

First edition
2012-11-01

AMENDMENT 5
2015-09-01

**Information technology —
Telecommunications and information
exchange between systems — Local and
metropolitan area networks — Specific
requirements —**

**Part 11:
Wireless LAN medium access control
(MAC) and physical layer (PHY)
specifications**

AMENDMENT 5

*Technologies de l'information — Télécommunications et échange
d'information entre systèmes — Réseaux locaux et métropolitains —
Exigences spécifiques —*

*Partie 11: Spécifications du contrôle d'accès du milieu sans fil (MAC) et
de la couche physique (PHY)*

AMENDEMENT 5



Reference number
ISO/IEC/IEEE 8802-11:2012/Amd.5:2015(E)



© IEEE 2014



COPYRIGHT PROTECTED DOCUMENT

© IEEE 2014

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from ISO, IEC or IEEE at the respective address below.

ISO copyright office
Case postale 56
CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
E-mail inmail@iec.ch
Web www.iec.ch

Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York
NY 10016-5997, USA
E-mail stds.ipr@ieee.org
Web www.ieee.org

Published in Switzerland

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

The main task of ISO/IEC JTC 1 is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is called to the possibility that implementation of this standard may require the use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. ISO/IEEE is not responsible for identifying essential patents or patent claims for which a license may be required, for conducting inquiries into the legal validity or scope of patents or patent claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance or a Patent Statement and Licensing Declaration Form, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from ISO or the IEEE Standards Association.

Amendment 5 to ISO/IEC/IEEE 8802-11 was prepared by the LAN/MAN of the IEEE Computer Society (as IEEE 802.11-2013). It was adopted by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in parallel with its approval by the ISO/IEC national bodies, under the “fast-track procedure” defined in the Partner Standards Development Organization cooperation agreement between ISO and IEEE. IEEE is responsible for the maintenance of this document with participation and input from ISO/IEC national bodies.

(blank page)

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/AMD5:2015

IEEE Standard for Information technology—
Telecommunications and information exchange between systems
Local and metropolitan area networks—
Specific requirements

Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

Amendment 5: Television White Spaces (TVWS) Operation

IEEE Computer Society

Sponsored by the

LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 802.11af™-2013
(Amendment to
IEEE Std 802.11™-2012,
as amended by IEEE Std 802.11ae™-2012,
IEEE Std 802.11aa™-2012,
IEEE Std 802.11ad™-2012,
and IEEE Std 802.11ac™-2013)

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/AMD5:2015

IEEE Std 802.11af™-2013

(Amendment to
IEEE Std 802.11™-2012,
as amended by IEEE Std 802.11ae™-2012,
IEEE Std 802.11aa™-2012,
IEEE Std 802.11ad™-2012,
and IEEE Std 802.11ac™-2013)

**IEEE Standard for Information technology—
Telecommunications and information exchange between systems
Local and metropolitan area networks—
Specific requirements**

**Part 11: Wireless LAN Medium Access Control
(MAC) and Physical Layer (PHY) Specifications**

**Amendment 5: Television White Spaces (TVWS)
Operation**

Sponsor

**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Approved 11 December 2013

IEEE-SA Standards Board

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/Amd.5:2015

Abstract: Enhancements to the IEEE 802.11 physical layers (PHYs) and medium access control (MAC) sublayer to support operation in the white spaces in television bands are defined.

Keywords: IEEE 802.11af™, television white spaces, TVWS, wireless LAN, WLAN

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

Copyright © 2014 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 21 February 2014. Printed in the United States of America.

IEEE and 802 are registered trademarks in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-0-7381-8748-8 STD98455
Print: ISBN 978-0-7381-8749-5 STDPD98455

IEEE prohibits discrimination, harassment, and bullying.

For more information, visit <http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html>.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading “Important Notice” or “Important Notices and Disclaimers Concerning IEEE Standards Documents.”

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (“IEEE-SA”) Standards Board. IEEE (“the Institute”) develops its standards through a consensus development process, approved by the American National Standards Institute (“ANSI”), which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied “AS IS” and “WITH ALL FAULTS.”

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE-SA Website at <http://ieeexplore.ieee.org/xpl/standards.jsp> or contact IEEE at the address listed previously. For more information about the IEEE-SA or IEEE's standards development process, visit the IEEE-SA Website at <http://standards.ieee.org>.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: <http://standards.ieee.org/findstds/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at <http://standards.ieee.org/about/sasb/patcom/patents.html>. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Participants

At the time this amendment was completed, the IEEE 802.11 Working Group had the following officers:

Bruce P. Kraemer, *Chair*
Jon W. Rosdahl and **Adrian P. Stephens**, *Vice-chairs*
Stephen McCann, *Secretary*

At the time this amendment was submitted for balloting, the TV White Space Operation Task Group had the following membership:

Richard H. Kennedy, *Chair*
Peter Ecclesine, *Vice Chair and Technical Editor*
Zhou Lan, *Vice Chair and Secretary*

Osama S. Aboulmagd	Sayantana Choudhury	David Hunter
Santosh P. Abraham	Liwen Chu	Sung Hyun Hwang
Roberto Aiello	Jinyoung Chun	Yasuhiko Inoue
Thomas Alexander	John Coffey	Mitsuru Iwaoka
Peiman Amini	Kenneth Coop	Sungeun Jin
Sirikiat Lek Ariyavisitakul	Carlos Cordeiro	Zhong Yi Jin
Lee R. Armstrong	Neiyer Correal	Nihar Jindal
Yusuke Asai	Subir Das	Vince Jones
Alex Ashley	Hendricus De Ruijter	Jari Junell
Kwok Shum Au	Rolf J. de Vegt	Padam Kafle
Vijay Auluck	Yohannes Demessie	Carl W. Kain
Stefan Aust	Xiangdong Dong	Hyunduk Kang
Geert A. Awater	Klaus Doppler	Mika Kasslin
David Bagby	Roger P. Durand	Shuzo Kato
Eugene Baik	Richard Edgar	Stuart J. Kerry
Gabor Bajko	Marc Emmelmann	Bonghoe Kim
Raja Banerjea	Vinko Erceg	Byoung-Hoon Kim
Phillip Barber	Ping Fang	Eun Sun Kim
Anuj Batra	Qin Fei	Eunkyung Kim
Tuncer Baykas	Stanislav Filin	Jeongki Kim
Alan Berkema	Matthew J. Fischer	Joonsuk Kim
Bijoy Bhukania	George Flammer	Suhwook Kim
Philippe Boucachard	Chittabrata Ghosh	Taejoon Kim
Andre Bourdoux	James P. K. Gilb	Youhan Kim
John Buffington	Reinhard Gloger	Youngsoo Kim
Lin Cai	Daning Gong	Shoichi Kitazawa
George Calcev	David Goodall	Tero Kivinen
Chris Calvert	Elad Gottlib	Jarkko Knecht
Radhakrishna Canchi	Sudheer A. Grandhi	Gwangzeen Ko
Laurent Cariou	Stephen Grau	Fumihide Kojima
William Carney	Michael Grigat	Tom Kolze
Jaesun Cha	David Halasz	Timo Koskela
Romana Challans	Mark Hamilton	Thomas M. Kurihara
Philippe Chambelin	Christopher J. Hansen	Jin-Sam Kwak
Kim Chang	Hiroshi Harada	Joseph Kwak
Kuor-Hsin Chang	Dan N. Harkins	Young Hoon Kwon
Xin Chang	Brian D. Hart	Paul Lambert
Clint F. Chaplin	Ahmadreza Hedayat	Leonardo Lanante
Bin Chen	Robert F. Heile	James Lansford
Lidong Chen	Jerome Henry	Anseok Lee
Minho Cheong	Ken Hiraga	Donghun Lee
George Cherian	Chin Keong Ho	Jae Seung Lee
Rojan Chitrakar	Anh Tuan Hoang	Wookbong Lee
Jinsoo Choi	Dien Hoang	Zhongding Lei
Li Chia Choo	Jing-Rong Hsieh	Wai Kong Leung

Joseph Levy	Vishakan Ponnampalam	Fei Tong
Feng Li	Daniel Popa	Solomon B. Trainin
Huan-Bang Li	Ron Porat	Ha Nguyen Tran
Lingjie Li	Henry S. Ptasinski	Kazuyoshi Tsukada
Yunbo Li	Rethnakaran Pulikkoonattu	Masahiro Umehira
Yunzhou Li	Chang-Woo Chang Pyo	Richard D. J. Van Nee
Erik Lindskog	Emily H. Qi	Allert Van Zelst
Jianhan Liu	Huyu Qu	Prabodh Varshney
Yong Liu	Harish Ramamurthy	Sameer Vermani
Peter Loc	Jayaram Ramasastry	Dalton T. Victor
Long Luo	Ivan Reede	Gabriel Villardi
Yi Luo	Edward Reuss	George A. Vlantis
Zhendong Luo	Maximilian Riegel	Chao Chun Wang
Kaiying Lv	Mark Rison	Haiguang Wang
Michael Lynch	Kiseon Ryu	James June Wang
Jouni K. Malinen	Kazuyuki Sakoda	Lei Wang
Hiroshi Mano	Ruben Salazar Cardozo	Qi Wang
Simone Merlin	Hemanth Sampath	Xuehuan Wang
James Miller	Sigurd Schelstraete	Lisa Ward
Apurva Mody	Timothy Schmidl	Fujio Watanabe
Michael Montemurro	Jean Schwoerer	Lei Wen
Kenichi Mori	Jonathan Segev	Menzo M. Wentink
Hitoshi Morioka	Cristina Seibert	Nicholas West
Ronald Murias	Yongho Seok	Eric Wong
Andrew Myles	Kunal Shah	Ian Wong
Yukimasa Nagai	Huairong Shao	Harry R. Worstell
Yuhei Nagao	Nir Shapira	Tianyu Wu
Hiroki Nakano	Stephen J. Shellhammer	Zhanji Wu
Sai Shankar Nandagopalan	Ian Sherlock	Xun Yang
Pradeep Nemavat	Wei Shi	Yunsong Yang
Chiu Ngo	Nobuhiko Shibagaki	James Yee
Paul Nikolich	Shusaku Shimada	Peter Yee
Hiroyo Ogawa	Thomas M. Siep	Wai-Leong Yeow
Minseok Oh	Michael Sim	Kaoru Yokoo
Min-Seok Oh	Dwight Smith	Su Khiong Yong
David Olson	Graham Kenneth Smith	Chanho Yoon
Satoshi Oyama	Ill Soo Sohn	Christopher Young
Michael J. Paljug	Robert Stacey	Heejung Yu
Santosh Ghanshyam Pandey	Dorothy Stanley	Zhan Yu
Anna Pantelidou	Rene Struik	Tevfik Yucek
Giwon Park	Jung Hoon Suh	Katsuo D. A. Yunoki
Jonghyun Park	Chin-Sean Sum	Dezhi Zhang
Minyoung Park	Bo Sun	Hongyuan Zhang
Seung-Hoon Park	Chen Sun	Junjian Zhang
Jaya Shankar Pathmasuntharam	Sheng Sun	Mu Zhao
Sandhya Patil	Mohammad Hossein Taghavi	Jun Zheng
Xiaoming Peng	Kazuaki Takahashi	Shoukang Zheng
Eldad Perahia	Mineo Takai	Mingtuo Zhou
James E. Petranovich	Sagar Tamhane	Chunhui Zhu
Albert Petrick	Joseph Teo	Yan Zhuang
John Petro	Thomas Tetzlaff	Lawrence Zuckerman
Krishna Madhavan Pillai	Jerry Thrasher	
Riku Pirhonen	Jens Tingleff	
Juho Pirskanen		

Major contributions were received from the following individuals:

Vinko Erceg	Wookbong Lee	Jae-Hyung Song
Padam Kafle	Dongguk Lim	Chen Sun
Eun Sun Kim	Ron Porat	Jens Tingleff
Zhou Lan	Yongho Seok	Tevfik Yucek

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

Tomoko Adachi	Noriyuki Ikeuchi	John Notor
Thomas Alexander	Sergiu Iordanescu	Robert O'Hara
Nobumitsu Amachi	Akio Iso	Satoshi Oyama
Butch Anton	Atsushi Ito	Brian Phelps
Lee R. Armstrong	Mitsuru Iwaoka	Clinton Powell
Kwok Shum Au	Raj Jain	Venkatesha Prasad
Stefan Aust	Bobby Jose	Michael Probasco
Tuncer Baykas	Padam Kafle	Demir Rakanovic
Harry Bims	Shinkyō Kaku	Jayaram Ramasastry
Gennaro Boggia	Hyunduk Kang	Ivan Reede
Nancy Bravin	Piotr Karocki	Maximilian Riegel
John Buffington	Assaf Kasher	Robert Robinson
William Byrd	Ruediger Kays	Benjamin Rolfe
William Carney	Richard H. Kennedy	Jon W. Rosdahl
Juan Carreon	John Kenney	John Santhoff
Dave Cavalcanti	Jeritt Kent	Shigenobu Sasaki
Wei-Peng Chen	Stuart J. Kerry	Naotaka Sato
Paul Chiuchiolo	Yongbum Kim	Yongho Seok
Sayantan Choudhury	Youhan Kim	Ian Sherlock
Keith Chow	Gwangeen Ko	Shusaku Shimada
Charles Cook	Bruce P. Kraemer	Tsuyoshi Shimomura
Neiyer Correal	Thomas M. Kurihara	Ju-Hyung Son
Joseph Decuir	Zhou Lan	Chunyi Song
Michael Denson	Jeremy Landt	Kapil Sood
Patrick Diamond	James Lansford	Amjad Soomro
Roger P. Durand	Wookbong Lee	Robert Stacey
Sourav Dutta	James Lepp	Thomas Starai
Peter Ecclesine	Jean-Pierre Le Rouzic	Adrian P. Stephens
Richard Edgar	Arthur H. Light	Rene Struik
Charles Einolf	Chih-Che Lin	Walter Struppler
Marc Emmelmann	Lu Liru	Gary Stuebing
David Evans	Philip Lunsford	Chandrasekaran Subramaniam
Stanislav Filin	Greg Luri	Chin-Sean Sum
Avraham Freedman	Michael Lynch	Bo Sun
Stefano Galli	Chris Lyttle	Thomas Tetzlaff
Matthew Gast	Elvis Maculuba	Jens Tingleff
Devon Gayle	Jouni K. Malinen	Keat Beng Toh
Pieter-Paul Giesberts	James Marin	Fei Tong
James P. K. Gilb	Roger Marks	Ha Nguyen Tran
Tim Godfrey	Jeffery Masters	Kazuyoshi Tsukada
David Goodall	Stephen McCann	Lorenzo Vangelista
Sudheer A. Grandhi	Neal Mellen	Allert Van Zelst
Randall Groves	Steven Methley	Dmitri Varsanofiev
Michael Gundlach	James Miller	Prabodh Varshney
Gloria Gwynne	David Mitton	George A. Vlantis
Rainer Hach	Keiichi Mizutani	Khurram Waheed
David Halasz	Apurva Mody	Thomas Wandeloski
Mark Hamilton	Michael Montemurro	James June Wang
Christopher J. Hansen	Kenichi Mori	Lei Wang
Hiroshi Harada	Ronald Murias	Stephen Webb
Jerome Henry	Rick Murphy	Hung-Yu Wei
Marco Hernandez	Peter Murray	James Yee
Dien Hoang	Andrew Myles	Oren Yuen
Werner Hoelzl	Nabil Nasser	Hongyuan Zhang
David Howard	Michael Newman	Daidi Zhong
David Hunter	Nick S. A. Nikjoo	Mingtuo Zhou
	Paul Nikolich	

When the IEEE-SA Standards Board approved this standard on 11 December 2013, it had the following membership:

John Kulick, *Chair*
David J. Law, *Vice Chair*
Richard H. Hulett, *Past Chair*
Konstantinos Karachalios, *Secretary*

Masayuki Ariyoshi
 Peter Balma
 Farooq Bari
 Ted Burse
 Stephen Dukes
 Jean-Philippe Faure
 Alexander Gelman

Mark Halpin
 Gary Hoffman
 Paul Houzé
 Jim Hughes
 Michael Janezic
 Joseph L. Koepfinger*
 Oleg Logvinov
 Ron Petersen

Gary Robinson
 Jon Walter Rosdahl
 Adrian Stephens
 Peter Sutherland
 Yatin Trivedi
 Phil Winston
 Yu Yuan

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Richard DeBlasio, *DOE Representative*
 Michael Janezic, *NIST Representative*

Catherine Berger
IEEE Standards Program Manager, Document Development

Kathryn Bennett
IEEE Standards Program Manager, Technical Program Development

Introduction

This introduction is not part of IEEE Std 802.11af™-2013, IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications—Amendment 5: Television White Spaces (TVWS) Operation.

This amendment defines enhancements to the IEEE 802.11 physical layers (PHYs) and medium access control (MAC) sublayer to support operation in the white spaces in television bands.

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/AMD5:2015

Contents

2.	Normative references	2
3.	Definitions, acronyms, and abbreviations.....	2
3.1	Definitions	2
3.2	Definitions specific to IEEE 802.11	2
3.2a	Definitions specific to IEEE 802.11 operation in some regulatory domains.....	4
3.3	Abbreviations and acronyms	7
3.4	Abbreviations and acronyms in some regulatory domains	7
4.	General description	8
4.3	Components of IEEE 802.11 architecture	8
4.3.10a	Very high throughput (VHT) STA	8
4.3.10b	Television very high throughput (TVHT) STA	8
4.3.19	Operation under geolocation database (GDB) control	9
6.	Layer management.....	12
6.3	MLME SAP Interface	12
6.3.3	Scan.....	12
6.3.3.3	MLME-SCAN.confirm.....	12
6.3.95	Channel Availability Query	12
6.3.95.1	Introduction.....	12
6.3.95.2	MLME-CHANNELAVAILABILITYQUERY.request	12
6.3.95.3	MLME-CHANNELAVAILABILITYQUERY.confirm	13
6.3.95.4	MLME-CHANNELAVAILABILITYQUERY.indication	14
6.3.95.5	MLME-CHANNELAVAILABILITYQUERY.response	15
6.3.96	Channel schedule management.....	16
6.3.96.1	Introduction.....	16
6.3.96.2	MLME-CHANNELSCHEDULEMANAGEMENT.request.....	17
6.3.96.3	MLME-CHANNELSCHEDULEMANAGEMENT.confirm.....	17
6.3.96.4	MLME-CHANNELSCHEDULEMANAGEMENT.indication	18
6.3.96.5	MLME-CHANNELSCHEDULEMANAGEMENT.response	19
6.3.97	Contact Verification Signal	20
6.3.97.1	Introduction.....	20
6.3.97.2	MLME-CVS.request.....	20
6.3.97.3	MLME-CVS.indication	21
6.3.98	GDD Enablement.....	22
6.3.98.1	Introduction.....	22
6.3.98.2	MLME-GDDENABLEMENT.request	22
6.3.98.3	MLME-GDDENABLEMENT.confirm.....	23
6.3.98.4	MLME-GDDENABLEMENT.indication	24
6.3.98.5	MLME-GDDENABLEMENT.response	25
6.3.99	Network channel control management	26
6.3.99.1	Introduction.....	26
6.3.99.2	MLME-NETWORKCHANNELCONTROL.request.....	26
6.3.99.3	MLME-NETWORKCHANNELCONTROL.confirm	27
6.3.99.4	MLME-NETWORKCHANNELCONTROL.indication	28
6.3.99.5	MLME-NETWORKCHANNELCONTROL.response	29
6.3.100	White space map (WSM).....	30
6.3.100.1	Introduction.....	30

6.3.100.2	MLME-WSM.request	31
6.3.100.3	MLME-WSM.indication.....	31
7.	PHY service specification.....	33
7.3	Detailed PHY service specifications.....	33
7.3.5	PHY-SAP detailed service specification	33
7.3.5.11	PHY-CCA.indication	33
8.	Frame formats	35
8.2	MAC frame formats.....	35
8.2.4	Frame fields	35
8.2.4.6	HT Control field.....	35
8.2.4.7	Frame Body field	35
8.2.6	TLV encodings	35
8.2.6.1	General.....	35
8.2.6.2	Common TLVs	36
8.3	Format of individual frame types.....	40
8.3.3	Management frames.....	40
8.3.3.2	Beacon frame format	40
8.3.3.9	Probe Request frame format	40
8.3.3.10	Probe Response frame format.....	41
8.4	Management frame body components.....	41
8.4.1	Fields that are not information elements.....	41
8.4.1.9	Status Code field.....	41
8.4.1.32	Rate Identification field	42
8.4.1.48	VHT Compressed Beamforming Report field	42
8.4.1.48a	TVHT Compressed Beamforming Report field.....	42
8.4.1.49	MU Exclusive Beamforming Report field.....	43
8.4.1.49a	TVHT MU Exclusive Beamforming Report field	43
8.4.1.50	Operating Mode field.....	44
8.4.1.53	Channel Schedule Management element.....	44
8.4.1.54	Device Location Information Body	46
8.4.1.55	WSM type and information	46
8.4.2	Information elements	47
8.4.2.1	General.....	47
8.4.2.24	Extended Capabilities element.....	47
8.4.2.29	Extended Capabilities element.....	48
8.4.2.31	EDCA Parameter Set element.....	48
8.4.2.54	DSE Registered Location element.....	49
8.4.2.95	Advertisement Protocol element.....	49
8.4.2.164	VHT Transmit Power Envelope element.....	50
8.4.2.165	Channel Switch Wrapper element	50
8.4.2.169	Device Location Information element	51
8.4.2.170	White Space Map element	51
8.4.2.171	Reduced Neighbor Report element.....	51
8.4.2.172	TVHT Operation element	53
8.4.5	Registered Location Query Protocol (RLQP) elements	55
8.4.5.1	General.....	55
8.4.5.2	Channel Availability Query RLQP-element.....	55
8.4.5.3	Channel Schedule Management RLQP-element	57
8.4.5.4	Network Channel Control RLQP-element.....	58
8.5	Action frame format details	59

8.5.8	Public Action details	59
8.5.8.1	Public Action frames	59
8.5.8.27	Channel Availability Query frame format	60
8.5.8.28	Channel Schedule Management frame format	60
8.5.8.29	Contact Verification Signal frame format	61
8.5.8.30	GDD Enablement Request frame format	61
8.5.8.31	GDD Enablement Response frame format	62
8.5.8.32	Network Channel Control frame format	62
8.5.8.33	White Space Map Announcement frame format	63
8.5.11	Protected Dual of Public Action frames	64
8.5.11.1	Protected Dual of Public Action details	64
9.	MAC sublayer functional description	65
9.2	MAC architecture	65
9.2.1	General	65
9.3	DCF	65
9.3.2	Procedures common to the DCF and EDCAF	65
9.3.2.3	IFS	65
9.7	Multirate support	65
9.7.1	Overview	65
9.12	A-MPDU operation	66
9.12.2	A-MPDU length limit rules	66
9.19	HCF	66
9.19.2	HCF contention-based channel access (EDCA)	66
9.19.2.8	EDCA channel access in a VHT and TVHT BSSs	66
9.24	MAC frame processing	66
9.24.9	Extensible subelement parsing	66
9.24.10	Extensible TLV parsing	66
9.31	Null data packet (NDP) sounding	67
9.31.5	VHT sounding protocol	67
9.31.5.2	Rules for VHT sounding protocol sequences	67
9.31.5.3	Rules for fragmented feedback in VHT sounding protocol sequences	67
10.	MLME	68
10.11	Radio measurement procedures	68
10.11.9	Specific measurement usage	68
10.11.9.6	Location Configuration Information Report	68
10.24	WLAN interworking with external networks procedures	68
10.24.3	Interworking procedures: generic advertisement service (GAS)	68
10.24.3.2	ANQP procedures	68
10.24.3.3	Registered Location Query Protocol (RLQP) procedures	68
10.42	Basic TVHT BSS functionality	68
10.43	Operation under the control of a GDB	70
10.43.1	General	70
10.43.2	GDD enabling STA operation	70
10.43.3	GDD dependent STA operation	71
10.43.4	Channel availability query (CAQ) procedure	72
10.43.4.1	Introduction	72
10.43.4.2	CAQ requesting STA	73
10.43.4.3	CAQ responding STA	74
10.43.5	Channel schedule management (CSM) procedures	75
10.43.5.1	Introduction	75

10.43.5.2	CSM requesting STA.....	76
10.43.5.3	CSM responding STA.....	76
10.43.6	Contact verification signal (CVS).....	77
10.43.7	Network channel control (NCC) procedures	77
10.43.7.1	Introduction.....	77
10.43.7.2	NCC requesting STA	78
10.43.7.3	NCC responding STA.....	79
10.43.8	Reduced neighbor report.....	79
10.43.9	White space map (WSM).....	80
23.	Television Very High Throughput (TVHT) PHY specification.....	82
23.1	Introduction.....	82
23.1.1	Introduction to the TVHT PHY	82
23.1.2	Scope.....	83
23.1.3	TVHT PHY functions.....	84
23.1.3.1	General.....	84
23.1.3.2	PHY management entity (PLME).....	84
23.1.3.3	Service specification method	84
23.1.4	PPDU formats	84
23.2	TVHT PHY service interface	84
23.2.1	Introduction.....	84
23.2.2	TXVECTOR and RXVECTOR parameters	84
23.2.3	Effects of CH_BANDWIDTH parameter on PPDU format.....	91
23.2.4	Support for NON_HT and HT formats.....	92
23.3	TVHT PHY sublayer	96
23.3.1	Introduction.....	96
23.3.2	VHT PPDU format in TVWS bands.....	96
23.3.3	Transmitter block diagram	96
23.3.4	Overview of the PPDU encoding process.....	98
23.3.4.1	General.....	98
23.3.4.2	Construction of L-STF.....	98
23.3.4.3	Construction of the L-LTF.....	98
23.3.4.4	Construction of L-SIG	99
23.3.4.5	Construction of TVHT-SIG-A.....	99
23.3.4.6	Construction of TVHT-STF.....	99
23.3.4.7	Construction of TVHT-LTF	99
23.3.4.8	Construction of TVHT-SIG-B	99
23.3.4.9	Construction of the Data field in an SU PPDU	100
23.3.4.10	Construction of the Data field in an MU PPDU	100
23.3.5	Modulation and coding scheme (MCS)	101
23.3.6	Timing-related parameters	101
23.3.7	Mathematical description of signals	102
23.3.8	TVHT preamble	106
23.3.8.1	Introduction.....	106
23.3.8.2	Non-TVHT portion of VHT format preamble.....	106
23.3.8.3	TVHT portion of VHT format preamble	107
23.3.9	Transmission of NON_HT and HT PPDUs with multiple antennas	109
23.3.9.1	Transmission of NON_HT PPDUs with more than one antenna	109
23.3.9.2	Transmission of HT format PPDUs with more than four antennas	109
23.3.10	Data field.....	109
23.3.10.1	General.....	109
23.3.10.2	SERVICE field	109
23.3.10.3	CRC calculation for TVHT-SIG-B.....	109

23.3.10.4	Scrambler	109
23.3.10.5	Coding	109
23.3.10.6	Stream parser	110
23.3.10.7	Segment parser	110
23.3.10.8	BCC interleaver	110
23.3.10.9	Constellation mapping	110
23.3.10.10	Pilot subcarriers	111
23.3.10.11	OFDM modulation transmission in VHT format	111
23.3.10.12	Non-HT duplicate transmission	112
23.3.11	SU-MIMO and MU-MIMO Beamforming	112
23.3.11.1	General	112
23.3.11.2	Beamforming Feedback Matrix V	113
23.3.11.3	Group ID	113
23.3.12	TVHT preamble format for sounding PPDU	113
23.3.13	Regulatory requirements	113
23.3.14	Channelization	113
23.3.15	Transmit RF delay	115
23.3.16	Slot time	115
23.3.17	Transmit and receive port impedance	115
23.3.18	PMD transmit specification	115
23.3.18.1	Transmit spectrum mask	115
23.3.18.2	Spectral flatness	116
23.3.18.3	Transmit center frequency and symbol clock frequency tolerance	118
23.3.18.4	Modulation accuracy	118
23.3.18.5	Time of Departure accuracy	119
23.3.19	TVHT receiver specification	119
23.3.19.1	General	119
23.3.19.2	Receiver minimum input sensitivity	119
23.3.19.3	Adjacent channel rejection	120
23.3.19.4	Nonadjacent channel rejection	120
23.3.19.5	Receiver maximum input level	121
23.3.19.6	CCA sensitivity	121
23.3.19.7	RSSI	122
23.3.20	PLCP transmit procedure	123
23.3.21	PLCP receive procedure	123
23.4	TVHT PLME	123
23.4.1	PLME_SAP sublayer management primitives	123
23.4.2	PHY MIB	123
23.4.3	TXTIME and PSDU_LENGTH calculation	123
23.4.4	PHY characteristics	123
23.5	Parameters for TVHT MCSs	124
Annex B (normative) Protocol Implementation Conformance Statement (PICS) proforma		131
B.2	Abbreviations and special symbols	131
B.2.2	General abbreviations for Item and Support columns	131
B.4	PICS proforma—IEEE Std. 802.11-2012	131
B.4.4.1	MAC protocol capabilities	132
B.4.4.2	MAC frames	132
B.4.12	Spectrum management extensions	133
B.4.14	QoS base functionality	135
B.4.18	DSE functions	135
B.4.19.1	HT MAC features	138
B.4.21	WNM extensions	139

B.4.25 RobustAVT extensions	140
B.4.28 TVWS functions.....	140
B.4.28.1 TVHT MAC features	141
B.4.28.2 TVHT PHY features	143
Annex C (normative) ASN.1 encoding of the MAC and PHY MIB	146
C.3 MIB Detail	146
Annex D (normative) Regulatory references.....	170
D.1 External regulatory references	170
Annex E (normative) Country elements and operating classes	171
E.1 Country information and operating classes	171
E.2 Band specific operating requirements.....	171
E.2.5 TVWS band in the United States and Canada (54 MHz to 698 MHz)	171
E.2.6 TVWS band in Europe	174
Annex H (normative) Usage of Ethertype 89-0d.....	175
Annex T (informative) Location and Time Difference accuracy test.....	176
T.2 Time Difference of Departure accuracy test.....	176

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/AMDS:2015

Tables

Table 4-1—GDD mechanisms and timescales	11
Table 7-5—The channel-list parameter elements	33
Table 8-13b—MFB subfield in the VHT variant HT Control field	35
Table 8-14b—Device Class field definition	36
Table 8-14a—General TLV format	36
Table 8-14d—Device Location Information field definition	37
Table 8-14e—Channel Schedule Descriptor Tuple attribute definition	37
Table 8-14c—Device Identification Information field definition	37
Table 8-14f—Channel Schedule Descriptor Value fields	38
Table 8-14h—WSM Information Value fields	39
Table 8-14g—WSM information values	39
Table 8-20—Beacon frame body	40
Table 8-20—Beacon frame body	40
Table 8-26—Probe Request frame body	40
Table 8-27—Probe Response frame body	41
Table 8-27—Probe Response frame body	41
Table 8-37—Status codes	41
Table 8-53k—Subfield values of the Operating Mode field	44
Table 8-53n—Channel Schedule Management Mode field values	45
Table 8-53m—Reason Result Code field values	45
Table 8-54—Element IDs	47
Table 8-53o—WSM Type definition	47
Table 8-103—Capabilities field	48
Table 8-105—Default EDCA Parameter Set element parameter values if dot11OCBAActivated is false	48
Table 8-175—Advertisement protocol ID definitions	49
Table 8-183v—Subfields of the VHT Capabilities Info field	50
Table 8-183aa—TVHT Operation Information subfields	54
Table 8-190.a1—RLQP-element definitions	55
Table 8-190.a2—Reason Result Code field values	56
Table 8-190.a3—Reason Result Code field values	58
Table 8-210—Public Action field values	59
Table 8-228—Public Action field values defined for Protected Dual of Public Action frames	64
Table 10-20—TVHT BSS operating channel width	69
Table 23-1—TXVECTOR and RXVECTOR parameters	85
Table 23-2—PPDU format as a function of CH_BANDWIDTH parameter	91
Table 23-4—RATE field in L-SIG	93
Table 23-3—Modulation-dependent parameters for Non-HT duplicate mode in TVWS band	93
Table 23-5—Timing-related constants in Non-HT PPDU	94
Table 23-6—Tone location in Non-HT PPDU	95
Table 23-7—Fields of the VHT PPDU in TVWS bands	96
Table 23-8—Timing-related parameters	101
Table 23-9—Tone location	102
Table 23-10—Center frequency of a PPDU transmitted in frequency segment iSeg	104
Table 23-11—Tone scaling factor and guard interval duration values for PLCP fields	105
Table 23-12—Transmission mode and Gamma subk,m	105
Table 23-13—B0-B1 (BW) in TVHT-SIG-A1	108
Table 23-14—Number of rows and columns in the interleaver	110
Table 23-15—LDPC Tone Mapping Distance for each transmission mode	111
Table 23-16—Parameters for Non-HT duplicate transmissions	112
Table 23-17—Fields to specify TVHT channels	113
Table 23-18—Spectral mask frequency scaling factor for contiguous transmission	115
Table 23-19—Spectral mask frequency scaling factor for TVHT_MODE_4N	115

Table 23-20—Spectral mask frequency scaling factor for TVHT_MODE_2N	116
Table 23-21—Maximum transmit spectral flatness deviations	117
Table 23-22—Receiver minimum input level sensitivity	119
Table 23-23—Minimum required adjacent and nonadjacent channel rejection levels.....	120
Table 23-24—Conditions for CCA BUSY on the primary channel	122
Table 23-25—TVHT PHY characteristics	123
Table 23-26—TVHT MCSs for TVHT_MODE_1, NSS = 1	124
Table 23-27—TVHT MCSs for TVHT_MODE_1, NSS = 2	125
Table 23-28—TVHT MCSs for TVHT_MODE_1, NSS = 3	125
Table 23-29—TVHT MCSs for TVHT_MODE_1, NSS = 4	126
Table 23-30—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, NSS = 1	126
Table 23-31—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, NSS = 2	127
Table 23-32—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, NSS = 3	127
Table 23-33—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, NSS = 4	128
Table 23-34—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, NSS = 1	128
Table 23-35—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, NSS = 2	129
Table 23-36—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, NSS = 3	129
Table 23-37—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, NSS = 4	130
Table D-1—Regulatory requirement list	170
Table D-2—Behavior limits sets	170
Table E-4—Global operating classes	171
Table E-7—TVWS GDD timer limits	172
Table E-8—Device Identification Information Value fields	173
Table E-9—WSM Information Value fields	173
Table E-10—TVWS GDD timer limits	174
Table H-1—Payload Type field values	175

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/Amd.5:2015

Figures

Figure 4-10b— Multiple APs and Multiple GDBs.....	10
Figure 7-2a— TVHT channel-list parameter element and channel bandwidth for TVHT_W, TVHT_2W, and TVHT_W+W	33
Figure 7-2b— TVHT channel-list parameter element and channel bandwidth for TVHT_4W and TVHT_2W+2W	34
Figure 8-80h— Channel Schedule Management element format	44
Figure 8-80i— Device Location Information Body field format	46
Figure 8-401cd— Device Location Information element format	51
Figure 8-401ce— WSM element format	51
Figure 8-401cf— Reduced Neighbor Report element format	51
Figure 8-401cg— Neighbor AP Information field format.....	52
Figure 8-401ch— TBTT Information Header subfield	52
Figure 8-401ci— TBTT Information field	53
Figure 8-401cj— TVHT Operation element format.....	53
Figure 8-401ck— TVHT Operation Information field.....	53
Figure 8-431.a1— RLQP-element format	55
Figure 8-431.a2— Channel Availability Query RLQP-element format.....	56
Figure 8-431.a3— Channel Query Info field format.....	57
Figure 8-431.a4— Channel Schedule Management RLQP-element format.....	57
Figure 8-431.a5— Network Channel Control RLQP-element format	58
Figure 8-460f— Channel Availability Query frame Action field format.....	60
Figure 8-460g— Channel Schedule Management frame Action field format.....	60
Figure 8-460h— Contact Verification Signal frame Action field format	61
Figure 8-460i— GDD Enablement Request frame Action field format.....	61
Figure 8-460j— GDD Enablement Response frame Action field format	62
Figure 8-460k— Network Channel Control frame Action field format.....	62
Figure 8-460l— White Space Map Announcement frame Action field format	63
Figure 10-39— GDD dependent STA state transition diagram	71
Figure 23-1— VHT PPDU format in TVWS bands.....	96
Figure 23-2— Transmitter block diagram for the Data field of a TVHT_MODE_2N or TVHT_MODE_4N SU PPDU with BCC encoding	97
Figure 23-3— Transmitter block diagram for the Data field of a TVHT_MODE_2N or TVHT_MODE_4N SU PPDU with LDPC encoding.....	98
Figure 23-4— Example transmit spectral mask for an 6+6 MHz mask PPDU	117

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/AMD5:2015

**IEEE Standard for Information technology—
Telecommunications and information exchange between systems
Local and metropolitan area networks—
Specific requirements**

**Part 11: Wireless LAN Medium Access Control
(MAC) and Physical Layer (PHY) Specifications**

**Amendment 5: Television White Spaces (TVWS)
Operation**

IMPORTANT NOTICE: IEEE Standards documents are not intended to ensure safety, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

This IEEE document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading “Important Notice” or “Important Notices and Disclaimers Concerning IEEE Documents.” They can also be obtained on request from IEEE or viewed at <http://standards.ieee.org/IPR/disclaimers.html>.

(This amendment is based on IEEE Std 802.11™-2012, as amended by IEEE Std 802.11ae™-2012, IEEE Std 802.11aa™-2012, IEEE Std 802.11ad™-2012, and IEEE Std 802.11ac™-2013.)

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard. The editing instructions are shown in **bold italic**. Four editing instructions are used: change, delete, insert, and replace. **Change** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strike through~~ (to remove old material) and underscore (to add new material). **Delete** removes existing material. **Insert** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. **Replace** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editorial instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.¹

¹Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

2. Normative references

Delete the following reference from Clause 2:

~~IETF RFC 3825, Dynamic Host Configuration Protocol Option for Coordinate-based Location Configuration Information, Polk, J., Schnizlein, J., Linsner, M., July 2004.~~

Insert the following reference into Clause 2 in alphanumeric order:

IETF RFC 6225, Dynamic Host Configuration Protocol Options for Coordinate-Based Location Configuration Information, J. Polk, M. Linsner, M. Thomson, B. Aboba, July 2011.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

Change the following definition in 3.1:

location configuration information (LCI): As defined in IETF RFC ~~6225~~³⁸²⁵: includes latitude, longitude, and altitude, with resolution indicators for each.

Insert the following definitions into 3.1 in alphabetic order:

geolocation: Geolocation is a location within an earth-centric frame of reference.

registered location: The geolocation of a station (STA) registered in accordance with the requirements for the regulatory domain.

Registered Location Query Protocol (RLQP): The query protocol for registered location information that is received and transported by generic advertisement service (GAS) Public Action frames.

registered location secure server (RLSS): An entity that accesses and manages a database that organizes storage of information by geographic location and securely holds the location and some operating parameters of one or more basic service sets (BSSs).

television white spaces (TVWS): The opportunistic use of allocated but not assigned spectrum—spectrum allocated for broadcast television, but with no assignment at a particular location.

type/length/value (TLV): A formatting scheme that adds a tag to each transmitted parameter containing the parameter type (and implicitly its encoding rules) and the length of the encoded parameter.

3.2 Definitions specific to IEEE 802.11

Change the following definition in 3.2:

~~**very high throughput (VHT) basic service set (BSS) basic very high throughput (VHT) modulation and coding scheme (MCS) and number of spatial streams (NSS) set (BSSBasicVHTMCS NSSSet)**~~
(BSS basic VHT MCS and NSS set): The set of MCS and NSS tuples that are supported by all VHT stations (STAs) that are members of a VHT BSS or are supported by television very high throughput (TVHT) STAs that are members of a TVHT BSS.

