Part 1: Common Part and Part 2: UNI Service Specific Convergence Sublayer (SSCS).
- ETSI TS 102 117 v1.1.1: Broadband Radio Access Networks (BRAN); HiperACCESS; Packet-based Convergence Layer. Part 1: Common Part and Part 2: Ethernet SSCS.

Abstract: HiperACCESS specifies the air interface of fixed broadband wireless access systems with P-MP (point-to-multipoint) topology. The standard is optimized for packet- and cell-based core networks. The main applications are backhaul networks under line-of-sight (LoS) conditions, SME (small medium enterprise) and SOHO (small office home office). The HiperACCESS specification consists of several parts: physical layer based on single-carrier transmission, optimized for LoS links above 10 GHz, DLC (data link control layer) with a well-controlled set of optional features and hooks for future evolution, several convergence layers, a comprehensive set of test specifications to ensure interoperability between equipment from different manufacturers. The adaptive concept of HiperACCESS provides high throughput of more than 100 Mbit/s under normal propagation conditions, allows high frequency reuse factors, and guarantees minor and controllable interference to other systems and adjustable power flux-densities according to national regulatory conditions.

Standards: All the ETSI standards are available in electronic form at: http://pda.etsi.org/pda/queryform.asp, by specifying in the search box the standard number.

Appendix 1
to Annex 1

Comparison and equivalency of the IEEE and ETSI standards

1 Introduction

This Appendix illustrates the equivalency between the IEEE and ETSI standards covered in this Recommendation. Since the specifications are different for the interoperability standards for systems intended to operate below 11 GHz or above 10 GHz, they are shown separately in Figs. 1 and 2.

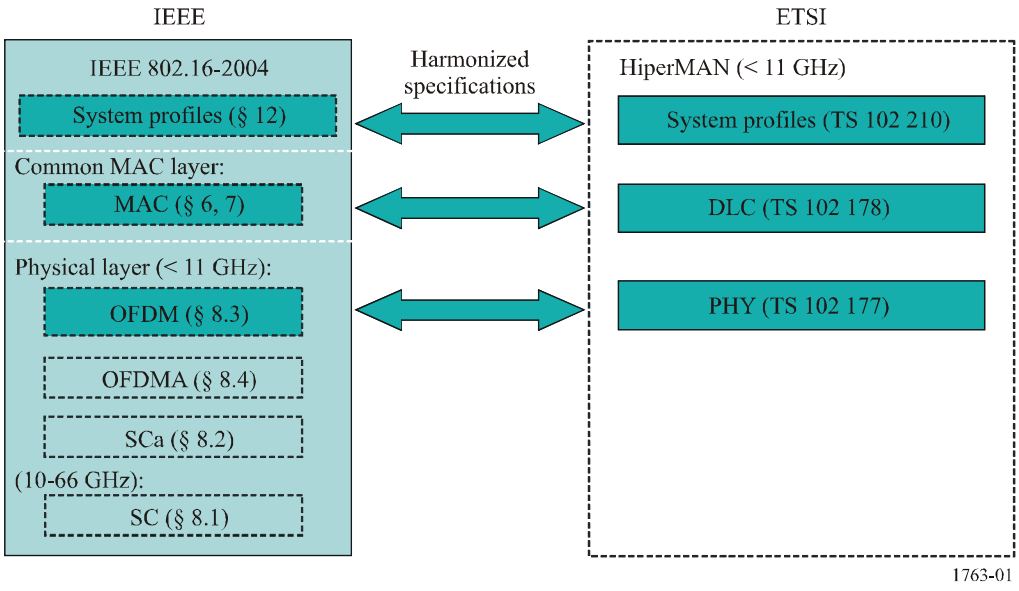
It should be noted that there is a 1 GHz overlap between the applicability of the two sets of standards. This offers a choice of specifications in the 10-11 GHz range, and system designers will select the standards to use for this band, depending on whether they wish to achieve commonality with systems below 10 GHz or systems above 11 GHz.

2 Standards for bands below 11 GHz

Figure 1 shows the harmonized interoperability specifications of the IEEE WirelessMAN and the ETSI HiperMAN standards, for bands below 11 GHz, which include specifications for the OFDM physical layer, MAC, security, and the system profiles.

