

IEEE Standard for WirelessMAN-Advanced Air Interface for Broadband Wireless Access Systems

IEEE Computer Society
and the
IEEE Microwave Theory and Techniques Society

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
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IEEE Standard for WirelessMAN-Advanced Air Interface for Broadband Wireless Access Systems

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IEEE Microwave Theory and Techniques Society



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Abstract: The WirelessMAN-Advanced Air Interface, an enhanced air interface designated as “IMT-Advanced” by the International Telecommunication Union—Radiocommunication Sector (ITU-R), is specified in this standard.

Keywords: broadband wireless access, IEEE 802.16, IEEE 802.16.1, IMT-Advanced radio interface, mobile broadband, orthogonal frequency-division multiple access (OFDMA), WirelessMAN®-Advanced Air Interface, wireless metropolitan area networks

The Institute of Electrical and Electronics Engineers, Inc.
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Erik Colban, *Secretary*

Harry Bims, *Secretary*

Zheng Yan-Xiu (鄭延修), *Maintenance Task Group Chair and Technical Editor*

The following members of the IEEE 802.16 Working Group on Broadband Wireless Access participated in the Working Group Letter Ballot in which this standard was prepared and finalized for IEEE ballot:

Anil Agiwal	Heewon Kang	Sudhir Ramakrishna
Hanan Ahmed	Hyunjeong Kang	Wonil Roh
Hassan Al-Kanani	Brian Kiernan	Kiseon Ryu
Youngkyo Baek	Eunkyung Kim	Sam Sambasivan
Phillip Barber	Hokyung Kim	Ji-Yun Seol
Harry Bims	Jeongki Kim	Peretz Shekalim
Inbar Bratspiess	Ronny (Yong-Ho) Kim	Matthew Sherman
Jaesun Cha	Sangheon Kim	Takashi Shono
Sungcheol Chang	Seokki Kim	Jung Je Son
YoungBin Chang	Taeyoung Kim	Yeongmoon Son
Bin Chen	Jin Sam Kwak	Mineo Takai
Chiu-Wen Chen	Eunjong Lee	Ming-Hung Tao
HanGyu Cho	Jin Lee	Rakesh Taori
Hee Jeong Cho	Ying Li	Joseph Teo
Jaeweon Cho	Chiwoo Lim	Alessandro Triglia
Youngbo Cho	Yi-Ting Lin	Tsung-Yu Tsai
Jinsoo Choi	Lu Liru	Arthur Wang
Ching-Chun Chou	Andreas Maeder	Hai Wang
Jin Young Chun	Ronald Mao	Haiguang Wang
Erik Colban	Roger B. Marks	Lei Wang
Yu-Chuan Fang	Shantidev Mohanty	Limei Wang
Dan Gal	Ron Murias	Hung-Yu Wei
Tim Godfrey	Anshuman Nigam	Xiangying Yang
Anh Tuan Hoang	Mitsuo Nohara	Zheng Yan-Xiu
Vinh-Dien Hoang	Masayuki Oodo	Wai Leong Yeow
Ying-Chuan Hsiao	Giwon Park	Hyunkyu Yu
Chun-Yen Hsu	Jeongho Park	Nader Zein
Satoshi Imata	Jisoo Park	Eldad Zeira
Kaushik Josiam	Jaya Shankar Pathmasuntharam	Xin Zhang
Inuk Jung	Fei Qin	Lei Zhou
Soojung Jung		Mingtuo Zhou

Historical information regarding IEEE Std 802.16.1

The following individuals participated in the IEEE 802.16 Working Group during development of this standard and its predecessor, IEEE Std 802.16m™-2011. Included is a historical list of participants who have dedicated their valuable time, energy, and knowledge to the creation of this standard.