Insert the following definitions into 3.2 in alphabetic order:

basic channel unit (BCU): For television very high throughput (TVHT) operation, 6 MHz, 7 MHz, or 8 MHz, depending on the regulatory domain.

geolocation database (GDB): A database whose operation is mandated or authorized by a regulatory authority and that organizes storage of information by geographic location.

geolocation database dependent (GDD): A modifier describing when station (STA) operation is dependent on information received from a geolocation database (GDB).

geolocation database dependent (GDD) access point (AP): A station (STA) dependent on information received from a geolocation database (GDB) in order to initiate and maintain a network.

geolocation database dependent (GDD) dependent station (STA): A STA that is under the control of a GDD enabling STA.

geolocation database dependent (GDD) enabling station (STA): A STA that has the authority to control the operation of GDD dependent STAs after obtaining available spectrum for use at its own location.

geolocation database dependent (GDD) fixed station (STA): A STA whose geographical location information is fixed and maintained in a geolocation database (GDB) and whose operation depends on information received from that database.

geolocation database dependent (GDD) geolocated non-access point (non-AP) station (STA): A STA that is not an AP and is authorized by a geolocation database (GDB) to operate at its current location.

geolocation database dependent (GDD) non-access point (non-AP) station (STA): A STA that is not an AP but operates under the control of a GDD enabling STA.

television very high throughput 2W (TVHT_2W): Two contiguous basic channel units (BCUs) in television white spaces (TVWS).

television very high throughput 2W+2W (TVHT_2W+2W): Two noncontiguous frequency segments, each of which comprises two contiguous basic channel units (BCUs) in television white spaces (TVWS).

television very high throughput 4W (TVHT_4W): Four contiguous basic channel units (BCUs) in television white spaces (TVWS).

television very high throughput W (TVHT_W): One basic channel unit in television white spaces (TVWS).

television very high throughput W+W (TVHT_W+W): Two noncontiguous basic channel units (BCUs) in television white spaces (TVWS).

television very high throughput (TVHT) basic service set (BSS): A set of stations (STAs) that consists of a geolocation database dependent (GDD) enabling STA operating in television white spaces (TVWS) and one or more of its GDD STAs.

white space map (WSM): Information on identified available frequencies that is obtained from a geolocation database (GDB) and that is used by IEEE 802.11 stations (STAs).

Insert the following subclause, 3.2a, after 3.2:

3.2a Definitions specific to IEEE 802.11 operation in some regulatory domains

ISO 3166-1 defines the international two-letter designation for country names, and these designations are included [in square brackets] at the end of each definition that has clear attribution to a regulatory domain.

contact verification signal (CVS): A signal sent by a geolocation database dependent (GDD) enabling station (STA) to validate the list of available frequencies and to verify that the receiving GDD STA is within reception range of the master white space device (WSD) [US].

model identifier: A unique text string set by the manufacturer at the time a device is placed on the market. The model identifier is communicated to a database provider as required by regulation.

non-high-throughput (non-HT) duplicate in television white spaces (TVWS) band: A transmission format of the physical layer (PHY) that duplicates a single basic channel unit (BCU) non-high-throughput (non-HT) transmission in two or more BCUs and allows a station (STA) in a non-HT basic service set (BSS) on any one BCU to receive the transmission. A non-HT duplicate format is one of the following:

- a) TVHT_W non-HT duplicate: A PHY transmission that replicates a non-HT physical layer convergence procedure (PLCP) protocol data unit (PPDU) two times in a single BCU
- b) TVHT_2W non-HT duplicate: A PHY transmission that replicates a non-HT PPDU four times in two contiguous BCUs
- c) TVHT_4W non-HT duplicate: A PHY transmission that replicates a non-HT PPDU eight times in four contiguous BCUs
- d) TVHT_W+W non-HT duplicate: A PHY transmission that replicates a non-HT PPDU two times in each single BCU
- e) TVHT_2W+2W non-HT duplicate: A PHY transmission that replicates a non-HT PPDU four times in each of two contiguous BCUs

non-high-throughput (non-HT) duplicate physical layer convergence procedure (PLCP) protocol data unit (PPDU) in television white spaces (TVWS) band: A PPDU transmitted by a Clause 23 physical layer (PHY) with the TXVECTOR parameter FORMAT set to NON_HT and the TXVECTOR parameter CH_BANDWIDTH set to TVHT_W, TVHT_2W, TVHT_4W, TVHT_W+W, or TVHT_2W+2W.

personal/portable station (STA): A STA that uses network communications at unspecified locations [US].

shared bands: Radio frequency bands in which dissimilar services are permitted.

television band device (TVBD): An intentional radiator that operates on an unlicensed basis on available channels in the broadcast television frequency bands [US].

TVHT_2W mask physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs:

- a) A Clause 23 TVHT_2W very high throughput (VHT) PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_2W transmit spectral mask defined in 23.3.18.1
- b) A Clause 23 TVHT_2W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_2W transmit spectral mask defined in 23.3.18.1

- c) A Clause 23 TVHT_W VHT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_2W transmit spectral mask defined in 23.3.18.1
- d) A Clause 23 TVHT_W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_2W transmit spectral mask defined in 23.3.18.1

TVHT_2W+2W mask physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs:

- a) A Clause 23 TVHT_2W+2W very high throughput (VHT) PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W+2W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_2W+2W transmit spectral mask defined in 23.3.18.1
- b) A Clause 23 TVHT_2W+2W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W+2W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_2W+2W transmit spectral mask defined in 23.3.18.1
- c) A Clause 23 TVHT_2W VHT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_2W+2W transmit spectral mask defined in 23.3.18.1
- d) A Clause 23 TVHT_2W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_2W+2W transmit spectral mask defined in 23.3.18.1
- e) A Clause 23 TVHT_W VHT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_2W+2W transmit spectral mask defined in 23.3.18.1
- f) A Clause 23 TVHT_W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_2W+2W transmit spectral mask defined in 23.3.18.1

TVHT_4W mask physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs:

- a) A Clause 23 TVHT_4W very high throughput (VHT) PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_4W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_4W transmit spectral mask defined in 23.3.18.1
- b) A Clause 23 TVHT_4W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_4W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_4W transmit spectral mask defined in 23.3.18.1
- c) A Clause 23 TVHT_2W VHT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_4W transmit spectral mask defined in 23.3.18.1
- d) A Clause 23 TVHT_2W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_2W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_4W transmit spectral mask defined in 23.3.18.1
- e) A Clause 23 TVHT_W VHT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_4W transmit spectral mask defined in 23.3.18.1

- f) A Clause 23 TVHT_W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_4W transmit spectral mask defined in 23.3.18.1

TVHT_MODE_1 physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs: A Clause 23 TVHT_W VHT PPDU or TVHT_W NON_HT PPDU.

TVHT_MODE_2C physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs: A Clause 23 TVHT_2W VHT PPDU or TVHT_2W NON_HT PPDU.

TVHT_MODE_2N physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs: A Clause 23 TVHT_W+W VHT PPDU or TVHT_W+W NON_HT PPDU.

TVHT_MODE_4C physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs: A Clause 23 TVHT_4W VHT PPDU or TVHT_4W NON_HT PPDU.

TVHT_MODE_4N physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs: A Clause 23 TVHT_2W+2W VHT PPDU or TVHT_2W+2W NON_HT PPDU.

TVHT_W mask physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs:

- a) A Clause 23 TVHT_W very high throughput (VHT) PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_W transmit spectral mask defined in 23.3.18.1
- b) A Clause 23 TVHT_W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_W transmit spectral mask defined in 23.3.18.1

TVHT_W+W mask physical layer convergence procedure (PLCP) protocol data unit (PPDU): One of the following PPDUs:

- a) A Clause 23 TVHT_W+W very high throughput (VHT) PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W+W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_W+W transmit spectral mask defined in 23.3.18.1
- b) A Clause 23 TVHT_W+W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W+W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_W+W transmit spectral mask defined in 23.3.18.1
- c) A Clause 23 TVHT_W VHT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W and TXVECTOR parameter FORMAT set to VHT) transmitted using the TVHT_W+W transmit spectral mask defined in 23.3.18.1
- d) A Clause 23 TVHT_W NON_HT PPDU (TX_VECTOR parameter CH_BANDWIDTH set to TVHT_W, TXVECTOR parameter FORMAT set to NON_HT, and TXVECTOR parameter NON_HT_MODULATION set to NON_HT_DUP_OFDM) transmitted using the TVHT_W+W transmit spectral mask defined in 23.3.18.1

white space device (WSD): Entity that employs cognitive facilities to use white space spectrum without causing harmful interference to protected services [EU].

3.3 Abbreviations and acronyms

Insert the following abbreviations into 3.3 in alphabetic order:

BCU	basic channel unit
CAQ	channel availability query
CSM	channel schedule management
CVS	contact verification signal
GDB	geolocation database
GDD	geolocation database dependent
NCC	network channel control
RLQP	Registered Location Query Protocol
RLSS	registered location secure server
TLV	type/length/value
TVHT	television very high throughput
TVWS	television white spaces
WSM	white space map

Insert the following subclause, 3.4, after 3.3:

3.4 Abbreviations and acronyms in some regulatory domains

ISO 3166-1 defines the international two-letter designation for country names, and these designations are included [in square brackets] at the end of each abbreviation that has clear attribution to a regulatory domain.

PLMR/CRS	private land mobile radio/cellular radio service [US]
TVBD	television band device [US]
WSD	white space device [EU]

4. General description

4.3 Components of IEEE 802.11 architecture

4.3.10a Very high throughput (VHT) STA

Insert the following subclause, 4.3.10b, after 4.3.10a:

4.3.10b Television very high throughput (TVHT) STA

The IEEE 802.11 TVHT STA operates in television white spaces (TVWS) bands.

A TVHT STA supports all mandatory features of a VHT STA as mandatory features except for 20 MHz, 40 MHz, and 80 MHz channel widths. A TVHT STA supports all optional features of a VHT STA as optional features except for 160 MHz or 80+80 MHz channel widths and more than 4 spatial streams. The 20 MHz, 40 MHz, 80 MHz, 160 MHz, or 80+80 MHz channel widths and more than 4 spatial streams are not permitted for STAs operating as TVHT STAs. The features and behaviors of VHT STAs specified in Clause 6, Clause 7, Clause 8, Clause 9, Clause 10, Clause 13, and Annex G apply to TVHT STAs as well, unless stated otherwise.

For Clause 6, Clause 7, Clause 8, Clause 9, Clause 10, and Clause 13, the following replacements are applied for TVHT STAs:

- “TVHT_W/TVHT_2W” replaces “20/40 MHz”.
- “TVHT_W/TVHT_2W/TVHT_4W” replaces “20/40/80/160 MHz”.
- “TVHT_W”, “TVHT_2W”, and “TVHT_4W” replace “20 MHz”, “40 MHz”, and “80 MHz,” respectively.
- “TVHT_W” replaces “CBW20”.
- “TVHT_2W” replaces “CBW40”.
- “TVHT_4W” replaces “CBW80” and “CBW80+80”.
- “secondaryTVHT_2W” replaces “secondary40”.
- “TVHT STA” replaces “VHT STA”.
- “TVHT AP” replaces “VHT AP”.
- “TVHT BSS” replaces “VHT BSS”.
- “TVHT-MCS” replaces “VHT-MCS”.
- “TVHT Operation” replaces “VHT Operation”.
- “dot11TVHTOptionImpelemented” replaces “dot11VHTOptionImplemented”.
- “dot11TVHTControlFieldOptionImplemented” replaces both “dot11VHTControlFieldOption-Implemented” and “dot11HTControlFieldSupported”.
- “dot11TVHTShortGIOptionIn80Activated” replaces “dot11VHTShortGIOptionIn80Activated”.
- “dot11TVHTSUBeamformerOptionImplemented” replaces “dot11VHTSUBeamformerOption-Implemented”.
- “dot11TVHTSUBeamformeeOptionImplemented” replaces “dot11VHTSUBeamformeeOption-Implemented”.
- “dot11TVHTMUBeamformerOptionImplemented” replaces “dot11VHTMUBeamformerOption-Implemented”.
- “dot11TVHTMUBeamformeeOptionImplemented” replaces “dot11VHTMUBeamformeeOption-Implemented”.
- “dot11TVHTSUBeamformeeActivated” replaces “dot11VHTSUBeamformeeActivated”.

- “dot11TVHTTXOPPowerSaveOptionImplemented” replaces “dot11VHTTXOPPowerSaveOptionImplemented”.
- “dot11VHTOBSSScanCount” replaces “dot11VHTOBSSScanCount”.
- Reference to 8.4.1.48a replaces reference to 8.4.1.48.
- Reference to 8.4.1.49a replaces reference to 8.4.1.49.
- Reference to 8.4.2.172 replaces reference to 8.4.2.161.
- Reference to 10.42 replaces reference to 10.39.1.
- Reference to Clause 23 and its subclauses replace reference to Clause 22 and its subclauses.

For Annex G, the following replacements are applied for TVHT STAs:

- “TVHT” replaces “VHT”.
- “tvht” replaces “vht”.

The main PHY features in a TVHT STA that are not present in a VHT STA are the following:

- Mandatory support for TVHT_W channel width.
- Optional support for TVHT_W+W channel width.
- Optional support for TVHT_2W channel width.
- Optional support for TVHT_4W channel width.
- Optional support for TVHT_2W+2W channel width.

These TVHT features are available to TVHT STAs associated with a TVHT AP in a BSS. A subset of the TVHT features is available for use between two TVHT STAs that are members of the same IBSS.

Insert the following subclause, 4.3.19 (including Figure 4-10b and Table 4-1), after 4.3.18:

4.3.19 Operation under geolocation database (GDB) control

Regulators are specifying television broadcast bands for the deployment of dynamic sharing technologies. Different schemes result in different times that should elapse from the moment an authorized database is told to change access to a particular slice of spectrum and the time that sharing radios are required to change their operations.

One current system design allows the GDBs to utilize a fully populated map of all protected services, and the databases have precalculated maps that are effective on timescales of one to two days.

Another system design allows the protected services to negotiate with controllers of unlicensed devices so that both may share available broadcast channels and facilitate response times of less than an hour where necessary and even within minutes if desired.

Another system design has the GDB fully control all white space devices by requiring them to tell the database their intended location and emissions footprint and receive permission before any broadcast band transmission starts. Any change of intended frequencies or powers is told to the database, and permission is received before the change takes place.

The architectural role of components depends on the security and timeliness requirements in particular regulatory domains. Figure 4-10b shows two infrastructure BSSs in which APs are geolocation database dependent (GDD) enabling STAs and the other STAs are GDD dependent STAs.

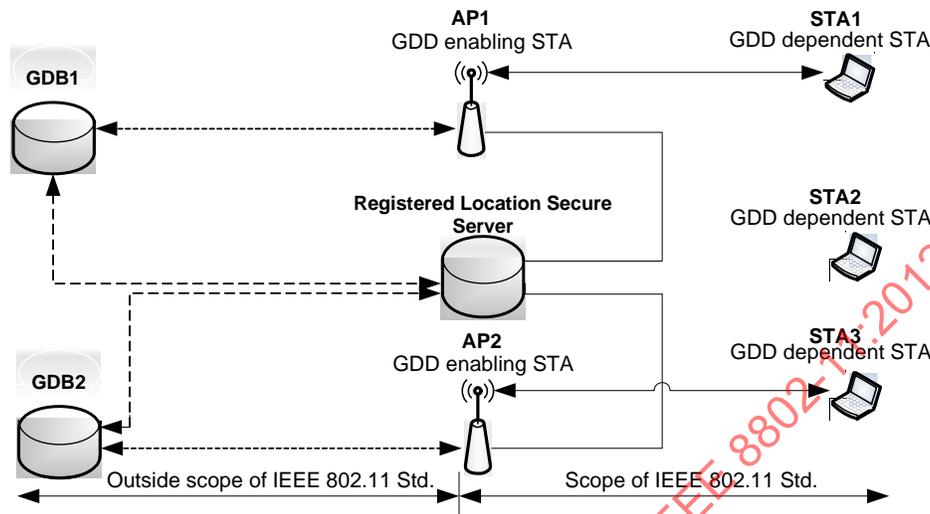


Figure 4-10b—Multiple APs and Multiple GDBs

In most regulatory domains, GDD enabling STAs are required to

- Securely communicate with GDBs
- Maintain the white space maps (WSMs) and other information received from GDBs
- Create and transmit a contact verification signal to inform GDD dependent STAs that the map they received is still valid

A Registered Location Query Protocol (RLQP) is provided to share the WSMs and current channel use among GDD enabling STAs in a neighborhood. GDD dependent STAs can query both their GDD enabling STA and the registered location secure server (RLSS) about WSMs and channel utilization. In some regulatory domains, a RLSS can provide GDBs with the current channel use information for all the BSSs and IBSSs that communicate with it. In some regulatory domains, the RLSS communicates with controllers of other white space systems to coordinate emissions footprints of their services. By accessing and using this information, the STAs can make intelligent decisions about the most effective way to utilize the available spectrum, power, and bandwidth for their communications.

The specific mechanisms are as follows:

- Channel availability query, used to obtain one or more WSMs of available channels for an area or a geolocation
- Channel schedule management, used to obtain start and ending times for each available white space channel
- Contact verification signal, used by a GDD dependent STA to verify it is still receiving frames from its GDD enabling STA
- GDD enablement, the procedure where a GDD enabling STA forms a network and maintains the network under the control of a GDB
- Network channel control, used to inform a local channel controller that has a view of nearby transmitters and their emissions footprints

- WSM, used to retrieve the available white space channels and their transmit power restrictions

The use of the mechanisms in a particular regulatory domain depends on the specific regulatory requirements. Table 4-1 gives a view of the use of specific mechanisms to meet regulatory requirements in terms of daily, hourly, and minute timescales. Implementers are referred to the regulatory sources in Table D-1 for further information. Operation in countries within defined regional regulatory domains might be subject to additional or alternative national regulations.

Table 4-1—GDD mechanisms and timescales

Mechanism	Daily consultation required	Hourly consultation required	Minute responsiveness
Channel availability query	Informative	Informative	Not applicable
Channel schedule management	Informative	Informative	Not applicable
Contact verification signal	Required to be secure	May be secure	Loss of consecutive signals requires action
GDD enablement	Required	Required	Required
Network channel control	Informative	Informative	Not applicable
WSM	Required for GDD enabling STA, might be translated for GDD dependent STA	Required for GDD enabling STA, might be translated for GDD dependent STA	Required for GDD enabling STA, might be translated for GDD dependent STA

These mechanisms allow a BSS to manage and query its radio environment and a GDB to control the radio environment for all wireless services.

6. Layer management

6.3 MLME SAP Interface

6.3.3 Scan

6.3.3.3 MLME-SCAN.confirm

6.3.3.3.2 Semantics of the service primitive

Insert the following row at the end of the untitled table describing BSSDescriptions in 6.3.3.3.2:

Name	Type	Valid range	Description	IBSS adoption
TVHT Operation	As defined in frame format	As defined in 8.4.2.172	The values from the TVHT Operation element if such an element was present in the Probe Response or Beacon frame; otherwise, null. The parameter is optionally present only if dot11TVHTOptionImplemented is true.	Adopt

Insert the following subclauses, 6.3.95 to 6.3.100.3.4, after 6.3.94.3.4:

6.3.95 Channel Availability Query

6.3.95.1 Introduction

The following MLME primitives support the signaling of channel availability query process for the channel query requests and responses.

6.3.95.2 MLME-CHANNELAVAILABILITYQUERY.request

6.3.95.2.1 Function

This primitive requests that a (Protected) Channel Availability Query Public Action frame be sent to a specified peer MAC entity.

6.3.95.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-CHANNELAVAILABILITYQUERY.request (
    PeerSTAAddress,
    ChannelAvailabilityQuery,
    Protected,
    VendorSpecificInfo
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual MAC address	The address of the peer MAC entity to which the Channel Availability Query frame is sent.
ChannelAvailabilityQuery	A set of information subfields	As defined in 8.5.8.27	Specifies the parameters of channel query.
Protected	Boolean	true, false	Specifies whether the request is sent using a Robust Management frame. If true, the request is sent using the Protected Channel Availability Query frame. If false, the request is sent using the Channel Availability Query frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.95.2.3 When generated

This primitive is generated by the SME to request channel query procedure with a specified peer MAC entity.

6.3.95.2.4 Effect of receipt

This primitive initiates a channel query procedure. The MLME subsequently issues a MLME-CHANNELAVAILABILITYQUERY.confirm primitive that reflects the results.

6.3.95.3 MLME-CHANNELAVAILABILITYQUERY.confirm**6.3.95.3.1 Function**

This primitive reports the results of a channel query attempt with a specified peer MAC entity.

6.3.95.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-CHANNELAVAILABILITYQUERY.confirm (
    PeerSTAAddress,
    ResultCode,
    ChannelAvailabilityQuery,
    Protected,
    VendorSpecificInfo
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual MAC address	The address of the peer MAC entity from which the response to the Channel Availability Query frame was received.
ResultCode	Enumeration	SUCCESS, SUCCESS_MULTIPLE, REFUSED, DEVICE_VERIFICATION_FAILURE	Indicates the result of MLME-CHANNELAVAILABILITYQUERY.request primitive.
ChannelAvailabilityQuery	A set of information fields	As defined in 8.5.8.27	Specifies the parameters of channel query.
Protected	Boolean	true, false	Specifies whether the response was received using a Robust Management frame. If true, the response was received using the Protected Channel Availability Query Public Action frame. If false, the response was received using the Channel Availability Query Public Action frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.95.3.3 When generated

This primitive is generated by the MLME as a result of an MLME-CHANNELAVAILABILITYQUERY.request and indicates the results of a channel availability query procedure.

6.3.95.3.4 Effect of receipt

The SME is notified of the results of the channel query procedure.

6.3.95.4 MLME-CHANNELAVAILABILITYQUERY.indication**6.3.95.4.1 Function**

This primitive indicates that a (Protected) Channel Availability Query frame was received from a peer STA.

6.3.95.4.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-CHANNELAVAILABILITYQUERY.indication (

PeerSTAAddress,
ChannelAvailabilityQuery,
Protected,
VendorSpecificInfo

)

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual MAC address	The address of the peer MAC entity from which the Channel Availability Query frame was received.
ChannelAvailabilityQuery	A set of information subfields	As defined in 8.5.8.27	Specifies the parameters of channel query.
Protected	Boolean	true, false	Specifies whether the request was received using a Robust Management frame. If true, the request was received using the Protected Channel Availability Query Public Action frame. If false, the request was received using the Channel Availability Query Public Action frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.95.4.3 When generated

This primitive is generated by the MLME as a result of the receipt of a channel query request from a specific peer MAC entity.

6.3.95.4.4 Effect of receipt

The SME is notified of the receipt of this channel query request.

6.3.95.5 MLME-CHANNELAVAILABILITYQUERY.response**6.3.95.5.1 Function**

This primitive is used to send a response to a specified peer MAC entity that requested channel query with the STA that issued this primitive.

6.3.95.5.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-CHANNELAVAILABILITYQUERY.response (

PeerSTAAddress,
ResultCode,
ChannelAvailabilityQuery,
Protected,
VendorSpecificInfo

)

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual MAC address	The address of the peer MAC entity to which the Channel Availability Query frame with the response is sent.
ResultCode	Enumeration	SUCCESS, SUCCESS_MULTIPLE, REFUSED, DEVICE_VERIFICATION_FAILURE	Indicates the result response of the channel availability query from the peer MAC entity.
ChannelAvailabilityQuery	A set of information subfields	As defined in 8.5.8.27	Specifies the parameters of channel query.
Protected	Boolean	true, false	Specifies whether the response is sent using a Robust Management frame. If true, the response is sent using the Protected Channel Availability Query Public Action frame. If false, the response is sent using the Channel Availability Query Public Action frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.95.5.3 When generated

This primitive is generated by the SME of a STA as a response to an MLME-CHANNELAVAILABILITYQUERY.indication primitive.

6.3.95.5.4 Effect of receipt

Upon receipt of this primitive, the MLME constructs the Channel Availability Query frame as the response. This frame is then scheduled for transmission to the peer MAC address.

6.3.96 Channel schedule management**6.3.96.1 Introduction**

The following MLME primitives support the signaling of channel schedule management.

6.3.96.2 MLME-CHANNELSCHEDULEMANAGEMENT.request**6.3.96.2.1 Function**

This primitive requests that a (Protected) Channel Schedule Management frame be sent.

6.3.96.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-CHANNELSCHEDULEMANAGEMENT.request (
    PeerSTAAddress,
    ChannelScheduleManagement,
    Protected,
    VendorSpecificInfo
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any valid individual MAC address	The address of the peer MAC entity to which the Channel Schedule Management frame is sent.
ChannelScheduleManagement	A set of information subfields	As defined in 8.4.1.53	Specifies the parameters of channel schedule management.
Protected	Boolean	true, false	Specifies whether the request is sent using a Robust Management frame. If true, the request is sent using the Protected Channel Schedule Management frame. If false, the request is sent using the Channel Schedule Management frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.96.2.3 When generated

This primitive is generated by the SME to request that a (Protected) Channel Schedule Management frame be sent by a STA.

6.3.96.2.4 Effect of receipt

On receipt of this primitive, the MLME constructs and schedules transmission of a (Protected) Channel Schedule Management frame.

6.3.96.3 MLME-CHANNELSCHEDULEMANAGEMENT.confirm**6.3.96.3.1 Function**

This primitive reports the result of a channel schedule management query.

6.3.96.3.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-CHANNELSCHEDULEMANAGEMENT.confirm (

PeerSTAAddress,

ChannelScheduleManagement,

Protected,

VendorSpecificInfo

)

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any valid individual MAC address	The address of the peer MAC entity from which the Channel Schedule Management frame was received.
ChannelScheduleManagement	A set of information subfields	As defined in 8.4.1.53	Specifies the parameters of channel schedule management.
Protected	Boolean	true, false	Specifies whether the response is sent using a Robust Management frame. If true, the response is sent using the Protected Channel Schedule Management frame. If false, the response is sent using the Channel Schedule Management Public Action frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.96.3.3 When generated

This primitive is generated by the MLME when a channel schedule request completes. Possible unspecified failure causes include an inability to provide the channel schedule information.

6.3.96.3.4 Effect of receipt

The SME is notified of the results of the channel schedule management procedure.

6.3.96.4 MLME-CHANNELSCHEDULEMANAGEMENT.indication**6.3.96.4.1 Function**

This primitive indicates that a (Protected) Channel Schedule Management frame was received from a peer STA.

6.3.96.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-CHANNELSCHEDULEMANAGEMENT.indication (
    PeerSTAAddress,
    ChannelScheduleManagement,
    Protected,
    VendorSpecificInfo
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any valid individual MAC address	The address of the peer MAC entity from which the Channel Schedule Management frame was received.
ChannelScheduleManagement	A set of information subfields	As defined in 8.4.1.53	Specifies the parameters of channel schedule management.
Protected	Boolean	true, false	Specifies whether the request was received using a Robust Management frame. If true, the request was received using the Protected Channel Schedule Management frame. If false, the request was received using the Channel Schedule Management frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.96.4.3 When generated

This primitive is generated by the MLME when a valid (Protected) Channel Schedule Management frame is received.

6.3.96.4.4 Effect of receipt

On receipt of this primitive, the SME decides whether to provide the channel schedule information.

6.3.96.5 MLME-CHANNELSCHEDULEMANAGEMENT.response**6.3.96.5.1 Function**

This primitive is used to provide channel schedule information on channel availability.

6.3.96.5.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-CHANNELSCHEDULEMANAGEMENT.response (
    PeerSTAAddress,
    ChannelScheduleManagement,
    Protected,
    VendorSpecificInfo
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any valid individual MAC address	The address of the peer MAC entity to which the Channel Schedule Management frame is sent.
ChannelScheduleManagement	A set of information subfields	As defined in 8.4.1.53	Specifies the parameters of channel schedule management.
Protected	Boolean	true, false	Specifies whether the response is sent using a Robust Management frame. If true, the response is sent using the Protected Channel Schedule Management Public Action frame. If false, the response is sent using the Channel Schedule Management Public Action frame.
VendorSpecificInfo	A set of elements	As defined in 8.4.2.28	Zero or more elements.

6.3.96.5.3 When generated

This primitive is generated by the SME to provide the channel schedule information.

6.3.96.5.4 Effect of receipt

On receipt of this primitive, the MLME constructs the appropriate (Protected) channel schedule management response frame and schedules the transmission of the frame to the peer MAC entity.

6.3.97 Contact Verification Signal**6.3.97.1 Introduction**

The following MLME primitives support the signaling of the contact verification signal (CVS).

6.3.97.2 MLME-CVS.request**6.3.97.2.1 Function**

This primitive requests that a Contact Verification Signal frame be sent by a STA to a specified peer MAC entity in order to validate a WSM.

6.3.97.2.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-CVS.request (

PeerSTAAAddress,
Protected,
ContactVerificationSignal
)

Name	Type	Valid range	Description
PeerSTAAAddress	MAC Address	Any valid individual MAC Address	Specifies the address of the peer MAC entity with which to perform the contact verification signal process.
Protected	Boolean	true, false	Specifies whether the request is sent using a Robust Management frame. If true, the request is sent using the Protected Contact Verification Signal frame. If false, the request is sent using the Contact Verification Signal frame.
ContactVerificationSignal	Contact Verification Signal element	As defined in 8.5.8.29	Specifies the service parameters for the Contact Verification Signal frame.

6.3.97.2.3 When generated

This primitive is generated by the SME to request that a Protected Contact Verification Signal frame be sent by a STA to a specified peer MAC entity.

6.3.97.2.4 Effect of receipt

On receipt of this primitive, the MLME constructs a Protected Contact Verification Signal frame. This frame is then scheduled for transmission.

6.3.97.3 MLME-CVS.indication

6.3.97.3.1 Function

This primitive indicates that a Contact Verification Signal frame was received from a specific peer MAC entity.

6.3.97.3.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-CVS.indication (

PeerSTAAddress,
Protected,
ContactVerificationSignal
)

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual MAC Address	The address of the peer MAC entity from which a Contact Verification Signal frame was received.
Protected	Boolean	true, false	Specifies whether the request is sent using a Robust Management frame. If true, the request is sent using the Protected Contact Verification Signal frame. If false, the request is sent using the Contact Verification Signal frame.
ContactVerificationSignal	Contact Verification Signal element	As defined in 8.5.8.29	Specifies the service parameters for the Contact Verification Signal frame.

6.3.97.3.3 When generated

This primitive is generated by the MLME when a valid Protected Contact Verification Signal frame is received.

6.3.97.3.4 Effect of receipt

On receipt of this primitive, the SME is notified of the receipt of the Contact Verification Signal frame.

6.3.98 GDD Enablement**6.3.98.1 Introduction**

The following MLME primitives support the signaling of GDD enablement.

6.3.98.2 MLME-GDDENABLEMENT.request**6.3.98.2.1 Function**

This primitive requests that a (Protected) GDD Enablement Request frame be sent to a peer entity.

6.3.98.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-GDDENABLEMENT.request (
    PeerSTAAddress,
    DialogToken,
    Protected,
    DeviceClass,
    DeviceID
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any individual valid MAC address	Specifies the address of the peer MAC entity with which to perform the GDD enablement process.
DialogToken	Integer	1–255	The dialog token to identify the event transaction.
Protected	Boolean	true, false	Specifies whether the request is sent using a Robust Management frame. If true, the request is sent using the Protected GDD Enablement Request frame. If false, the request is sent using the GDD Enablement Request frame.
DeviceClass	DeviceClass	As defined in 8.2.6.2.1	Specifies the service parameters for the GDD Enablement Request frame.
DeviceID	Device Identification Information	As defined in 8.2.6.2.2	Specifies the service parameters for the GDD Enablement Request frame.

6.3.98.2.3 When generated

This primitive is generated by the SME to request that a (Protected) GDD Enablement Request frame be sent to the peer entity.

6.3.98.2.4 Effect of receipt

On receipt of this primitive, the MLME constructs a (Protected) GDD Enablement Request frame. This frame is then scheduled for transmission.

6.3.98.3 MLME-GDDENABLEMENT.confirm**6.3.98.3.1 Function**

This primitive reports the result of an MLME-GDDENABLEMENT.request primitive to initiate GDD enablement.

6.3.98.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-GDDENABLEMENT.confirm (
    PeerSTAAddress,
    DialogToken,
    Protected,
    ResultCode,
    WSM
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any individual valid MAC address	Specifies the address of the peer MAC entity with which to perform the GDD enablement process.
DialogToken	Integer	1–255	The dialog token to identify the event transaction.
Protected	Boolean	true, false	Specifies whether the response is sent using a Robust Management frame. If true, the response is sent using the Protected GDD Enablement Response frame. If false, the response is sent using the GDD Enablement Response frame.
ResultCode	Enumeration	SUCCESS, REFUSED, ENABLEMENT DENIED, ENABLEMENT Denied due to restriction from GDB	Indicates the result response to the GDD Enablement Request frame from the peer entity.
WSM	WSM element	As defined in 8.4.1.55	Specifies the service parameters for the white space map.

6.3.98.3.3 When generated

This primitive is generated by the MLME as a result of an MLME-GDDENABLEMENT.request primitive and indicates the results of the request.

This primitive is generated when the STA successfully receives a GDD Enablement Response frame from the peer entity or when an unspecified failure occurs.

6.3.98.3.4 Effect of receipt

On receipt of this primitive, the SME evaluates the results of the MLME-GDDENABLEMENT.request primitive and may use the reported data.

6.3.98.4 MLME-GDDENABLEMENT.indication**6.3.98.4.1 Function**

This primitive indicates that a (Protected) GDD Enablement Request frame was received from a peer entity.

6.3.98.4.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-GDDENABLEMENT.indication (
 PeerSTAAddress,
 DialogToken,
 Protected,
 DeviceClass,
 DeviceID
)

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any individual valid MAC address	The address of the peer entity from which a GDD Enablement Request frame was received.
DialogToken	Integer	1–255	The dialog token to identify the event transaction.
Protected	Boolean	true, false	Specifies whether the request is sent using a Robust Management frame. If true, the request is sent using the Protected GDD Enablement Request frame. If false, the request is sent using the GDD Enablement Request frame.
DeviceClass	DeviceClass	As defined in 8.2.6.2.1	Specifies the service parameters for the GDD Enablement Request frame.
DeviceID	Device Identification Information	As defined in 8.2.6.2.2	Specifies the service parameters for the GDD Enablement Request frame.

6.3.98.4.3 When generated

This primitive is generated by the MLME when a valid (Protected) GDD Enablement Request frame is received.

6.3.98.4.4 Effect of receipt

On receipt of this primitive, the SME operates according to the procedure in 10.43.1.

6.3.98.5 MLME-GDDENABLEMENT.response**6.3.98.5.1 Function**

This primitive indicates that a (Protected) GDD Enablement Response frame be sent to the peer entity.

6.3.98.5.2 Semantics of the service primitive

MLME-GDDENABLEMENT.response (

PeerSTAAddress,
DialogToken,
Protected,
ResultCode,
WSM

)

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any individual valid MAC address	The address of the peer entity from which a GDD Enablement Request frame was received.
DialogToken	Integer	1–255	The dialog token to identify the event transaction.
Protected	Boolean	true, false	Specifies whether the response is sent using a Robust Management frame. If true, the response is sent using the Protected GDD Enablement Response frame. If false, the response is sent using the GDD Enablement Response frame.
ResultCode	Enumeration	SUCCESS, REFUSED, ENABLEMENT DENIED, ENABLEMENT Denied due to restriction from GDB	Indicates the result response to the GDD Enablement Request frame from the peer entity.
WSM	WSM element	As defined in 8.4.1.55	Specifies the service parameters for the white space map.

6.3.98.5.3 When generated

This primitive is generated by the SME to request that a GDD Enablement Response frame be sent to the peer entity.

6.3.98.5.4 Effect of receipt

On receipt of this primitive, the MLME constructs a GDD Enablement Response frame. This frame is then scheduled for transmission.

6.3.99 Network channel control management**6.3.99.1 Introduction**

The following MLME primitives support the signaling of network channel control management.

6.3.99.2 MLME-NETWORKCHANNELCONTROL.request**6.3.99.2.1 Function**

This primitive requests that a (Protected) Network Channel Control Public Action frame be sent by a STA to a specified peer MAC entity.

6.3.99.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-NETWORKCHANNELCONTROL.request (
    PeerSTAAddress,
    DialogToken,
    NetworkChannelControl,
    Protected,
    VendorSpecificInfo
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual or group MAC Address	The address of the peer MAC entity to which the Network Channel Control frame is transmitted.
DialogToken	Integer	0–255	The dialog token to identify the network channel control transaction.
NetworkChannelControl	A set of information subfields	As defined in 8.5.8.32	Specifies the parameters of network channel control.
Protected	Boolean	true, false	Specifies whether the request is sent using a Robust Management frame. If true, the request is sent using the Protected Network Channel Control frame. If false, the request is sent using the Network Channel Control frame.
VendorSpecificInfo	A set of vendor specific elements	As defined in 8.4.2.28	Zero or more elements.

6.3.99.2.3 When generated

This primitive is generated by the SME to request that a (Protected) Network Channel Control Public Action frame be sent by a STA to the specified peer MAC entity.

6.3.99.2.4 Effect of receipt

On receipt of this primitive, the MLME constructs a (Protected) Network Channel Control Public Action frame. This frame is then scheduled for transmission.

6.3.99.3 MLME-NETWORKCHANNELCONTROL.confirm**6.3.99.3.1 Function**

This primitive reports the result of a request to network channel control.