FIGURE 1

BWA Standards harmonized for interoperability for frequencies below 11 GHz

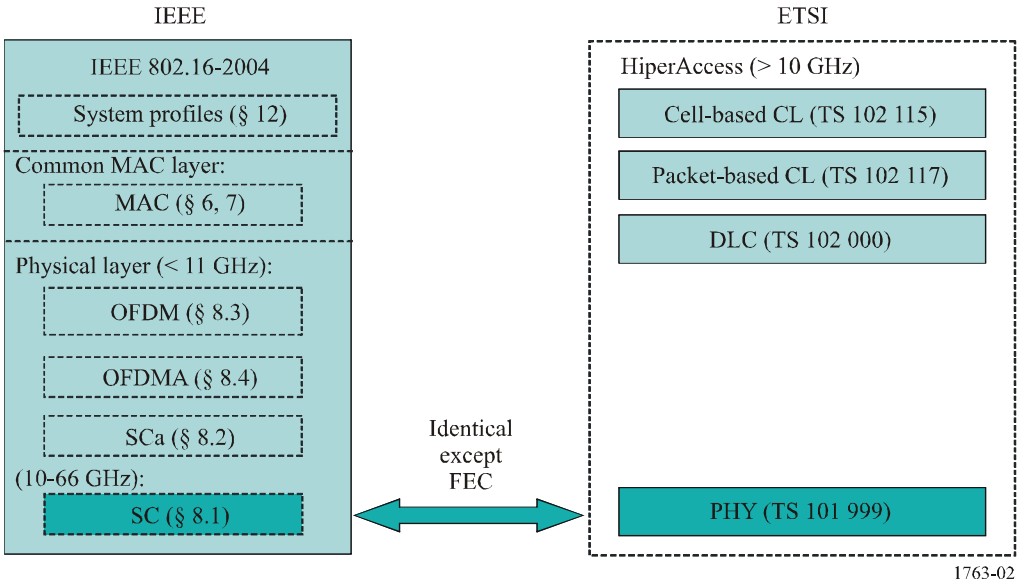


3 Standards for bands above 10 GHz

Figure 2 shows the similarities between the IEEE WirelessMAN and ETSI HiperACCESS standards for frequencies above 10 GHz. The specifications for systems above 10 GHz are different in HiperACCESS and WirelessMAN.

FIGURE 2

BWA Standards common elements for frequencies above 10 GHz



Appendix 2 to Annex 1

Conformance testing specifications

1 Introduction

The system profiles are sets of features to be used in typical implementation cases. Since the standards contain options to fulfil the needs in multiple environments, the first step towards ensuring interoperability is the definition of common system profiles. An exception is HiperAccess where system profiles are not needed since the base station has full control about the use of optional features on a per terminal basis.

Features specified in the standard as optional may be listed in a profile as “required” or “conditionally required”. Profiles do not change “mandatory” status if specified in the standard itself. Optional features shall be implemented as specified in the standard.

The next steps towards ensuring interoperability are conformance testing and interoperability testing.

– Conformance testing is the act of determining to what extent a single implementation conforms to the individual requirements of its base standard.

– Interoperability testing is the act of determining if end-to-end functionality between at least) two communicating systems is as required by those base systems’ standards.

The conformance testing specifications for WirelessMAN, HiperMAN and HiperACCESS are defined according to ISO/IEC 9646 “Information Technology – Open Systems Interconnection – Conformance testing methodology and framework”.

2 Conformance test specifications for IEEE 802.16-2004 WirelessMAN and ETSI HiperMAN for bands below 11 GHz

The following HiperMAN test specifications are applicable equally to both the HiperMAN DLC and WirelessMAN MAC standards, which demonstrate the equivalency of these standards.

ETSI TS 102 385-1 V1.1.1 (2005-02)

Broadband Radio Access Networks (BRAN); HiperMAN; Conformance testing for the Data Link Control Layer (DLC); Part 1: Procotol Implementation Conformance Statement (PICS) proforma.

ETSI TS 102 385-2 V1.1.1 (2005-02)

Broadband Radio Access Networks (BRAN); HiperMAN; Conformance testing for the Data Link Control Layer (DLC); Part 2: Test Suite Structure and Test Purposes (TSS&TP) specification.

3 Conformance test specifications for IEEE 802.16-2004 WirelessMAN and ETSI HiperACCESS for bands above 10 GHz

The testing specifications for systems above 10 GHz are different for WirelessMAN and HiperACCESS.

3.1 Conformance test specifications for IEEE 802.16-2004 WirelessMAN for 10-66 GHz

The conformance test specifications for IEEE 802.16-2004 WirelessMAN are in the following IEEE standards:

IEEE Standard 802.16/Conformance01-2003

IEEE Standard for Conformance to IEEE 802.16 – Part 1: Protocol Implementation Conformance Statements for 10-66 GHz WirelessMAN-SC Air Interface.

IEEE Standard 802.16/Conformance02-2003

IEEE Standard for Conformance to IEEE 802.16 – Part 2: Test Suite Structure and Test Purposes (TSS&TP) for 10-66 GHz WirelessMAN-SC.

IEEE Standard 802.16/Conformance03-2004

IEEE Standard for Conformance to IEEE 802.16 – Part 3: Radio Conformance Tests (RCT) for 10-66 GHz WirelessMAN-SC Air Interface 10-66 GHz WirelessMAN-SC Air Interface.

3.2 Conformance test specifications for ETSI HiperACCESS for bands above 10 GHz

Figure 3 shows the relation between base and test specifications for HiperACCESS.

FIGURE 3

BRAN HiperACCESS standards and test specifications