IEEE 802.16 Standards	Date approved by IEEE	Officers
IEEE Std 802.16m-2011 (amendment)	6 May 2011	Roger B. Marks: <i>Working Group Chair</i> Jose Puthenkulam: <i>Working Group Vice Chair</i> Rakesh Taori: <i>Working Group Vice Chair</i> Scott Migaldi: <i>Working Group Treasurer</i> Peiying Zhu: <i>Working Group Secretary</i> Herbert Ruck: <i>Working Group Secretary</i> Erik Colban: <i>Working Group Secretary</i> Brian Kiernan: <i>Task Group Chair</i> Phillip Barber: <i>Task Group Vice Chair</i> Jong-Kae Fwu: <i>Task Group Vice Chair</i> Carl Eklund: <i>Task Group Vice Chair</i> Hokyu Choi: <i>Task Group Secretary</i> Avraham Freedman: <i>Task Group Secretary</i> Ronald Murias: <i>Chief Technical Editor</i> M. Scott Probasco: <i>Assistant Editor; Working Group Secretary</i> Hyunjeong Kang: <i>Assistant Editor</i> Mark Cudak: <i>Editor: System Requirements Document</i> Shkumbin Hamiti: <i>Editor: System Description Document</i> Roshni Srinivasan: <i>Editor: Evaluation Methodology Document</i> Reza Arefi: <i>ITU-R Liaison</i> Takashi Shono: <i>ITU-R Liaison</i> José M. Costa: <i>ITU-R Liaison</i>

The following members of the IEEE 802.16 Working Group on Broadband Wireless Access participated in the Working Group Letter Ballot in which IEEE Std 802.16m-2011 was approved:

Mohamed Abdallah	Chengyan Feng	Sungkyung Kim
Rajni Agarwal	Mo-Han Fong	Taeyoung Kim
Anil Agiwal	I-Kang Fu	Won Ik Kim
Sassan Ahmadi	Jong-Kae (JK) Fwu	Takaaki Kishigami
Hassan Al-Kanani	Dan Gal	J. Klutto Milleth
Xavier Ambroise	Mariana Goldhamer	Ali Koc
Dov Andelman	Yanfeng Guan	Thanasis Korakis
Ramesh Annavajjala	Michael Gundlach	Gokhan Korkmaz
Tsuguhide Aoki	Zion Hadad	Kiran Kumar Kuchi
Reza Arefi	GeneBeck Hahn	Ping-Heng Kuo
Youngkyo Baek	Seishi Hanaoka	Toshiyuki Kuze
Phillip Barber	Tom Harel	Jin Sam Kwak
Harry Bims	Shigenori Hayase	Dong Seung Kwon
Erez Biton	William Hillery	Young Hoon Kwon
Adrian Boyer	Nageen Himayat	Jonathan Labs
Sean Cai	Chieh Yuan Ho	Byung Moo Lee
Jaesun Cha	Chung-Lien Ho	Howon Lee
Suchang Chae	Ying-Chuan Hsiao	Hyun Lee
Sungcheol Chang	Ching-Tarng Hsieh	HyunWoo Lee
YoungBin Chang	Yu-Tao Hsieh	Jeong Julie Lee
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Whai-En Chen	Lei Huang	Wookbong Lee
Yih-Shen Chen	Jie Hui	Yang-Han Lee
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Paul Cheng	Bin-Chul Ihm	Guangjie Li
Ray-Guang Cheng	Tetsu Ikeda	Ying Li
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Hua (Mary) Chion	Yih Guang Jan	Pei-Kai Liao
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Ching-Chun Chou	Hyunjeong Kang	Kaiying Lv
Joey Chou	Minsuk Kang	Michael Lynch
Jerry Chow	Seunghyun Kang	Mohammad Madhian
Ming-Hsueh Chuang	Hajime Kanzaki	Andreas Maeder
Jin Young Chun	Chien-Yu Kao	Alexander Maltsev
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Mark Cudak	Brian Kiernan	Arif Maskatia
Alexey Davydov	Eunkyung Kim	Wataru Matsumoto
Kamran Etemad	Jeong Gon Kim	David Mazzarese
Yu-Chang Eun	Jihyung Kim	Sean McBeath
Linghang Fan	Juhee Kim	Djamal-Eddine Meddour
Huiying Fang	Namgi Kim	Scott Migaldi
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Sungho Moon
 Ron Murias
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 Min-Seok Oh
 Masato Okuda
 Kim Olszewski
 Ryoji Ono
 Philip Orlik
 Apostolos Papathanassiou
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 Sung-Eun Park
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 M. Scott Probasco
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 Sam Sambasivan
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 Shahab Sayeedi
 Joerg Schaepperle
 Joseph Schumacher
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 Ahmed Shalash
 Peretz Shekalim
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Wooram Shin
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 Sten Sjoberg
 Tricci So
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 Doo-hyun Sung
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 Anup Talukdar
 Yang Tang
 Jeffrey Tao
 Ming-Hung Tao
 Rakesh Taori
 Shawn Taylor
 Yongjoo Tcha
 Arnaud Tonnerre
 Chang-Lan Tsai
 Jiann-An Tsai
 Tsung-Yu Tsai
 Yi-Hsueh Tsai
 Fan Shuo Tseng
 Hsien-Wei Tseng
 Stavros Tzavidas
 Sunil Vadgama
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 Jiacheng Wang