6.3.99.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-NETWORKCHANNELCONTROL.confirm (
    PeerSTAAddress,
    DialogToken,
    NetworkChannelControl,
    Protected,
    VendorSpecificInfo
)
```

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual MAC address	The address of the peer MAC entity from which the network channel control response frame is received.
DialogToken	Integer	0–255	The dialog token to identify the network channel control transaction.
NetworkChannelControl	A set of information subfields	As defined in 8.5.8.32	Specifies the parameters of network channel control.
Protected	Boolean	true, false	Specifies whether the response is sent using a Robust Management frame. If true, the response is sent using the Protected Network Channel Control Public Action frame. If false, the response is sent using the Network Channel Control Public Action frame.
VendorSpecificInfo	A set of vendor specific elements	As defined in 8.4.2.28	Zero or more elements.

6.3.99.3.3 When generated

This primitive is generated by the MLME when a network channel control request completes. Possible unspecified failure causes include an inability to schedule a Network Channel Control Public Action frame.

6.3.99.3.4 Effect of receipt

The SME is notified of the results of the network channel control procedure.

6.3.99.4 MLME-NETWORKCHANNELCONTROL.indication**6.3.99.4.1 Function**

This primitive indicates that a (Protected) Network Channel Control Public Action frame was received from a STA.

6.3.99.4.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-NETWORKCHANNELCONTROL.indication (

PeerSTAAddress,
DialogToken,
NetworkChannelControl,
Protected,
VendorSpecificInfo

)

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any valid individual MAC address	The address of the peer MAC entity from which the Network Channel Control frame was received.
DialogToken	Integer	0–255	The dialog token to identify the network channel control transaction.
NetworkChannelControl	A set of information subfields	As defined in 8.5.8.32	Specifies the parameters of network channel control.
Protected	Boolean	true, false	Specifies whether the request was received using a Robust Management frame. If true, the request was received using the Protected Network Channel Control Public Action frame. If false, the request was received using the Network Channel Control Public Action frame.
VendorSpecificInfo	A set of vendor specific elements	As defined in 8.4.2.28	Zero or more elements.

6.3.99.4.3 When generated

This primitive is generated by the MLME when a valid (Protected) Network Channel Control Public Action frame is received.

6.3.99.4.4 Effect of receipt

On receipt of this primitive, the SME decides whether to accept the network channel control request.

6.3.99.5 MLME-NETWORKCHANNELCONTROL.response**6.3.99.5.1 Function**

This primitive is generated by the SME to schedule the transmission of a network channel control response.

6.3.99.5.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-NETWORKCHANNELCONTROL.response (

PeerSTAAddress,
DialogToken,
NetworkChannelControl,
Protected,
VendorSpecificInfo
)

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual or group MAC address	The address of the peer MAC entity to which the network channel control response frame is transmitted.
DialogToken	Integer	0–255	The dialog token to identify the network channel control transaction.
NetworkChannelControl	A set of information subfields	As defined in 8.5.8.32	Specifies the parameters of network channel control.
Protected	Boolean	true, false	Specifies whether the response is sent using a Robust Management frame. If true, the response is sent using the Protected Network Channel Control Public Action frame. If false, the response is sent using the Network Channel Control Public Action frame.
VendorSpecificInfo	A set of vendor specific elements	As defined in 8.4.2.28	Zero or more elements.

6.3.99.5.3 When generated

This primitive is generated by the SME to request that a network channel control response be sent to the peer entity.

6.3.99.5.4 Effect of receipt

On receipt of this primitive, the MLME schedules the response to the specific peer MAC entity that has requested a network channel control response.

6.3.100 White space map (WSM)**6.3.100.1 Introduction**

The following MLME primitives support the signaling of the WSM.

6.3.100.2 MLME-WSM.request**6.3.100.2.1 Function**

This primitive requests that a White Space Map Announcement frame be sent by a GDD enabling STA in order to provide a WSM to a GDD dependent STA.

6.3.100.2.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-WSM.request (

PeerSTAAddress,
WhiteSpaceMap

)

Name	Type	Valid range	Description
PeerSTAAddress	MAC Address	Any valid individual MAC Address	Specifies the address of the peer MAC entity with which to perform the WSM process.
WhiteSpaceMap	White Space Map element	As defined in 8.4.2.170	Specifies the service parameters for the WSM.

6.3.100.2.3 When generated

This primitive is generated by the SME to request that a White Space Map Announcement frame be sent by a GDD enabling STA to a specified peer MAC entity.

6.3.100.2.4 Effect of receipt

On receipt of this primitive, the MLME constructs a White Space Map Announcement frame. This frame is then scheduled for transmission.

6.3.100.3 MLME-WSM.indication**6.3.100.3.1 Function**

This primitive indicates receipt of a request of a White Space Map Announcement frame.

7. PHY service specification

7.3 Detailed PHY service specifications

7.3.5 PHY-SAP detailed service specification

7.3.5.11 PHY-CCA.indication

7.3.5.11.2 Semantics of the service primitive

Change the following rows of Table 7-5:

Table 7-5—The channel-list parameter elements

channel-list elements	Meaning
primary	For an HT STA that is not a VHT STA, indicates that the primary 20 MHz channel is busy. For a VHT STA, indicates that the primary 20 MHz channel is busy according to the rules specified in 22.3.19.5.3. <u>For a TVHT STA, indicates that the primary channel is busy according to the rules specified in 23.3.19.6.3.</u>
secondary	For an HT STA that is not a VHT STA, indicates that the secondary channel is busy. For a VHT STA, indicates that the secondary 20 MHz channel is busy according to the rules specified in 22.3.19.5.4. <u>For a TVHT STA, indicates that the secondary channel is busy according to the rules specified in 23.3.19.6.4.</u>
secondary40	Indicates that the secondary 40 MHz channel is busy according to the rules specified in 22.3.19.5.4. <u>For a TVHT STA, indicates that the secondary TVHT 2W channel is busy according to the rules specified in 23.3.19.6.4.</u>

Insert the following paragraphs and figures (Figure 7-2a and Figure 7-2b) at the end of the 7.3.5.11.2:

For a TVHT STA, the relationship of the channel-list parameter elements to the TVHT_W, TVHT_2W, and TVHT_W+W BSS operating channel is illustrated in Figure 7-2a.

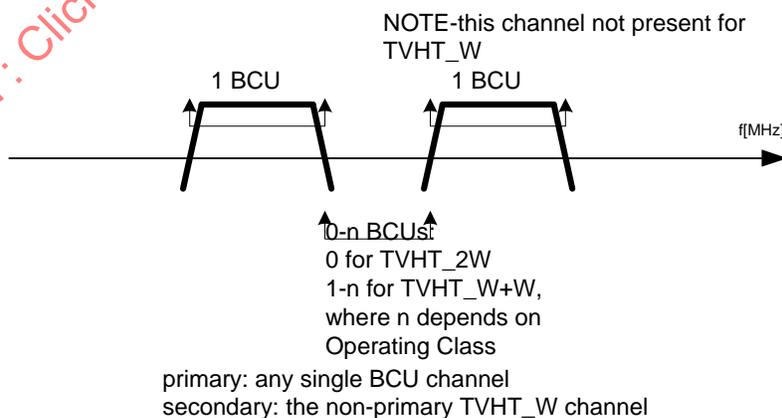
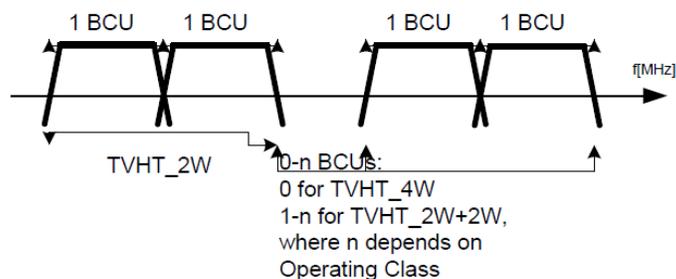


Figure 7-2a—TVHT channel-list parameter element and channel bandwidth for TVHT_W, TVHT_2W, and TVHT_W+W

For a TVHT STA, the relationship of the channel-list parameter elements to the TVHT_4W and TVHT_2W+2W BSS operating channel is illustrated in Figure 7-2b.



primary: any single BCU channel

secondary: the non-primary TVHT_W channel in the same TVHT_2W channel group

secondary40: the TVHT_2W channel group that does not contain the primary TVHT_W

Figure 7-2b—TVHT channel-list parameter element and channel bandwidth for TVHT_4W and TVHT_2W+2W

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/Amd5:2015

8. Frame formats

8.2 MAC frame formats

8.2.4 Frame fields

8.2.4.6 HT Control field

8.2.4.6.3 VHT variant

Change the following row of Table 8-13b:

Table 8-13b—MFB subfield in the VHT variant HT Control field

Subfield	Meaning	Definition
BW	Bandwidth of the recommended VHT-MCS	<p>If the Unsolicited MFB subfield is 1, the BW subfield indicates the bandwidth for which the recommended VHT-MCS is intended, as defined in 9.28.3:</p> <p><u>For a VHT STA:</u> Set to 0 for 20 MHz Set to 1 for 40 MHz Set to 2 for 80 MHz Set to 3 for 160 MHz and 80+80 MHz.</p> <p><u>For a TVHT STA:</u> Set to 0 for TVHT W Set to 1 for TVHT 2W and TVHT W+W Set to 2 for TVHT 4W and TVHT 2W+2W <u>The value 3 is reserved.</u></p> <p>If the Unsolicited MFB subfield is 0, the BW subfield is reserved.</p>

8.2.4.7 Frame Body field

8.2.4.7.1 General

Change the second list item in the dashed list after the first paragraph of 8.2.4.7.1 as follows:

- The maximum PPDU duration (e.g., HT_MF, L_SIG, L_LENGTH, HT_GF, VHT, TVHT, or DMG aPPDU_{MaxTime} (see Table 8-13c); any nonzero TXOP Limit; any regulatory constraints (e.g., CS4-msBehavior))

Insert the following subclauses, 8.2.6 to 8.2.6.2.5 (including Table 8-14a to Table 8-14h), after 8.2.5.8:

8.2.6 TLV encodings

8.2.6.1 General

The following TLV encodings are used to convey parameters within MAC Management frames (8.3.3, 8.4, and 8.5). The specification is complete regarding the endianness of multi-octet fields as they are covered by 8.2.2. Be aware that most protocols above the MAC operate in the opposite endianness. TLV tuples with type values that are unknown, not specified in this subclause, or specified as “reserved” are discarded upon receipt. The form of TLVs is shown in Table 8-14a.

Table 8-14a—General TLV format

Name	Type	Length (octets)	Value	Scope/ Country code
The name of the TLV	1	variable	Single Octet, Single Value, or Compound TLV tuples.	

Name is the name of the TLV tuple.

The ' $m.n$ ' syntax in the Type field means that the TLV has type n , an unsigned 1-octet integer, and is embedded in the Value field of a TLV of type m . The length of the Type field is 1 octet.

The format of the Length field is an unsigned number of size 1 octet, and the value in the Length field specifies the number of octets in the Value field.

A single octet TLV has a Value field that is a single octet, a single value TLV has a Value field larger than 1-octet, and a compound TLV has a Value field that represents more than 1-octet fields.

When a Scope field entry contains two characters, it identifies the country or other entity to which the STA's operation is bound. If the two-character value stands for a country or other entity, then the value matches a code defined in ISO 3166-1. When a Scope field entry contains more than two characters, it identifies a scope for the TLV tuple.

8.2.6.2 Common TLVs

The general form of common TLVs is shown in Table 8-14a and is used in 8.2.6.2.1 to 8.2.6.2.5.

8.2.6.2.1 Device Class

This parameter contains the intended class of device for operation in TVWS band after it receives the available channel list at its location. The Device Class field format is shown in Table 8-14b.

Table 8-14b—Device Class field definition

Name	Type	Length (octets)	Value	Scope/ Country code
Device Class	2	1	The Device Class field contains an integer that indicates the device's TVWS band mode of operation as follows: 0: GDD non-AP STA 1: GDD geolocated non-AP STA 2: GDD AP 3: GDD fixed STA 4–255: Reserved	CAQ, GDDENABLE MENT, WSM

8.2.6.2.2 Device Identification Information

This parameter contains the identification information of the device initiating the channel availability query. The Device Identification Information field format is shown in Table 8-14c and related Device Identification Information Value fields tables in E.2 for specific regulatory domains.

Table 8-14c—Device Identification Information field definition

Name	Type	Length (octets)	Value	Scope/ Country code
Device Identification Information	3	variable	Single value TLV comprising fields in related table in E.2 for a specific regulatory domain.	CAQ, GDDENABLEMENT, CSM

8.2.6.2.3 Device Location Information

This parameter contains the location information of the device initiating the channel availability query. The Device Location Information field format is shown in Table 8-14d.

Table 8-14d—Device Location Information field definition

Name	Type	Length (octets)	Value	Scope/ Country code
Device Location Information	10	16	The Device Location Information field contains the latitude, longitude, and altitude information of the device in the format specified by the Device Location Information Body fields in Figure 8-80i. When the Device Type subfield (see Table 8-14b) is not GDD fixed STA, the altitude information (Altitude Type, Altitude Uncertainty, Altitude Fraction, and Altitude Integer subfields) of the Device Location Information field remain unused.	CAQ

8.2.6.2.4 Channel Schedule Descriptor

This parameter contains the channel number associated with channel schedule information used for channel schedule management. The Channel Schedule Descriptor Tuple attribute format is shown in Table 8-14e and Table 8-14f. Channel Schedule Descriptor field is constructed with either Channel Availability Starting Time field or Channel Availability Starting Timestamp field present or neither of these two fields present.

Table 8-14e—Channel Schedule Descriptor Tuple attribute definition

Name	Type	Length (octets)	Value	Scope/ Country code
Channel Schedule Descriptor	11	variable	Compound TLVs in Table 8-14f.	CSM

Table 8-14f—Channel Schedule Descriptor Value fields

Name	Subtype	Length (octets)	Value	Scope/ Country code
Operating Class	1	1	The Operating Class field is the number of the operating class of the channel, which is defined in E.1.	CSM
Channel Number	2	1	The Channel Number field is the number of the channel, which is the subject of the value of Channel Schedule Management Mode field. If the Channel Schedule Management Mode field indicates the schedule information is based on WLAN channels, the Channel Number is a channel from the STA's operating class as defined in E.1; otherwise, the Operating Class compound TLV is not present, and the Channel Number is a positive integer value as defined in D.1 to indicate the available TV channel for WLAN operation.	CSM
Channel Availability Starting Time	3	8	The Channel Availability Starting Time field indicates the starting time in Coordinated Universal Time (UTC) from when the channel indicated in the Channel Number field is available for operation. When neither this field nor a Channel Availability Starting Timestamp is present, the STA takes the time that the response element is received as the starting time of the channel availability. NOTE—The Channel Availability Starting Time field follows the UTC time definition of the Time Value field of the Time Advertisement element in 8.4.2.63, and the first 6 octets are used to indicate the UTC time until minutes. The left 2 octets are reserved.	CSM
Channel Availability Starting Timestamp	4	8	The Channel Availability Starting Timestamp field indicates the starting timestamp from when the channel indicated in the Channel Number field is available for operation. When neither this field nor a Channel Availability Starting Time field is present, the STA takes the time that the response element is received as the starting time of the channel availability.	CSM
Channel Availability Offset Time	5	2	The Channel Availability Offset Time field indicates the offset of channel availability time with respect to the time that the Channel Schedule Descriptor is received. This field is present when the Channel Availability Starting Time field is not present in the response TLV and the channel is not available at the moment the TLV is received.	CSM
Channel Availability Duration	6	2	The Channel Availability Duration field indicates the duration in minutes of the availability of the channel that indicated in the Channel Number field.	CSM

8.2.6.2.5 WSM information values

The format of the WSM information values is shown in Table 8-14g. If the value of WSM Type field of the White Space Map element (8.4.1.55) is 1, the WSM Information field specifies available channel information for TVWS, which is country-specific.

Table 8-14g—WSM information values

Name	Type	Length (octets)	Value	Scope/ Country code
WSM Information	12	variable	Single value TLV comprising fields in related table in E.2 for a specific regulatory domain.	WSM

The format of the WSM Information Value fields is shown in Table 8-14h.

Table 8-14h—WSM Information Value fields

Name	Length (octets)	Value	Scope/ Country code
Device Class	1	Single octet TLV comprising fields in Table 8-14b.	WSM
Map ID	1	Bit 0: Type bit indicates whether the following channel list is a full channel list or a partial channel list. If the Type bit is 1, the following channel list is a full channel list; and if the Type bit is 0, the following channel list is a partial channel list. Bits 1–7: Map version identifies the version of the WSM.	WSM
Channel Number	1	Channel Number field in related WSM Information Value fields table in E.2.	WSM
Maximum Power Level	1	Maximum Power Level field in related WSM Information Value fields table in E.2.	WSM
Validity	1	The Validity field indicates the time duration in minutes for which the Channel Number is available with the allowed maximum power level, where the Validity field is provided for each available Channel Number.	WSM, UK
Maximum Channel Bandwidth	2	Limits on the maximum contiguous and maximum noncontiguous instantaneous bandwidths of STA specified as $n \times 0.1$ MHz, where $n > 0$.	WSM, UK

The Device Class field is defined in 8.2.6.2.1 and identifies the device class used by the WSM. It determines the length of the channel availability tuple consisting of the Channel Number, Maximum Power Level, and Validity fields, which is repeated as indicated by the length field of WSM element. If the Device Class field is 0, the Validity field in WSM Information Value field is not present. Otherwise, the Validity field exists in the WSM Information Value field.

8.3 Format of individual frame types

8.3.3 Management frames

8.3.3.2 Beacon frame format

Change the following rows of Table 8-20:

Table 8-20—Beacon frame body

Order	Information	Notes
36	Supported Operating Classes	The Supported Operating Classes element is present if dot11ChannelSwitchActivated is true. <u>The Supported Operating Classes element is optionally present if dot11TVHTOptionImplemented is true.</u>
63	Channel Switch Wrapper element	The Channel Switch Wrapper is optionally present if dot11VHTOptionImplemented is true and at least one of a Channel Switch Announcement element or an Extended Channel Switch Announcement element is also present in the Beacon frame and the Channel Switch Wrapper element contains at least one subelement. <u>The Channel Switch Wrapper element is optionally present if dot11TVHTOptionImplemented is true and at least one of a Channel Switch Announcement element or an Extended Channel Switch Announcement element is also present in the Beacon frame and the Channel Switch Wrapper element contains at least one subelement.</u>

Insert the following rows into Table 8-20 before the Last row:

Table 8-20—Beacon frame body

Order	Information	Notes
201	Reduced Neighbor Report	The Reduced Neighbor Report element is optionally present if dot11TVHTOptionImplemented is true.
202	TVHT Operation	The TVHT Operation element is present for a TVHT STA when the dot11TVHTOptionImplemented is true; otherwise it is not present.

8.3.3.9 Probe Request frame format

Change the following row of Table 8-26:

Table 8-26—Probe Request frame body

Order	Information	Notes
6	Supported Operating Classes	The Supported Operating Classes element is present if dot11ChannelSwitchActivated is true. <u>The Supported Operating Classes element is optionally present if dot11TVHTOptionImplemented is true.</u>

8.3.3.10 Probe Response frame format

Change the following rows of Table 8-27:

Table 8-27—Probe Response frame body

Order	Information	Notes
36	Supported Operating Classes	The Supported Operating Classes element is present if dot11ChannelSwitchActivated is true. <u>The Supported Operating Classes element is optionally present if dot11TVHTOptionImplemented is true.</u>
63	Channel Switch Wrapper element	The Channel Switch Wrapper is optionally present if dot11VHTOptionImplemented is true and at least one of a Channel Switch Announcement element or an Extended Channel Switch Announcement element is also present in the Beacon frame and the Channel Switch Wrapper element contains at least one subelement. <u>The Channel Switch Wrapper element is optionally present if dot11TVHTOptionImplemented is true and at least one of a Channel Switch Announcement element or an Extended Channel Switch Announcement element is also present in the Beacon frame and the Channel Switch Wrapper element contains at least one subelement.</u>

Insert the following rows into Table 8-27 before the Last-1 row:

Table 8-27—Probe Response frame body

Order	Information	Notes
201	Reduced Neighbor Report	The Reduced Neighbor Report element is optionally present if dot11TVHTOptionImplemented is true.
202	TVHT Operation	The TVHT Operation element is present for a TVHT STA when the dot11TVHTOptionImplemented is true; otherwise it is not present.

8.4 Management frame body components**8.4.1 Fields that are not information elements****8.4.1.9 Status Code field**

Insert the following rows into Table 8-37 in numeric order, and change the reserved values accordingly:

Table 8-37—Status codes

Status code	Name	Meaning
105	ENABLEMENT DENIED	Enablement denied
106	RESTRICTION FROM AUTHORIZED GDB	Enablement denied due to restriction from an authorized GDB
107	AUTHORIZATION DEENABLED	Authorization deenabled

8.4.1.32 Rate Identification field

Insert the following paragraphs, starting after the fifth paragraph, into 8.4.1.32:

The MCS Selector field value 4 indicates that the MCS Index field specifies values that are taken from Table 22-38 through Table 22-45, indicating a VHT-MCS for a 40 MHz channel width.

In frames transmitted by a TVHT STA, the MCS Selector field value 4 indicates that the MCS Index field specifies values that are taken from Table 23-26 through Table 23-29, indicating a TVHT MCS for a TVHT W channel width.

The MCS Selector field value 5 indicates that the MCS Index field specifies values that are taken from Table 22-46 through Table 22-53, indicating a VHT-MCS for an 80 MHz channel width.

In frames transmitted by a TVHT STA, the MCS Selector field value 5 indicates that the MCS Index field specifies values that are taken from Table 23-30 through Table 23-33, indicating a TVHT MCS for a TVHT 2W or TVHT W+W channel width.

The MCS Selector field value 6 indicates that the MCS Index field specifies values that are taken from Table 22-54 through Table 22-61, indicating a VHT-MCS for a 160 MHz or 80+80 MHz channel width.

In frames transmitted by a TVHT STA, the MCS Selector field value 6 indicates that the MCS Index field specifies values that are taken from Table 23-34 through Table 23-37, indicating a TVHT MCS for a TVHT 4W or TVHT 2W+2W channel width.

Change the now 14th paragraph of 8.4.1.32 as follows:

If MCS Selector is 3, 4, 5, or 6, the MCS Index field format is as shown in Figure 8-70a. The NSS subfield indicates the number of spatial streams, and the VHT-MCS Index Row subfield indicates a value from the “VHT-MCS Index” column of Table 22-30 through Table 22-61 in 22.5 or from the “MCS Index” column of Table 23-26 through Table 23-37 in 23.5 that corresponds to the channel width and N_{SS} values.

8.4.1.48 VHT Compressed Beamforming Report field

Insert the following subclause, 8.4.1.48a, after 8.4.1.48:

8.4.1.48a TVHT Compressed Beamforming Report field

The format of the TVHT Compressed Beamforming Report field is the same as the VHT Compressed Beamforming Report field in 8.4.1.48 except for the following modifications.

The subcarriers for which Compressed Feedback Beamforming Matrix subfield is sent in Table 8-53g for 40 MHz are used for each basic channel unit (BCU) in TVHT_MODE_1 and TVHT_MODE_2N. See tone location description in Table 23-9.

For TVHT_MODE_2C with 6 MHz and 8 MHz channelization, the subcarriers for which Compressed Feedback Beamforming Matrix subfield is sent in the Lower BCU are based on subtracting 72 from the values shown in Table 8-53g and for the Upper BCU by adding 72.

For TVHT_MODE_2C with 7 MHz channelization, the subcarriers for which Compressed Feedback Beamforming Matrix subfield is sent in the Lower BCU are based on subtracting 84 from the values shown in Table 8-53g and for the Upper BCU by adding 84.

For TVHT_MODE_4C with 6 MHz and 8 MHz channelization, the subcarriers for which Compressed Feedback Beamforming Matrix subfield is sent in the lowest, second to lowest, second to highest, and highest BCUs are based on subtracting 216, subtracting 72, adding 72, and adding 216 from the values shown in Table 8-53g, respectively.

For TVHT_MODE_4C with 7 MHz channelization, the subcarriers for which Compressed Feedback Beamforming Matrix subfield is sent in the lowest, second to lowest, second to highest, and highest BCUs are based on subtracting 252, subtracting 84, adding 84, and adding 252 from the values shown in Table 8-53g, respectively.

For TVHT_MODE_4N channelization, the subcarriers for which Compressed Feedback Beamforming Matrix subfield is sent in each of the two noncontiguous frequency segments are as described for TVHT_MODE_2C.

A STA with a TVHT_2W, TVHT_4W, TVHT_W+W, or TVHT_2W+2W operating channel width and sending feedback for a TVHT_W channel width includes a representation of the compressed beamforming feedback matrices of the subcarriers corresponding to the primary TVHT_W channel in the Compressed Feedback Beamforming Matrix subfield.

A STA with an TVHT_4W or TVHT_2W+2W operating channel width and sending feedback for a TVHT_2W channel width includes a representation of the compressed beamforming feedback matrices of the subcarriers corresponding to the primary TVHT_2W channel in the Compressed Feedback Beamforming Matrix subfield.

8.4.1.49 MU Exclusive Beamforming Report field

Insert the following subclause, 8.4.1.49a, after 8.4.1.49:

8.4.1.49a TVHT MU Exclusive Beamforming Report field

See 8.4.1.49 with the following modifications.

For each BCU in TVHT_MODE_1 and TVHT_MODE_2N, the subcarriers used in the Delta SNR subfield are defined in Table 8-53j for 40 MHz. See the tone location description in Table 23-9.

For TVHT_MODE_2C with 6 MHz and 8 MHz channelization, the subcarriers for which Delta SNR subfield is sent in the Lower BCU are based on subtracting 72 from the values shown in Table 8-53j and for the Upper BCU by adding 72.

For TVHT_MODE_2C with 7 MHz channelization, the subcarriers for which Delta SNR subfield is sent in the Lower BCU are based on subtracting 84 from the values shown in Table 8-53j and for the Upper BCU by adding 84.

For TVHT_MODE_4C with 6 MHz and 8 MHz channelization, the subcarriers for which Delta SNR subfield is sent in the lowest, second to lowest, second to highest, and highest BCUs are based on subtracting 216, subtracting 72, adding 72, and adding 216 from the values shown in Table 8-53j, respectively.

For TVHT_MODE_4C with 7 MHz channelization, the subcarriers for which Delta SNR subfield is sent in the lowest, second to lowest, second to highest, and highest BCUs are based on subtracting 252, subtracting 84, adding 84, and adding 252 from the values shown in Table 8-53j, respectively.

For TVHT_MODE_4N channelization, the subcarriers for which Delta SNR subfield is sent in each of the two noncontiguous frequency segments are as described for TVHT_MODE_2C.

8.4.1.50 Operating Mode field

Change the following row of Table 8-53k:

Table 8-53k—Subfield values of the Operating Mode field

Subfield	Description
Channel Width	<p>If the Rx NSS Type subfield is 0, indicates the supported channel width:</p> <p><u>For a VHT STA:</u> Set to 0 for 20 MHz Set to 1 for 40 MHz Set to 2 for 80 MHz Set to 3 for 160 MHz or 80+80 MHz</p> <p><u>For a TVHT STA:</u> Set to 0 for TVHT W Set to 1 for TVHT 2W and TVHT W+W Set to 2 for TVHT 4W and TVHT 2W+2W The value of 3 is reserved.</p> <p>Reserved if the Rx NSS Type subfield is 1.</p>

Insert the following subclauses, 8.4.1.53 to 8.4.1.55 (including Figure 8-80h, Figure 8-80i, and Table 8-53m to Table 8-53o), after 8.4.1.52:

8.4.1.53 Channel Schedule Management element

The Channel Schedule Management element is transmitted in the Public Action frame or protected Public Action or protected Public Action of RLQP to indicate a channel schedule change. The format of the Channel Schedule Management element is shown in Figure 8-80h.

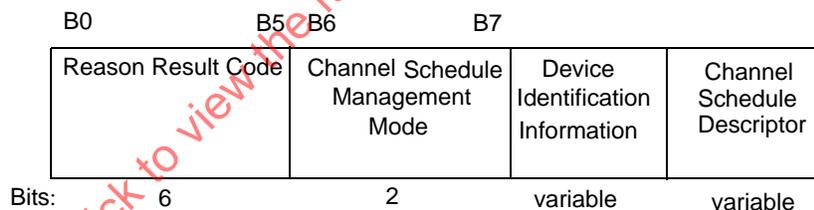


Figure 8-80h—Channel Schedule Management element format

The Length field indicates the length of the remaining fields in octets, and the value is variable.

The Reason Result Code field indicates the reason for transmitting a query request for channel schedule information. It also indicates the result of a query as successful or not and the reason when the query is not successful. The value of this field is defined in Table 8-53m.

Table 8-53m—Reason Result Code field values

Reason Result Code field values	Description
0	Request for channel schedule information from a RLSS.
1	Request for channel schedule information from a GDD enabling STA.
2	Success, returning full channel schedule information on the requested channels.
3	Success, returning additional timeslots from the list of the last query on the requested channels.
4	Success, returning timeslots deleted from the list of last query on the requested channels.
5	Success, returning deleted and added timeslots from the list of last query on the requested channels.
6	Success, returning no channel schedule changes from last query.
7	Request declined by the GDD enabling STA for unspecified reason.
8	Request declined by the GDD enabling STA because of no capability for providing schedule information on WLAN channels.
9	Request declined by RLSS for unspecified reason.
10	Request declined by RLSS because of no capability for providing schedule information on WLAN channels.
11	Unknown reason.
12	Continuation frame. This frame continues the fields from the previous CSM frame.
13–63	Reserved.

The Channel Schedule Management Mode field indicates if the schedule information of the channel availability is based on TV channels or WLAN channels. If the schedule information is based on WLAN channels, the optional Operating Class field is present in the Channel Schedule Descriptor field as defined in E.1. This field also indicates whether the optional Channel Availability Starting Time field is present in the Channel Schedule Descriptor field. The value of this field is defined in Table 8-53n.

Table 8-53n—Channel Schedule Management Mode field values

Channel Schedule Management Mode value	Description
0	The channel schedule information is based on TV channels. The Reason Result Code field is set to either 0 or 1.
1	The channel schedule information is based on WLAN channels. The Reason Result Code field is set to either 0 or 1.
2–3	Reserved.

The Device Identification Information field indicates the regulatory identification of the STA that is requesting the schedule information. The Device Identification Information field is present only when Reason Result Code is either 0 or 1. The value of the field is defined in 8.2.6.2.2.

The Channel Schedule Descriptor field indicates the channels for which the schedule information is requested, and the channel schedule information is provided in the response. The value of the field is defined in 8.2.6.2.4. The Channel Schedule Descriptor field is repeated, as determined by the Length field.

8.4.1.54 Device Location Information Body

A Device Location Information Body includes the location configuration information (LCI), which contains latitude, longitude, and altitude information.

The structure and information fields are little endian, per conventions defined in 8.2.2.

The format of the Device Location Information Body field is shown in Figure 8-80i.

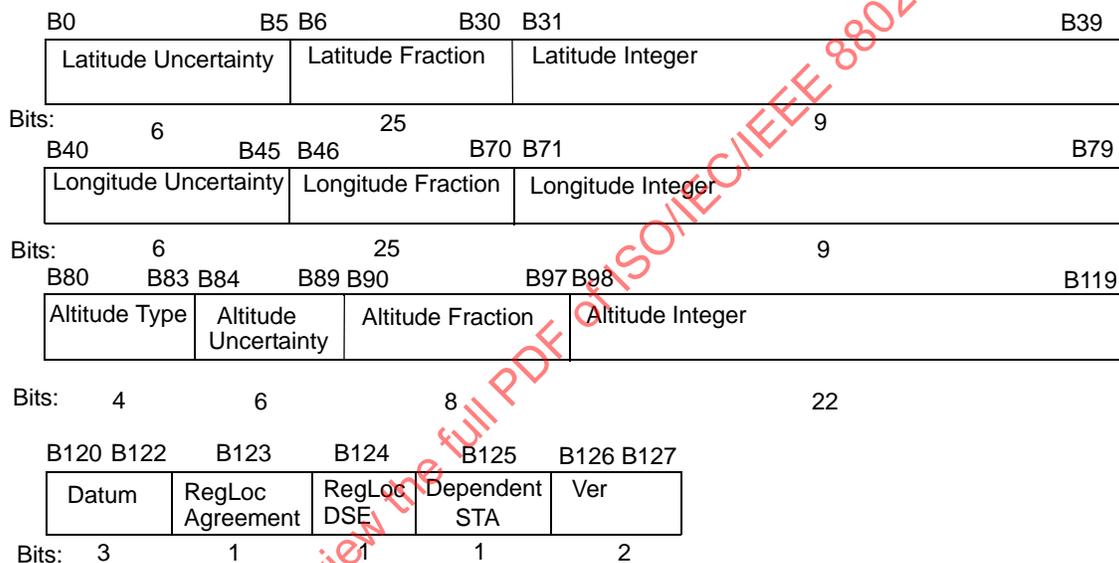


Figure 8-80i—Device Location Information Body field format

The fields within the Device Location Information Body field are as defined in section 2.2 of IETF RFC 6225-2011² except as defined in 8.4.2.54, and RegLocAgreement and RegLocDSE are set to zero.

8.4.1.55 WSM type and information

The WSM Type field is set to a number that identifies the type of WSM information and the frequency band where the following WSM Information field is applicable. The values of WSM Types are shown in Table 8-53o. A WSM Type field value of 1 indicates the WSM Information field of the WSM element contains available frequency information for operation in the TVWS. Other values are reserved.

The WSM Information field indicates the available channel information as defined in 8.2.6.2.5.

² Information on normative references can be found in Clause 2.

Table 8-53o—WSM Type definition

Name	WSM Type
Reserved	0
TV band WSM	1
Reserved	2–255

The WSM Information field corresponding to a TV band WSM is shown in Table 8-14g.

8.4.2 Information elements

8.4.2.1 General

Insert the following rows into Table 8-54 in numeric order, and change the reserved values accordingly:

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
Reduced Neighbor Report (see 8.4.2.171)	201	8 to 257	Yes
TVHT Operation (see 8.4.2.172)	202	8	Yes
Device Location Information (see 8.4.2.169)	204	18 to 242	Yes
White Space Map (see 8.4.2.170)	205	3 to 257	Yes

8.4.2.24 Extended Capabilities element

8.4.2.24.10 Location Configuration Information Report

Change the second and third paragraphs of 8.4.2.24.10 as follows:

This structure and information fields are little endian, per conventions defined in 8.2.2, and are based on the LCI format described in IETF RFC [62253825](#).

The definition of elements within the LCI report are as defined in section 2.24 of IETF RFC [62253825](#) (July 20112004) or as defined herein.

Change the beginning of the note after Figure 8-162 in 8.4.2.24.10 as follows:

NOTE—An example of fixed/fractional notation, using the longitude of the Sears Tower from p. 2813 of IETF RFC [62253825](#) (July 20112004):

8.4.2.29 Extended Capabilities element

Insert the following rows into Table 8-103 in numeric order, and change the reserved values accordingly:

Table 8-103—Capabilities field

Bit	Information	Notes
65	Channel Schedule Management	The STA sets the Channel Schedule Management field to 1 when dot11ChannelScheduleManagementActivated is true and sets it to 0 otherwise. See 10.43.5.
66	Geodatabase Inband Enabling Signal	The STA sets the Geodatabase Inband Enabling Signal field to 1 when dot11GDDActivated is true and the STA permits GDD dependent STAs to operate. See 10.43.2.
67	Network Channel Control	The STA sets the Network Channel Control field to 1 when dot11NetworkChannelControlActivated is true and sets it to 0 otherwise. See 10.43.7.
68	White Space Map	The STA sets the White Space Map field to 1 when dot11WhiteSpaceMapActivated is true and sets it to 0 otherwise. See 10.43.9.
69	Channel Availability Query	The STA sets the Channel Availability Query field to 1 when dot11ChannelAvailabilityActivated is true and sets it to 0 otherwise. See 10.43.4.

8.4.2.31 EDCA Parameter Set element

Change Table 8-105 as follows:

Table 8-105—Default EDCA Parameter Set element parameter values if dot11OCBActivated is false

AC	CWmin	CWmax	AIFSN	TXOP limit			
				For PHYs defined in Clause 16 and Clause 17	For PHYs defined in Clause 18, Clause 19, Clause 20, and Clause 22	For PHY defined in Clause 23	Other PHYs
AC_BK	aCWmin	aCWmax	7	0	0	0	0
AC_BE	aCWmin	aCWmax	3	0	0	0	0
AC_VI	$(aCWmin + 1)/2 - 1$	aCWmin	2	6.016 ms	3.008 ms	22.56 ms (BCU: 6 or 7 MHz), 16.92 ms (BCU: 8 MHz)	0
AC_VO	$(aCWmin + 1)/4 - 1$	$(aCWmin + 1)/2 - 1$	2	3.264 ms	1.504 ms	11.28 ms (BCU: 6 or 7 MHz), 8.46 ms (BCU: 8 MHz)	0

8.4.2.54 DSE Registered Location element

Change the third, fifth, and seventh paragraphs of 8.4.2.54 as follows:

This structure and information fields are little endian, per conventions defined in 8.2.2, and are based on the LCI format described in IETF RFC ~~62253825~~.