Lei Wang
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 Fujio Watanabe
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 Changlong Xu
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 Chang Feng Yang
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 Nader Zein
 Eldad Zeira
 Jie Zhang
 Zheng Zhao
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 Hua Zhou
 Lei Zhou
 Chenxi Zhu
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 Peiying Zhu
 Yuan Zhu

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Iwan Adhicandra	Tai Kaitz	Jeongho Park
Hanan Ahmed	Shinkyo Kaku	Jungshin Park
Thomas Alexander	Hyunjeong Kang	Seung-Hoon Park
Nobumitsu Amachi	Noh-Gyoung Kang	Sung-Eun Park
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Catherine Berger
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Patricia Gerdon
IEEE Client Services Manager, Professional Services

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This introduction is not part of IEEE Std 802.16.1-2012, IEEE Standard for WirelessMAN-Advanced Air Interface for Broadband Wireless Access Systems.

This standard specifies the WirelessMAN-Advanced Air Interface, an enhanced air interface designated as “IMT-Advanced” by the International Telecommunication Union—Radiocommunication Sector (ITU-R).

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1. Overview

1.1 Scope

This standard specifies the WirelessMAN-Advanced Air Interface, including the medium access control layer (MAC) and physical layer (PHY), of a broadband wireless access (BWA) system supporting multiple services. The WirelessMAN-Advanced Air Interface supports the International Telecommunication Union (ITU)'s IMT-Advanced requirements.

1.2 Purpose

This standard enables rapid worldwide deployment of innovative, cost-effective, and interoperable multivendor broadband wireless access products, facilitates competition in broadband access by providing alternatives to wireline broadband access, encourages consistent worldwide spectrum allocation, and accelerates the commercialization of broadband wireless access systems. The standard serves as a basis for IMT-Advanced recommendations within the ITU.

1.3 Frequency bands

The primary bands of interest are described in 1.3.1.

1.3.1 Frequencies below 11 GHz

Frequencies below 11 GHz provide a physical environment where, due to the longer wavelength, line-of-sight (LOS) is not necessary and multipath may be significant. The ability to support near-LOS and non-LOS (NLOS) scenarios requires additional PHY functionality, such as the support of advanced power management techniques, interference mitigation/coexistence, and multiple antennas.

1.4 Reference models

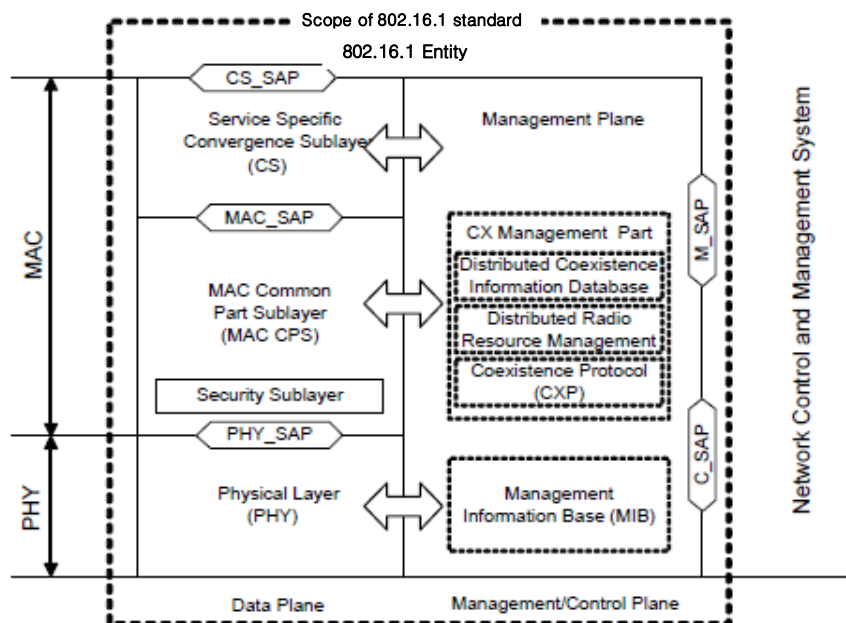


Figure 1-1—IEEE 802.16.1 protocol layering, showing service access points (SAPs)

The MAC common part sublayer (CPS) provides the core MAC functionality of system access, bandwidth allocation, connection establishment, and connection maintenance. It receives data from the various convergence sublayers (CSs), through the MAC SAP, classified to particular MAC connections. Quality of service (QoS) is applied to the transmission and scheduling of data over the PHY. The MAC also contains a separate security sublayer providing authentication, secure key exchange, and encryption. Data, PHY control, and statistics are transferred between the MAC CPS and the PHY via the PHY SAP (which is implementation specific). The PHY specifications supported is discussed in 6.3. All these parts are supported at the MAC level. The MAC comprises three sublayers. The service-specific CS provides any transformation or mapping of external network data, received through the CS SAP, into MAC service data units (SDUs) received by the MAC CPS through the MAC SAP. This includes classifying external network SDUs and associating them to the proper MAC service flow identifier (SFID) and, for an advanced base station (ABS) or advanced mobile station (AMS), a Station Identifier + Flow Identifier (STID + FID) combination. It may also include such functions as payload header suppression (PHS). Multiple CS specifications are provided for interfacing with various protocols. The internal format of the CS payload is unique to the CS, and the MAC CPS is not required to understand the format of or to parse any information from the CS payload.

1.4.1 IEEE 802.16.1 entity

An IEEE 802.16.1 entity is defined as the logical entity in an AMS or ABS that comprises the PHY and MAC layers of the Data Plane and the Management/Control Plane.

1.4.2 Network reference model

Figure 1-2 describes a simplified network reference model. Multiple AMS may be attached to an ABS. An AMS communicate to the ABS over the U interface using a Primary Management Connection, a Basic Connection, or a Secondary Management Connection.

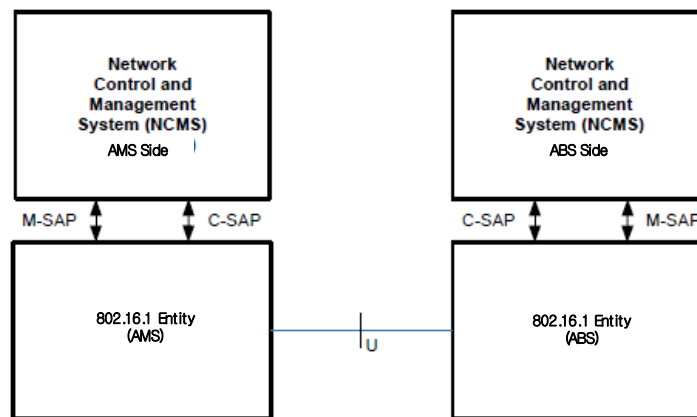


Figure 1-2—IEEE 802.16.1 Network reference model

1.4.2.1 AMS and ABS interface

This standard observes the following correlation:

- MAC control PDUs that are exchanged on the control connection trigger or are triggered by primitives that are exchanged over either the C-SAP or the M-SAP depending on the particular management or control operation.

1.4.2.2 IEEE 802.16 entity to NCMS interface

This interface is a set of SAP between an IEEE 802.16 entity and NCMS and is represented in Figure 1-2. It is decomposed into two parts: the Management SAP (M-SAP) is used for less time-sensitive Management plane primitives, and the Control SAP (C-SAP) is used for more time-sensitive Control plane primitives that support handovers, security context management, radio resource management, and low-power operations (such as idle mode and paging functions).

Architecturally, the base stations and their backbone connections form the access service network (ASN), defined as a complete set of network functions, are needed to provide radio access to the mobile stations. The ASN is outside the scope of this standard.

1.4.3 Management SAP (M-SAP)

The Management SAP may include, but is not limited to, primitives related to the following:

- System configuration
- Monitoring statistics
- Notifications/triggers
- Multimode interface management

The network control and management system (NCMS) interacts with the management information base (MIB) through the M-SAP in a method not defined in this standard.