The DSE Registered Location element body fields are shown in Figure 8-244.

Figure 8-244 remains unchanged.

The ~~definition of~~ fields within the DSE Registered Location element body is ~~as~~ defined in section 2.24 of IETF RFC ~~62253825~~ (July ~~20112004~~) or as defined in this standard.

With an Altitude Type field value of 3 (i.e., height above ground is in meters), the altitude is defined to be in meters and is formatted in twos-complement, fixed-point, 22-bit integer part with 8-bit fraction.

The Datum field is a 3-bit field, ~~rather than the 8-bit field~~ defined in IETF RFC ~~62253825~~, and the codes used are as defined in IETF RFC ~~62253825~~.

Change the beginning of the note after the 13th paragraph (“The Channel Number field”) in 8.4.2.54 as follows:

NOTE—An example of fixed/fractional notation, using the longitude of the Sears Tower from p. ~~2843~~ of IETF RFC ~~62253825~~ (July ~~20112004~~) is shown below:

8.4.2.95 Advertisement Protocol element

Insert the following row into Table 8-175 in numeric order, and change the reserved values accordingly:

Table 8-175—Advertisement protocol ID definitions

Name	Value
Registered Location Query Protocol (RLQR)	4

Insert the following list item after the fourth list item (“The EAS allows”) of the dashed list after the sixth paragraph (“The Advertisement Protocol ID is”) of 8.4.2.95:

- The RLQP supports information retrieval from a RLSS. RLQP is a protocol used by a requesting STA to query another STA (i.e., the receiving STA can respond to queries with and without proxying the query to a server in an external network). See 10.24 for information on RLQP procedures.

8.4.2.160.2 VHT Capabilities Info field

Change the following rows of Table 8-183v:

Table 8-183v—Subfields of the VHT Capabilities Info field

Subfield	Definition	Encoding
Supported Channel Width Set	Indicates the channel widths supported by the STA. See 10.39.	Set to 0 if the STA does not support either 160 or 80+80 MHz. Set to 1 if the STA supports 160 MHz. Set to 2 if the STA supports 160 MHz and 80+80 MHz. The value 3 is reserved. <u>For a TVHT STA, set the value of B2 to 1 if it supports TVHT MODE 2C.</u> <u>For a TVHT STA, set the value of B3 to 1 if it supports TVHT MODE 2N.</u>
Short GI for 80 MHz	Indicates short GI support for the reception of packets transmitted with TXVECTOR parameters FORMAT equal to VHT and CH_BANDWIDTH equal to CBW80.	Set to 0 if not supported. Set to 1 if supported. <u>For a TVHT STA, set the value of B5 to 1 if it supports TVHT MODE 4C.</u>
Short GI for 160 and 80+80 MHz	Indicates short GI support for the reception of packets transmitted with TXVECTOR parameters FORMAT equal to VHT and CH_BANDWIDTH equal to CBW160 or CBW80+80.	Set to 0 if not supported. Set to 1 if supported. <u>For a TVHT STA, set the value of B6 to 1 if it supports TVHT MODE 4N.</u>

Insert the following sentence at the end of the last paragraph of 8.4.2.160.2:

For a TVHT STA, support for Short GI is mandatory.

8.4.2.164 VHT Transmit Power Envelope element

Insert the following paragraph at the end of 8.4.2.164:

In frames transmitted by a TVHT STA the Local Maximum Transmit Power for 20 MHz fields indicates the Local Maximum Transmit Power for TVHT_W bandwidth; the local Maximum Transmit Power for 40 MHz fields indicates the Local Maximum Transmit Power for TVHT_2W or TVHT_W+W bandwidth; the local Maximum Transmit Power for 80 MHz fields indicates the Local Maximum Transmit Power for TVHT_4W or TVHT_2W+2W bandwidth; the local Maximum Transmit Power for 160/80+80 MHz fields is not included in the VHT Transmit Power Envelope element.

8.4.2.165 Channel Switch Wrapper element

Insert the following paragraph at the end of 8.4.2.165:

For a TVHT STA, the Wide Bandwidth Channel Switch subelement is present when channel switching to a BSS operating channel width of TVHT_2W or TVHT_W+W bandwidth or wider; if switching to a TVHT_W bandwidth BSS operating channel width then this subelement is not present.

Insert the following subclauses, 8.4.2.169 to 8.4.2.172 (including Figure 8-401cd to Figure 8-401ck and Table 8-183aa), after 8.4.2.168:

8.4.2.169 Device Location Information element

A Device Location Information element includes the location configuration information (LCI), which contains latitude, longitude, and altitude information. The Device Location Information element format is shown in Figure 8-401cd.



Figure 8-401cd—Device Location Information element format

The Element ID and Length fields are defined in 8.4.2.1.

The format of the Device Location Information Body is defined in 8.4.1.54.

8.4.2.170 White Space Map element

The White Space Map element includes available radio frequency information obtained from a GDB. The format of the WSM Information field is determined by the value of the WSM Type field. The format of the White Space Map Announcement element is shown in Figure 8-401ce.

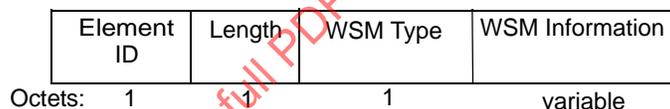


Figure 8-401ce—WSM element format

The Element ID and Length fields are defined in 8.4.2.1.

The format and values of WSM Type and WSM Information fields are defined in 8.4.1.55.

8.4.2.171 Reduced Neighbor Report element

The Reduced Neighbor Report element contains channel and other information related to neighbor APs. The format of the Reduced Neighbor Report element is shown in Figure 8-401cf.

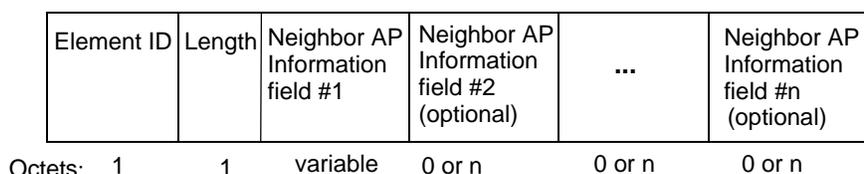


Figure 8-401cf—Reduced Neighbor Report element format

The Element ID and Length fields are defined in 8.4.2.1.

The format of Neighbor AP Information field is defined in 8.4.2.171.1.

8.4.2.171.1 Neighbor AP Information field

The Neighbor AP Information field specifies TBTT and other information related to a group of neighbor APs on one channel. See Figure 8-401cg.

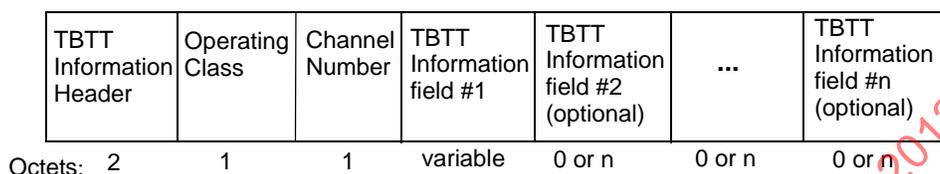


Figure 8-401cg—Neighbor AP Information field format

The format of TBTT Information Header subfield is defined in Figure 8-401ch.

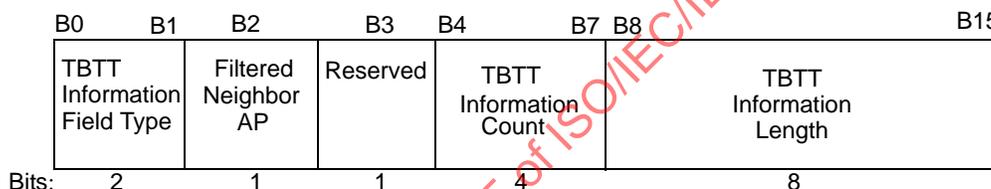


Figure 8-401ch—TBTT Information Header subfield

The TBTT Information Field Type subfield is 2 bits in length and defines the structure of the TBTT Information field. Its value is 0. Values 1, 2, and 3 are reserved.

The Filtered Neighbor AP subfield is 1 bit in length. It is set to 1 if the SSID of APs in this Neighbor AP Information field matches the specific SSID in the Probe Request frame. It is set to 0 otherwise. This field is valid only in the Reduced Neighbor AP Report element in a Probe Response frame and is reserved otherwise.

The TBTT Information Count subfield is 4 bits in length and contains the number of TBTT Information fields that are included in the Neighbor AP Information field, minus one. A value of 0 indicates one TBTT Information field is present.

The TBTT Information Length subfield is 1 octet in length and contains the length in octets of the TBTT Information field that is included in the Neighbor AP Information field.

Operating Class field is 1 octet in length and indicates the band and bandwidth of the primary channel of the APs in this Neighbor AP Information field. Valid values of Operating Class are shown in Table E-4.

Channel Number field is 1 octet in length and indicates the last known primary channel of the APs in this Neighbor AP Information field. Channel Number is defined within an Operating Class as shown in Table E-4.

The format of TBTT Information field is shown in Figure 8-401ci.

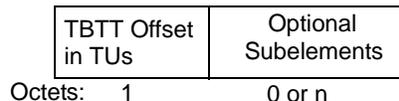


Figure 8-401ci—TBTT Information field

The TBTT Offset in TUs subfield is 1 octet in length and indicates the offset in TUs, rounded down to nearest TU, to the next TBTT of an AP from the immediately prior TBTT of the AP that transmits this element. The value 254 is used to indicate an offset of 254 TUs or higher. The value 255 is used to indicate an unknown offset value.

The Optional Subelements field format contains zero or more subelements, each consisting of a 1-octet Subelement ID field, a 1-octet Length field, and a variable-length Data field, as shown in Figure 8-402. Any optional subelements are ordered by nondecreasing Subelement ID.

8.4.2.172 TVHT Operation element

The operation of TVHT STAs in the BSS is controlled by the TVHT Operation element. The format of the TVHT Operation element is defined in Figure 8-401cj.



Figure 8-401cj—TVHT Operation element format

The Element ID and Length fields are defined in 8.4.2.1.

The structure of the TVHT Operation Information field is defined in Figure 8-401ck.

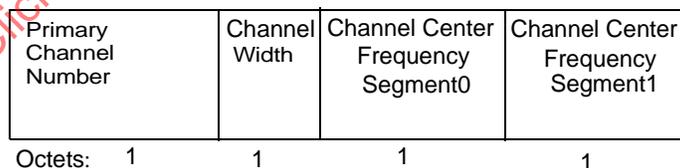


Figure 8-401ck—TVHT Operation Information field

The subfields of the TVHT Operation Information field are defined in Table 8-183aa.

Table 8-183aa—TVHT Operation Information subfields

Field	Definition	Encoding
Primary Channel Number	Indicates the channel number of the primary channel (see 10.42).	Channel number of the primary channel.
Channel Width	This field defines the BSS operating channel width (see 10.42).	Set to 0 for TVHT_W operating channel width. Set to 1 for TVHT_2W operating channel width. Set to 2 for TVHT_W+W operating channel width. Set to 3 for TVHT_4W operating channel width. Set to 4 for TVHT_2W+2W operating channel width. Values in the range 5 to 255 are reserved.
Channel Center Frequency Segment0	Defines the channel center frequency for a TVHT_W, TVHT_2W, and TVHT_4W TVHT BSS and the segment 0 channel center frequency for a TVHT_W+W and TVHT_2W+2W TVHT BSS. See 23.3.14.	For TVHT_W or TVHT_2W or TVHT_4W operating channel width, indicates the center frequency of the lowest TV channel index for the TVHT_W or TVHT_2W or TVHT_4W channel on which the TVHT BSS operates. For TVHT_W+W or TVHT_2W+2W operating channel width, indicates the lowest TV channel index for the TVHT_W or TVHT_2W channel of frequency segment 0 on which the TVHT BSS operates. Reserved otherwise.
Channel Center Frequency Segment1	Defines the segment 1 channel center frequency for a TVHT_W+W and TVHT_2W+2W TVHT BSS. See 23.3.14.	For a TVHT_W+W or TVHT_2W+2W operating channel width, indicates the lowest TV channel index in the segment for the TVHT_W or TVHT_2W channel of frequency segment 1 on which the TVHT BSS operates. Reserved otherwise.

The Basic VHT-MCS and NSS Set field indicates the MCSs for each spatial stream in VHT PPDU in TVWS bands that are supported by all TVHT STAs in the BSS (including IBSS). The Basic VHT-MCS and NSS Set field is a bitmap of size 16 bits; B8-B9, B10-B11, B12-B13, and B14-B15 are set to 3. For B0-B7, each 2 bits indicates the supported MCS set for N_{SS} from 1 to 4. The Basic VHT-MCS and NSS Set field is defined as B0-B7 of Rx VHT-MCS Map subfield in 8.4.2.160.3.

Insert the following subclauses, 8.4.5 to 8.4.5.4 (including Figure 8-431.a1 to Figure 8-431.a5 and Table 8-190.a1 to Table 8-190.a3), after 8.4.4.19:

8.4.5 Registered Location Query Protocol (RLQP) elements

8.4.5.1 General

RLQP-elements are defined to have a common format consisting of a 2-octet Info ID field, a 2-octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Info ID as defined in this standard. The RLQP-element format is shown in Figure 8-431.a1.

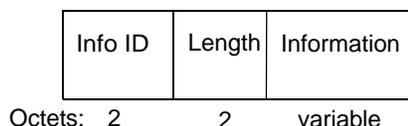


Figure 8-431.a1—RLQP-element format

Each RLQP-element in 8.4.5 is assigned a unique 2-octet Info ID. The set of valid Info IDs is defined in Table 8-190.a1. The 2-octet Info ID field is encoded following the conventions given in 8.2.2.

The Length field is a 2-octet field that indicates the number of octets in the Information field and is encoded following the conventions given in 8.2.2.

The RLQP-elements are shown in Table 8-190.a1. Info ID 56 797 stands for Vendor Specific information. When the Info ID is equal to 56 797, the format of the subfield follows the format of the vendor specific element in 8.4.2.28.

Table 8-190.a1—RLQP-element definitions

RLQP-element name	Info ID	RLQP-element (subclause)
Reserved	0–272	N/A
Channel Availability Query	273	8.4.5.2
Channel Schedule Management	274	8.4.5.3
Network Channel Control	275	8.4.5.4
Reserved	276–56 796	N/A
Vendor Specific	56 797	8.4.2.28
Reserved	56 798– 65 535	N/A

8.4.5.2 Channel Availability Query RLQP-element

The Channel Availability Query element is used to exchange the requests and responses for the channel availability query process using the GAS protocol. The Channel Availability Query RLQP-element is included in a GAS Query Request or returned in a response to a GAS Query Request.

The element is in the format shown in Figure 8-431.a2.

Info ID	Length	Requester STA Address	Responder STA Address	Reason Result Code	Channel Query Info	Device Class	Device Identification Information	Device Location Information	WSM Information
Octets:	2	6	6	1	1	variable	variable	0 or n	variable

Figure 8-431.a2—Channel Availability Query RLQP-element format

The Info ID and Length fields are defined in 8.4.5.1.

The RequesterSTAAddress field is the MAC address of the requesting STA that initiates the channel query process. The length of the RequesterSTAAddress field is 6 octets.

The ResponderSTAAddress field is the MAC address of the responding STA that responds to the channel query requesting STA. The length of the ResponderSTAAddress field is 6 octets.

The Reason Result Code field is used to indicate the reason that a channel availability query was generated. It also indicates the result of the query as successful or not and the reason when the query is not successful. The length of the Reason Result Code field is 1 octet. The Reason Result Code field values that have been allocated are shown in Table 8-190.a2.

Table 8-190.a2—Reason Result Code field values

Reason Result Code field value	Name	Description
0		Reserved.
1		Channel availability list requested.
2	SUCCESS	Success with the available channel list result for a Device Location Information field.
3	SUCCESS_MULTIPLE	Success with an available channel list result for a bounded geographic area defined by multiple Device Location Information fields.
4	REFUSED	Request declined.
5	DEVICE_VERIFICATION_FAILURE	Request not successful because of device identification verification failure. NOTE—Failure of providing an authorized identification of the corresponding regulatory organization can cause the responding STA to reject the query and return such a Reason Result Code.
6	Continuation frame	This frame continues the fields from the previous CAQ frame.
7–255		Reserved.

The Channel Query Info field is used to indicate the type of Channel Query request and associated parameters. The format of the Channel Query Info field is shown in Figure 8-431.a3.

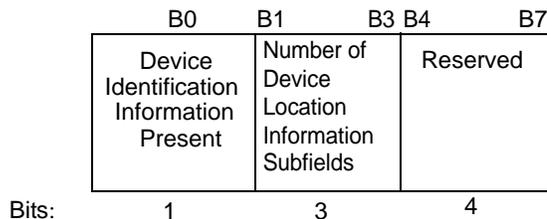


Figure 8-431.a3—Channel Query Info field format

A Device Identification Information Present subfield value of ‘1’ indicates that the Device Location Information field is present in the Channel Availability Query element; otherwise it is 0 to indicate that the Device Identification Information field is not provided.

The Number of Device Location Information Subfields subfield indicates the number of device location information subfields presented in the Channel Availability Query element. When no device location is present, the Number of Device Location Information Subfields is 0.

The Device Class field is used to indicate the characteristics of STA requesting the channel availability query. The format of the Device Class field is specified in 8.2.6.2.1. The TLV is present only when the Reason Result Code field value is 1.

The Device Identification Information field is used to indicate the identification of the STA requesting the channel availability query. The format of the Device Identification Information field is specified in 8.2.6.2.2.

The Device Location Information field is used to provide the location of the STA requesting the channel availability query, which is provided in the format specified in 8.2.6.2.3.

The WSM Information field is defined in the White Space Map element (see 8.4.2.170). The TLV is present only when the Reason Result Code field value is 2 or 3, as the successful result of the query.

8.4.5.3 Channel Schedule Management RLQP-element

The Channel Schedule Management element is used by an GDD enabling STA to query the RLSS or another GDD enabling STA for channel schedule information. The element is in the format shown in Figure 8-431.a4.

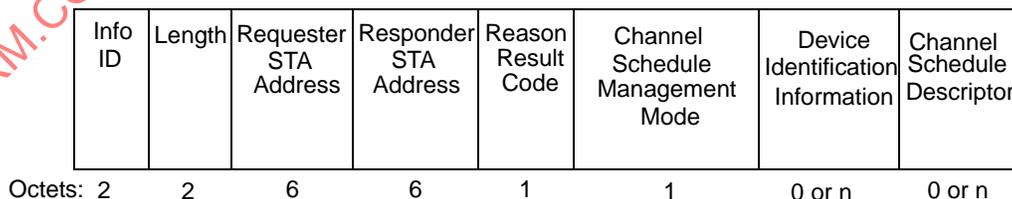


Figure 8-431.a4—Channel Schedule Management RLQP-element format

The Info ID and Length fields are defined in 8.4.5.1.

The Requester STA Address field is the MAC address of the requesting STA that initiates the channel schedule management process.

The Responder STA Address field is the MAC address of the responding STA that grants the channel schedule management process.

The remaining fields are as defined in the Channel Schedule Management element (see 8.4.1.53).

8.4.5.4 Network Channel Control RLQP-element

The Network Channel Control element is used to request network channel control and respond to network channel requests using the GAS protocol. The element is in the format shown in Figure 8-431.a5.

						a Network Channel Control triplet		
Info ID	Length	Requester STA Address	Responder STA Address	Reason Result Code	Number of Network Channel Control Triplets	Operating Class	Channel Number	Maximum Transmit Power
Octets: 2	2	6	6	1	1	1	1	1

Figure 8-431.a5—Network Channel Control RLQP-element format

The Info ID and Length fields are defined in 8.4.5.1.

The RequesterSTAAddress field is the MAC address of the requesting STA that initiates the network channel control process.

The ResponderSTAAddress field is the MAC address of the responding STA that grants the network channel control process.

The Reason Result Code field is used to indicate the reason that a Network Channel Control frame was generated. The length of the Reason Result Code field is 1 octet. The encoding of the Reason Result Code field is shown in Table 8-190.a3.

Table 8-190.a3—Reason Result Code field values

Reason Result Code field value	Name	Description
0	REQUEST	Network channel request.
1	SUCCESS	Success.
2	REFUSED	Request declined.
3	TOO_MANY_SIMULTANEOUS_REQUESTS	Network channel request denied because the GDD enabling STA is unable to handle additional GDD dependent STAs.
4	Continuation frame	This frame continues the fields from the previous NCC frame.
5–255		Reserved.

The Number of Network Channel Control Triplets field indicates the number of triplets of Operating Class, Channel Number, and Transmit Power Constraint fields.

The Operating Class field indicates the channel set for which the network channel control request applies. The Operating Class field and Channel Number field are used together to specify the channel frequency and channel bandwidth for which the network channel control applies. Values for the Operating Class field are shown in E.1.

The Channel Number field of network channel control request indicates the channel that the requesting STA intends to operate on. The Channel Number field in the network channel control response frame indicates the channels that the responding STA permits the requesting STA to operate on. The Channel Number is defined within an Operating Class as shown in E.1.

The Maximum Transmit Power field gives the intended maximum transmit power in dBm for operation in the request frame and indicates the maximum allowable transmit power in dBm for operation in the response frame. The field is coded as a signed integer in units of 0.5 dBm. The field is set to -128 when a requesting STA requests a responding STA to provide a network channel control response without specifying in the request the intended maximum transmit power.

8.5 Action frame format details

8.5.8 Public Action details

8.5.8.1 Public Action frames

Insert the following rows into Table 8-210 in numeric order, and change the reserved values accordingly:

Table 8-210—Public Action field values

Public Action field value	Description
25	Channel Availability Query
26	Channel Schedule Management
27	Contact Verification Signal
28	GDD Enablement Request
29	GDD Enablement Response
30	Network Channel Control
31	White Space Map Announcement

Insert the following subclauses, 8.5.8.27 to 8.5.8.33 (including Figure 8-460f to Figure 8-460l), after 8.5.8.26:

8.5.8.27 Channel Availability Query frame format

The Channel Availability Query frame is an Action frame. It is transmitted by a STA as part of channel query. The format of the Channel Availability Query frame Action field is shown in Figure 8-460f.

Category	Public Action	Requester STA Address	Responder STA Address	Reason Result Code	Length	Channel Query Info	Device Class	Device Identification Information	Device Location Information	WSM Information
Octets:	1	6	6	1	1	1	variable	0 or n	0 or n	variable

Figure 8-460f—Channel Availability Query frame Action field format

The Category field is set to the value indicating the Public category, as specified in Table 8-38.

The Public Action field is set to the value indicating a Channel Availability Query frame, as specified in Table 8-210 in 8.5.8.1.

The Length field indicates the length of the remaining frame fields in octets, and the value is variable.

The remaining fields are as defined in the Channel Availability Query element (see 8.4.5.2) and White Space Map element (see 8.4.2.170).

8.5.8.28 Channel Schedule Management frame format

The Channel Schedule Management frame is a Public Action frame. It is transmitted by a STA to exchange the channel schedule information as part of the channel schedule management procedure. The format of the Channel Schedule Management frame Action field is shown in Figure 8-460g.

Category	Public Action	Requester STA Address	Responder STA Address	Length	Reason Result Code	Channel Schedule Management Mode	Device Identification Information	Channel Schedule Descriptor
Octets:	1	6	6	1	1	1	0 or n	0 or n

Figure 8-460g—Channel Schedule Management frame Action field format

The Category field is set to the value indicating the Public category, as specified in Table 8-38.

The Public Action field is set to the value indicating a Channel Schedule Management frame, as specified in Table 8-210 in 8.5.8.1.

The Requester STA Address field is the MAC address of the requesting STA that initiates the Channel Schedule Management process.

The Responder STA Address field is the MAC address of the responding STA that grants channel schedule management process.

The remaining fields are as defined in the Channel Schedule Management element (see 8.4.1.53).

8.5.8.29 Contact Verification Signal frame format

The Contact Verification Signal frame is a Public Action frame that is transmitted by a GDD enabling STA to notify whether the available channel information from the GDB has been updated. The format of the Contact Verification Signal frame Action field is shown in Figure 8-460h.

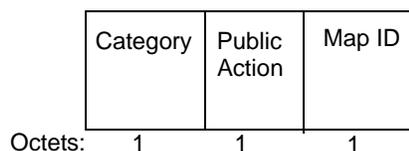


Figure 8-460h—Contact Verification Signal frame Action field format

The Category field is set to the value indicating the Public category, as specified in Table 8-38.

The Public Action field is set to the value indicating Contact Verification Signal frame, as specified in Table 8-210 in 8.5.8.1.

The Map ID field is set to a number that is equal to the Map ID of the recently received WSM. The WSM is defined in Table 8-14h in 8.2.6.2.5.

8.5.8.30 GDD Enablement Request frame format

The GDD Enablement Request frame is a Public Action frame. The format of the GDD Enablement Request frame action field is shown in Figure 8-460i.



Figure 8-460i—GDD Enablement Request frame Action field format

The Category field is set to the value indicating the Public category, as specified in Table 8-38.

The Public Action field is set to the value indicating the GDD Enablement Request frame, as specified in Table 8-210 in 8.5.8.1.

The Dialog Token field is a nonzero value chosen by the STA sending the GDD Enablement Request frame to identify the request/response transaction.

The Device Class field is used to indicate the characteristic of the STA requesting the GDD Enablement Request frame. The format of the Device Class field is specified in 8.2.6.2.1.

The Device Identification Information field is used to indicate the identification of the STA requesting the GDD Enablement Request frame. The format of the Device Identification Information field is specified in 8.2.6.2.2.

8.5.8.31 GDD Enablement Response frame format

The GDD Enablement Response frame is a Public Action frame. The format of the GDD Enablement Response frame action field is shown in Figure 8-460j.

Category	Public Action	Dialog Token	Status Code	WSM Information
Octets:	1	1	2	variable

Figure 8-460j—GDD Enablement Response frame Action field format

The Category field is set to the value indicating the Public category, as specified in Table 8-38.

The Public Action field is set to the value indicating the GDD Enablement Response frame, as specified in Table 8-210 in 8.5.8.1.

The Dialog Token field is a nonzero value of the corresponding GDD Enablement Request frame. If a GDD Enablement Response frame is being transmitted other than in response to an GDD Enablement Request frame, then the Dialog Token field is 0.

The Status Code field contains the status code in response to a GDD Enablement Request frame as defined in Table 8-37.

The remaining field is as defined in the WSM element (see 8.4.2.170).

8.5.8.32 Network Channel Control frame format

The Network Channel Control frame is a Public Action frame. It is transmitted by a GDD dependent STA and a GDD enabling STA as part of the procedure that allows a GDD enabling STA to control the frequency usage of a GDD dependent STA's WLAN network channels. The format of the Network Channel Control frame is shown in Figure 8-460k.

							a Network Channel Control triplet		
Category	Public Action	Length	Requester STA Address	Responder STA Address	Reason Result Code	Number of Network Channel Control Triplets	Operating class	Channel Number	Maximum Transmit Power
1	1	1	6	6	1	1	1	1	1
Octets:									

Figure 8-460k—Network Channel Control frame Action field format

The Category field is set to the value indicating the Public category, as specified in Table 8-38.

The Public Action field is set to the value indicating the Network Channel Control frame, as specified in Table 8-210 in 8.5.8.1.

The Length field indicates the length of the remaining frame fields in octets, and the value is variable. The minimum value of the Length field is 14.

The Requester STA Address field is the MAC address of the requesting STA that initiates the network channel control process.

The Responder STA Address field is the MAC address of the responding STA that grants the network channel control process.

The Reason Result Code field is used to indicate the reason that a Network Channel Control frame was generated. The length of the Reason Result Code field is 1 octet. The encoding of the Reason Result Code field is shown in Table 8-190.a3.

The Number of Network Channel Control Triplets field indicates the number of triplets of Operating Class, Channel Number, and Maximum Transmit Power fields.

The Operating Class field indicates the channel set for which the network channel control request applies. The Operating Class and Channel Number fields together specify the channel frequency and channel bandwidth for which the network channel control applies. Values for the Operating Class field are shown in E.1.

The Channel Number field of network channel control request indicates the channel that the requesting STA intends to operate on. The Channel Number field in the network channel control response frame indicates the channels that the responding STA permits the requesting STA to operate on. The Channel Number is defined within an Operating Class as shown in E.1.

The Maximum Transmit Power field gives the intended maximum transmit power in dBm for operation in the request frame and indicates the maximum allowable transmit power in dBm for operation in the response frame. The field contains EIRP per channel bandwidth and is coded as a signed integer in units of 0.5 dBm. The field is set to 0 when a requesting STA requests a responding STA to provide a network channel control response without specifying in the request the intended maximum transmit power.

8.5.8.33 White Space Map Announcement frame format

The White Space Map Announcement frame is a Public Action frame. The format of the White Space Map Announcement frame body is shown in Figure 8-460I.

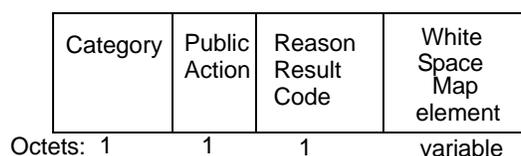


Figure 8-460I—White Space Map Announcement frame Action field format

The Category field is set to the value indicating the Public category, as specified in Table 8-38.

The Public Action field is set to the value indicating White Space Map Announcement frame, as specified in Table 8-210 in 8.5.8.1.

The Reason Result Code value of 1 indicates the Public Action frame is a continuation of the previous WSM Public Action frame, and any other value indicates this is not a continuation of the previous WSM Public Action frame.

The remaining field is as defined in the White Space Map element (see 8.4.2.170).

8.5.11 Protected Dual of Public Action frames

8.5.11.1 Protected Dual of Public Action details

Insert the following rows into Table 8-228 in numeric order, and change the reserved values accordingly.

Table 8-228—Public Action field values defined for Protected Dual of Public Action frames

Action field value	Description	Defined in
25	Protected Channel Availability Query	8.5.8.27
26	Protected Channel Schedule Management	8.5.8.28
27	Protected Contact Verification Signal	8.5.8.29
28	Protected GDD Enablement Request	8.5.8.30
29	Protected GDD Enablement Response	8.5.8.31
30	Protected Network Channel Control	8.5.8.32
31	Protected White Space Map Announcement	8.5.8.33

9. MAC sublayer functional description

9.2 MAC architecture

9.2.1 General

Change the first paragraph of 9.2.1 as follows:

The MAC architecture is shown in Figure 9-1. When operating with any of the Clause 14 through Clause 20 PHYs, or Clause 22 PHY, or Clause 23 PHY, the MAC provides the HCF, including the PCF, through the services of the DCF. In a non-DMG QoS STA implementation, both DCF and HCF are present. In a non-DMG non-QoS STA implementation, only DCF is present. PCF is optional in all non-DMG STAs.

Change the text in the lower left box of Figure 9-1 as follows:

FHSS, IR, DSSS, OFDM, HR/DSSS, ERP, ~~or HT, VHT, or TVHT~~ PHY

9.3 DCF

9.3.2 Procedures common to the DCF and EDCAF

9.3.2.3 IFS

9.3.2.3.4 PIFS

Insert the following list item at the end of the dashed list after the second paragraph of 9.3.2.3.4:

- A TVHT STA performing CCA in the secondary TVHT_W and TVHT_2W channels before transmitting a TVHT_2W or TVHT_W+W mask PPDU and TVHT_4W or TVHT_2W+2W mask PPDU, respectively, using EDCA channel access as defined in 9.19.2.8

9.7 Multirate support

9.7.1 Overview

Change the last paragraph of 9.7.1 (including creating two new paragraphs) as follows:

For specific PHYs, the value of the Duration/ID field is determined using the PLME-TXTIME.request primitive and the PLME-TXTIME.confirm primitive. These specific PHYs are defined in

- Clause 17 for HR/DSSS
- Clause 18 for OFDM
- Clause 19 for ERP
- Clause 20 for HT
- Clause 21 for DMG
- Clause 22 for VHT
- Clause 23 for TVHT

The two PLME-TXTIME primitives are defined in the respective PHY specifications:

- 17.3.4 for HR TXTIME calculation
- 18.4.3 for OFDM TXTIME calculation

- 19.8.3.2, 19.8.3.3, and 19.8.3.4 for ERP-OFDM, ERP-PBCC, and DSSS-OFDM TXTIME calculations, respectively
- 20.4.3 for HT TXTIME calculation
- 21.12.3 for DMG PLME TXTIME calculation
- 22.4.3 for VHT PLME TXTIME calculation
- 23.4.3 for TVHT PLME TXTIME calculation

For the Clause 18, Clause 17, Clause 19, Clause 20, Clause 21, and Clause 22 PHYs, the time required to transmit a frame for use in calculating the value for the Duration/ID field is determined using the PLME-TXTIME.request primitive (see 6.5.7) and the PLME-TXTIME.confirm primitive (see 6.5.8), both defined in 18.4.3, 17.3.4, 19.8.3.2, 19.8.3.3, 19.8.3.4, 20.4.3, 21.12.3, or 22.4.3 depending on the PHY options. In QoS STAs, the Duration/ID field in QoS STAs may cover multiple frames and may involve using the PLME-TXTIME.request primitive several times.

9.12 A-MPDU operation

9.12.2 A-MPDU length limit rules

Insert the following paragraph at the end of 9.12.2:

A STA shall not transmit a VHT PPDU in TVWS bands if the PPDU duration exceeds aPPDUMaxTime (defined in Table 23-25).

9.19 HCF

9.19.2 HCF contention-based channel access (EDCA)

Change the title of 9.19.2.8 as follows:

9.19.2.8 EDCA channel access in a VHT and TVHT BSSs

Insert the following list items at the end of the lettered list in 9.19.2.8.

- f) Transmit a TVHT_4W or TVHT_2W+2W mask PPDU if the secondary TVHT_W channel and the secondary TVHT_2W channel were idle during an interval of PIFS immediately preceding the start of the TXOP.
- g) Transmit an TVHT_2W or TVHT_W+W mask PPDU if the secondary TVHT_W channel was idle during an interval of PIFS immediately preceding the start of the TXOP.
- h) Transmit a TVHT_W mask PPDU on the primary TVHT_W channel.

9.24 MAC frame processing

9.24.9 Extensible subelement parsing

Insert the following subclause, 9.24.10, after 9.24.9:

9.24.10 Extensible TLV parsing

A TVHT STA that receives a frame containing a TLV tuple with an unknown Type value shall discard the tuple and continue processing the next tuple.

9.31 Null data packet (NDP) sounding

9.31.5 VHT sounding protocol

9.31.5.2 Rules for VHT sounding protocol sequences

Insert following text at the end of 9.31.5.2:

In a frame transmitted by a TVHT STA, the TVHT Compressed Beamforming Report field replaces the VHT Compressed Beamforming Report field.

In a frame transmitted by a TVHT STA, the TVHT MU Exclusive Beamforming Report field replaces the MU Exclusive Beamforming Report field.

9.31.5.3 Rules for fragmented feedback in VHT sounding protocol sequences

Insert following text at the end of 9.31.5.3:

In a frame transmitted by a TVHT STA, the TVHT Compressed Beamforming Report field replaces the VHT Compressed Beamforming Report field.

In a frame transmitted by a TVHT STA, the TVHT MU Exclusive Beamforming Report field replaces the MU Exclusive Beamforming Report field.

10. MLME

10.11 Radio measurement procedures

10.11.9 Specific measurement usage

10.11.9.6 Location Configuration Information Report

Change the first sentence in the note after the first paragraph in 10.11.9.6 as follows:

NOTE—Section 2.24 of IETF RFC ~~62253825~~ (July ~~20112004~~) defines formats and information fields for reporting physical location to sub-centimeter resolution.

10.24 WLAN interworking with external networks procedures

10.24.3 Interworking procedures: generic advertisement service (GAS)

10.24.3.2 ANQP procedures

Insert the following subclause, 10.24.3.3, after 10.24.3.2.10:

10.24.3.3 Registered Location Query Protocol (RLQP) procedures

When dot11GDDActivated is true, a STA may use RLQP to retrieve information as defined in Table 8-175 from a peer STA that has transmitted an Advertisement Protocol element indicating support for RLQP (see 8.4.2.95) in a Beacon or Probe Response frame.

If information is not configured for a particular RLQP-element, then a query for that element returns that element with no optional fields.

When RLQP is transmitted between the GDD enabling STA and the RLSS, it uses Ethertype 89-0d frames, as defined in Annex H. The RLQP payload contains RLQP-elements as specified in 8.4.5 and the Advertising Protocol element with an Advertising Protocol tuple whose Advertisement Protocol ID is set to the value of RLQR specified in Table 8-175. When RLQP is transmitted between the GDD dependent STA and its GDD enabling STA, it uses protected Action frames, but does not use Ethertype 89-0d frames.

In some regulatory domains, the GDD enabling STA may be required to have secured connection with the RLSS. In cases where security is required by regulation, the Ethertype 89-0d frame body may employ corresponding security features. Alternatively, various security protocols may also be selected by setting the Ethertype field to respective values. A webpage maintained by the IEEE Registration Authority Committee allowing search of the public values of the Ethertype field is found at <http://standards.ieee.org/develop/regauth/ethertype/public.html>.

Insert the following subclauses, 10.42 and 10.43.9 (including Table 10-20 and Figure 10-39), after 10.41:

10.42 Basic TVHT BSS functionality

The STA that is creating the BSS shall be able to receive and transmit at each of the <VHT-MCS, NSS> tuple values indicated by the BSSBasicVHTMCS_NSSSet and shall be able to receive at each of the <VHT-MCS, NSS> tuple values indicated by the OperationalVHTMCS_NSSSet. A STA for which dot11TVHTOptionImplemented is true shall set dot11VHTOptionImplemented to true.

A TVHT AP declares its channel width capability in the Supported Channel Width Set subfield of the VHT Capabilities element VHT Capabilities Info field, as defined in 8.4.2.160.2.

A TVHT AP shall set the Channel Width subfield in the TVHT Operation Information field to indicate the BSS operating channel width and transmitted PPDU type depending on value of B0-B1 in TVHT-SIG-A1 field from those shown in Table 10-20.

Table 10-20—TVHT BSS operating channel width

TVHT Operation element Channel Width field	BSS operating channel width	B0-B1 (BW) in TVHT-SIG-A1	PPDU type
0	TVHT_W	1	TVHT_MODE_1
1	TVHT_2W	1	TVHT_MODE_1
		2	TVHT_MODE_2C
2	TVHT_W+W	1	TVHT_MODE_1
		2	TVHT_MODE_2N
3	TVHT_4W	1	TVHT_MODE_1
		2	TVHT_MODE_2C
		3	TVHT_MODE_4C
4	TVHT_2W+2W	1	TVHT_MODE_1
		2	TVHT_MODE_2C
		3	TVHT_MODE_4N

A TVHT non-AP STA that receives a frame containing a TVHT Operation element shall determine the channelization based on the Channel Center Frequency Segment0, Channel Center Frequency Segment1, and Primary Channel Number subfields of the TVHT Operation Information field (see 23.3.14).

A TVHT STA that is a member of a TVHT BSS shall transmit a TVHT_MODE_1 PPDU only on the primary TVHT_W channel of the BSS, except for a TVHT_MODE_1 PPDU transmission on an off-channel TDLS direct link.

A TVHT STA that is a member of a TVHT BSS with a TVHT_2W, TVHT_4W, or TVHT_W+W operating channel width shall not transmit a TVHT_MODE_2C or TVHT_MODE_2N PPDU that does not use the primary TVHT_W channel and the secondary TVHT_W channel of the BSS, except for a TVHT_MODE_2C, TVHT_MODE_4C, or TVHT_MODE_2N PPDU transmission on an off-channel TDLS direct link.

A TVHT STA that is a member of a TVHT BSS with a TVHT_4W or TVHT_2W+2W operating channel width shall not transmit a TVHT_MODE_4C or TVHT_MODE_4N PPDU that does not use the primary TVHT_2W channel and the secondary TVHT_2W channel of the BSS, except for a TVHT_MODE_4C or TVHT_MODE_4N PPDU transmission on an off-channel TDLS direct link.

A TVHT STA shall not transmit to a TVHT STA using a bandwidth that is not indicated as supported in the Supported Channel Width Set subfield in the VHT Capabilities element or Operating Mode Notification frame recently received from that TVHT STA.

In a TVHT BSS, the primary TVHT_W channel is the primary channel.

10.43 Operation under the control of a GDB

10.43.1 General

When a STA implements support for one or more of the procedures described in this subclause, it shall set dot11TVHTOptionImplemented to true. When dot11TVHTOptionImplemented is true and a STA is initialized for operation in a band that requires GDB control, then dot11GDDActivated shall be true.

In some regulatory domains, STAs shall consult a GDB to determine permissible operating frequencies and parameters before transmitting. Such STAs may operate as geolocation database dependent (GDD) enabling STAs, which are required by regulation to provide their identification, geolocation, and other information to the GDB as specified by regulatory authorities. Other STAs are permitted to transmit when enabled by a GDD enabling STA. Such STAs operate as GDD dependent STAs.

Subclause 10.43 describes procedures for STAs when they are operating under the control of a GDB to satisfy regulatory requirements. For operation under such restrictions, GDD dependent STAs operate according to the control procedures of a GDD enabling STA that enables their operation. The frame exchange sequence between GDD enabling STA and GDD dependent STAs for enabling their operation occurs in State 4 (see 10.3.1).

A GDD enabling STA is a STA that is able to access a GDB and to obtain the information about the permitted frequencies and other information for use in its location. A GDD enabling STA or geolocated non-AP STA populates its dot11STALCITable with location information by a means that has received regulatory approval and is outside the scope of this standard. When location information is set in dot11STALCITable, the STA sets dot11GeolocationCapabilityActivated. The current dot11DSTALCITable entry in the MIB allows management access to the location information that is the basis for operation. A GDD enabling STA may transmit a GDD enabling signal and may enable operations of GDD dependent STAs.

A GDD dependent STA is a STA that is under the control of a GDD enabling STA.

The GDD enablement procedure for GDD dependent STAs and the operating rules for GDD enabling and GDD dependent STAs are defined in the following subclauses.

10.43.2 GDD enabling STA operation

A GDD enabling STA may transmit a GDD enabling signal in-band on an available frequency to indicate that it offers GDD enablement service.

The GDD enabling signal is a Beacon frame with an Extended Capabilities element that contains a Geodatabase Inband Enabling Signal field with a value of '1'. A GDD dependent STA shall not transmit any frames before it receives a GDD enabling signal over the air directly from a GDD enabling STA.

In some regulatory domains the GDD enabling STA may be required to have secure authentication or association with the GDD dependent STA before it sends the GDD Enablement Response frame. If required by regulation, the GDD enabling STA may contact a GDB to verify that the requesting GDD dependent STA is authorized to operate in the frequency band.

Upon receipt of a GDD Enablement Request frame from a GDD dependent STA, the GDD enabling STA sends a GDD Enablement Response frame with either of the following results:

- a) The Status Code field set to 0 ("Successful") to indicate the successful enablement of the requesting GDD dependent STA

- b) The Status Code field set to 105 (“Enablement denied”) or 38 (“The request has not been successful as one or more parameters have invalid values”) or 106 (“Enablement denied due to restriction from the authorized GDB”), in which case the GDD enablement request has been denied

A GDD enabling STA may issue an unsolicited GDD Enablement Response frame with a Status Code 107 (“Authorization Deenabled”) to notify a GDD dependent STA to cease its transmissions and change its GDD enablement state to *Unenabled*. When an unsolicited GDD Enablement Response frame with a Status Code 107 (“Authorization Deenabled”) is transmitted, the WSM element is not included.

10.43.3 GDD dependent STA operation

A GDD dependent STA is configured with a GDD enablement state variable which is set to one of the following three states: *Unenabled*, *AttemptingGDDEnablement*, or *GDDEnabled*. A GDD dependent STA begins operation by setting its GDD enablement state variable to *Unenabled* and operates in receive-only mode within the band, passively scanning channels for a GDD enabling signal from a GDD enabling STA.

A typical state machine implementation of GDD dependent STA operation under GDD is provided in Figure 10-39.

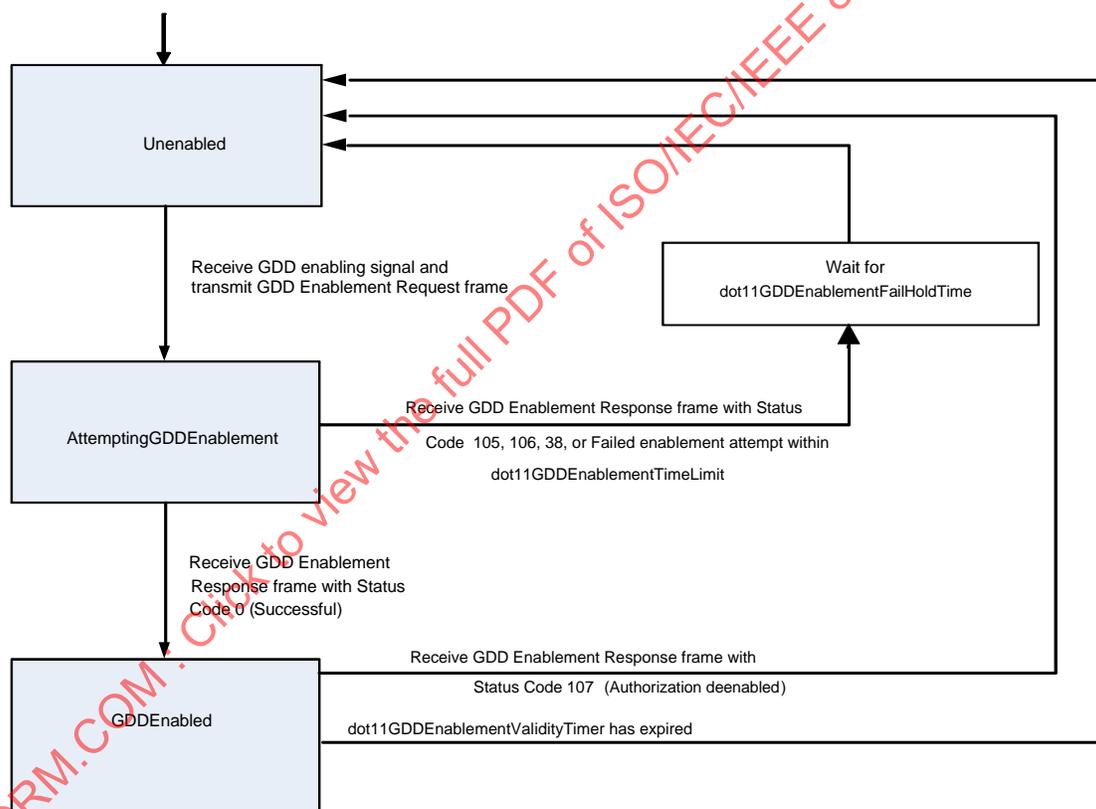


Figure 10-39—GDD dependent STA state transition diagram

A GDD dependent STA shall not transmit any frames unless it has received a valid GDD enabling signal from a GDD enabling STA.

A GDD dependent STA that is able to receive a valid GDD enabling signal, but has not been enabled by a GDD enabling STA shall not transmit, except to perform GDD enablement with a GDD enabling STA transmitting the GDD enabling signal.

A GDD dependent STA shall not transmit any frames other than GDD enablement-related frames and authentication and association frames before it performs the following GDD enablement procedure:

- a) The GDD dependent STA changes its GDD enablement state variable to *AttemptingGDDEnablement* after receiving a GDD enabling signal.
- b) After authentication and association, the GDD dependent STA securely sends a GDD Enablement Request frame to a GDD enabling STA from which it has received a GDD enabling signal. Based on the input received from the GDD dependent STA, the GDD enabling STA responds with a GDD Enablement Response frame indicating the result for the enablement request.
- c) When a GDD dependent STA receives a GDD Enablement Response frame with the Status Code 0 (“Successful”) within *dot11GDDEnablementTimeLimit*, the GDD enablement state variable of the GDD dependent STA is set to *GDDEnabled*. Once it becomes enabled, the GDD dependent STA maintains a GDD enablement validity timer, which is initialized to *dot11ContactVerificationSignalInterval*.

A GDD dependent STA that has not attained GDD enablement from a GDD enabling STA shall not transmit beyond *dot11GDDEnablementTimeLimit*, measured from the time of the first PHY-TXSTART.request primitive, while attempting to attain GDD enablement. Then, when the GDD enablement attempt fails within the allowed maximum time, it shall not transmit for *dot11GDDEnablementFailHoldTime*, before it may again attempt to attain GDD enablement.

NOTE—A GDD dependent STA might detect several GDD enabling STAs. If the GDD dependent STA is unable to obtain a GDD Enablement Response frame from one GDD enabling STA, it might make further attempts with additional GDD enabling STAs within the maximum time limit of *dot11GDDEnablementTimeLimit*.

Once in *GDDEnabled* state, the following rules apply to a GDD dependent STA during its operations:

- The GDD dependent STA shall maintain a GDD enablement validity timer by decrementing the *dot11GDDEnablementValidityTimer* attribute. The procedures for maintaining the GDD enablement validity timer are defined in 10.43.9, 10.43.6, and 10.43.4.
- A GDD dependent STA shall cease all transmission when the *dot11GDDEnablementValidityTimer* has expired. It then changes its GDD enablement state to *Unenabled*.
- A GDD dependent STA shall immediately cease all transmission if it receives an unsolicited GDD Enablement Response frame with a Status Code of 107 (“Authorization Deenabled”) from the GDD enabling STA that enabled its operation.

10.43.4 Channel availability query (CAQ) procedure

10.43.4.1 Introduction

This subclause describes a channel availability query procedure that can be used to obtain the list of available channels for the operation of a GDD STA. A STA shall not use the CAQ procedure specified here unless *dotGDDActivated* is true.

A GDD dependent STA sends the channel availability query request to a GDD enabling STA to obtain the list of available channels. The CAQ procedure might be initiated by the GDD dependent STA in order to remain in the *GDDEnabled* state during its normal operational mode, as specified in 10.43.3.

The GDD dependent STA sends the Channel Availability Query frame to obtain the new channel availability information when it receives an indication of change in the available channel list for its use, such as from a recent CVS signal (see 10.43.6).

Once the GDD dependent STA successfully receives the response for its Channel Availability Query frame from the GDD enabling STA, it reinitializes the dot11GDDEnablementValidityTimer to dot11ContactVerificationSignalInterval.

A GDD STA that acquires its geolocation position with the accuracy required by the regulatory domain sets its dot11GeolocationCapabilityActivated attribute to true. Any STA that operates as a GDD enabling STA might have its geolocation position before it initiates the CAQ procedure. Such a STA might transmit a channel availability query request to another GDD enabling STA. The responding STA generates the CAQ response after communicating to the RLSS, if the Channel Availability Query frame was received in a Channel Availability Query RLQP-element.

NOTE—A GDD enabling STA can send the Channel Availability Query frame to another GDD enabling STA. The responding GDD enabling STA, in such a case, can contact a GDB with the location and identifying parameters sent by the requesting STA.

A GDD enabling STA performs the CAQ procedure to update its channel availability when it determines that its geolocation position has moved beyond the permitted distance or beyond the validity time since its last query, as required by regulation.

STAs might transmit a channel availability query request in the protected dual of a CAQ Public Action frame (see 8.5.8.27, or in a GAS Initial Request frame containing an Channel Availability Query RLQP-element (see 8.4.5.2).

The procedures for channel availability query requesting STA and channel availability query responding STA are specified in 10.43.4.2 and 10.43.4.3.

In some regulatory domains, CAQ procedures may be conducted in other bands with properly implemented security to meet regulatory requirements. In such cases, CAQ RLQP rather than CAQ protected duals of public action frames shall be used.

10.43.4.2 CAQ requesting STA

A GDD dependent STA or a GDD enabling STA may initiate a CAQ procedure as a CAQ requesting STA.

A CAQ requesting STA may use RLQP to transmit a CAQ request when it detects RLQP support by its intended CAQ responder in a Beacon or Probe Response frame and to transmit a CAQ request to a STA with which it is associated when the requesting STA detects RLQP support.

Upon receipt of the MLME-GAS.request primitive with an AdvertisementProtocolID value of RLQP and Query parameters with the values of the fields in the RLQP Channel Availability Query element, the requesting STA performs the procedure specified in 10.24.3.1.2 to transmit a GAS Initial Request frame that contains the Channel Availability Query RLQP-element. The specific information items in the Query Request field of the GAS Initial Request frame are defined in 8.4.5.2.

The CAQ requesting STA may send the protected dual of a channel availability query Public Action frame where the CAQ responding STA does not support RLQP capability. Upon receipt of the MLME-CHANNELAVAILABILITYQUERY.request primitive with Reason Result Code of 1, the MLME schedules for transmission a Channel Availability Query Public Action frame. The specific information items in the protected dual of a CAQ Public Action are defined in 8.5.8.27.

The CAQ requesting STA sets the Reason Result Code field to 1 and provides the Query Info field, as shown in Figure 8-431.a3, to indicate if the Device Identification or Location Information fields are included in the Channel Availability Query frame.

A GDD enabling STA sending the Channel Availability Query frame should provide its device identification information in a format specified in 8.2.6.2.2.

A GDD enabling STA that has its dot11GeolocationCapabilityActivated attribute true should provide one or more Location Information fields in its Channel Availability Query frame.

A CAQ requesting STA may request a common channel list applicable to a bounded geographic area by providing more than one Device Location Information field in the Channel Availability Query frame. The bounded geographic area is defined by the area surrounded by the given sets of geographic coordinates in the multiple Device Location Information fields.

10.43.4.3 CAQ responding STA

A GDD enabling STA that receives the Channel Availability Query frame performs the role of the CAQ responding STA.

When a GDD enabling STA that has dot11RLSSActivated true receives a Channel Availability Query RLQP-element request, it generates and transmits the Channel Availability Query RLQP-element response to the requesting STA. Upon receipt of the MLME-GAS.response primitive with ResponseInfo parameter having a value of the corresponding field in the CAQ element, the responding STA transmits a Channel Availability Query RLQP-element response.

The CAQ responding STA generates the response to the CAQ requesting STA based on the result obtained from the RLSS. The specific information items in the Channel Availability Query RLQP-element response are defined in 8.4.5.2 and are set as follows:

- Requester STA Address field set to the MAC address of the STA from which the query was received.
- If no security method is enabled on the connection between the CAQ requesting STA and the CAQ responding STA, the Reason Result Code field is set to 4 (REFUSED).
- Reason Result Code field set to 2 or 3 for successful result or to 4 or 5 for failure, as defined in 8.4.5.2.
- WSM Information field, as defined in 8.2.6.2.5 when the Reason Result Code is set to 2 or 3.

NOTE—For the CAQ process, the RLSS provides the list of available channels for the location(s) provided by the requesting STA in the Query Response. In some regulatory domains, the RLSS can perform access to a GDB to derive its response for channel query request and the associated information it provides in its Query Response.

A CAQ responding STA might receive a Channel Availability Query Public Action frame or its protected dual. Upon receipt of the MLME-CHANNELAVAILABILITYQUERY.response primitive, the MLME schedules for transmission of a channel availability query response frame. The Channel Availability Query Public Action frame or its protected dual is generated based on the ResultCode and other parameters received from the SME for the Channel Availability Query frame, as follows:

- Requester STA Address field set to the value of the PeerSTAAddress parameter.
- If no security method is enabled on the connection between the CAQ framing STA and the CAQ responding STA, the Reason Result Code field is set to 4 (REFUSED).
- Reason Result Code field set to 2 or 3 for successful result or to 4 or 5 for failure, as defined in 8.4.5.2.
- WSM Information field, as defined in 8.2.6.2.5 when the Reason Result Code is set to 2 or 3.

When a CAQ Responding STA receives the Channel Availability Query frame from a GDD dependent STA, it sets the Reason Result Code field to 2 when the query is successful and provides the WSM information it has obtained for its own location.

When a CAQ Responding STA receives the Channel Availability Query frame from another GDD enabling STA that includes one or more Device Location Information fields in the Channel Availability Query frame, it sets the Reason Result Code field to 2 or 3 when the query is successful and provides the WSM information that is valid for the location of the requesting STA.

When the Channel Availability Query frame contains multiple Device Location Information fields, the WSM information in the CAQ response is applicable for any location within the bounded area defined by the multiple locations. When the Channel Availability Query frame contains two Device Location Information fields, the WSM information in the CAQ response is applicable for any location within the bounded area determined by the uncertainty values of the coordinates of the second Device Location Information field. If no common channels are available to the bounded geographic area defined by multiple locations, CAQ responding STA responds with Reason Result Code field set to 2 (Success with the available channel list result for Device Location Information field) and WSM information applicable to the first Device Location Information field in the Channel Availability Query frame. If one or more common channels are available to the bounded geographic area defined by multiple locations, the CAQ responding STA responds with Reason Result Code field set to 3 (Success with an available channel list result for a bounded geographic area defined by multiple Device Location Information fields) and a corresponding WSM Information field.

When a CAQ responding STA receives the protected Channel Availability Query frame, the response shall be sent using the protected Channel Availability Query frame.

10.43.5 Channel schedule management (CSM) procedures

10.43.5.1 Introduction

This subclause describes a channel schedule management procedure that can be used to obtain the list of available channels for the operation of a GDD STA. STAs can use the CSM procedure specified here when dot11GDDActivated is true.

Upon receipt of MLME-CHANNELSCHEDULEMANAGEMENT.request primitive, the MLME schedules transmission for a CSM request frame. If the parameter Protected of the MLME-CHANNELSCHEDULEMANAGEMENT.request primitive has the value true, then the CSM request frame as defined in 8.5.8.28 is transmitted in a Protected Dual of Public Action frame; otherwise the CSM request frame is transmitted in a Public Action frame.

Upon receipt of MLME-GAS.request primitive with an AdvertisementProtocolID parameter value of RLQP and Query parameter for a Channel Schedule Management RLQP-element, the requesting STA performs the procedure specified in 10.24.3.1.2 to transmit a GAS Initial Request frame that contains the Channel Schedule Management RLQP-element.

A GDD enabling STA transmits a CSM request to a RLSS to query the schedule information on TV channels. By default, a RLSS is able to provide channel schedule information on TV channels. However, the RLSS may reject the request by responding with Reason Result Code field set to the value for "Request declined by RLSS for unspecified reason."

A GDD enabling STA transmits a CSM request to a RLSS to query the schedule information on WLAN channels. The RLSS maps channel schedule information from TV channels to WLAN channels and provides the schedule information, as defined in 8.2.6.2.4, to the GDD enabling STA that sent the query to facilitate WLAN operation. A RLSS that is not capable of providing WLAN channel schedule information responds to a request using the CSM response with the Reason Result Code field set to the value for "Request declined by RLSS because of no capability for providing schedule information on WLAN channels."

A GDD enabling STA transmits a CSM request to another GDD enabling STA that is capable of database access as indicated in the GDD enabling signal. The GDD enabling STA that is capable of database access is able to access the RLSS and obtain the channel schedule information on TV channels. The GDD enabling STA may respond to a request by sending the CSM response with Reason Result Code field set to the value for “Request Declined by the GDD enabling STA because of no capability for providing schedule information on WLAN channels.”

A GDD enabling STA may transmit a CSM request to query WLAN channel information from another GDD enabling STA. A GDD enabling STA responds to a CSM request using a CSM response with the Reason Result Code field set to the value for “Success” if it is capable of providing channel schedule information on WLAN channels obtained from a RLSS and responds with the Reason Result Code field set to the value for “Request declined by the GDD enabling STA because of no capability for providing schedule information on WLAN channels,” otherwise.

When the information in a CSM response is identical to the information in the most recently transmitted CSM response to the same requesting STA, the responding STA can set the Reason Result Code field value CSM element in a query response to “Successful” with no channel schedule changes from the last query of the RLSS and omit both the Channel Schedule Management Mode and Channel Schedule Descriptor fields.

A GDD enabling STA with dot11ChannelScheduleManagementActivated true may send a CSM frame to update the channel schedule information of another GDD enabling STA that receives an available channel list from it.

The GDD dependent STA shall not transmit a CSM request.

The details of requesting and responding with CSM are provided in 10.43.5.2 and 10.43.5.3.

10.43.5.2 CSM requesting STA

A STA employing RLQP uses the GAS protocol for its CSM procedure with a RLSS. Upon receipt of the MLME-GAS.request primitive with an AdvertisementProtocolID value of RLQP and Query parameter with the value of Channel Schedule Management RLQP-element, the CSM requesting STA transmits an RLQP-element with RLQP ID for CSM in the Query Request field in a GAS Initial Request frame. The specific information items in the Query Request field of the GAS Initial Request frame are generated as follows:

- Reason Result Code field = 0 or 1 as defined in 8.4.1.53.
- Channel Schedule Management Mode field = 0 or 1 as defined in 8.4.1.53.
- Channel Schedule Descriptor field, as defined in 8.2.6.2.4, containing the channel that the STA wants to query.

A STA uses the CSM Public Action frame or its protected dual to query another STA for channel schedule information. Upon receipt of the MLME-CHANNELSCHEDULEMANAGEMENT.request primitive with the CSM parameter of CSM element, the requesting STA transmits a CSM frame. The request frame is generated as follows:

- Reason Result Code field = 0 or 1 as defined in 8.4.1.53.
- Channel Schedule Management Mode field = 0 or 1 as defined in 8.4.1.53.
- Channel Schedule Descriptor field, as defined in 8.2.6.2.4, contains only the channel that the STA wants to query.

10.43.5.3 CSM responding STA

A STA employing RLQP uses the GAS protocol for its CSM procedure with a RLSS. Upon receipt of the MLME-GAS.request primitive with an ResponseInfo parameter value of Channel Schedule Management

RLQP-element, the CSM responding STA transmits a RLQP-element with RLQP ID for CSM in the Query Response field in a GAS Initial Response frame or one or more GAS Comeback Response frames. The responding RLQP CSM shall be transmitted in a Protected Dual of Public Action frame if the received CSM is protected. The specific information items in the Query Response field of the GAS Initial Response frame are generated as follows:

- Reason Result Code field = values 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 as defined in 8.4.1.53.
- Channel Schedule Descriptor field, as defined in 8.2.6.2.4, contains the channel and related channel schedule information.

A STA uses CSM Public Action frame or its protected dual to respond to another STA with channel schedule information. Upon receipt of the MLME-CHANNELSCHEDULEMANAGEMENT.request primitive with CSM parameter value of CSM element, the CSM responding STA transmits a CSM frame in response. The responding CSM shall be transmitted in a Protected Dual of Public Action frame if the received CSM is protected. The CSM response frame is generated as follows:

- Reason result code field = values 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 as defined in 8.4.1.53.
- Channel Schedule Descriptor field, as defined in 8.2.6.2.4, contains the channel and related channel schedule information.

10.43.6 Contact verification signal (CVS)

The Contact Verification Signal frame is transmitted by a GDD enabling STA to establish that its GDD dependent STAs are within the reception range of the GDD enabling STA and to validate the available channel list. A GDD enabling STA with dot11ContactVerificationSignalActivated true shall transmit an individually addressed Protected CVS frame (see 8.5.8.29) to its GDD dependent STAs.

A GDD dependent STA receives a CVS frame transmitted from its GDD enabling STA that provided the WSMs to verify that it is within reception range of that GDD enabling STA. The CVS frame has a Map ID field that indicates whether the WSM has been changed. A GDD dependent STA compares values of the Map ID field in the CVS frame with the Map ID of its existing WSM. If they are the same, then the GDD dependent STA assumes that its WSM is valid, and it sets dot11GDDEnablementValidTimer equal to dot11ContactVerificationSignalInterval. If they are different, the WSM is invalid because WSM information has changed. The STA should transmit a channel availability query request frame and receive a channel availability query response frame that contains an updated WSM. If the GDD dependent STA fails to retrieve the updated WSM, it shall change its GDD enablement state to *unenabled* and stop transmitting over the air after dot11GDDEnablementValidTimer has expired.

10.43.7 Network channel control (NCC) procedures

10.43.7.1 Introduction

This subclause describes network channel control procedures that can be used to manage channels for operation of a GDD STA. STAs can use the NCC procedures specified here when dot11GDDActivated is true.

Network channel control utilizes a two-message transaction sequence to allow an NCC responding STA to control the frequency usage in TV bands of an NCC requesting STA's WLAN network channels. The first message sent by the NCC requesting STA asserts identity and requests NCC information. The NCC requesting STA may select its preferred frequencies from its WSM and request usage. The message sent by the NCC responding STA returns the NCC result. The NCC responding STA might grant permission for using the selected frequencies for multiple WLAN network channels to the NCC requesting STA by using the NCC response frame (see 8.5.8.32). When responding, the NCC responding STA provides the confirmed WLAN network channels and the transmit power constraints as well. The WLAN network channels that the

network channel control responding STA confirms might be the same network channels listed in the NCC request frame or a subset of the list in the NCC request frame.

An NCC requesting STA employing RLQP may send an NCC frame to the RLSS to request its preferred frequencies given by the WSM for WLAN network channels. The NCC requesting STA accomplishes this by transmitting an RLQP-element with the RLQP ID for NCC in the Query Request field in a Gas Initial Request frame. After it receives this frame the NCC responding STA forwards the NCC request to the RLSS. After receiving the NCC request, the RLSS responds and sends an NCC response via the NCC responding STA to the NCC requesting STA. When responding, the RLSS also provides the confirmed WLAN network channels and the transmit power constraints. The WLAN network channels that the RLSS confirms might be the same network channels listed in the NCC request frame or a subset of the list in the NCC request frame.

Whenever the WSM has changed due to the update of the database information or detection of the primary service signals, the network channel control requesting STAs may transmit the NCC request frame again.

10.43.7.2 NCC requesting STA

The NCC requesting STA may be a GDD dependent STA. An NCC requesting STA employing RLQP may use GAS protocol for its NCC procedure with a RLSS. Upon receipt of the MLME-GAS.request primitive with an AdvertisementProtocolID value of RLQP and Query parameter with the value of Network Channel Control RLQP-element, the NCC requesting STA transmits an RLQP-element with Info ID for NCC in the Query Request field in a GAS Initial Request frame. The specific information items in the Query Request field of the GAS Initial Request frame are generated as follows:

- The Requester STA Address field is set to the MAC address of the NCC requesting STA.
- The Responder STA Address field is set to the MAC address of the NCC responding STA.
- The Reason Result code is 0, as defined in 8.4.5.4.
- The Number of Network Channel Control Triplets field, as defined in 8.4.5.4, gives the number of triplets of Operating Class, Channel Number, and Transmit Power Constraint fields.
- The Operating Class and Channel Number fields, with the values defined in E.1, together specify the channel frequency and channel bandwidth for WLAN network channels selected by the NCC requesting STA.
- The Maximum Transmit Power field, as defined in 8.4.5.4, is set to the intended maximum transmit power in dBm for operation of the requesting STA.

An NCC Requesting STA might use the NCC Public Action frame or its protected dual to query another STA to request frequency usage in TV bands for WLAN network channels. Upon receipt of the MLME-NETWORKCHANNELCONTROL.request primitive with NCC parameter value of NCC element, the requesting STA transmits an Action frame containing an NCC element. The request frame is generated as follows:

- The Requester STA Address field is set to the MAC address of the NCC requesting STA.
- The Responder STA Address field is set to the MAC address of the NCC responding STA.
- The Reason Result Code is 0, as defined in 8.4.5.4.
- The Number of Network Channel Control Triplets field, as defined in 8.4.5.4, gives the number of triplets of Operating Class, Channel Number, and Transmit Power Constraint fields.
- The Operating Class and Channel Number fields, with the values defined in E.1, together specify the channel frequency and channel bandwidth for WLAN network channels selected by the NCC requesting STA.
- The Maximum Transmit Power field, as defined in 8.4.5.4, is set to the intended maximum transmit power in dBm for operation of the requesting STA.

10.43.7.3 NCC responding STA

The NCC responding STA may be a GDD enabling STA. An NCC responding STA employing RLQP may use the GAS protocol for its NCC procedure with a RLSS. Upon receipt of the MLME-GAS.response primitive with a ResponseInfo parameter value of Network Channel Control RLQP-element, the NCC responding STA transmits a RLQP-element with Info ID for NCC in the Query Response field in a GAS Initial Response frame or one or more GAS Comeback Response frames. The specific information items in the Query Response field of the GAS Initial Response frame are generated as follows:

- Requester STA Address field set to the MAC address of the NCC requesting STA.
- Responder STA Address field set to the MAC address of the NCC responding STA.
- Reason Result Code field = values 2, 3, 4, 5, or 6 as defined in 8.4.5.4.
- The Number of Network Channel Control Triplets field, as defined in 8.4.5.4, gives the number of triplets of Operating Class, Channel Number, and Transmit Power Constraint fields.
- The Operating Class and Channel Number fields, with the values defined in E.1, together specify the channel frequency and channel bandwidth that the NCC responding STA has granted permission to the NCC requesting STA for WLAN operation.
- The Maximum Transmit Power field, as defined in 8.4.5.4, sets to maximum allowable transmit power in dBm of the requesting STA's WLAN operation.

An NCC responding STA may use an NCC Public Action frame or its protected dual to respond to another STA with NCC information. Upon receipt of the MLME-NETWORKCHANNELCONTROL.response primitive with NCC parameter value of NCC element, the NCC responding STA transmits an Action frame containing an NCC element. The response frame is generated as follows:

- Requester STA Address field set to the MAC address of the NCC requesting STA.
- Responder STA Address field set to the MAC address of the NCC responding STA.
- Reason Result Code = values 2, 3, 4, 5, or 6 as defined in 8.4.5.4.
- The Number of Network Channel Control Triplets field, as defined in 8.4.5.4, gives the number of triplets of Operating Class, Channel Number, and Transmit Power Constraint fields.
- The Operating Class and Channel Number fields, with the values defined in E.1, together specify the channel frequency and channel bandwidth that the NCC responding STA has granted permission to the NCC requesting STA for WLAN operation.
- The Maximum Transmit Power field, as defined in 8.4.5.4, sets to maximum allowable transmit power in dBm of the requesting STA's WLAN operation.

10.43.8 Reduced neighbor report

In Beacon and Probe Response frames, a Reduced Neighbor Report element may be transmitted by an AP with dot11TVHTOptionImplemented true. A Reduced Neighbor Report element contains information on neighbor APs. A Reduced Neighbor Report element might not be exhaustive either by choice or by the fact that there may be neighbor APs not known to the AP.