1.4.4 Control SAP (C-SAP)

The Control SAP may include, but is not limited to primitives related to the following:

- Handovers [e.g., notification of handover (HO) request from AMS]
- Idle mode mobility management (e.g., Mobile entering idle mode)
- Subscriber and session management (e.g., Mobile requesting session setup)
- Radio resource management
- AAA server signaling [e.g., extensible authentication protocol (EAP) payloads]

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

FIPS 197, Advanced Encryption Standard (AES).¹

IEEE Std 802[®], IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture.^{2, 3}

IEEE Std 802.16[™], IEEE Standard for Air Interface for Broadband Wireless Access Systems.

IEEE Std 802.21[™]-2008, IEEE Standard for Local and Metropolitan Area Networks: Media Independent Handover Services.

IETF RFC 791, “Internet Protocol,” J. Postel, Sept. 1981.⁴

IETF RFC 2132, “DHCP Options and BOOTP Vendor Extensions,” S. Alexander, R. Droms, Mar. 1997.

IETF RFC 2460, “Internet Protocol, Version 6 (IPv6) Specification,” S. Deering, R. Hinden, Dec. 1998.

IETF RFC 3095, “RObust Header Compression (ROHC): Framework and four profiles: RTP, UDP, ESP, and uncompressed,” C. Bormann, et al., July 2001.

IETF RFC 3243, “RObust Header Compression (ROHC): Requirements and Assumptions for 0-byte IP/UDP/RTP Compression,” L-E. Jonsson, Apr. 2002.

IETF RFC 3315, “Dynamic Host Configuration Protocol for IPv6 (DHCPv6),” R. Droms, et al., July 2003.

IETF RFC 3748, “Extensible Authentication Protocol (EAP),” B. Aboba, L. Blunk, J. Vollbrecht, J. Carlson, H. Levkowitz, June 2004.

IETF RFC 3759, “RObust Header Compression (ROHC): Terminology and Channel Mapping Examples,” L-E Jonsson, Apr. 2004.

IETF RFC 3825, “DHCP for Coordinate-based Location Configuration Information,” July 2004.

IETF RFC 3843, “RObust Header Compression (ROHC): A Compression Profile for IP,” L-E. Jonsson, G. Pelletier, June 2004.

IETF RFC 4995, “The RObust Header Compression (ROHC) Framework,” L-E. Jonsson, G. Pelletier, K. Sandlund, July 2007.

IETF RFC 4996, “RObust Header Compression (ROHC): A Profile for TCP/IP (ROHC-TCP),” G. Pelletier, K. Sandlund, L-E. Jonsson, M. West, July 2007.

ITU-T Recommendation G.704—Synchronous Frame Structures Used at 1544, 6312, 2048, 8448 and 44 736 kbit/s Hierarchical Levels, Oct. 1998.⁵

¹FIPS publications are available from the National Technical Information Service (<http://www.ntis.gov/>).

²The IEEE standards or products referred to in this clause are trademarks of The Institute of Electrical and Electronics Engineers, Inc.

³IEEE publications are available from the Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).

⁴IETF documents (i.e., RFCs) are available for download at <http://www.rfc-archive.org/>.

ITU-T Recommendation X.25—Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit, Oct. 1996.

NIST Special Publication 800-38A—Recommendation for Block Cipher Modes of Operation—Methods and Techniques.⁶

NIST Special Publication 800-38B—Recommendation for Block Cipher Modes of Operation: The CMAC Mode for Authentication.

NIST Special Publication 800-38C—Recommendation for Block Cipher Modes of Operation: The CCM Mode for Authentication and Confidentiality, May 2004.

⁵ITU-T publications are available from the International Telecommunications Union (<http://www.itu.int/>).

⁶NIST publications are available from the National Institute of Standards and Technology (<http://www.nist.gov/>).

3. Definitions

For the purposes of this document, the following terms and definitions apply. *The IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁷

AAI (DL/UL) Access Zone: An integer multiple of subframes located in the MZone of the ABS frame or ARS frame, where an ABS or ARS transmits to the AMSs or receives from the AMSs.

AAI (DL/UL) Relay Zone: An integer multiple of subframes located in the MZone of the ABS frame, where an ABS transmits to the ARSs and/or AMSs or receives from the ARSs and AMSs, or the ARS frame, where an ARS transmits to the ABS or receives from the ABS.