The Reduced Neighbor Report element contains a list of operating classes and channels along with TBTT information for the reported neighbor APs on each operating class and channel. A Reduced Neighbor Report element includes only channels that are consistent with the Country element in the frame in which the Reduced Neighbor Report element appears. The Reduced Neighbor Report element contents may be derived from the NeighborListSet parameter of the MLME-NEIGHBORREPRESP.request primitive. The contents of the Reduced Neighbor Report element might also be configured or obtained by other means beyond the scope of this standard.

If the Supported Operating Classes element of the STA is included in the Probe Request frame, the reduced neighbor report contains information on neighbor APs whose current operating class matches the supported operating classes in the Probe Request frame.

The Reduced Neighbor Report element shall include the information on neighbor APs whose SSID matches the specific SSID in the Probe Request frame if the Filtered Neighbor AP bit in the Neighbor AP Information field is set to 1.

A serving AP shall include a value less than 255 in the TBTT Offset in TUs subfield if it is able to guarantee an accumulated error of 1.5 TU or better.

A STA receiving a Reduced Neighbor Report element may use the report to schedule passive scanning for faster AP discovery. The scheduling process is beyond the scope of this standard. A STA receiving a Reduced Neighbor Report element with an unknown subelement identifier shall ignore the unknown subelement and continue to process the remaining subelements.

10.43.9 White space map (WSM)

This subclause describes WSM procedures that can be used to obtain lists of available channels for operation of a GDD STA. STAs can use the WSM procedure specified here when dot11GDDActivated is true.

When dot11WhiteSpaceMapActivated is true, a GDD STA shall follow the procedures in this subclause.

If dot11WhiteSpaceMapActivated is true, a GDD enabling STA transmits a WSM, and a GDD dependent STA can transmit frames only on the available channels indicated in its valid WSM. GDBs can be different according to each regulatory domain and its regulatory requirements. A WSM Type field value of 1 indicates that the WSM is generated from the GDB and the WSM Information field of the WSM element specifies the available information for TVWS, which is country-specific and defined in 8.2.6.2.5.

A GDD enabling STA contacts a GDB to obtain the permissible frequencies and operating parameters before it begins its transmissions. After receiving the WSM information from a GDB, a GDD enabling STA operates in TVWS only in the frequencies that the GDB indicates are available. The GDD enabling STA generates WSMs based on the information from the GDB. It may update WSMs when STAs perform a measurement or receive a measurement report in which a primary service signal is measured on a channel, which is indicated as available from the GDB.

A WSM element includes a list of identified available channels and corresponding maximum allowed transmission powers for each available channel.

When a GDD enabling STA retrieves updated available frequency information, it is able to transmit individually addressed Protected WSM Announcement frames with an updated WSM element to its GDD dependent STAs.

A GDD dependent STA receiving a WSM element operates on the channels indicated in the WSM. A GDD dependent STA that receives an updated WSM from its GDD enabling STA shall move its channel of operation if it is operating on a channel that has become unavailable in the updated WSM.

A GDD enabling STA transmits a WSM within a GDD Enablement Response frame, CAQ response frame, and WSM Announcement frame. A Device Class field of a WSM in a GDD Enablement Response frame and CAQ response frame is set to a value of a Device Class field in a GDD Enablement Request frame and Channel Availability Query frame, respectively. A Device Class field of WSM in a WSM Announcement frame is set to a value of the Device Class field of a WSM in a GDD Enablement Request frame.

The value of the Map version bits in the Map ID field is increased by 1 (modulo 127) whenever the GDD enabling STA transmits the updated WSM. The most recently received WSM is used by the WSM receiving STAs. A WSM with a Map version value of 127 indicates that the WSM is informative and it does not affect the GDD enablement states of a GDD dependent STA. If the Type bit in the Map ID field is set to 1, the following channel list is a full channel list; and if the Type bit is set to 0, the following channel list is a partial channel list. If a STA receives several WSMs with the same Map version and the Type bit is equal to 0, the STA should construct the whole channel list using the multiple WSMs having the same Map version.

GDD dependent STAs receiving a WSM should scan for existing BSSs on the available channels identified within received WSM element. In TVWS a GDD dependent STA receiving a WSM element shall operate on the channels indicated in the WSM. A GDD dependent STA that has previously received a WSM and that receives an updated WSM from its AP or GDD enabling STA shall move its channel of operation if it is operating on a channel that has become unavailable in the updated WSM.

If dot11WhiteSpaceMapActivated is true, then the enabled GDD dependent STA may send a Probe Request frame on any channel identified in the received WSM element. An AP that has dot11WhiteSpaceMapActivated true and that receives a Probe Request frame should respond with a Probe Response frame containing a WSM element.

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/Amd.5:2015

Insert the following text, Clause 23, after Clause 22:

23. Television Very High Throughput (TVHT) PHY specification

23.1 Introduction

23.1.1 Introduction to the TVHT PHY

Clause 23 specifies the PHY entity for a television very high throughput (TVHT) orthogonal frequency division multiplexing (OFDM) system.

Three basic channel units (BCUs) are defined as 6 MHz, 7 MHz, or 8 MHz, depending on the regulatory domain, and denoted in the rest of this clause as a BCU or TVHT_W. Many of the terms used in this clause refer to different bands, depending on the regulatory domain. These terms include

- TVHT_2W, which represents two contiguous BCUs (12 MHz, 14 MHz, or 16 MHz)
- TVHT_W+W, which represents two noncontiguous BCU (6+6 MHz, 7+7 MHz, or 8+8 MHz)
- TVHT_4W, which represents four contiguous BCUs (24 MHz, 28 MHz, or 32 MHz)
- TVHT_2W+2W, which represents two noncontiguous frequency segments, each of which is composed of two BCUs (12+12 MHz, 14+14 MHz, or 16+16 MHz)

TVHT_2W, TVHT_W+W, TVHT_4W, and TVHT_2W+2W represent two contiguous BCUs (12 MHz, 14 MHz, or 16 MHz), two noncontiguous BCUs (6+6 MHz, 7+7 MHz, or 8+8 MHz), four contiguous BCUs (24 MHz, 28 MHz, or 32 MHz), and two noncontiguous frequency segments whereby each frequency segment comprises two contiguous BCUs (12+12 MHz, 14+14 MHz, or 16+16 MHz), respectively.

The TVHT PHY is based on the VHT PHY as defined in 22.3, 22.4, 22.5, and 22.6 and on Clause 18.

All TVHT transmissions in one BCU shall use the VHT PHY parameters for 40 MHz channel defined in 22.3, 22.4, 22.5, and 22.6 with a sampling clock change to fit into each of the BCU bandwidths and with the number of encoders (N_{ES}) always being 4 (for SU-MIMO and per user in MU-MIMO).

Table 23-8 describes the sampling clock for each of the BCUs and the basic PHY parameters for transmission over one BCU.

For all VHT PPDU and non-HT PPDU in TVWS band, timing-related parameters shall be used as defined in Table 23-5 and Table 23-8; frequently used parameters shall be used as defined in Table 23-6 and Table 23-9; phase rotation parameter $\Upsilon_{k,BW}$ shall be replaced by $\Upsilon_{k,M}$, which is defined in Table 23-12; and cyclic shift parameters shall be used as defined in 23.3.8.3.2.

As shown in Table 23-8, the design is based on defining 144 OFDM tones in the 6 MHz and 8 MHz channel units and using up to tone 58 on each side of the DC tone for data and pilots, exactly matching the VHT 40 MHz PHY parameters. The 7 MHz channel unit is split into 168 tones to maintain the same tone spacing and PHY design as used for 6 MHz channels (note the ratio of 168 to 144 is identical to the ratio of 7 to 6). The choice of 144 and not 128 was made to reduce the PHY channel BW from 6 MHz to 5 1/3 MHz in order to allow sharper filtering to achieve 55 dB ACLR.

The TVHT PHY defines the following transmission modes that incorporate transmission on one, two, or four BCUs:

- a) Mandatory transmission mode - one BCU (TVHT_MODE_1)
- b) Optional transmission modes - multi-BCUs
 - 1) Two contiguous BCUs (TVHT_MODE_2C)
 - 2) Two noncontiguous BCUs (TVHT_MODE_2N)
 - 3) Four contiguous BCUs (TVHT_MODE_4C)
 - 4) Two noncontiguous frequency segments, each of which comprises two contiguous BCUs. (TVHT_MODE_4N)

The tone spacing, DFT duration, and other timing parameters remain unchanged for all optional modes compared with the definition in Table 23-8.

The number of occupied tones in each BCU of any optional mode is the same as the number defined in Table 23-8.

The location of the occupied tones in each BCU of any optional mode is shown in Table 23-9.

The DATA encoding process for multi-BCUs transmission is similar to one BCU transmission and is defined in 23.3.10.

A TVHT STA shall support the following features:

- TVHT_MODE_1 (one BCU)
- Single spatial stream MCSs 0 to 7 (transmit and receive)
- Binary convolutional coding
- Normal and short guard interval (transmit and receive)

A TVHT STA may support the following features:

- TVHT_MODE_2C, TVHT_MODE_2N, TVHT_MODE_4C, or TVHT_MODE_4N (two or four BCUs)
- Two or more spatial streams (transmit and receive)
- Beamforming sounding (by sending a VHT NDP frame)
- Respond to transmit beamforming sounding (provide compressed beamforming feedback)
- STBC (transmit and receive)
- LDPC (transmit and receive)
- VHT MU PPDU (transmit and receive)
- MCSs 8 and 9 (transmit and receive)

23.1.2 Scope

The services provided to the MAC by the TVHT PHY consist of two protocol functions, defined as follows:

- a) A PHY convergence function, which adapts the capabilities of the physical medium dependent (PMD) system to the PHY service. This function is supported by the physical layer convergence procedure (PLCP), which defines a method of mapping the PSDUs into a framing format (PPDU) suitable for sending and receiving PSDUs between two or more STAs using the associated PMD system.
- b) A PMD system whose function defines the characteristics and method of transmitting and receiving data through a wireless medium between two or more STAs. These STAs support a TVHT PHY.

23.1.3 TVHT PHY functions

23.1.3.1 General

See 22.1.3.1 with “TVHT” replacing “VHT”.

23.1.3.2 PHY management entity (PLME)

See 22.1.3.2.

23.1.3.3 Service specification method

See 22.1.3.3 with “TVHT” replacing “VHT”.

23.1.4 PPDU formats

The structure of the PPDU transmitted by a TVHT STA is determined by the TXVECTOR parameters as defined in 23.2.2.

The FORMAT parameter determines the overall structure of the PPDU and includes the following:

- Non-HT format (NON_HT), based on Clause 18. Support for non-HT format is mandatory.
- VHT format (VHT). Support for TVHT_W VHT format is mandatory.

23.2 TVHT PHY service interface

23.2.1 Introduction

See 22.2.1.

23.2.2 TXVECTOR and RXVECTOR parameters

The TXVECTOR and RXVECTOR parameters are defined in Table 23-1.

The TXVECTOR parameter FORMAT shall be set to NON_HT or VHT. When the TXVECTOR parameter FORMAT equals NON_HT, then NON_HT_MODULATION shall be set to NON_HT_DUP_OFDM.

When the TXVECTOR parameter FORMAT equals NON_HT, the TXVECTOR parameter L_DATARATE indicates the data rate used to transmit the PSDU in Mb/s. The allowed values are 6 Mb/s, 9 Mb/s, 12 Mb/s, 18 Mb/s, 24 Mb/s, 36 Mb/s, 48 Mb/s, and 54 Mb/s divided by 7.5 for 6 MHz and 7 MHz unit channels and by 5.625 for 8 MHz channels.

When the TXVECTOR parameter FORMAT equals VHT, the TXVECTOR parameter CH_BANDWIDTH indicates the channel width of the transmitted PPDU:

Enumerated type:

- TVHT_W for one BCU
- TVHT_2W for two contiguous BCUs
- TVHT_W+W for two noncontiguous BCUs
- TVHT_4W for four contiguous BCUs
- TVHT_2W+2W for two noncontiguous frequency segments, each of which comprises two contiguous BCUs

Note that TVHT_W represents the broadcast channel bandwidth for the regulatory domain, e.g., TVHT_W is 6 MHz, 7 MHz, or 8 MHz. TVHT_2W represents two contiguous BCUs with the same regulatory domain, e.g., TVHT_2W is 12 MHz, 14 MHz, or 16 MHz.

When the TXVECTOR parameter FORMAT equals NON_HT, the TXVECTOR parameter CH_BANDWIDTH indicates the channel width of the transmitted PPDU on transmission and the estimated channel width of the received PPDU on reception:

Enumerated type:

- TVHT_W, TVHT_2W, TVHT_W+W, TVHT_4W, TVHT_2W+2W

When the TXVECTOR parameter FORMAT equals VHT, the TXVECTOR parameter NUM_STS indicates the number of space-time streams: range 1 to 4 for SU, 1 to 3 per user for MU. NUM_STS summed over all users shall be less than or equal to 4. The TXVECTOR parameter NUM_STS is not present when the TXVECTOR parameter FORMAT equals to NON_HT.

Table 23-1—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	TXVECTOR	RXVECTOR
FORMAT		Determines the format of the PPDU. Enumerated type: NON_HT indicates non-HT duplicated PPDU format. In this case, the modulation is determined by the NON_HT_MODULATION parameter. VHT indicates VHT format.	Y	Y
NON_HT_MODULATION	FORMAT is NON_HT	In TXVECTOR, indicates the format type of the transmitted non-HT PPDU. In RXVECTOR, indicates the estimated format type of the received non-HT PPDU. Enumerated type: NON_HT_DUP_OFDM indicates non-HT duplicate format.	Y	Y
	Otherwise	Not present	N	N
L_LENGTH	FORMAT is NON_HT	Indicates the length of the PSDU in octets in the range of 1 to 4095. This value is used by the PHY to determine the number of octet transfers that occur between the MAC and the PHY.	Y	Y
	FORMAT is VHT	Not present NOTE—The Length field of the L-SIG in VHT PDUs is defined in Equation (23-9) using the scaling factor defined in 23.3.8.2.1.	N	N
L_DATARATE	FORMAT is NON_HT	Indicates the data rate used to transmit the PSDU in Mb/s. The allowed values are 6, 9, 12, 18, 24, 36, 48, and 54 divided by 7.5 for 6 MHz and 7 MHz unit channels and by 5.625 for 8 MHz channels.	Y	Y
	FORMAT is VHT	Not present NOTE—The RATE field in the L-SIG field in a VHT PDU is set to the value representing 6/X Mb/s in TVWS band “Modulation BPSK and Coding rate 1/2” row of Table 23-4.	N	N

Table 23-1—TXVECTOR and RXVECTOR parameters (continued)

Parameter	Condition	Value	TXVECTOR	RXVECTOR
N_TX	FORMAT is VHT	Indicates the number of transmit chains.	Y	N
	Otherwise	Not present	N	N
EXPANSION_MAT_TYPE	FORMAT is VHT and EXPANSION_MAT is present.	Set to COMPRESSED_SV	Y	N
	Otherwise	See corresponding entry in Table 20-1		
EXPANSION_MAT	FORMAT is VHT	Contains a vector in the number of selected subcarriers containing feedback matrices as defined in 23.3.11.2 based on the channel measured during the training symbols of a previous VHT NDP PPDU.	M U	N
	Otherwise	See corresponding entry in Table 20-1		
CHAN_MAT_TYPE	FORMAT is VHT and PSDU_LENGTH equals zero	Set to COMPRESSED_SV NOTE—This parameter is present only for TVHT NDP PPDU.	N	Y
	FORMAT is VHT and PSDU_LENGTH is greater than zero	Not present	N	N
	Otherwise	See corresponding entry in Table 20-1		
CHAN_MAT	FORMAT is VHT and PSDU_LENGTH equals zero	Contains a set of compressed beamforming feedback matrices as defined in 22.3.11.2 based on the channel measured during the training symbols of the received VHT NDP PPDU.	N	Y
	FORMAT is VHT and PSDU_LENGTH is greater than zero	Not present	N	N
	Otherwise	See corresponding entry in Table 20-1		
DELTA_SNR	FORMAT is VHT	Contains an array of delta SNR values as defined in 8.4.1.49a based on the channel measured during the training symbols of the received VHT NDP PPDU. NOTE—In the RXVECTOR this parameter is present only for VHT NDP PPDU for MU sounding.	M U	Y
	Otherwise	Not present	N	N
RCPI		Is a measure of the received RF power averaged over all the receive chains in the Data field of a received PPDU. Refer to 20.3.21.6 for the definition of RCPI.	N	Y

Table 23-1—TXVECTOR and RXVECTOR parameters (continued)

Parameter	Condition	Value	TXVECTOR	RXVECTOR
SNR	FORMAT is VHT	Contains an array of measures of the received SNR for each spatial stream. SNR indications of 8 bits are supported. SNR shall be the sum of the decibel values of SNR per tone divided by the number of tones represented in each stream as described in 8.4.1.48a.	N	Y
	Otherwise	See corresponding entry in Table 20-1		
NO_SIG_EXTN	FORMAT is VHT	Not present	N	N
	Otherwise	See corresponding entry in Table 20-1		
FEC_CODING	FORMAT is HT	Indicates which FEC encoding is used. Enumerated type: BCC_CODING indicates binary convolutional code. LDPC_CODING indicates low-density parity check code.	M U	Y
	Otherwise	See corresponding entry in Table 20-1		
STBC	FORMAT is VHT	Indicates whether STBC is used. 0 indicates no STBC ($N_{STS}=N_{SS}$ in the Data field). 1 indicates STBC is used ($N_{STS}=2N_{SS}$ in the Data field).	Y	Y
	Otherwise	See corresponding entry in Table 20-1		
GI_TYPE	FORMAT is VHT	Indicates whether a short guard interval is used in the transmission of the Data field of the PPDU. Enumerated type: LONG_GI indicates short GI is not used in the Data field of the PPDU. SHORT_GI indicates short GI is used in the Data field of the PPDU.	Y	Y
	Otherwise	Not present	N	N
TXPWR_LEVEL	FORMAT is VHT	The allowed values for the TXPWR_LEVEL parameter are in the range from 1 to $\text{numberOfOctets}(\text{dot11TxPowerLevelExtended})/2$. This parameter is used to indicate which of the available transmit output power levels defined in dot11TxPowerLevelExtended shall be used for the current transmission.	Y	N
	Otherwise	See corresponding entry in Table 20-1		
RSSI	FORMAT is VHT	The allowed values for the RSSI parameter are in the range 0 to 255 inclusive. This parameter is a measure by the PHY of the power observed at the antennas used to receive the current PPDU measured during the reception of the TVHT-LTF field. RSSI is intended to be used in a relative manner, and it is a monotonically increasing function of the received power.	N	Y
	Otherwise	See corresponding entry in Table 20-1		

Table 23-1—TXVECTOR and RXVECTOR parameters (continued)

Parameter	Condition	Value	TXVECTOR	RXVECTOR
MCS	FORMAT is VHT	Indicates the modulation and coding scheme used in the transmission of the PPDU. Integer: range 0 to 9	M U	Y
	Otherwise	See corresponding entry in Table 20-1		
REC_MCS	FORMAT is VHT	Indicates the MCS that the STA's receiver recommends.	N	O
	Otherwise	Not present	N	N
CH_BANDWIDTH	FORMAT is VHT	Indicates the channel width of the transmitted PPDU: Enumerated type: TVHT_W for one BCU TVHT_2W for two contiguous BCUs TVHT_W+W for two noncontiguous BCUs TVHT_4W for four contiguous BCUs TVHT_2W+2W for two noncontiguous frequency segments, each of which comprises two contiguous BCUs	Y	Y
	FORMAT is NON_HT	In TXVECTOR, indicates the channel width of the transmitted PPDU. In RXVECTOR, indicates the estimated channel width of the received PPDU. Enumerated type: TVHT_W, TVHT_2W, TVHT_W+W, TVHT_4W, TVHT_2W+2W if NON_HT_MODULATION equals NON_HT_DUP_OFDM	Y	Y
DYN_BANDWIDTH_IN_NON_HT	FORMAT is NON_HT	In TXVECTOR, if present, indicates whether the transmitter is capable of Static or Dynamic bandwidth operation. In RXVECTOR, if valid, indicates whether the transmitter is capable of Static or Dynamic bandwidth operation. Enumerated type: Static if the transmitter is capable of Static bandwidth operation Dynamic if the transmitter is capable of Dynamic bandwidth operation NOTE—In the RXVECTOR, the validity of this parameter is determined by the MAC based on the contents of the received MPDU.	O	Y
	Otherwise	Not present	N	N
CH_BANDWIDTH_IN_NON_HT	FORMAT is NON_HT	In TXVECTOR, if present, indicates the channel width of the transmitted PPDU, which is signaled via the scrambling sequence. In RXVECTOR, if valid, indicates the channel width of the received PPDU, which is signaled via the scrambling sequence. Enumerated type: TVHT_W, TVHT_2W, TVHT_W+W, TVHT_4W, TVHT_2W+2W. NOTE—In the RXVECTOR, the validity of this parameter is determined by the MAC based on the contents of the received MPDU.	O	Y
	Otherwise	Not present	N	N

Table 23-1—TXVECTOR and RXVECTOR parameters (continued)

Parameter	Condition	Value	TXVECTOR	RXVECTOR
APEP_LENGTH	FORMAT is VHT	If equal to zero, indicates a TVHT NDP PDU for both RXVECTOR and TXVECTOR. If greater than zero, in the TXVECTOR, indicates the number of octets in the range 1 to 1 048 575 in the A-MPDU pre-EOF padding (see 9.12.2) carried in the PSDU. This parameter is used to determine the number of OFDM symbols in the Data field and, after being rounded up to a 4-octet boundary with the two LSBs removed, is placed in the VHT-SIG-B Length field. NOTE—The rounding up of the APEP_LENGTH parameter to a 4-octet word boundary could result in a value that is larger than the PSDU_LENGTH calculated using the equations in 23.4.3. If greater than zero, in the RXVECTOR, is the value obtained from the VHT-SIG-B Length field multiplied by 4.	M U	O
	Otherwise	Not present	N	N
PSDU_LENGTH	FORMAT is VHT	Indicates the number of octets in the VHT PSDU in the range of 0 to 1 065 600 octets. A value of 0 indicates a VHT NDP PDU.	N	Y
	Otherwise	Not present	N	N
USER_POSITION	FORMAT is VHT and $1 \leq \text{GROUP_ID} \leq 62$	Index for user in MU transmission. Integer: range 0 to 3. NOTE—The entries in the USER_POSITION array are in ascending order.	M U	O
	Otherwise	Not present	N	N
NUM_STS	FORMAT is VHT	Indicates the number of space-time streams. Integer: range 1 to 4 for SU, 1 to 3 per user in the TXVECTOR, and 0 to 4 in the RXVECTOR for MU. NUM_STS summed over all users is between 1 and 4.	M U	Y
	Otherwise	Not present	N	N
GROUP_ID	FORMAT is VHT	Indicates the group ID. Integer: range 0 to 63 (see Table 22-12) A value of 0 or 63 indicates a VHT SU PDU. A value in the range 1 to 62 indicates a VHT MU PDU.	Y	Y
	Otherwise	Not present	N	N
PARTIAL_AID	FORMAT is VHT and GROUP_ID is 0 or 63	Provides an abbreviated indication of the intended recipient(s) of the PSDU (see 9.17a). Integer: range 0 to 511.	Y	Y
	Otherwise	Not present	N	N

Table 23-1—TXVECTOR and RXVECTOR parameters (continued)

Parameter	Condition	Value	TXVECTOR	RXVECTOR
NUM_USERS	FORMAT is VHT	Indicates the number of users with nonzero space-time streams. Integer: range 1 to 4.	Y	N
	Otherwise	Not present	N	N
BEAMFORMED	FORMAT is VHT and GROUP_ID is 0 or 63	Set to 1 if a beamforming steering matrix is applied to the waveform in an SU transmission as described in 20.3.11.11.2. Set to 0 otherwise. NOTE—When BEAMFORMED is set to 1, smoothing is not recommended.	Y	O
	Otherwise	Not present	N	N
TXOP_PS_NOT_ALLOWED	FORMAT is VHT	Indicates whether a VHT AP allows non-AP VHT STAs in TXOP power save mode to enter Doze state during the TXOP. 0 indicates that the VHT AP allows non-AP VHT STAs to enter doze mode during a TXOP. 1 indicates that the VHT AP does not allow non-AP VHT STAs to enter doze mode during a TXOP.	Y	Y
	Otherwise	Not present	N	N
TIME_OF_DEPARTURE_REQUESTED		Boolean value: true indicates that the MAC entity requests that the PHY entity measures and reports time of departure parameters corresponding to the time when the first PPDU energy is sent by the transmitting port. false indicates that the MAC entity requests that the PHY entity neither measures nor reports time of departure parameters.	O	N

Table 23-1—TXVECTOR and RXVECTOR parameters (continued)

Parameter	Condition	Value	TXVECTOR	RXVECTOR
RX_START_OF_FRAME_OFFSET	dot11MgmtOptionTimingMsmtActivated is true	0 to $2^{32}-1$. An estimate of the offset (in 10 ns units) from the point in time at which the start of the preamble corresponding to the incoming frame arrived at the receive antenna port to the point in time at which this primitive is issued to the MAC.	N	Y
	Otherwise	Not present	N	N
<p>NOTE 1—In the “TXVECTOR” and “RXVECTOR” columns, the following apply: Y = Present; N = Not present; O = Optional; MU indicates that the parameter is present once for a VHT SU PPDU and present per user for a VHT MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by u, where u takes values 0 to NUM_USERS – 1.</p> <p>NOTE 2—On reception, where valid, the CH_BANDWIDTH_IN_NON_HT parameter is likely to be a more reliable indication of subformat and channel width than the NON_HT_MODULATION and CH_BANDWIDTH parameters, since for non-HT or non-HT duplicate frames, CH_BANDWIDTH is a receiver estimate of the bandwidth, whereas CH_BANDWIDTH_IN_NON_HT is the signaled bandwidth.</p>				

23.2.3 Effects of CH_BANDWIDTH parameter on PPDU format

Table 23-2 shows the PPDU format as a function of the CH_BANDWIDTH and FORMAT parameters.

Table 23-2—PPDU format as a function of CH_BANDWIDTH parameter

FORMAT	CH_BANDWIDTH	PPDU format
VHT	TVHT_W	The STA transmits a VHT PPDU in TVWS bands (when FORMAT is VHT) with TVHT_MODE_1.
VHT	TVHT_2W	The STA transmits a VHT PPDU in TVWS bands (when FORMAT is VHT) with TVHT_MODE_2C.
VHT	TVHT_4W	The STA transmits a VHT PPDU in TVWS bands (when FORMAT is VHT) with TVHT_MODE_4C.
VHT	TVHT_W+W	The STA transmits a VHT PPDU in TVWS bands (when FORMAT is VHT) with TVHT_MODE_2N.
VHT	TVHT_2W+2W	The STA transmits a VHT PPDU in TVWS bands (when FORMAT is VHT) with TVHT_MODE_4N.

Table 23-2—PPDU format as a function of CH_BANDWIDTH parameter (continued)

FORMAT	CH_BANDWIDTH	PPDU format
NON_HT	TVHT_W	The STA transmits a NON_HT PPDU with NON_HT_MODULATION set to NON_HT_DUP_OFDM using one TVHT_W channel as defined in 23.3.10.12. If the BSS operating channel width is wider than TVHT_W, then the transmission shall use the primary TVHT_W channel.
NON_HT	TVHT_2W	The STA transmits a NON_HT PPDU with NON_HT_MODULATION set to NON_HT_DUP_OFDM using two adjacent TVHT_W channels as defined in 23.3.10.12. If the BSS operating channel width is wider than TVHT_2W, then the transmission shall use the primary TVHT_2W channel.
NON_HT	TVHT_4W	The STA transmits a NON_HT PPDU with NON_HT_MODULATION set to NON_HT_DUP_OFDM using four adjacent TVHT_W channels as defined in 23.3.10.12.
NON_HT	TVHT_W+W	The STA transmits a NON_HT PPDU with NON_HT_MODULATION set to NON_HT_DUP_OFDM using two nonadjacent frequency segments, with each frequency segment consisting of single TVHT_W channels as defined in 23.3.10.12.
NON_HT	TVHT_2W+2W	The STA transmits a NON_HT PPDU with NON_HT_MODULATION set to NON_HT_DUP_OFDM using two nonadjacent frequency segments, with each frequency segment consisting of two adjacent TVHT_W channels as defined in 23.3.10.12.

23.2.4 Support for NON_HT and HT formats

Transmission of HT PPDU is not supported in Clause 23. Except for Non-HT duplicate transmission defined in 23.3.10.12, transmission of NON_HT is not supported in Clause 23.

Non-HT duplicate transmission is based on Clause 18, unless otherwise stated in Clause 23.

Non-HT PPDU format is same as in Figure 18-1. Overview of the PPDU encoding process is defined in 18.3.2.2 except for following modifications:

Modulation-dependent parameters for Non-HT duplicate mode in TVWS band is defined in Table 23-3. Timing related parameters are defined in Table 23-5. t_{SIGNAL} in Equation (18-2) is equal to 16 multiplied by X μs , and t_{DATA} in Equation (18-2) is equal to 20 multiplied by X μs where X is 7.5 for 6 MHz and 7 MHz unit channels and X is 5.625 for 8 MHz channels.

The timings for preamble are multiplied by X where X is 7.5 for 6 MHz and 7 MHz unit channels and X is 5.625 for 8 MHz channels.

Constructions of L-STF, L-LTF, and L-SIG are same as in 23.3.4.2, 23.3.4.3, and 23.3.4.4 except for the value field parameters in L-SIG.

Table 23-3—Modulation-dependent parameters for Non-HT duplicate mode in TVWS band

Modulation	Coding rate (R)	Coded bits per subcarrier (N_{BPSC})	Coded bits per OFDM symbol (N_{CBPS})	Data bits per OFDM symbol (N_{DBPS})	Data rate (Mb/s) (TVWS band)
BPSK	1/2	1	48	24	6/X (see NOTE)
BPSK	3/4	1	48	36	9/X (see NOTE)
QPSK	1/2	2	96	48	12/X (see NOTE)
QPSK	3/4	2	96	72	18/X (see NOTE)
16-QAM	1/2	4	192	96	24/X (see NOTE)
16-QAM	3/4	4	192	144	36/X (see NOTE)
64-QAM	2/3	6	288	192	48/X (see NOTE)
64-QAM	3/4	6	288	216	54/X (see NOTE)

NOTE—In TVWS band, X depends on regulatory domain, i.e., 7.5 for 6 MHz and 7 MHz unit channels and 5.625 for 8 MHz channels.

Interpretation of the bits R1-R4 in the SIGNAL field is modified as in Table 23-4.

Table 23-4—RATE field in L-SIG

R1-R4	Modulation	Coding rate
1101	BPSK	1/2
1111	BPSK	3/4
0101	QPSK	1/2
0111	QPSK	3/4
1001	16-QAM	1/2
1011	16-QAM	3/4
0001	64-QAM	2/3
0011	64-QAM	3/4

Table 23-5 and Table 23-6 define the timing-related parameters for Non-HT format and location of occupied tones.

Table 23-5—Timing-related constants in Non-HT PPDU

Parameter	6 MHz	7 MHz	8 MHz	Description
N_{SD}	96	96	96	Number of complex data numbers per BCU
N_{SP}	8	8	8	Number of pilot values per BCU
N_{ST}	104	104	104	Total number of subcarriers per BCU
N_{SR}	58	58	58	Highest data subcarrier index per BCU
Δ_F	$\frac{6 \text{ MHz}}{144} = 41\frac{2}{3} \text{ kHz}$	$\frac{7 \text{ MHz}}{168} = 41\frac{2}{3} \text{ kHz}$	$\frac{8 \text{ MHz}}{144} = 55\frac{5}{9} \text{ kHz}$	Subcarrier frequency spacing
T_{DFT}	24 μs	24 μs	18 μs	IDFT/DFT period
T_{GI}	$6 \mu\text{s} = T_{DFT}/4$	$6 \mu\text{s} = T_{DFT}/4$	$4.5 \mu\text{s} = T_{DFT}/4$	Guard interval duration
T_{GIS}	$3 \mu\text{s} = T_{DFT}/8$	$3 \mu\text{s} = T_{DFT}/8$	$2.25 \mu\text{s} = T_{DFT}/8$	Short guard interval duration

Other timing parameters are derived as in Table 18-5 using the definition of TFFT in Table 23-5. Table 23-6 defines the number of occupied tones and their location in all transmission modes. Zero denotes the DC tone of any contiguous segment.

Refer to Table 22-6 for parameters definition. The definitions in the table are applicable to Clause 23 with the exception that in each transmission mode in Clause 23 $N_{CBPSSI} = N_{CBPSS}$ for SU and MU PPDUs.

Table 23-6—Tone location in Non-HT PPDU

Parameter	TVHT_MODE_1	TVHT_MODE_2C	TVHT_MODE_2N	TVHT_MODE_4C	TVHT_MODE_4N	Description
N_{ST}	104	104	104	104	104	Total number of occupied subcarriers per BCU
N_{TT}	104	208	208	416	416	Total number of occupied subcarriers across all BCUs
Subcarrier index	-58 to -33, -31 to -6, +6 to +31, and +33 to +58	-130 to -105, -103 to -78, -66 to -41, -39 to -14, +14 to +39, +41 to +66, +78 to +103, and +105 to +130	-58 to -33, -31 to -6, +6 to +31, and +33 to +58 for each BCU	-274 to -249, -247 to -222, -210 to -185, -183 to -158, -130 to -105, -103 to -78, -66 to -41, -39 to -14, +14 to +39, +41 to +66, +78 to +103, +105 to +130, +158 to +183, +185 to +210, +222 to +247, and +249 to +274	-130 to -105, -103 to -78, -66 to -41, -39 to -14, +14 to +39, +41 to +66, +78 to +103, and +105 to +130 for each BCU	Location of occupied subcarriers for 6 MHz and 8 MHz channel units
Subcarrier index	-58 to -33, -31 to -6, +6 to +31, and +33 to +58	-142 to -117, -115 to -90, -78 to -53, -51 to -26, +26 to +51, +53 to +78, +90 to +115, and +117 to +142	-58 to -33, -31 to -6, +6 to +31, and +33 to +58 for each BCU	-310 to -285, -283 to -258, -246 to -221, -219 to -194, -142 to -117, -115 to -90, -78 to -53, -51 to -26, +26 to +51, +53 to +78, +90 to +115, +117 to +142, +194 to +219, +221 to +246, +258 to +283, and +285 to +310	-142 to -117, -115 to -90, -78 to -53, -51 to -26, +26 to +51, +53 to +78, +90 to +115, and +117 to +142 for each BCU	Location of occupied subcarriers for 7 MHz

23.3 TVHT PHY sublayer

23.3.1 Introduction

See 22.3.1.

23.3.2 VHT PDU format in TVWS bands

A single PDU format is defined for this PLCP: the VHT PDU format in TVWS bands. Figure 23-1 shows the VHT PDU format in TVWS bands, with the timing parameters (8 μ s and 4 μ s) in Figure 22-4 replaced by numbers from Table 23-8.

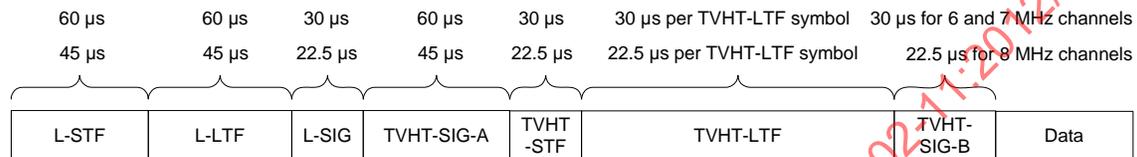


Figure 23-1—VHT PDU format in TVWS bands

The fields of the VHT PDU format in TVWS bands are summarized in Table 23-7.

Table 23-7—Fields of the VHT PDU in TVWS bands

Field	Description
L-STF	Non-HT Short Training field
L-LTF	Non-HT Long Training field
L-SIG	Non-HT SIGNAL field
TVHT-SIG-A	TVHT Signal A field
TVHT-STF	TVHT Short Training field
TVHT-LTF	TVHT Long Training field
TVHT-SIG-B	TVHT Signal B field
Data	The Data field includes the PSDU (PLCP Service Data Unit)

The TVHT-SIG-A, TVHT-STF, TVHT-LTF, and TVHT-SIG-B fields exist only in VHT PDU in TVWS bands. In a TVHT NDP, the Data field is not present. The number of symbols in the TVHT-LTF field, $N_{TVHTLTF}$, can be 1, 2, or 4 and is determined by the total number of space-time streams across all users being transmitted in the VHT PDU in TVWS bands (see Table 22-13).

23.3.3 Transmitter block diagram

The transmit process for the L-SIG and TVHT-SIG-A fields of a VHT PDU using one BCU is shown in Figure 22-5, with “TVHT” replacing “VHT” and with bandwidth corrected according to TVHT bandwidth.

The transmit process for generating the TVHT-SIG-B field of a VHT SU PDU and VHT MU PDU using one frequency segment is shown in Figure 22-6 and Figure 22-7, respectively, with “TVHT” replacing “VHT” and with bandwidth corrected according to TVHT bandwidth.

The transmit process for generating the Data field of a SU PDU in TVHT_MODE_1, TVHT_MODE_2C, or TVHT_MODE_4C with BCC and LDPC encodings, using one BCU, is shown Figure 22-10 and Figure 22-11, respectively, with “TVHT” replacing “VHT” and with bandwidth corrected according to TVHT bandwidth. Single BCC encoder shall be assumed in Figure 22-10.

The transmit process for generating the Data field of a MU PDU in TVHT_MODE_1, TVHT_MODE_2C, or TVHT_MODE_4C with BCC and LDPC encoding is shown in Figure 22-12, with “TVHT” replacing “VHT” and with bandwidth corrected according to TVHT bandwidth. In the case of BCC encoding, single BCC encoder shall be assumed in Figure 22-12.

Figure 23-2 and Figure 23-3 show the transmit process for generating the Data field of a TVHT_MODE_2N or TVHT_MODE_4N SU PDU with BCC and LDPC encoding, respectively, where the subcarrier allocation block allocates the subcarriers for the two IDFTs in each transmit path by the subcarrier mapper as described in 23.3.10.11.

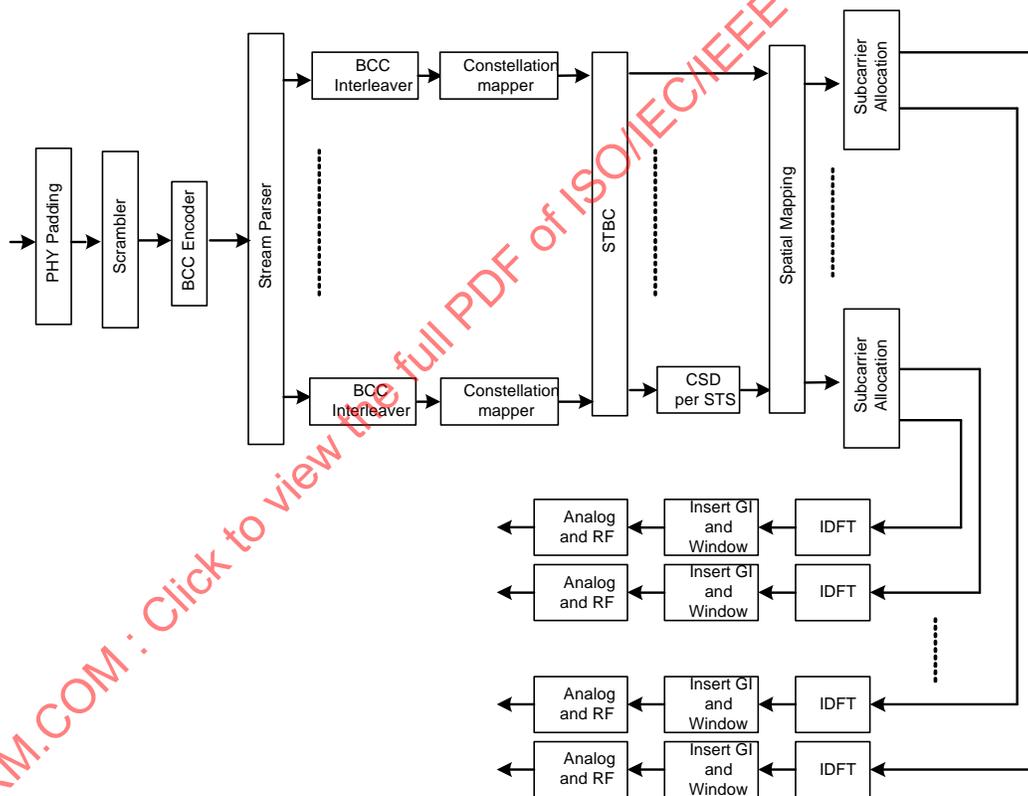


Figure 23-2—Transmitter block diagram for the Data field of a TVHT_MODE_2N or TVHT_MODE_4N SU PDU with BCC encoding

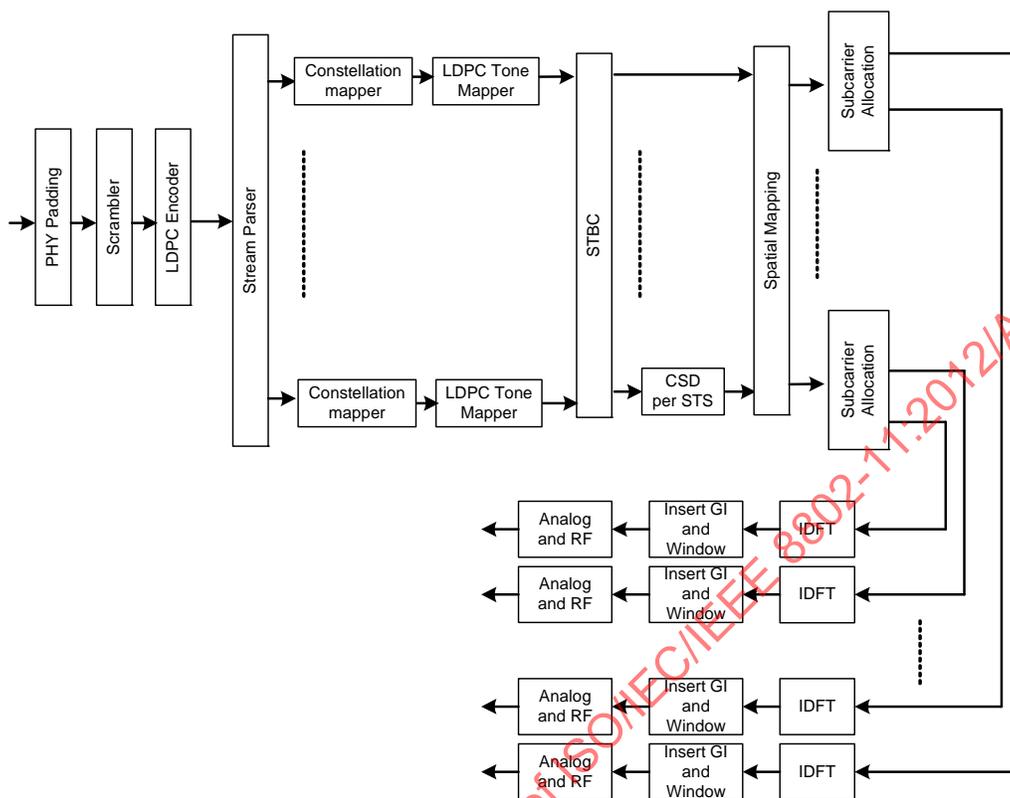


Figure 23-3—Transmitter block diagram for the Data field of a TVHT_MODE_2N or TVHT_MODE_4N SU PPDU with LDPC encoding

23.3.4 Overview of the PPDU encoding process

23.3.4.1 General

This subclause provides an overview of the VHT PPDU in TVWS bands encoding process.

23.3.4.2 Construction of L-STF

Construct the L-STF field as defined in 23.3.8.2.2 following the procedure in 22.3.4.2 reading “Clause 23” for references to “Clause 22” except the following:

- c) Duplication and phase rotation: Duplicate the L-STF over the BCUs of the CH_BANDWIDTH. Apply appropriate phase rotation as defined in 23.3.7.

23.3.4.3 Construction of the L-LTF

Construct the L-LTF field as defined in L-LTF definition following the procedure in 22.3.4.3 reading “Clause 23” for references to “Clause 22” except the following:

- c) Duplication and phase rotation: Duplicate the L-LTF over the BCUs of the CH_BANDWIDTH. Apply appropriate phase rotation as defined in 23.3.7.

23.3.4.4 Construction of L-SIG

Construct the L-SIG field as the SIGNAL field defined by 23.3.8.2.4 following the procedure in 22.3.4.4 reading “Clause 23” for references to “Clause 22” except the following:

- a) For a VHT PPDU in TVWS bands, set the RATE subfield in the SIGNAL field R1-R4 to 1101. Set the Length, Parity, and Tail bits in the SIGNAL field as defined in 23.3.8.2.4. Add calculated one bit parity and N_{tail} bits into the L-SIG symbol.
- f) Duplication and phase rotation: Duplicate the L-SIG field over the BCUs of the CH_BANDWIDTH. Apply appropriate phase rotation as defined in 23.3.7.

23.3.4.5 Construction of TVHT-SIG-A

The TVHT-SIG-A field consists of two symbols, TVHT-SIG-A1 and TVHT-SIG-A2, constructed as defined in 23.3.8.3.3 following the procedure in 22.3.4.5 reading “Clause 23” for references to “Clause 22” except the following:

- e) Pilot insertion: Insert pilots following the steps defined in 23.3.10.10.
- f) Duplication and phase rotation: Duplicate TVHT-SIG-A1 and TVHT-SIG-A2 over of the BCUs of the CH_BANDWIDTH. Apply the appropriate phase rotation as defined in 23.3.7.
- i) Insert GI and apply windowing: Prepend a GI (LONG_GI) and apply windowing as defined in 23.3.7.

23.3.4.6 Construction of TVHT-STF

Construct the TVHT-STF field for each BCU as defined in 23.3.8.3.4 with channel bandwidth being 40 MHz, following the procedure in 22.3.4.6 reading “Clause 23” for references to “Clause 22” except the following:

- b) Phase rotation: Apply appropriate phase rotation as defined in 23.3.7.
- f) Insert GI and apply windowing: Prepend a GI (LONG_GI) and apply windowing as defined in 23.3.7.

In multiple BCU transmissions TVHT_MODE_2C, TVHT_MODE_2N, TVHT_MODE_4C, and TVHT_MODE_4N, the TVHT-STF subcarriers of one BCU are repeated in each BCU with an appropriate phase rotation factor being applied as described in 23.3.8.3.4.

23.3.4.7 Construction of TVHT-LTF

Construct the TVHT-LTF field for each BCU as defined in 23.3.8.3.5 with channel bandwidth being 40 MHz, following the procedure in 22.3.4.7 reading “Clause 23” for references to “Clause 22” except the following:

- b) Phase rotation: Apply appropriate phase rotation as defined in 23.3.7.
- g) Insert GI and apply windowing: Prepend a GI (LONG_GI) and apply windowing as defined in 23.3.7.

In multiple BCU transmissions TVHT_MODE_2C, TVHT_MODE_2N, TVHT_MODE_4C, and TVHT_MODE_4N, the TVHT-LTF subcarriers of one BCU are repeated in each BCU with an appropriate phase rotation factor being applied as described in 23.3.8.3.5.

23.3.4.8 Construction of TVHT-SIG-B

The TVHT-SIG-B field is constructed per-user for each BCU as defined in 22.3.4.8 with channel bandwidth being 40 MHz, reading “Clause 23” for references to “Clause 22” except the following:

- i) Pilot insertion: Insert pilots following the steps defined in 23.3.10.10.
- m) Phase rotation: Apply the appropriate phase rotations as defined in 23.3.7.
- o) Insert GI and apply windowing: Prepend a GI (LONG_GI) and apply windowing as defined in 23.3.7.

In multiple BCU transmissions TVHT_MODE_2C, TVHT_MODE_2N, TVHT_MODE_4C, and TVHT_MODE_4N, the TVHT-SIG-B subcarriers of one BCU are repeated in each BCU with an appropriate phase rotation factor being applied as described in 23.3.8.3.6.

23.3.4.9 Construction of the Data field in an SU PPDU

23.3.4.9.1 Using BCC

The construction of the Data field in a VHT SU PPDU with BCC encoding proceeds as defined in 22.3.4.9.1 reading “Clause 23” for references to “Clause 22” except the following:

- d) BCC encoder: Only one encoder is used.
- f) Segment parser is omitted.
- i) Segment deparser is omitted.
- l) CSD: Apply CSD for each space-time stream and frequency segment as described in 23.3.8.3.2.
- n) Phase rotation: Apply the appropriate phase rotations as defined in 23.3.7.
- o) IDFT: When in TVHT_MODE_2N or VHT_MODE_4N, allocate the subcarriers for the two IDFTs in each transmit path as described in 23.3.10.11.
- p) Insert GI and apply windowing: Prepend a GI (SHORT_GI or LONG_GI) and apply windowing as defined in 23.3.7.

23.3.4.9.2 Using LDPC

The construction of the Data field in a VHT SU PPDU with LDPC encoding proceeds as defined in 22.3.4.9.2 reading “Clause 23” for references to “Clause 22” except the following:

- f) Segment parser is omitted.
- i) Segment deparser is omitted.
- l) CSD: Apply CSD for each space-time stream and frequency segment as described in 23.3.8.3.2.
- n) Phase rotation: Apply the appropriate phase rotations as defined in 23.3.7. When in TVHT_MODE_2N or VHT_MODE_4N, allocate the subcarriers for the two IDFTs in each transmit path as described in 22.3.10.11.1.
- o) IDFT: When in TVHT_MODE_2N or VHT_MODE_4N, allocate the subcarriers for the two IDFTs in each transmit path as described in 23.3.10.11.
- p) Insert GI and apply windowing: Prepend a GI (SHORT_GI or LONG_GI) and apply windowing as defined in 23.3.7.

23.3.4.10 Construction of the Data field in an MU PPDU

23.3.4.10.1 General

See 22.3.4.10.1.

23.3.4.10.2 Using BCC

A Data field with BCC encoding is constructed using the process defined in 23.3.4.9.1 before the spatial mapping block and repeated for each user that uses BCC encoding.

23.3.4.10.3 Using LDPC

A Data field with LDPC encoding is constructed using the process defined in 23.3.4.9.2 before the spatial mapping block and repeated for each user that uses LDPC encoding.

23.3.4.10.4 Combining to form MU PPDU

The per-user data is combined as defined in 22.3.4.10.4 except the following:

- Spatial mapping: The Q matrix is applied as defined in 23.3.10.11. The combining of all user data is done in this block.
- Phase rotation: Apply the appropriate phase rotations as defined in 23.3.7.
- Insert GI and apply windowing: Prepend a GI (SHORT_GI or LONG_GI) and apply windowing as defined in 23.3.7.
- Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 23.3.7 and 23.3.8 for details.

23.3.5 Modulation and coding scheme (MCS)

The MCS is a value that determines the modulation and coding used in the Data field of the PPDU. It is a compact representation that is carried in the TVHT-SIG-A field for SU PDUs and in the TVHT-SIG-B field for MU PDUs. Rate-dependent parameters for the full set of MCSs are shown in Table 23-26 to Table 23-37 (in 23.5). These tables give rate-dependent parameters for MCSs with indices 0 to 9, with number of spatial streams from 1 to 4 and bandwidth options of one, two, or four BCUs. Equal modulation (EQM) is applied to all streams for a particular user.

Table 23-26 to Table 23-29 show rate-dependent parameters for MCSs for one to four streams for one BCU operation. Table 23-30 to Table 23-33 show rate-dependent parameters for MCSs for one to four streams for dual BCU operation. Table 23-34 to Table 23-37 show rate-dependent parameters for MCSs for one to four streams for quad BCU operation.

23.3.6 Timing-related parameters

Table 23-8 and Table 23-9 define the timing-related parameters for VHT format and location of occupied tones in TVWS bands.

Table 23-8—Timing-related parameters

Parameter	6 MHz	7 MHz	8 MHz	Description
N_{SD}	108	108	108	Number of complex data numbers per BCU
N_{SP}	6	6	6	Number of pilot values per BCU
N_{ST}	114	114	114	Total number of subcarriers per BCU
N_{SR}	58	58	58	Highest data subcarrier index per BCU
Δ_F	$\frac{6 \text{ MHz}}{144} = 41\frac{2}{3} \text{ kHz}$	$\frac{7 \text{ MHz}}{168} = 41\frac{2}{3} \text{ kHz}$	$\frac{8 \text{ MHz}}{144} = 55\frac{5}{9} \text{ kHz}$	Subcarrier frequency spacing
T_{DFT}	24 μs	24 μs	18 μs	IDFT/DFT period
T_{GI}	6 $\mu\text{s} = T_{DFT}/4$	6 $\mu\text{s} = T_{DFT}/4$	4.5 $\mu\text{s} = T_{DFT}/4$	Guard interval duration

The rest of the timing parameters are derived as in Table 22-5 using the definition of T_{DFT} in Table 23-8. Table 23-9 defines the number of occupied tones and their location in all transmission modes. Zero denotes the DC tone of any contiguous segment.

Table 23-9—Tone location

Parameter	TVHT_MODE_1	TVHT_MODE_2C	TVHT_MODE_2N	TVHT_MODE_4C	TVHT_MODE_4N	Description
N_{ST}	114	114	114	114	114	Total number of occupied subcarriers per BCU
N_{TT}	114	228	228	456	456	Total number of occupied subcarriers across all BCUs
Subcarrier index	-58 to -2 and +2 to +58	-130 to -74, -70 to -14, +14 to +70, and +74 to +130	-58 to -2 and +2 to +58 for each BCU	-274 to -218, -214 to -158, -130 to -74, -70 to -14, +14 to +70, +74 to +130, +158 to +214, and +218 to +274	-130 to -74, -70 to -14, +14 to +70, and +74 to +130 for each BCU	Location of occupied subcarriers for 6 MHz and 8 MHz channel units
Subcarrier index	-58 to -2 and +2 to +58	-142 to -86, -82 to -26, +26 to +82, and +86 to +142	-58 to -2 and +2 to +58 for each BCU	-310 to -254, -250 to -194, -142 to -86, -82 to -26, +26 to +82, +86 to +142, +194 to +250, and +254 to +310	-142 to -86, -82 to -26, +26 to +82, and +86 to +142 for each BCU	Location of occupied subcarriers for 7 MHz

Refer to Table 22-6 for the frequency parameters. The definitions in the table are applicable to Clause 23 with the exception that in each transmission mode in Clause 23 $N_{CBPSSI} = N_{CBPSS}$ for SU and MU PPDU.

23.3.7 Mathematical description of signals

For a description of the conventions used for the mathematical description of the signals, see 18.3.2.5.

For all VHT PPDU in TVWS bands transmission modes the signal is transmitted on subcarriers as defined in Table 23-9.

Let

$$f_{c, \text{idx}0} = \text{dot11CurrentChannelCenterFrequencyIndex0 (see Table 23-17)}$$

$$f_{c, \text{idx}1} = \text{dot11CurrentChannelCenterFrequencyIndex1 (see Table 23-17)}$$

$$f_{\text{PW}, \text{idx}} = \text{dot11CurrentPrimaryChannel (see Table 23-17), where TVHT_W refers to a BCU of 6 MHz, 7 MHz, or 8 MHz}$$

$$f_{\text{CH}, \text{start}} = \text{Channel starting frequency given in the operation class (E.1)}$$

When dot11CurrentChannelWidth is TVHT_W, TVHT_2W, TVHT_W+W, TVHT_4W, or TVHT_2W+2W, $f_{\text{PW}, \text{idx}}$ and $f_{c, \text{idx}1}$ shall have the relationship specified in Equation (23-1).

$$f_{\text{PW}, \text{idx}} = f_{c, \text{idx}0} + n_{\text{PW}} \quad (23-1)$$

where

$$N_{\text{PW}} = \begin{cases} 1 & \text{in TVHT_W and TVHT_W+W} \\ 2 & \text{in TVHT_2W and TVHT_2W+2W} \\ 4 & \text{in TVHT_4W} \end{cases}$$

$$n_{\text{PW}} \text{ is an integer with possible range } 0 \leq n_{\text{PW}} \leq N_{\text{PW}} - 1$$

When dot11CurrentChannelWidth is TVHT_W, TVHT_2W, TVHT_W+W, TVHT_4W, or TVHT_2W+2W,

— The primary TVHT_W channel is the channel with TVHT_W bandwidth centered at $f_{\text{CH}, \text{start}} + \text{TVHT_W} \times f_{\text{PW}, \text{idx}}$, where $f_{\text{PW}, \text{idx}}$ is given in Equation (23-1).

When dot11CurrentChannelWidth is TVHT_2W, TVHT_4W, or TVHT_2W+2W,

— The secondary TVHT_W channel is the channel with TVHT_W bandwidth centered at $f_{\text{CH}, \text{start}} + \text{TVHT_W} \times f_{\text{SW}, \text{idx}}$, where $f_{\text{SW}, \text{idx}}$ is given in Equation (23-2).

$$f_{\text{SW}, \text{idx}} = \begin{cases} f_{\text{PW}, \text{idx}} + 1, & \text{if } n_{\text{PW}} \text{ is even} \\ f_{\text{PW}, \text{idx}} - 1, & \text{if } n_{\text{PW}} \text{ is odd} \end{cases} \quad (23-2)$$

When dot11CurrentChannelWidth is TVHT_W+W,

— The secondary TVHT_W channel is the channel with TVHT_W bandwidth centered at $f_{\text{CH}, \text{start}} + \text{TVHT_W} \times f_{\text{SW}, \text{idx}}$, where $f_{\text{SW}, \text{idx}}$ is given in Equation (23-3).

$$f_{\text{SW}, \text{idx}} = f_{c, \text{idx}1} \quad (23-3)$$

When dot11CurrentChannelWidth is TVHT_2W, TVHT_4W, or TVHT_2W+2W,

— The primary TVHT_2W channel is the channel with TVHT_2W bandwidth centered at $f_{\text{CH}, \text{start}} + \text{TVHT_W} \times f_{\text{P2W}, \text{idx}} + 0.5 \times \text{TVHT_W}$ MHz, where $f_{\text{P2W}, \text{idx}}$ is given in Equation (23-4).

— The secondary TVHT_2W channel is the channel with TVHT_2W bandwidth centered at $f_{\text{CH}, \text{start}} + \text{TVHT_W} \times f_{\text{S2W}, \text{idx}} + 0.5 \times \text{TVHT_W}$ MHz, where $f_{\text{S2W}, \text{idx}}$ is given in Equation (23-5).

$$f_{\text{P2W}, \text{idx}} = f_{c, \text{idx}0} + 2 \times n_{\text{P2W}} \quad 0 \leq n_{\text{P2W}} \leq N_{\text{P2W}} - 1 \quad N_{\text{P2W}} = \begin{cases} 1 & \text{in TVHT_2W and TVHT_2W+2W} \\ 2 & \text{in TVHT_4W} \end{cases} \quad (23-4)$$

When dot11CurrentChannelWidth is TVHT_4W,

- The secondary TVHT_2W channel is the channel with TVHT_2W bandwidth centered at $f_{CH, start} + TVHT_W \times f_{S2W, idx} + 0.5 \times TVHT_W$ MHz, where $f_{S2W, idx}$ is given in Equation (23-5).

$$f_{S2W, idx} = \begin{cases} f_{P2W, idx} + 2, & \text{if } n_{P2W} \text{ is even} \\ f_{P2W, idx} - 2, & \text{if } n_{P2W} \text{ is odd} \end{cases} \quad (23-5)$$

When dot11CurrentChannelWidth is TVHT_2W+2W,

- The secondary TVHT_2W channel is the channel with TVHT_2W bandwidth centered at $f_{CH, start} + TVHT_W \times f_{S2W, idx} + 0.5 \times TVHT_W$ MHz, where $f_{S2W, idx}$ is given in Equation (23-3).

The transmitted signal is defined in complex baseband signal notation. The actual transmitted signal is related to the complex baseband signal by the relation shown in Equation (22-11) in Clause 22.

$f_c^{(i_{seg})}$ represents the center frequency of the PPDU transmitted in frequency segment i_{seg} in each transmission mode in Clause 23.

Note that in TVHT_MODE_2C and TVHT_MODE_4C, the gap between the center frequencies of the adjacent segments is as shown in Table 23-9.

Table 23-10 shows $f_c^{(i_{seg})}$ as a function of dot11CurrentChannelWidth.

Table 23-10—Center frequency of a PPDU transmitted in frequency segment i_{Seg}

dot11CurrentChannel Width	CH_BANDWIDTH	$f_c^{(i_{seg})} = f_{CH, start} + TVHT_W \times f_{(i_{seg})} + Correction$	
		$(f_{(0)}, Correction)$	$(f_{(1)}, Correction)$
TVHT_W	TVHT_W	$(f_{c, idx0}, 0)$	—
TVHT_2W	TVHT_W	$(f_{PW, idx}, 0)$	—
	TVHT_2W	$(f_{c, idx0}, 0.5 \times TVHT_W)$	—
TVHT_W+W	TVHT_W	$(f_{PW, idx}, 0)$	—
	TVHT_W+W	$(f_{c, idx0}, 0)$	$(f_{c, idx1}, 0)$
TVHT_4W	TVHT_W	$(f_{PW, idx}, 0)$	—
	TVHT_2W	$(f_{P2W, idx}, 0.5 \times TVHT_W)$	—
	TVHT_4W	$(f_{c, idx0}, 1.5 \times TVHT_W)$	—
TVHT_2W+2W	TVHT_W	$(f_{c, idx0}, 0)$	—
	TVHT_2W	$(f_{c, idx0}, 0.5 \times TVHT_W)$	—
	TVHT_2W+2W	$(f_{c, idx0}, 0.5 \times TVHT_W)$	$(f_{c, idx1}, 0.5 \times TVHT_W)$

NOTE—Transmitted signals in TVHT_MODE_2N and TVHT_MODE_4N may have different impairments such as phase offset or phase noise between the two frequency segments in TVHT_MODE_2N or TVHT_MODE_4N, which is not shown in Equation (22-11) for simplicity. See 23.3.18.3.

The transmitted RF signal is derived by up-converting the complex baseband signal, which consists of several fields. The signal transmitted on frequency segment i_{Seg} of transmit chain i_{TX} is described by Equation (22-12) in 22.3.7. The timing boundaries for the various fields are shown in Figure 22-17.

Each field is defined as the summation of one or more subfields, where each subfield is defined to be an inverse discrete Fourier transform as specified in Equation (22-13) and where references to Table 22-5, Table 22-6, Table 22-8, Table 22-9, Table 22-10, and Table 22-11 are replaced by the corresponding descriptions in Clause 23 including Table 23-8, Table 23-9, Table 23-11, and Table 23-12.

Table 23-11 summarizes the various values of N_{Field}^{Tone} as a function of number of BCUs (TVHT_MODE_1 has one BCU, TVHT_MODE_2C and TVHT_MODE_2N have two BCUs, and TVHT_MODE_4C and TVHT_MODE_4N have four BCUs).

Table 23-11—Tone scaling factor and guard interval duration values for PLCP fields

Field	N_{Field}^{Tone} as a function of the number of BCUs			Guard interval duration
	One	Two	Four	
L-STF	24	48	96	—
L-LTF	104	208	416	T_{GI2}
L-SIG	104	208	416	T_{GI}
VHT-SIG-A	104	208	416	T_{GI}
VHT-STF	24	48	96	-
VHT-LTF	114	228	456	T_{GI}
VHT-SIG-B	114	228	456	T_{GI}
VHT-Data	114	228	484	T_{GI} or T_{GIS} (see NOTE 2)
NON_HT_DUP_OFDM-Data (see NOTE 1)	104	208	416	T_{GI}

NOTE 1—For notational convenience, NON_HT_DUP_OFDM-Data is used as a label for the Data field of a NON_HT PPDU with format type NON_HT_DUP_OFDM.
NOTE 2— T_{GI} denotes guard interval duration when TXVECTOR parameter GI_TYPE equals LONG_GI, T_{GIS} denotes short guard interval duration when TXVECTOR parameter GI_TYPE equals SHORT_GI.

In addition, the parameter $\Upsilon_{k,BW}$ in Equation (22-13) is replaced by $\Upsilon_{k,M}$ as defined in Table 23-12.

Table 23-12—Transmission mode and Gamma sub $_{k,M}$

Transmission mode	$\Upsilon_{k,M}$
TVHT_MODE_1, TVHT_MODE_2N	$\Upsilon_{k,1}$ per segment
TVHT_MODE_2C, TVHT_MODE_4N	$\Upsilon_{k,2}$ per two contiguous segments
TVHT_MODE_4C	$\Upsilon_{k,4}$

For TVHT_MODE_1 and TVHT_MODE_2N PDU transmission,

$$Y_{k,1} = \begin{cases} 1, & k < 0 \\ j, & k \geq 0 \end{cases} \quad (23-6)$$

For TVHT_MODE_2C and TVHT_MODE_4N PDU transmission,

$$Y_{k,2} = \begin{cases} 1, & k < -72 \text{ for 6 MHz and 8 MHz channels, } k < -84 \text{ for 7 MHz channels} \\ -1, & k \geq -72 \text{ for 6 MHz and 8 MHz channels, } k \geq -84 \text{ for 7 MHz channels} \end{cases} \quad (23-7)$$

For TVHT_MODE_4C PDU transmission,

$$Y_{k,4} = \begin{cases} 1, & k < -216 \text{ for 6 MHz and 8 MHz channels, } k < -252 \text{ for 7 MHz channels} \\ -1, & -216 \leq k < 0 \text{ for 6 MHz and 8 MHz channels, } -252 \leq k < 0 \text{ for 7 MHz channels} \\ 1, & 0 \leq k < 72 \text{ for 6 MHz and 8 MHz channels, } 0 \leq k < 84 \text{ for 7 MHz channels} \\ -1, & k \geq 72 \text{ for 6 MHz and 8 MHz channels, } k \geq 84 \text{ for 7 MHz channels} \end{cases} \quad (23-8)$$

23.3.8 TVHT preamble

23.3.8.1 Introduction

A TVHT preamble is defined to carry the required information to operate in either single user or multi-user mode.

23.3.8.2 Non-TVHT portion of VHT format preamble

23.3.8.2.1 Cyclic shift definition for pre-TVHT modulated fields

The cyclic shift value $T_{CS}^{i_{TX}}$ for the L-STF, L-LTF, L-SIG, and VHT-SIG-A fields of the PPDU for transmit chain i_{TX} out of a total of N_{TX} is defined in Table 22-10 with a scaling factor to account for the change in sampling clock frequency. The CSD delay values shall be multiplied by the corresponding correction values for the 6 MHz, 7 MHz, and 8 MHz channels, respectively.

The scaling factor for transmissions over 6 MHz and 7 MHz channels is 7.5.

The scaling factor for transmissions over 8 MHz channels is 5.625.

As an example, the CSD value for antenna-2 with 2-transmit antennas is -200 ns, and the corresponding CSD value for 6 MHz channels is -1.5 us.

23.3.8.2.2 L-STF definition

The L-STF field for each BCU in any transmission mode is defined by Equation (20-9) in 20.3.9.3.3.

The time domain representation of the signal on BCU i_{Seg} in transmit chain i_{TX} is specified in Equation (22-20), where $Y_{k,BW}$ is replaced by $Y_{k,M}$ as defined in Table 23-12 and where N_{SR} is defined in Table 23-8.

23.3.8.2.3 L-LTF definition

The L-LTF field for each BCU in any transmission mode is defined by Equation (20-12) in 20.3.9.3.4.

Note that these equations do not include the phase rotations as defined in Table 23-12.

The time domain representation of the signal in transmit chain i_{TX} is specified in Equation (22-23), where $\Upsilon_{k,BW}$ is replaced by $\Upsilon_{k,M}$ as defined in Table 23-12 and where N_{SR} is defined in Table 23-8.

23.3.8.2.4 L-SIG definition

The L-SIG field is used to communicate data rate and length information. The structure of the L-SIG field is defined in Figure 18-5.

In a VHT PPDU, the RATE field shall be set to the value corresponding to 6 Mb/s in the 20 MHz channel spacing column of Table 18-6.

In a NON_HT_DUP PPDU, the RATE field is defined in 18.3.4.2 using the L_DATARATE parameter in the TXVECTOR.

The LENGTH field shall be set to the value given by Equation (23-9).

$$\text{LENGTH} = [(\text{TXTIME} - (20 \cdot \text{scaling factor})) / (4 \cdot \text{scaling factor})] \times 3 - 3 \quad (23-9)$$

where the scaling factor is defined in 23.3.8.2.1 and TXTIME is defined in 23.4.3. In a non-HT duplicate PPDU, the LENGTH field is defined in 18.3.4.3 using the L_LENGTH parameter in the TXVECTOR.

The time domain waveform of the L-SIG field in each BCU is specified in Equation (22-25) using $N_{20\text{MHz}} = 2$, where $\Upsilon_{k,BW}$ is replaced by $\Upsilon_{k,M}$ as defined in Table 23-12 and where the rest of the variables are specified in 23.3.7.

23.3.8.3 TVHT portion of VHT format preamble

23.3.8.3.1 Introduction

The TVHT portion of the VHT format preamble consists of the TVHT-SIG-A, TVHT-STF, TVHT-LTF, and TVHT-SIG-B fields.

Notational conventions are specified in 22.3.8.2.1.

23.3.8.3.2 Cyclic shift for TVHT modulated fields

The definition, application, and CSD values are defined in 22.3.8.3.2 with scaling factors as defined in 23.3.8.2.1.

23.3.8.3.3 TVHT-SIG-A definition

The TVHT-SIG-A field carries information required to interpret VHT PPDU in TVWS bands and defined in 22.3.8.3.3.

The time domain waveform of the TVHT-SIG-A field in each BCU is specified in Equation (22-28), where $N_{20\text{MHz}} = 2$ and where the rest of the variables are specified in 23.3.7.

Fields in the TVHT-SIG-A fields are the same as in Table 22-12 except for the description B0-B1 (BW) and B10-B21 in TVHT-SIG-A1. Description of B0-B1 is specified in Table 23-13

Table 23-13—B0-B1 (BW) in TVHT-SIG-A1

B0-B1	TVHT_MODE
00	Not used
10	TVHT_MODE_1
01	TVHT_MODE_2C and TVHT_MODE_2N
11	TVHT_MODE_4C and TVHT_MODE_4N

Description of B10-B21 (N_{STS} /Partial AID) is specified as follows:

For an MU PPDU:

N_{STS} is divided into 4 user positions of 3 bits each. User position p , where $0 \leq p \leq 3$, uses bits B(10+3 p)-B(12+3 p). The number of space-time streams for user u is indicated at user position $p = \text{USER_POSITION}[u]$ where $u = 0, 1, \dots, \text{NUM_USER} - 1$ and where the notation $A[b]$ denotes the value of array A at index b . Zero space-time streams are indicated at positions not listed in the USER_POSITION array.

- Set to 0 for 0 space time streams
- Set to 1 for 1 space time stream
- Set to 2 for 2 space time streams
- Set to 3 for 3 space time streams
- Values 4 to 7 are reserved

For an SU PPDU:

B10-B12

- Set to 0 for 1 space time stream
- Set to 1 for 2 space time streams
- Set to 2 for 3 space time streams
- Set to 3 for 4 space time streams
- Values 4 to 7 are reserved

B13-B21

Partial AID: Set to the value of the TXVECTOR parameter PARTIAL_AID. Partial AID provides an abbreviated indication of the intended recipient(s) of the PSDU (see 9.17a).

23.3.8.3.4 TVHT-STF definition

The TVHT-STF field for each BCU in any transmission mode is defined by Equation (22-30) in 22.3.8.3.4.

The time domain waveform of the TVHT-STF field in each BCU is specified in Equation (22-33), where $Y_{k,BW}$ is replaced by $Y_{k,M}$ as defined in Table 23-12 and where N_{SR} is defined in Table 23-8.

23.3.8.3.5 TVHT-LTF definition

The TVHT-LTF field is defined in 22.3.8.3.5.

The TVHT-LTF sequence transmitted for each BCU in any transmission mode is defined by Equation (22-37).

The time domain waveform of the TVHT-LTF field in each BCU is specified in Equation (22-42), where $Y_{k,BW}$ is replaced by $Y_{k,M}$ as defined in Table 23-12 and where N_{SR} is defined in Table 23-8.

23.3.8.3.6 TVHT-SIG-B definition

The TVHT-SIG-B field for each BCU in any transmission mode is as defined in 22.3.8.3.6 for 40 MHz bandwidth.

The 27 TVHT-SIG-B bits are first repeated twice; then BCC is encoded, interleaved, and made into constellations as described by Figure 22-22 and the corresponding text in 22.3.8.3.6. If the channel bandwidth of the current PPDU is TVHT_W, then the IDFT is conducted as defined in 22.3.8.3.6.

The time domain waveform for the TVHT-SIG-B field in each BCU in a VHT PPDU is the same as Equation (22-47) with channel bandwidth being 40 MHz. If the channel bandwidth of the current PPDU is larger than TVHT_W, then the TVHT-SIG-B subcarriers as described above are repeated in each BCU, with appropriate phase rotation factors $Y_{k,M}$ being applied as shown in Table 23-12, before conducting IDFT.

23.3.9 Transmission of NON_HT and HT PPDUs with multiple antennas

23.3.9.1 Transmission of NON_HT PPDUs with more than one antenna

A TVHT STA that transmits a NON_HT PPDU shall apply the cyclic shifts defined in 23.3.8.2.1 for L-STF, L-LTF, and L-SIG fields of the PPDU.

23.3.9.2 Transmission of HT format PPDUs with more than four antennas

Transmission of HT PPDU with any number of antennas is not supported in Clause 23.

23.3.10 Data field

23.3.10.1 General

See 22.3.10.1, with “TVHT” replacing “VHT”.

23.3.10.2 SERVICE field

See 22.3.10.2, with “TVHT” replacing “VHT”.

23.3.10.3 CRC calculation for TVHT-SIG-B

The CRC calculation and insertion is illustrated in Figure 22-23.

The value of the CRC field shall be the 1s complement of Equation (22-59) with the values of N set to 21 for all Modes.

23.3.10.4 Scrambler

See 22.3.10.4 with “TVHT” replacing “VHT”.

23.3.10.5 Coding

See 22.3.10.5 with “TVHT” replacing “VHT”.

23.3.10.6 Stream parser

After coding and puncturing, the data bit streams at the output of the FEC encoders are processed in groups of N_{CBPS} bits. Each of these groups is rearranged into N_{SS} blocks of N_{CBPSS} bits ($N_{SS,u}$ blocks of $N_{CBPSS,u}$ bits in the case of an MU transmission). This operation is referred to as “stream parsing” and is described in 22.3.10.6.

23.3.10.7 Segment parser

The segment parser as described in 22.3.10.7 is not used in Clause 23. All modes of operation use a common interleaver in the case of BCC or use a common tone mapper in the case of LDPC.

23.3.10.8 BCC interleaver

The BCC interleaver and deinterleaver for one BCU (TVHT_MODE_1) is as defined in 22.3.10.8 for 40 MHz.

The BCC interleaver and deinterleaver for TVHT_MODE_2C, TVHT_MODE_2N, TVHT_MODE_4C, and TVHT_MODE_4N reuse the same formulas as described in 22.3.10.8 for 40 MHz with new values for N_{COL} , N_{ROW} , and N_{ROT} as defined in Table 23-14.

Table 23-14—Number of rows and columns in the interleaver

Parameter	TVHT_MODE_1	TVHT_MODE_2C, TVHT_MODE_2N	TVHT_MODE_4C, TVHT_MODE_4N
N_{COL}	18	27	48
N_{ROW}	$6 \times N_{BPSCS}$	$8 \times N_{BPSCS}$	$9 \times N_{BPSCS}$
N_{ROT} ($N_{SS} \leq 4$)	29	46	78

23.3.10.9 Constellation mapping

23.3.10.9.1 General

The mapping between bits at the output of the interleaver and complex constellation points is as described in 22.3.10.9.1.

The streams of complex numbers in frequency subblock l for user u are denoted

$$d_{k,l,n,u}^*, \quad k = 0, 1, \dots, N_{SD} - 1; \quad i = 1, \dots, N_{SS,u}; \quad n = 0, 1, \dots, N_{SYM} - 1;$$

$d \neq 0$ for all transmission modes.

23.3.10.9.2 LDPC tone mapping

The LDPC tone mapping for one BCU (TVHT_MODE_1) is as defined in 22.3.10.9.2 for 40 MHz.

The LDPC tone mapping for TVHT_MODE_2C, TVHT_MODE_2N, TVHT_MODE_4C, and TVHT_MODE_4N reuses the same formulas as described in 22.3.10.9.2 for 40 MHz with values for D_{TM} as defined in Table 23-15.

Table 23-15—LDPC Tone Mapping Distance for each transmission mode

Parameter	TVHT_MODE_1	TVHT_MODE_2C, TVHT_MODE_2N	TVHT_MODE_4C, TVHT_MODE_4N
D_{TM}	6	8	9

For all Clause 23 transmission Modes, the LDPC tone mapping for LDPC-coded streams corresponding to user u is done by permuting the stream of complex numbers

$$d_{k,i,n,l,u}^l; \quad k = 0, 1, \dots, N_{SD} - 1; \quad i = 1, \dots, N_{SS,u}; \quad n = 0, 1, \dots, N_{SYM} - 1; \\ l = 0 \text{ for all transmission modes.}$$

generated by the constellation mappers, to obtain

$$d_{t(k),i,n,l,u}^l; \quad k = 0, 1, \dots, N_{SD} - 1; \quad i = 1, \dots, N_{SS,u}; \quad n = 0, 1, \dots, N_{SYM} - 1; \\ l = 0 \text{ for all transmission modes.}$$

where

$$t(k) = D_{TM} \left(k \bmod \frac{N_{SD}}{D_{TM}} \right) + \left\lfloor \frac{k \cdot D_{TM}}{N_{SD}} \right\rfloor \text{ for all transmission modes}$$

23.3.10.9.3 Segment deparser

The segment deparser is not used in Clause 23 as no segment parser is used in Clause 23.

23.3.10.9.4 Space-time block coding

See 22.3.10.9.4 with “TVHT” replacing “VHT”.

23.3.10.10 Pilot subcarriers

For TVHT_MODE_1 transmission, six pilot tones shall be inserted in subcarriers -53 , -25 , -11 , 11 , 25 , and 53 . The pilots are generated as described in 22.3.10.10 for 40 MHz transmission.

When multiple BCUs are used (TVHT_MODE_2C, TVHT_MODE_2N, TVHT_MODE_4C, and TVHT_MODE_4N), each BCU shall use the same pilot tones, which are generated as described in 22.3.10.10 for 40 MHz transmission.

23.3.10.11 OFDM modulation transmission in VHT format

For TVHT transmissions, the signal from transmit chain i_{TX} , $1 \leq i_{TX} \leq N_{TX}$ shall be as specified in Equation (22-95).

For TVHT_MODE_1 transmission, parameters shall be selected to be the same with 40 MHz VHT transmission as defined in 22.3.10.11.1.

For multi-segment transmissions TVHT_MODE_2C and TVHT_MODE_4C, each frequency segment shall follow the waveform as described in Equation (22-95), and the data and pilot subcarriers are allocated to the IDFT block according to the subcarrier mapping as specified in Table 23-9 in consecutive order from the lowest subcarrier to the highest subcarrier.

For multi-segment transmissions TVHT_MODE_2N and TVHT_MODE_4N, each frequency segment shall follow the waveform as described in Equation (22-95), and the data and pilot subcarriers are allocated by the subcarrier allocation block, as shown in Figure 23-2, to the two IDFT blocks according to the subcarrier mapping as specified in Equation (22-95) and Table 23-9 in consecutive order from the lowest subcarrier to the highest subcarrier in each of the two frequency segments, the lower half of the subcarriers are mapped to the IDFT corresponding to the lower frequency segment, and the upper half of the subcarriers are mapped to the IDFT corresponding to the upper frequency segment.

23.3.10.12 Non-HT duplicate transmission

When the TXVECTOR parameter FORMAT is NON_HT and the TXVECTOR parameter NON_HT_MODULATION is NON_HT_DUP_OFDM, the transmitted PPDU shall be a non-HT duplicate. Multiple BCUs non-HT duplicate transmission is used to transmit to TVHT STAs that may be present in a part of a channel.

For non-HT duplicate transmission, the Data field shall be as defined in 22.3.10.12, with “TVHT” replacing “VHT” and with references to “Clause 23” replacing references to “Clause 22”, using the parameter values defined in Table 23-16. The Data field shall be as defined by Equation (22-100) with following modifications. N_{20MHz} is defined in Table 23-16. $K_{Shift}(i)$ in Equation (22-100) is replaced by $K_{Shift}(i) = (N_{20MHz} - 1 - 2i) \cdot 32 + 8 \cdot \lfloor N_{20MHz}/4 \rfloor + 8 \cdot \lfloor N_{20MHz}/8 \rfloor - (16 \cdot \lfloor i/2 \rfloor)$.

$T_{CS}^{i_{TX}}$ represents the cyclic shift of the transmit chain i_{TX} and is defined in 23.3.8.2.1. $N_{NON_HT_DUP_OFDM_Data}^{Tone}$ is defined in Table 23-16.

Table 23-16—Parameters for Non-HT duplicate transmissions

Parameter	TVHT_MODE_1	TVHT_MODE_2C	TVHT_MODE_2N	TVHT_MODE_4C	TVHT_MODE_4N
N_{20MHz}	2	4	2	8	4
$N_{NON_HT_DUP_OFDM_Data}^{Tone}$	104	208	104	416	208

In addition, the parameter $\Upsilon_{k, BW}$ is replaced by $\Upsilon_{k, M}$ as defined in Table 23-12. For a noncontiguous TVHT_W+W or TVHT_2W+2W non-HT duplicate transmission, data transmission in each frequency segment shall be as defined for a TVHT_W or TVHT_2W non-HT duplicate transmission, respectively.

For the TXVECTOR and RXVECTOR parameter CH_BANDWIDTH_IN_NON_HT, if present, the value CBW40 indicates the TVHT_W bandwidth; the value CBW80 indicates the TVHT_2W or TVHT_W+W bandwidth; the value CBW160 and value CBW80+80 indicate the TVHT_4W or TVHT_2W+2W bandwidth; and the value CBW20 is not allowed.

23.3.11 SU-MIMO and MU-MIMO Beamforming

23.3.11.1 General

SU-MIMO and DL-MU-MIMO beamforming in TVWS band is used as defined in 22.3.11.1 reading “Clause 23” for references to “Clause 22” except for feedback report format described in 8.4.1.48a.

23.3.11.2 Beamforming Feedback Matrix V

Beamforming Feedback Matrix V is constructed as defined in 22.3.11.2 reading “Clause 23” for reference to “Clause 22” except for CSD values defined in 23.3.8.3.2.

23.3.11.3 Group ID

See 22.3.11.4 with “TVHT” replacing “VHT”.

23.3.12 TVHT preamble format for sounding PPDU

The format of a VHT NDP PPDU in TVWS bands is constructed as defined Figure 23-1.

NOTE—The number of VHT-LTF symbols in the NDP is determined by the SU N_{STS} field in VHT-SIG-A.

The VHT NDP PPDU has the following properties:

- Uses the VHT PPDU format but without the Data field.
- Is a VHT SU PPDU as indicated by the VHT-SIG-A field.
- Has the data bits of the VHT-SIG-B field set to a fixed bit pattern (see 23.3.8.3.6).

23.3.13 Regulatory requirements

See 22.3.13.

23.3.14 Channelization

A TVHT channel is specified by the four PLME MIB fields specified in Table 23-17.

Table 23-17—Fields to specify TVHT channels

Field	Meaning
dot11CurrentChannelWidth	Channel width. Possible values represent TVHT_W, TVHT_2W, TVHT_W+W, TVHT_4W, TVHT_2W+2W.
dot11CurrentChannelCenterFrequencyIndex0	In TVHT_MODE_1, TVHT_MODE_2C, and TVHT_MODE_4C operation denotes the center frequency of the lowest TV channel. In TVHT_MODE_2N and TVHT_MODE_4N operation, denotes the center frequency of the lowest TV channel in the frequency segment that contains the primary channel. Valid range is 1 to 200. See Equation (23-10).
dot11CurrentChannelCenterFrequencyIndex1	In TVHT_MODE_2N and TVHT_MODE_4N operation, denotes the center frequency of the lowest TV channel in the frequency segment that does not contain the primary channel. Valid range is 1 to 200. See Equation (23-10). Undefined for TVHT_MODE_1, TVHT_MODE_2C, and TVHT_MODE_4C operation.
dot11CurrentPrimaryChannel	Denotes the location of the primary TVHT_W channel. Valid range is 1 to 200. See Equation (23-11).

Given $\text{dot11CurrentChannelCenterFrequencyIndex0}$ and $\text{dot11CurrentChannelCenterFrequencyIndex1}$, the respective center frequency is given by Equation (23-10).

$$\begin{aligned} \text{Channel center frequency [MHz]} &= \text{Channel starting frequency} \\ &+ \text{TVHT_W} \times \text{dot11CurrentChannelCenterFrequencyIndex} + \text{ChannelCenterFrequencyCorrection} \end{aligned} \quad (23-10)$$

where

Channel starting frequency is given by the Operating Class (E.1) and $\text{dot11CurrentChannelCenterFrequencyIndex}$ is either $\text{dot11CurrentChannelCenterFrequencyIndex0}$ or $\text{dot11CurrentChannelCenterFrequencyIndex1}$ and

ChannelCenterFrequencyCorrection is

- 0 for TVHT_MODE_1 and TVHT_MODE_2N,
- $0.5 \times \text{TVHT_W}$ for TVHT_MODE_2C and TVHT+MODE_4N,
- $1.5 \times \text{TVHT_W}$ for TVHT_MODE_4C.

NOTE—Channel starting frequency is the frequency that results in the regulatory domain's channel number being the RLAN channel number, i.e., the center frequency of the channel for index 0. For example, the center frequency of U.S. TV channel 2 is 57 MHz. The center frequency of U.S. TV channel 2 is obtained by Equation (23-10) as follows: Channel center frequency [MHz] = Channel starting frequency + TVHT_W × dot11CurrentChannelCenterFrequencyIndex + ChannelCenterFrequencyCorrection = (0.045 × 1000) + 6 × 2 + 0 = 57 MHz.

The center frequency of the primary TVHT_W channel is given by Equation (23-11).

$$\begin{aligned} \text{Primary channel center frequency [MHz]} \\ = \text{Channel starting frequency} + \text{TVHT_W} \times \text{dot11CurrentPrimaryChannel} \end{aligned} \quad (23-11)$$

The channel starting frequency is given by the Operating Class (see E.1).

For TVHT_MODE_2N operation, any two non-identical channels may be used.

For TVHT_MODE_4N operation, any two channels that would each be allowed as TVHT_2W channels and whose center frequencies are separated by greater than TVHT_2W (difference between $\text{dot11CurrentChannelCenterFrequencyIndex0}$ and $\text{dot11CurrentChannelCenterFrequencyIndex1}$ corresponds to a frequency difference greater than 2) may be used.

For example, in the United States, a channel specified by

$\text{dot11CurrentChannelWidth} = \text{TVHT_2W}$ (12 MHz)
 $\text{dot11CurrentChannelCenterFrequencyIndex0} = 15$
 $\text{dot11CurrentPrimaryChannel} = 16$

is a 12 MHz channel with a center frequency of 482 MHz and the primary 6 MHz channel centered at 485 MHz.

A channel specified by

$\text{dot11CurrentChannelWidth} = \text{TVHT_4W}$ (24 MHz)
 $\text{dot11CurrentChannelCenterFrequencyIndex0} = 14$
 $\text{dot11CurrentPrimaryChannel} = 17$

is a 24 MHz channel with a center frequency of 482 MHz and the primary 6 MHz channel centered at 491 MHz.

A channel specified by