AAI subframe: A structured data sequence of predefined duration used by the Advanced Air Interface specification.

advanced base station (ABS): A base station that supports the WirelessMAN-Advanced Air Interface.

advanced mobile station (AMS): A subscriber station capable of performing the Wireless-MAN-OFDMA TDD Release 1 subset of mobile station (MS) features and functions and of implementing the WirelessMAN-Advanced Air Interface.

advanced network: An access network compliant with the WirelessMAN-Advanced Air Interface System.

advanced relay station (ARS): A relay station that supports the WirelessMAN-Advanced Air Interface.

ARS receive/transmit transition gap (ARSRTG): The minimum receive-to-transmit turnaround gap required at an ARS. ARS-RTG is measured from the time of the last sample of the received burst to the first sample of the transmitted burst at the antenna port of the ARS.

ARS transmit/receive transition gap (ARSTTG): The minimum transmit-to-receive turnaround gap required at an ARS. ARS-TTG is measured from the time of the last sample of the transmitted burst to the first sample of the received burst at the antenna port of the ARS.

closed subscriber group (CSG): A set of subscribers authorized by the Femto ABS owner or the network service provider, for accessing CSG Femto ABS.

contiguous resource unit (CRU): The resource allocation unit of the same size as the PRU that has undergone the subband partitioning and miniband permutation, assigned to contiguous allocation and will bypass subcarrier permutation in DL and tile permutation in UL.

CSG Femto ABS: CSG-Closed or CSG-Open Femto ABS.

CSG-Closed Femto ABS: A Femto ABS accessible only to the AMSs, which are in its CSG(s), except for emergency services. AMSs that are not the members of the CSG(s) should not try to access CSG-Closed Femto ABSs.

CSG-Open Femto ABS: A Femto ABS primarily accessible to the AMSs that belong to its CSG(s), while other AMSs, outside CSG(s), may also access such Femto ABS, and will be served at a lower priority. CSG-Open Femto ABS will provide service to such AMSs as long as the QoS of AMSs in its CSG(s) is not compromised.

⁷The *IEEE Standards Dictionary Online* subscription is available at http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

default service flow: A service flow that is established automatically without DSA procedure after successful registration procedure. QoS parameters for the default service flow are predefined.

distributed resource unit (DRU): The resource allocation unit of the same size as the PRU that has undergone the subband partitioning and miniband permutation, assigned to distributed allocation and will be submitted to the subcarrier permutation in DL and tile permutation in UL.

dual-radio MS: A multimode MS/AMS that can have both radios (transmitting and receiving) active at the same time. A dual-radio MS/AMS can simultaneously transmit and receive on both radios. A dual-radio MS/AMS may behave as a single-radio MS by operating in single radio mode.

Femto ABS: An ABS with low transmit power, typically installed by a subscriber in the home, SOHO, or enterprise to provide the access to closed or open group of users as configured by the subscriber and/or the access provider. A Femto ABS is typically connected to the service providers network via a broadband connection.

frame index: The frame order within a superframe (i.e., the first, second, third, or fourth frame of superframe).

frame number: In WirelessMAN-Advanced Air Interface, the frame number is obtained by concatenating the 12-bit superframe number (transmitted in every superframe) and the 2-bit frame index. Superframe numbers are synchronized across base stations.

horizontal encoding: Indicates transmitting multiple MIMO layers over multiple antennas. The number of MIMO layers is more than 1. The number of MIMO streams is the same as the number of MIMO layers in this case.

logical resource unit (LRU): The generic name of logical units for distributed and contiguous resource allocations.

LZone: A positive integer number of consecutive subframes during which an ABS communicates with RSs or R1 MSs, and where an ARS or an RS communicates with one or more R1 MSs.

Macro ABS: An ABS with high transmit power. A Macro ABS is directly connected to the service providers network.

Macro hot-zone ABS: An ABS with smaller transmission power/cell size than that of macro ABSs, typically deployed by service provider and operated on service provider backhaul.

MIMO layer: An information path fed to the MIMO encoder as an input. A MIMO layer represents one channel coding block.

MIMO stream: Each information path encoded by the MIMO encoder that is passed to the precoder.

mixed-mode ABS: An ABS with an operating LZone and operating MZone.

multilayer encoding: The number of MIMO streams is the same as the number of MIMO layers in this case.

multi-radio MS: A multimode MS/AMS that can have multiple radios (transmitting and receiving) active at the same time. A multi-radio MS/AMS can simultaneously transmit and receive on multiple radios. A multi-radio MS/AMS may behave as a single-radio MS by operating in single-radio mode.