```
dot11CurrentChannelWidth = TVHT_2W+2W (12+12 MHz)
dot11CurrentChannelCenterFrequencyIndex0 = 15
dot11CurrentChannelCenterFrequencyIndex1 = 40
dot11CurrentPrimaryChannel = 16
```

is an 12+12 MHz channel in which frequency segment 0 has 12 MHz bandwidth and center frequency of 482 MHz. Frequency segment 1 also has 12 MHz bandwidth and center frequency of 632 MHz. The primary 6 MHz channel is centered at 485 MHz.

23.3.15 Transmit RF delay

The transmitter RF delay is defined in 18.3.8.6.

23.3.16 Slot time

The slot time for the TVHT PHY shall be 24 μ s for 6 MHz and 7 MHz channel units and 20 μ s for 8 MHz channel units.

23.3.17 Transmit and receive port impedance

Transmit and receive antenna port impedance for each transmit and receive antenna is defined in 18.3.8.8.

23.3.18 PMD transmit specification

23.3.18.1 Transmit spectrum mask

For transmission in TVHT_MODE_1, TVHT_MODE_2C, and TVHT_MODE_4C, the transmit spectral mask shall be as described for 40 MHz mask PDU in 22.3.18.1 with the frequency axis multiplied by the frequency scaling factor as defined in Table 23-18.

Table 23-18—Spectral mask frequency scaling factor for contiguous transmission

Mode	Scaling for 6 MHz channels	Scaling for 7 MHz channels	Scaling for 8 MHz channels
TVHT_MODE_1	6 / 40	7 / 40	8 / 40
TVHT_MODE_2C	12 / 40	14 / 40	16 / 40
TVHT_MODE_4C	24 / 40	28 / 40	32 / 40

For transmission in mode TVHT_MODE_4N, the transmit spectral mask shall be as described for 80+80 MHz mask PDU in 22.3.18.1 with the frequency axis multiplied by the frequency scaling factor as defined in Table 23-19.

Table 23-19—Spectral mask frequency scaling factor for TVHT_MODE_4N

Mode	Scaling for 6 MHz channels	Scaling for 7 MHz channels	Scaling for 8 MHz channels
TVHT_MODE_4N	12 / 80	14 / 80	16 / 80

NOTE 1—In the presence of additional regulatory restrictions, the device has to meet both the regulatory requirements (measured as defined in the relevant regulation) and the mask defined in this subclause.

NOTE 2—For rules regarding TX center frequency leakage levels, see 23.3.18.4.2.

For a TVHT_W+W mask PDU of VHT or non-HT duplicate format, the overall transmit spectral mask is constructed in the following manner. First, the 40 MHz interim transmit spectral mask shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth of 38 MHz, -20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz frequency offset, and -40 dBr at 60 MHz frequency offset and above. The 40 MHz interim transmit spectral mask for frequency offsets in between 19 MHz and 21 MHz, 21 MHz and 40 MHz, and 40 MHz and 60 MHz shall be linearly interpolated in dB domain from the requirements for 19 MHz, 21 MHz, 40 MHz, and 60 MHz frequency offsets. Then the 40 MHz interim spectral mask frequency points are scaled as defined in Table 23-20 to produce a TVHT_W interim spectral mask. Then, the TVHT_W interim spectral mask is placed on each of the two segments to produce the TVHT_W+W interim spectral mask. Then, for each frequency at which both of the TVHT_W interim spectral masks have values greater than -40 dBr and less than -20 dBr, the sum of the two TVHT_W interim mask values (summed in linear domain) shall be taken as the overall TVHT_W+W interim spectral mask value. Next, for each frequency at which neither of the two TVHT_W interim masks has values greater than or equal to -20 dBr and less than or equal to 0 dBr, the higher value of the two interim masks shall be taken as the overall TVHT_W+W interim mask spectral value. Finally, for any frequency region where the TVHT_W+W interim mask value has not been defined yet, linear interpolation (in dB domain) between the nearest two frequency points with the TVHT_W+W interim spectral mask value defined shall be used to define the TVHT_W+W interim spectral mask value. The transmit spectrum shall not exceed the maximum of the TVHT_W+W interim transmit spectrum mask and -59 dBm/MHz at any frequency offset.

Table 23-20—Spectral mask frequency scaling factor for TVHT_MODE_2N

Mode	Scaling for 6 MHz channels	Scaling for 7 MHz channels	Scaling for 8 MHz channels
TVHT_MODE_2N	6 / 40	7 / 40	8 / 40

Example transmit spectral mask for a TVHT_W+W mask PDU for BCU of 6 MHz and spacing of 12 MHz is shown in Figure 23-4.

23.3.18.2 Spectral flatness

Spectral flatness measurements shall be conducted using BPSK modulated PPDU. See 23.3.18.4.4 for the demodulation procedure of the PPDU as well as the number of PPDU and OFDM symbols to be used for testing.

Let $E_{i,avg}$ denote the average constellation energy of a BPSK modulated subcarrier i in a TVHT data symbol.

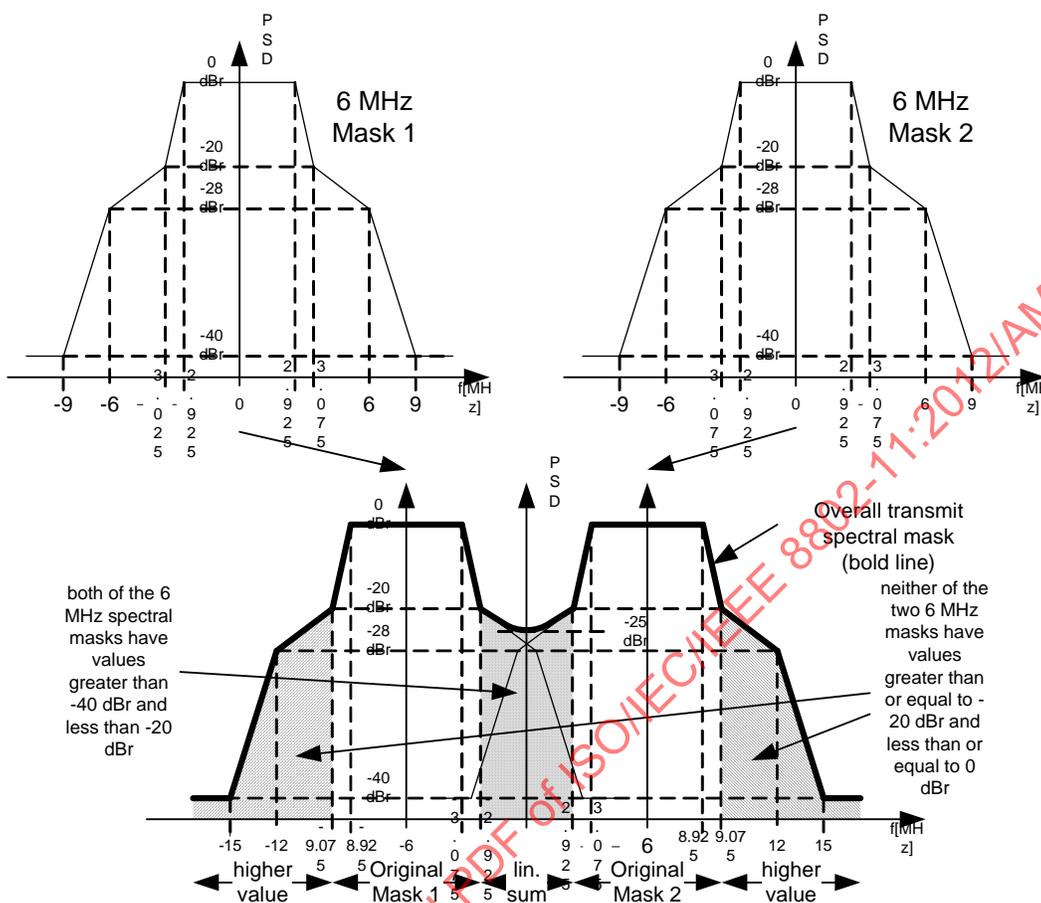


Figure 23-4—Example transmit spectral mask for an 6+6 MHz mask PDU

For TVHT_MODE_1 contiguous non-HT duplicate or TVHT transmission having a bandwidth listed in Table 23-21, $E_{i, avg}$ of each of the subcarriers with indices listed as tested subcarrier indices shall not deviate by more than the specified maximum deviation in Table 23-21 from the average of $E_{i, avg}$ over subcarrier indices listed as averaging subcarrier indices. Averaging of $E_{i, avg}$ is done in the linear domain.

Table 23-21—Maximum transmit spectral flatness deviations

Format	Bandwidth of transmission (MHz)	Averaging subcarrier indices (inclusive)	Tested subcarrier indices (inclusive)	Maximum deviation (dB)
VHT	TVHT_W	-42 to -2 and +2 to +42	-42 to -2 and +2 to +42	±4
			-58 to -43 and +43 to +58	+4/-6
non-HT duplicate	TVHT_W	-42 to -33, -31 to -6, +6 to +31, and +33 to +42	-42 to -33, -31 to -6, +6 to +31, and +33 to +42	±4
			-43 to -58 and +43 to +58	+4/-6

For transmissions consisting of multiple contiguous or noncontiguous BCUs, each BCU shall meet the spectral flatness requirement for TVHT_MODE_1 transmission.

For the spectral flatness test, the transmitting STA shall be configured to use a spatial mapping matrix Q_k (see 23.3.10.11) with flat frequency response. Each output port under test of the transmitting STA shall be connected through a cable to one input port of the testing instrumentation.

23.3.18.3 Transmit center frequency and symbol clock frequency tolerance

The transmitter center frequency maximum allowable deviation shall be ± 25 ppm. Carrier (LO) and symbol clock frequencies for the all transmit chains and BCUs shall be derived from the same reference oscillator.

NOTE—For multi-channel operation, the signal phase of each BCU might be uncorrelated.

The symbol clock frequency tolerance shall be maximum ± 25 ppm. The transmit center frequency and the symbol clock frequency for all transmit antennas and contiguous BCUs shall be derived from the same reference oscillator.

23.3.18.4 Modulation accuracy

23.3.18.4.1 Introduction to modulation accuracy tests

Transmit modulation accuracy specifications are defined in 23.3.18.4.2 and 23.3.18.4.3. The test method is described in 22.3.18.4.4.

23.3.18.4.2 Transmit center frequency leakage

For transmissions using all formats except noncontiguous where the RF LO falls outside both BCUs, TX LO leakage shall meet the following requirements:

- When the RF LO is in the center of the transmitted PPDU BW, the power measured at the center of transmission BW using resolution BW (6/144 or 8/144) MHz shall not exceed the average power per subcarrier of the transmitted PPDU, or equivalently $(P - 10\log_{10}(N_{ST}))$, where P is the transmit power per antenna in dBm and N_{ST} is defined in Table 23-8.
- When the RF LO is not at the center of the transmitted PPDU BW, the power measured at the location of the RF LO using resolution BW (6/144 or 8/144) MHz shall not exceed the maximum of -32 dB relative to the total transmit power and -20 dBm, or equivalently $\max(P - 32, -20)$, where P is the transmit power per antenna in dBm and N_{ST} is defined in Table 23-8.

For transmissions using TVHT_MODE_2N and TVHT_MODE_4N, where the RF LO falls outside both BCUs, the RF LO shall follow the spectral mask requirements as defined in 23.3.18.1.

23.3.18.4.3 Transmitter constellation error

For all modes defined in TVHT PHY, the requirements for transmit constellation RMS error is same as defined in 22.3.18.4.3.

For non-HT duplicate transmissions, requirements defined in 18.3.9.7.4 apply to all parts of the channel bandwidth. The channel bandwidth is determined by the TXVECTOR parameter CH_BANDWIDTH.

23.3.18.4.4 Transmitter modulation accuracy (EVM) test

For the transmit modulation accuracy test, the same methodology as that defined in 22.3.18.4.4 shall be as a BCU of the channel bandwidth. The channel bandwidth is determined by the TXVECTOR parameter CH_BANDWIDTH.

23.3.18.5 Time of Departure accuracy

For Time of Departure accuracy test, the test parameters defined in 22.3.18.5 shall be used for evaluation of TOD except the channel bandwidth, TTR and TIME_OF_DEPARTURE_ACCURACY_TEST_THRESH. The channel bandwidth is determined by TXVECTOR parameter CH_BANDWIDTH in 23.2.2. TTR and TIME_OF_DEPARTURE_ACCURACY_TEST_THRESH shall be multiplied by the corresponding scaling factor for the 6 MHz, 7 MHz, and 8 MHz channels, where the scaling factor is defined in 23.3.8.2.1.

23.3.19 TVHT receiver specification

23.3.19.1 General

See 22.3.19.

23.3.19.2 Receiver minimum input sensitivity

The packet error ratio (PER) shall be less than 10% for a PSDU length of 4096 octets with the rate-dependent input levels listed in Table 23-22. The test in this subclause and the minimum sensitivity levels specified in Table 23-22 apply only to non-STBC modes, long GI, BCC, and VHT PPDU in TVWS bands.

Table 23-22—Receiver minimum input level sensitivity

Modulation	Rate (R)	Minimum sensitivity (dBm)					
		6 or 7 MHz (TVHT_MODE_1)	12/14 MHz (TVHT_MODE_2C) or 6+6/7+7 MHz (TVHT_MODE_2N)	24/28 MHz (TVHT_MODE_4C) or 12+12/14+14 MHz (TVHT_MODE_4N)	8 MHz (TVHT_MODE_1)	16 MHz (TVHT_MODE_2C) or 8+8 MHz (TVHT_MODE_2N)	32 MHz (TVHT_MODE_4C) or 16+16/16+16 MHz (TVHT_MODE_4N)
BPSK	1/2	-88	-85	-82	-87	-84	-81
QPSK	1/2	-85	-82	-79	-84	-81	-78
QPSK	3/4	-83	-80	-77	-82	-79	-76
16-QAM	1/2	-80	-77	-74	-79	-76	-73
16-QAM	3/4	-76	-73	-70	-75	-72	-69
64-QAM	2/3	-72	-69	-66	-71	-68	-65
64-QAM	3/4	-71	-68	-65	-70	-67	-64
64-QAM	5/6	-70	-67	-64	-69	-66	-63
256-QAM	3/4	-65	-62	-59	-64	-61	-58
256-QAM	5/6	-63	-60	-57	-62	-59	-56

23.3.19.3 Adjacent channel rejection

Adjacent channel rejection for TVHT_MODE_1, TVHT_MODE_2C, and TVHT_MODE_4C follow the definition in the first paragraph of 22.3.19.2 and use the values in Table 23-23.

Adjacent channel rejection for TVHT_MODE_2N (TVHT_W+W) and TVHT_MODE_4N (TVHT_2W+2W) follows the definition in the second paragraph of 22.3.19.2, where “80 MHz” is replaced by “TVHT_W” for TVHT_MODE_2N and “TVHT_2W” for TVHT_MODE_4N, and uses the values in Table 23-23.

The definitions in the rest of 22.3.19.2 apply to Clause 23 using the values in Table 23-23.

Table 23-23—Minimum required adjacent and nonadjacent channel rejection levels

Modulation	Rate (R)	Adjacent channel rejection (dB)		Nonadjacent channel rejection (dB)	
		6 MHz, 7 MHz, 8 MHz, 12 MHz (TVHT_MODE_2C), 14 MHz (TVHT_MODE_2C), 16 MHz (TVHT_MODE_2C), 24 MHz (TVHT_MODE_4C), 28 MHz (TVHT_MODE_4C), 32 MHz (TVHT_MODE_4C)	6+6 MHz (TVHT_MODE_2N), 7+7 MHz (TVHT_MODE_2N), 8+8 MHz (TVHT_MODE_2N), 12+12 MHz (TVHT_MODE_4N), 14+14 MHz (TVHT_MODE_4N), 16+16 MHz (TVHT_MODE_4N)	6 MHz, 7 MHz, 8 MHz, 12 MHz (TVHT_MODE_2C), 14 MHz (TVHT_MODE_2C), 16 MHz (MTVHT_MODE_2C), 24 MHz (TVHT_MODE_4C), 28 MHz (TVHT_MODE_4C), 32 MHz (TVHT_MODE_4C)	6+6 MHz (TVHT_MODE_2N), 7+7 MHz (TVHT_MODE_2N), 8+8 MHz (TVHT_MODE_2N), 12+12 MHz (TVHT_MODE_4N), 14+14 MHz (TVHT_MODE_4N), 16+16 MHz (TVHT_MODE_4N)
BPSK	1/2	16	13	32	29
QPSK	1/2	13	10	29	26
QPSK	3/4	11	8	27	24
16-QAM	1/2	8	5	24	21
16-QAM	3/4	4	1	20	17
64-QAM	2/3	0	-3	16	13
64-QAM	3/4	-1	-4	15	12
64-QAM	5/6	-2	-5	14	11
256-QAM	3/4	-7	-10	9	6
256-QAM	5/6	-9	-12	7	4

23.3.19.4 Nonadjacent channel rejection

Nonadjacent channel rejection for TVHT_MODE_1, TVHT_MODE_2C, and TVHT_MODE_4C channels follows the definition in the first paragraph of 22.3.19.3 and use the values in Table 23-23.

Nonadjacent channel rejection for TVHT_MODE_2N (TVHT_W+W) and TVHT_MODE_4N (TVHT_2W+2W) follows the definition in the second paragraph of 22.3.19.3, where “80 MHz” is replaced by “TVHT_W” for TVHT_MODE_2N and “TVHT_2W” for TVHT_MODE_4N, and uses the values in Table 23-23.

The definitions in the rest of 22.3.19.3 apply to Clause 23 using the values in Table 23-23.

23.3.19.5 Receiver maximum input level

The receiver shall provide a maximum PER of 10% at a PSDU length of 4096 octets, for a maximum input level of -20 dBm, measured at each antenna for any baseband TVHT modulation.

23.3.19.6 CCA sensitivity

23.3.19.6.1 General

The thresholds in this subclause are compared with the signal level at each receiving antenna.

23.3.19.6.2 CCA sensitivity for operating classes requiring CCA-ED

For the operating classes requiring CCA-Energy Detect (CCA-ED), CCA shall also detect a medium busy condition when CCA-ED detects a channel busy condition.

For improved spectrum sharing, CCA-ED is required in some bands. The behavior class indicating CCA-ED is given in Table D-2. The operating classes requiring the corresponding CCA-ED behavior class are given in E.1. A STA that is operating within an operating class that requires CCA-ED shall operate with CCA-ED. The CCA-ED is not required for license-exempt operation in any band.

CCA-ED shall indicate a channel busy condition when the received signal strength exceeds the CCA-ED threshold as given by dot11OFDMEDThreshold for the primary TVHT_W channel and the secondary TVHT_W channel and dot11OFDMEDThreshold+3 dB for the secondary TVHT_2W channel. The CCA-ED thresholds for the operating classes requiring CCA-ED are subject to the criteria in D.2.5.

NOTE—The requirement to issue a CCA signal busy as stated in 23.3.19.6.3 and 23.3.19.6.4 is a mandatory energy detect requirement on all Clause 23 receivers. Support for CCA-ED is an additional requirement that relates specifically to the sensitivities defined in D.2.5.

23.3.19.6.3 CCA sensitivity for signals occupying the primary channel

The PHY shall issue a PHY-CCA.indication(BUSY, {primary}) if one of the conditions listed in Table 23-24 is met in an otherwise idle TVHT_W (TVHT_MODE_1), TVHT_2W (TVHT_MODE_2C), TVHT_4W (TVHT_MODE_4C), TVHT_W+W (TVHT_MODE_2N), and TVHT_2W+2W (TVHT_MODE_4N) operating channel width. With $>90\%$ probability, the PHY shall detect the start of a PPDU that occupies at least the primary TVHT_W channel under the conditions listed in Table 23-24 within a period of aCCATime (see 23.4.4) and hold the CCA signal busy (PHY_CCA.indicate(BUSY, channel-list)) for the duration of the PPDU.

The receiver shall issue a PHY-CCA.indication(BUSY, {primary}) for any signal that exceeds a threshold equal to 20 dB above the minimum modulation and coding rate sensitivity ($-88 + 20 = -68$ dBm in the case of 6 MHz channel) in the primary TVHT_W channel within a period of aCCATime after the signal arrives at the receiver's antenna(s); then the receiver shall not issue a PHY-CCA.indication(BUSY, {secondary}), PHY-CCA.indication(BUSY, {secondaryTVHT_2W}), or PHY-CCA.indication(IDLE) while the threshold continues to be exceeded.

Table 23-24—Conditions for CCA BUSY on the primary channel

Frequency segment width	Conditions
6 MHz	The start of a 6 MHz non-HT duplicate or VHT PPDU in TVWS bands in the primary 6 MHz channel at or above -88 dBm.
7 MHz	The start of a 7 MHz non-HT duplicate or VHT PPDU in TVWS bands in the primary 7 MHz channel at or above -88 dBm.
8 MHz	The start of a 8 MHz non-HT duplicate or VHT PPDU in TVWS bands in the primary 8 MHz channel at or above -87 dBm.

23.3.19.6.4 CCA sensitivity for signals not occupying the primary channel

The PHY shall issue a PHY-CCA.indication(BUSY, {secondary}) if the conditions for issuing PHY-CCA.indication(BUSY, {primary}) are not present and one of the following conditions is present in an otherwise idle TVHT_W (TVHT_MODE_1), TVHT_2W (TVHT_MODE_2C), TVHT_4W (TVHT_MODE_4C), TVHT_W+W (TVHT_MODE_2N), and TVHT_2W+2W (TVHT_MODE_4N) operating channel width:

- Any signal within the secondary channel at or above a threshold (-68 dBm for 6 MHz, -68 dBm for 7 MHz, and -67 dBm for 8 MHz) within a period of aCCATime after the signal arrives at the receiver's antenna(s); then the PHY shall not issue a PHY-CCA.indication(BUSY, {secondaryTVHT_2W}) or PHY-CCA.indication(IDLE) while the threshold continues to be exceeded.
- A TVHT_W non-HT duplicate or VHT PPDU in TVWS bands detected in the secondary channel at or above a threshold (-81 dBm for 6 MHz, -81 dBm for 7 MHz, and -80 dBm for 8 MHz) with $>90\%$ probability within a period aCCAMidTime (see 23.4.4).

The PHY shall issue a PHY-CCA.indication(BUSY, {secondaryTVHT_2W}) if the conditions for issuing PHY-CCA.indication(BUSY, {primary}) and PHY-CCA.indication(BUSY, {secondary}) are not present and one of the following conditions is present in an otherwise idle TVHT_2W (TVHT_MODE_2C), TVHT_4W (TVHT_MODE_4C), TVHT_W+W (TVHT_MODE_2N), and TVHT_2W+2W (TVHT_MODE_4N) operating channel width:

- Any signal within the secondary TVHT_2W channel at or above a threshold (-65 dBm for 12 MHz, -65 dBm for 14 MHz, and -64 dBm for 16 MHz) within a period of aCCATime after the signal arrives at the receiver's antenna(s); then the PHY shall not issue a PHY-CCA.indication(IDLE) while the threshold continues to be exceeded.
- A TVHT_2W non-HT duplicate or VHT PPDU in TVWS bands detected in the secondary TVHT_2W channel at or above a threshold (-78 dBm for 6+6 MHz, -78 dBm for 7+7 MHz, and -77 dBm for 8+8 MHz or 16 MHz) with $>90\%$ probability within a period aCCAMidTime (see 23.4.4).
- A TVHT_W non-HT duplicate or VHT PPDU in TVWS bands detected in any TVHT_W subchannel of the secondary TVHT_2W channel at or above a threshold (-81 dBm for 6 MHz, -81 dBm for 7 MHz, and -80 dBm for 8 MHz) with $>90\%$ probability within a period aCCAMidTime.

23.3.19.7 RSSI

See 22.3.19.6 with "TVHT" replacing "VHT".

23.3.20 PLCP transmit procedure

See 22.3.20 with “TVHT” replacing “VHT”.

23.3.21 PLCP receive procedure

See 22.3.21 with “TVHT” replacing “VHT”.

23.4 TVHT PLME**23.4.1 PLME_SAP sublayer management primitives**

See 22.4.1 with “TVHT” replacing “VHT”.

23.4.2 PHY MIB

See 22.4.2 with “tvht(10)” replacing “vht(9)”, “TVHT” replacing “VHT”, and “In4W” replacing “In80” and with the removal of “dot11VHTShortGIOptionIn160and80p80Implemented” and “dot11VHTShortGIOptionIn-160and80p80Activated”.

23.4.3 TXTIME and PSDU_LENGTH calculation

See 22.4.3 with “TVHT” replacing “VHT”.

23.4.4 PHY characteristics

The static TVHT PHY characteristics, provided through the PLME-CHARACTERISTICS service primitive, shall be as shown in Table 20-25 except parameters listed in Table 23-25 and aPreambleLength, aSTFOneLength, aSTFTwoLength, aLTFOneLength, aLTFTwoLength, aPLCPHeaderLength, and aPLCPSigTwoLength, which are multiplied by 7.5 for 6 MHz and 7 MHz unit channels and by 5.625 for 8 MHz unit channels. The definitions for these characteristics are given in 6.5.

Table 23-25—TVHT PHY characteristics

Characteristics	Value
aSlotTime	24 μ s (BCUs: 6 MHz or 7 MHz) 20 μ s (BCUs: 8 MHz)
aSifsTime	120 μ s (BCUs: 6 MHz or 7 MHz) 90 μ s (BCUs: 8 MHz)
aSignalExtension	0 μ s
aCCATime	< 15 μ s (6 MHz or 7 MHz) < 11.25 μ s (8 MHz)
aCCAMidTime	< 94 μ s (6 MHz or 7 MHz) < 70 μ s (8 MHz)
aAirPropagationTime	3 μ s
aPPDUMaxTime	20 ms
aPSDUMaxLength	1 065 600 octets (see NOTE)
NOTE—This is the maximum length in octets for SU PPDU with a bandwidth of 32 MHz or 16+16 MHz, MCS9 and 4 spatial streams, limited by 740 possible Short GI data symbols in aPPDUMaxTime.	

23.5 Parameters for TVHT MCSs

The rate-dependent parameters for one BCU mode (6 MHz, 7 MHz, and/or 8 MHz) and corresponding two and four BCU modes with $N_{SS} = 1, \dots, 4$ are given in Table 23-26 through Table 23-37. Support for MCS 8 and 9 (when valid) is optional in all cases. A TVHT STA shall support single spatial stream MCSs within the range MCS 0 to MCS 7 for all channel widths for which it has indicated support regardless of the Tx or Rx Highest Supported Data Rate subfield values in the TVHT Supported MCS Set field. When more than one spatial stream is supported, the Tx or Rx Highest Supported Data Rate subfield values in the TVHT Supported MCS Set field may result in a reduced MCS range (cut-off) for $N_{SS} = 2, \dots, 4$. Support for 6 MHz, 7 MHz, or 8 MHz with $N_{SS} = 1$ is mandatory. Support for 6 MHz, 7 MHz, and 8 MHz with $N_{SS} = 2, \dots, 4$ is optional. Support for two BCU modes with 12 MHz, 14 MHz, and 16 MHz or with 6+6 MHz, 7+7 MHz, and 8+8 MHz with $N_{SS} = 1, \dots, 4$ is optional. Support for four BCU modes with 24 MHz, 28 MHz, and 32 MHz or with 12+12 MHz, 14+14 MHz, and 16+16 MHz with $N_{SS} = 1, \dots, 4$ is optional. N_{ES} values were chosen to yield an integer number of punctured blocks per OFDM symbol. Note that N_{ES} values are 1 for all Clause 23 modulations.

Table 23-26 through Table 23-37 define TVHT MCSs not only for SU transmission but also for user u of MU transmission. In the case of TVHT MCSs for MU transmission, the parameters, N_{SS} , R , N_{BPSCS} , N_{CBPS} , and N_{DBPS} are replaced with $N_{SS,u}$, R_u , $N_{BPSCS,u}$, $N_{CBPS,u}$ and $N_{DBPS,u}$ respectively.

Table 23-26—TVHT MCSs for TVHT_MODE_1, $N_{SS} = 1$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	108	6	108	54	1.8	2.0	2.4	2.7
1	QPSK	1/2	2	108	6	216	108	3.6	4.0	4.8	5.3
2	QPSK	3/4	2	108	6	216	162	5.4	6.0	7.2	8.0
3	16-QAM	1/2	4	108	6	432	216	7.2	8.0	9.6	10.7
4	16-QAM	3/4	4	108	6	432	324	10.8	12.0	14.4	16.0
5	64-QAM	2/3	6	108	6	648	432	14.4	16.0	19.2	21.3
6	64-QAM	3/4	6	108	6	648	486	16.2	18.0	21.6	24.0
7	64-QAM	5/6	6	108	6	648	540	18.0	20.0	24.0	26.7
8	256-QAM	3/4	8	108	6	864	648	21.6	24.0	28.8	32.0
9	256-QAM	5/6	8	108	6	864	720	24.0	26.7	32.0	35.6

Table 23-27—TVHT MCSs for TVHT_MODE_1, $N_{SS} = 2$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	108	6	216	108	3.6	4.0	4.8	5.3
1	QPSK	1/2	2	108	6	432	216	7.2	8.0	9.6	10.7
2	QPSK	3/4	2	108	6	432	324	10.8	12.0	14.4	16.0
3	16-QAM	1/2	4	108	6	864	432	14.4	16.0	19.2	21.3
4	16-QAM	3/4	4	108	6	864	648	21.6	24.0	28.8	32.0
5	64-QAM	2/3	6	108	6	1296	864	28.8	32.0	38.4	42.7
6	64-QAM	3/4	6	108	6	1296	972	32.4	36.0	43.2	48.0
7	64-QAM	5/6	6	108	6	1296	1080	36.0	40.0	48.0	53.3
8	256-QAM	3/4	8	108	6	1728	1296	43.2	48.0	57.6	64.0
9	256-QAM	5/6	8	108	6	1728	1440	48.0	53.3	64.0	71.1

Table 23-28—TVHT MCSs for TVHT_MODE_1, $N_{SS} = 3$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	108	6	324	162	5.4	6.0	7.2	8.0
1	QPSK	1/2	2	108	6	648	324	10.8	12.0	14.4	16.0
2	QPSK	3/4	2	108	6	648	486	16.2	18.0	21.6	24.0
3	16-QAM	1/2	4	108	6	1296	648	21.6	24.0	28.8	32.0
4	16-QAM	3/4	4	108	6	1296	972	32.4	36.0	43.2	48.0
5	64-QAM	2/3	6	108	6	1944	1296	43.2	48.0	57.6	64.0
6	64-QAM	3/4	6	108	6	1944	1458	48.6	54.0	64.8	72.0
7	64-QAM	5/6	6	108	6	1944	1620	54.0	60.0	72.0	80.0
8	256-QAM	3/4	8	108	6	2592	1944	64.8	72.0	86.4	96.0
9	256-QAM	5/6	8	108	6	2592	2160	72.0	80.0	96.0	106.7

Table 23-29—TVHT MCSs for TVHT_MODE_1, $N_{SS} = 4$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	108	6	432	216	7.2	8.0	9.6	10.7
1	QPSK	1/2	2	108	6	864	432	14.4	16.0	19.2	21.3
2	QPSK	3/4	2	108	6	864	648	21.6	24.0	28.8	32.0
3	16-QAM	1/2	4	108	6	1728	864	28.8	32.0	38.4	42.7
4	16-QAM	3/4	4	108	6	1728	1296	43.2	48.0	57.6	64.0
5	64-QAM	2/3	6	108	6	2592	1728	57.6	64.0	76.8	85.3
6	64-QAM	3/4	6	108	6	2592	1944	64.8	72.0	86.4	96.0
7	64-QAM	5/6	6	108	6	2592	2160	72.0	80.0	96.0	106.7
8	256-QAM	3/4	8	108	6	3456	2592	86.4	96.0	115.2	128.0
9	256-QAM	5/6	8	108	6	3456	2880	96.0	106.7	128.0	142.2

Table 23-30—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, $N_{SS} = 1$

MCS Index	Modulation	R	N_{BPSCS}	$N_{SD} \cdot N_{Seg}$	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	216	12	216	108	3.6	4.0	4.8	5.3
1	QPSK	1/2	2	216	12	432	216	7.2	8.0	9.6	10.7
2	QPSK	3/4	2	216	12	432	324	10.8	12.0	14.4	16.0
3	16-QAM	1/2	4	216	12	864	432	14.4	16.0	19.2	21.3
4	16-QAM	3/4	4	216	12	864	648	21.6	24.0	28.8	32.0
5	64-QAM	2/3	6	216	12	1296	864	28.8	32.0	38.4	42.7
6	64-QAM	3/4	6	216	12	1296	972	32.4	36.0	43.2	48.0
7	64-QAM	5/6	6	216	12	1296	1080	36.0	40.0	48.0	53.3
8	256-QAM	3/4	8	216	12	1728	1296	43.2	48.0	57.6	64.0
9	256-QAM	5/6	8	216	12	1728	1440	48.0	53.3	64.0	71.1

Table 23-31—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, $N_{SS} = 2$

MCS Index	Modulation	R	N_{BPSCS}	$N_{SD} \cdot N_{Seg}$	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	216	12	432	216	7.2	8.0	9.6	10.7
1	QPSK	1/2	2	216	12	864	432	14.4	16.0	19.2	21.3
2	QPSK	3/4	2	216	12	864	648	21.6	24.0	28.8	32.0
3	16-QAM	1/2	4	216	12	1728	864	28.8	32.0	38.4	42.7
4	16-QAM	3/4	4	216	12	1728	1296	43.2	48.0	57.6	64.0
5	64-QAM	2/3	6	216	12	2592	1728	57.6	64.0	76.8	85.3
6	64-QAM	3/4	6	216	12	2592	1944	64.8	72.0	86.4	96.0
7	64-QAM	5/6	6	216	12	2592	2160	72.0	80.0	96.0	106.7
8	256-QAM	3/4	8	216	12	3456	2592	86.4	96.0	115.2	128.0
9	256-QAM	5/6	8	216	12	3456	2880	96.0	106.7	128.0	142.2

Table 23-32—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, $N_{SS} = 3$

MCS Index	Modulation	R	N_{BPSCS}	$N_{SD} \cdot N_{Seg}$	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	216	12	648	324	10.8	12.0	14.4	16.0
1	QPSK	1/2	2	216	12	1296	648	21.6	24.0	28.8	32.0
2	QPSK	3/4	2	216	12	1296	972	32.4	36.0	43.2	48.0
3	16-QAM	1/2	4	216	12	2592	1296	43.2	48.0	57.6	64.0
4	16-QAM	3/4	4	216	12	2592	1944	64.8	72.0	86.4	96.0
5	64-QAM	2/3	6	216	12	3888	2592	86.4	96.0	115.2	128.0
6	64-QAM	3/4	6	216	12	3888	2916	97.2	108.0	129.6	144.0
7	64-QAM	5/6	6	216	12	3888	3240	108.0	120.0	144.0	160.0
8	256-QAM	3/4	8	216	12	5184	3888	129.6	144.0	172.8	192.0
9	256-QAM	5/6	8	216	12	5184	4320	144.0	160.0	192.0	213.3

Table 23-33—TVHT MCSs for TVHT_MODE_2C and TVHT_MODE_2N, $N_{SS} = 4$

MCS Index	Modulation	R	N_{BPSCS}	$\frac{N_{SD}}{N_{Seg}}$	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	216	12	864	432	14.4	16.0	19.2	21.3
1	QPSK	1/2	2	216	12	1728	864	28.8	32.0	38.4	42.7
2	QPSK	3/4	2	216	12	1728	1296	43.2	48.0	57.6	64.0
3	16-QAM	1/2	4	216	12	3456	1728	57.6	64.0	76.8	85.3
4	16-QAM	3/4	4	216	12	3456	2592	86.4	96.0	115.2	128.0
5	64-QAM	2/3	6	216	12	5184	3456	115.2	128.0	153.6	170.7
6	64-QAM	3/4	6	216	12	5184	3888	129.6	144.0	172.8	192.0
7	64-QAM	5/6	6	216	12	5184	4320	144.0	160.0	192.0	213.3
8	256-QAM	3/4	8	216	12	6912	5184	172.8	192.0	230.4	256.0
9	256-QAM	5/6	8	216	12	6912	5760	192.0	213.3	256.0	284.4

Table 23-34—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, $N_{SS} = 1$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	432	24	432	216	7.2	8.0	9.6	10.7
1	QPSK	1/2	2	432	24	864	432	14.4	16.0	19.2	21.3
2	QPSK	3/4	2	432	24	864	648	21.6	24.0	28.8	32.0
3	16-QAM	1/2	4	432	24	1728	864	28.8	32.0	38.4	42.7
4	16-QAM	3/4	4	432	24	1728	1296	43.2	48.0	57.6	64.0
5	64-QAM	2/3	6	432	24	2592	1728	57.6	64.0	76.8	85.3
6	64-QAM	3/4	6	432	24	2592	1944	64.8	72.0	86.4	96.0
7	64-QAM	5/6	6	432	24	2592	2160	72.0	80.0	96.0	106.7
8	256-QAM	3/4	8	432	24	3456	2592	86.4	96.0	115.2	128.0
9	256-QAM	5/6	8	432	24	3456	2880	96.0	106.7	128.0	142.2

Table 23-35—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, $N_{SS} = 2$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	432	24	864	432	14.4	16.0	19.2	21.3
1	QPSK	1/2	2	432	24	1728	864	28.8	32.0	38.4	42.7
2	QPSK	3/4	2	432	24	1728	1296	43.2	48.0	57.6	64.0
3	16-QAM	1/2	4	432	24	3456	1728	57.6	64.0	76.8	85.3
4	16-QAM	3/4	4	432	24	3456	2592	86.4	96.0	115.2	128.0
5	64-QAM	2/3	6	432	24	5184	3456	115.2	128.0	153.6	170.7
6	64-QAM	3/4	6	432	24	5184	3888	129.6	144.0	172.8	192.0
7	64-QAM	5/6	6	432	24	5184	4320	144.0	160.0	192.0	213.3
8	256-QAM	3/4	8	432	24	6912	5184	172.8	192.0	230.4	256.0
9	256-QAM	5/6	8	432	24	6912	5760	192.0	213.3	256.0	284.4

Table 23-36—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, $N_{SS} = 3$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	432	24	1296	648	21.6	24.0	28.8	32.0
1	QPSK	1/2	2	432	24	2592	1296	43.2	48.0	57.6	64.0
2	QPSK	3/4	2	432	24	2592	1944	64.8	72.0	86.4	96.0
3	16-QAM	1/2	4	432	24	5184	2592	86.4	96.0	115.2	128.0
4	16-QAM	3/4	4	432	24	5184	3888	129.6	144.0	172.8	192.0
5	64-QAM	2/3	6	432	24	7776	5184	172.8	192.0	230.4	256.0
6	64-QAM	3/4	6	432	24	7776	5832	194.4	216.0	259.2	288.0
7	64-QAM	5/6	6	432	24	7776	6480	216.0	240.0	288.0	320.0
8	256-QAM	3/4	8	432	24	10368	7776	259.2	288.0	345.6	384.0
9	256-QAM	5/6	8	432	24	10368	8640	288.0	320.0	384.0	426.7

Table 23-37—TVHT MCSs for TVHT_MODE_4C and TVHT_MODE_4N, $N_{SS} = 4$

MCS Index	Modulation	R	N_{BPSCS}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s) for 6 MHz or 7 MHz		Data rate (Mb/s) for 8 MHz	
								6.0 μ s GI	3.0 μ s GI	4.5 μ s GI	2.25 μ s GI
0	BPSK	1/2	1	432	24	1728	864	28.8	32.0	38.4	42.7
1	QPSK	1/2	2	432	24	3456	1728	57.6	64.0	76.8	85.3
2	QPSK	3/4	2	432	24	3456	2592	86.4	96.0	115.2	128.0
3	16-QAM	1/2	4	432	24	6912	3456	115.2	128.0	153.6	170.7
4	16-QAM	3/4	4	432	24	6912	5184	172.8	192.0	230.4	256.0
5	64-QAM	2/3	6	432	24	10368	6912	230.4	256.0	307.2	341.3
6	64-QAM	3/4	6	432	24	10368	7776	259.2	288.0	345.6	384.0
7	64-QAM	5/6	6	432	24	10368	8640	288.0	320.0	384.0	426.7
8	256-QAM	3/4	8	432	24	13824	10368	345.6	384.0	460.8	512.0
9	256-QAM	5/6	8	432	24	13824	11520	384.0	426.7	512.0	568.9

IECNORM.COM : Click to view the full PDF of ISO/IEC/IEEE 8802-11:2012/Amd.5:2015

Annex B

(normative)

Protocol Implementation Conformance Statement (PICS) proforma

B.2 Abbreviations and special symbols

B.2.2 General abbreviations for Item and Support columns

Insert the following abbreviation into B.2.2:

TVHTM	television very high throughput medium access control (MAC) features
TVHTP	television very high throughput physical layer (PHY) features
TVWS	television white spaces
WS	white spaces

B.4 PICS proforma—IEEE Std. 802.11-2012

Change the following rows of the B.4.3 table, and insert the new row in numeric order as shown:

B.4.3 IUT configuration

Item	IUT configuration	References	Status	Support
*CF10	Is spectrum management operation supported?	8.4.1.4, 10.6	(CF6 OR CF16 OR CF29 OR CF30): O	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
*CF11	Operating classes capability implemented	8.4.2.10, 18.3.8.4.2, 18.3.8.6, 18.4.2, Annex D	(CF6 OR CF16 OR CF30) & CF8 & CF10:O	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
*CF12	Quality of service (QoS) supported	9.19, 9.21, 4.3.10, 4.3.15.3	O (CF16 OR CF21 OR CF22): M CF30:M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
...				
*CF30	TVWS Operation	Annex D, Annex E	O	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

Change the following rows of the B.4.4.1 table, and insert the new rows in numeric order as shown:

B.4.4.1 MAC protocol capabilities

Item	Protocol capability	References	Status	Support
PC9	Multirate support	9.7, Annex J	M	Yes <input type="checkbox"/> No <input type="checkbox"/>
<u>PC9.1</u>	<u>Rate selection using Rx Supported VHT-MCS and NSS Set / Tx Supported VHT-MCS and NSS Set</u>	<u>9.7.11.1,</u> <u>9.7.11.2</u>	<u>CF29:M</u> <u>CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
<u>PC9.2</u>	<u>Cropping of VHT Basic MCS Set</u>	<u>9.7.11.3</u>	<u>CF29:O</u> <u>CF30:O</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/>
...				
PC31	Support transmission of CTS-to-self sequence as described in the references	9.3.2.11	CF9:O <u>CF30:O</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
PC32	Support reception of CTS-to-self sequence as described in the references	9.3.2.11	CF9:M <u>CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

Change the following rows of the B.4.4.2 table, and insert the new rows in numeric order as shown:

B.4.4.2 MAC frames

Item	MAC frame	References	Status	Support
...	Is transmission of the following MAC frames supported?	Clause 8, Annex J		
<u>FT27</u>	<u>VHT NDP Announcement</u>	<u>Clause 8</u>	<u>VHTM4.1:M</u> <u>TVHTM4.1:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
<u>FT28</u>	<u>Beamforming Report Poll</u>	<u>Clause 8</u>	<u>VHTM4.1:O</u> <u>VHTM4.3:M</u> <u>TVHTM4.1:O</u> <u>TVHTM4.3:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
...	Is reception of the following MAC frames supported?	Clause 8, Annex J		
<u>FR27</u>	<u>VHT NDP Announcement</u>	<u>Clause 8</u>	<u>VHTM4.2:M</u> <u>TVHT4.2:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
<u>FR28</u>	<u>Beamforming Report Poll</u>	<u>Clause 8</u>	<u>VHTM4.2:O</u> <u>VHTM4.4:M</u> <u>TVHTM4.2:O</u> <u>TVHTM4.4:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
<u>FR29</u>	<u>Reception of Operating Mode Notification frame and Operating Mode Notification element</u>	<u>8.5.23.4,</u> <u>8.4.2.168,</u> <u>10.41</u>	<u>O</u> <u>CF29:M</u> <u>CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

Change the following rows of the B.4.12 table:

B.4.12 Spectrum management extensions

Item	IUT configuration	References	Status	Support
SM1	Country, Power Constraint, and transmit power control (TPC) Report elements included in Beacon and Probe Response frames	8.3.3.2, 8.3.3.10, 8.4.2.10, 8.4.2.14, 8.4.2.17	CF10: M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM1.1	VHT Transmit Envelope element(s) in Beacon and Probe Response frames	8.4.2.164	CF10 AND CF29:M <u>CF10 AND CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20	Channel switch procedure			
SM20.1	Transmission of channel switch announcement and channel switch procedure by an AP	10.9.8	(CF1 and CF10):M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20.2	Transmission of channel switch announcement and channel switch procedure by a STA	10.9.8	(CF2.2 and CF10):M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20.3	Reception of channel switch announcement and channel switch procedure by a STA	10.9.8	CF10:M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20.4	Transmission of Wide Bandwidth Channel Switch element in Channel Announcement frame and transmission of Wide Bandwidth Channel Switch subelement in Channel Switch Wrapper element in Beacon/Probe Response frames, and associated channel switching procedure by an AP	10.39.4	(CF1 and CF10 and CF29):M <u>(CF1 and CF10 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20.5	Transmission of Wide Bandwidth Channel Switch element in Channel Announcement frame and transmission of Wide Bandwidth Channel Switch subelement in Channel Switch Wrapper element in Beacon/Probe Response frames, and associated channel switching procedure by a STA.	10.39.4	(CF2.2 and CF10 and CF29):M <u>(CF2.2 and CF10 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

B.4.12 Spectrum management extensions (continued)

Item	IUT configuration	References	Status	Support
SM20.6	Reception of Wide Bandwidth Channel Switch element in Channel Announcement frame and reception of Wide Bandwidth Channel Switch subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated channel switching procedure by a STA.	10.39.4	(CF10 and CF29):M <u>(CF10 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20.7	Transmission of New VHT Transmit Power Envelope element in Channel Announcement frame and transmission of New VHT Transmit Power Envelope subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated channel switching procedure by an AP.	10.39.4	(CF1 and CF10 and CF29):M <u>(CF1 and CF10 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20.8	Transmission of New VHT Transmit Power Envelope element in Channel Announcement frame and transmission of New VHT Transmit Power Envelope subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated channel switching procedure by a STA.	10.39.4	(CF2.2 and CF10 and CF29):M <u>(CF2.2 and CF10 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
SM20.9	Reception of New VHT Transmit Power Envelope element in Channel Announcement frame and reception of New VHT Transmit Power Envelope subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated channel switching procedure by a STA.	10.39.4	(CF10 and CF29):M <u>(CF10 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

Change the following rows of the B.4.14 table:

B.4.14 QoS base functionality

Item	Protocol capability	References	Status	Support
QB4	Block Acknowledgments (Block Acks)			
QB4.1	Immediate Block Ack	8.3.1.8.1, 8.3.1.8.2, 8.3.1.9.1, 8.3.1.9.2, 8.5.5, 9.21 (except 9.21.7 and 9.21.8), 10.5	CF12:O (CF16 OR CF25 <u>OR</u> CF30):M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
QB4.3	Compressed Block Ack			
QB4.3.1	Compressed Block Ack	8.3.1.8.3	CF12:O (CF16 OR CF25 <u>OR</u> CF30):M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
QB4.4	MultiTID Block Ack	8.3.1.8.4	CF12:O (CF16 <u>OR</u> CF30):M	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

Change the following rows of the B.4.18 table:

B.4.18 DSE functions

Item	Protocol capability	References	Status	Support
DSE9	Extended channel switch procedure			
DES9.1	Transmission of extended channel switch announcement frame/element and extended channel switch procedure by an AP.	10.10.3	(CF15&CF1):M (CF1 and CF29):M <u>(CF1 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.2	Transmission of extended channel switch announcement frame/element and extended channel switch procedure by a STA.	10.10.3	(CF15&CF2.2):M (CF2.2 and CF29):M <u>(CF2.2 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.3	Reception of extended channel switch announcement frame/element and extended channel switch procedure by a STA.	10.10.3	CF15:M CF29:M <u>CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.4	Transmission of Wide Bandwidth Channel Switch element in Extended Channel Announcement frame and transmission of Wide Bandwidth Channel Switch subelement in Channel Switch Wrapper element in Beacon/Probe Response frames, and associated extended channel switching procedure by an AP.	10.39.4	(CF1 and CF29):M <u>(CF1 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

B.4.18 DSE functions (continued)

Item	Protocol capability	References	Status	Support
DSE9.5	Transmission of Wide Bandwidth Channel Switch element in Extended Channel Announcement frame and transmission of Wide Bandwidth Channel Switch subelement in Channel Switch Wrapper element in Beacon/Probe Response frames, and associated extended channel switching procedure by a STA.	10.39.4	(CF2.2 and CF29):M <u>(CF2.2 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.6	Reception of Wide Bandwidth Channel Switch element in Extended Channel Announcement frame and reception of Wide Bandwidth Channel Switch subelement in Channel Switch Wrapper element in Beacon/Probe Response frames, and associated extended channel switching procedure by a STA.	10.39.4	CF29:M <u>CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.7	Transmission of New VHT Transmit Power Envelope element in Extended Channel Announcement frame and transmission of New VHT Transmit Power Envelope subelement in Channel Switch Wrapper element in Beacon/Probe Response frames, and associated extended channel switching procedure by an AP.	10.39.4	(CF1 and CF29):M <u>(CF1 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.8	Transmission of New VHT Transmit Power Envelope element in Extended Channel Announcement frame and transmission of New VHT Transmit Power Envelope subelement in Channel Switch Wrapper element in Beacon/Probe Response frames, and associated extended channel switching procedure by a STA.	10.39.4	(CF2.2 and CF29):M <u>(CF2.2 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>

B.4.18 DSE functions (continued)

Item	Protocol capability	References	Status	Support
DSE9.9	Reception of New VHT Transmit Power Envelope element in Extended Channel Announcement frame and transmission of New VHT Transmit Power Envelope subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated extended channel switching procedure by a STA.	10.39.4	CF29:M <u>CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.10	Transmission of New Country element in Extended Channel Announcement frame and transmission of New Country subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated extended channel switching procedure by an AP.	10.39.4	(CF1 and CF29):M <u>(CF1 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.11	Transmission of New Country element in Extended Channel Announcement frame and transmission of New Country subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated extended channel switching procedure by a STA.	10.39.4	(CF2.2 and CF29):M <u>(CF2.2 and CF30):M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>
DSE9.12	Reception of New Country element in Extended Channel Announcement frame and reception of New Country subelement in Channel Switch Wrapper element in Beacon/ Probe Response frames, and associated extended channel switching procedure by a STA.	10.39.4	CF29:M <u>CF30:M</u>	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>