IEEE P802.11n™/D2.00

Draft 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 <number>: Enhancements for Higher Throughput

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EDITORIAL NOTE—Pronunciation. It is assumed that while reading the spec aloud, a reader will read "HT" as " 'aitch tee " (which slightly more stress on the initial syllable) rather than read it as "high throughput". This determines the spelling of the indefinite article to be "an" rather than "a". The attention of readers is also drawn to Footnote 1 (As presented in Document 11-04-1097-r0 and approved and minuted at the Berlin 2004 802.11 interim meeting, the standardized pronunciation of MIMO is 'mie-mow.), and are encourage to emit only compliant vocalizations of this and related terms.

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Draft 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 <number>: Enhancements for Higher Throughput

EDITORIAL NOTE—the amendment number will be inserted by IEEE-SA editorial staff during preparation for publication.

Prepared by the 802.11 Working Group of the 802 Committee

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Abstract: This amendment defines modifications to both the 802.11 physical layers (PHY) and the 802.11 Medium Access Control Layer (MAC) so that modes of operation can be enabled that are capable of much higher throughputs, with a maximum throughput of at least 100Mb/s, as measured at the MAC data service access point (SAP).

Keywords: Wireless LAN, Medium Access Control, Physical Layer, Radio, Multiple Input Multiple Output, MIMO, MIMO-OFDM, High Throughput

Introduction

(This introduction is not part of IEEE P802.11n/D2.00, Draft Amendment to Standard for Information Technology-Telecommunications and information exchange between systems-Local and Metropolitan networks-Specific requirements-Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Enhancements for Higher Throughput.)

IEEE draft amendment P802.11n

This amendment specifies enhancements to the following draft standard and draft amendments, in order to obtain higher throughput:

- IEEE P802.11 REV-ma D9.0
- IEEE P802.11k D7.0
- IEEE P802.11r D4.1
- IEEE P802.11p D2.0

Notice to users

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Errata, if any, for this and all other standards can be accessed at the following URL: http://standards.ieee.org/reading/ieee/updates/errata/index.html. Users are encouraged to check this URL for errata periodically.

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Participants

At the time this draft Standard was completed, the 802.11 Working Group had the following membership:

Stuart J. Kerry, *Chair*
Al Petrick and Harry Worstell, *Vice-chairs*
Tim Godfrey, *Secretary*

EDITORIAL NOTE—a three column list of voting members of 802.11 on the day the draft was sent for sponsor ballot will be inserted

The following were officers of Task Group n:

Bruce Kraemer, *Chair*
Sheung Li, *Vice-Chair*
Garth Hillman, *Secretary*
Adrian P. Stephens, *Technical Editor*

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

EDITORIAL NOTE—a three-column list of responding sponsor ballot members will be inserted by IEEE staff

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3. Definitions

Change definition 3.58 as follows:

3.58 **fragmentation:** The process of segmenting a medium access control (MAC) service data unit (MSDU), Aggregate MAC service data unit (A-MSDU) or MAC management protocol data unit (MMPDU) into a sequence of smaller MAC protocol data units (MPDUs) prior to transmission. The process of recombining a set of fragment MPDUs into an MSDU, A-MSDU or MMPDU is known as defragmentation. These processes are described in ISO/IEC 7498-1: 1994 5.8.1.9.

EDITORIAL NOTE—The subclause numbering of definitions is of the form "3.n<x>" where <x> is an increasing number. The 802.11 technical editor will assign numbers when merging this list into the baseline document.

Insert the following new definitions alphabetically into Clause 3, renumbering as necessary:

3.n1 **20 MHz mask PPDU:** either a Clause 17 PPDU, or Clause 19 OFDM PPDU, or a Clause 20 20 MHz HT-PPDU with the TXVECTOR parameter CH_BANDWIDTH set to HT_CBW20 and the CH_OFFSET parameter set to CH_OFF_20.

3.n2 **20 MHz PPDU:** either a Clause 17 PPDU, or Clause 19 OFDM PPDU, or a Clause 20 20 MHz HT-PPDU with the TXVECTOR parameter CH_BANDWIDTH set to HT_CBW20.

3.n3 **40 MHz affected channel:** any 20 MHz channel of the seven 20 MHz channels comprising the seven 20 MHz channels that are closest to the secondary channel and centered on the secondary channel.

3.n4 **40 MHz mask PPDU:** a 40 MHz HT PPDU (TXVECTOR parameter CH_BANDWIDTH set to HT_CBW40) or a 40 MHz non-HT duplicate PPDU (TXVECTOR parameter CH_BANDWIDTH set to NON_HT_CBW40) or a Clause 20 20 MHz HT-PPDU with the TXVECTOR parameter CH_BANDWIDTH set to HT_CBW20 and the CH_OFFSET parameter set to either CH_OFF_20U or CH_OFF_20L.

3.n5 **40 MHz PPDU:** a 40 MHz HT PPDU (TXVECTOR parameter CH_BANDWIDTH set to HT_CBW40) or a 40 MHz non-HT duplicate PPDU (TXVECTOR parameter CH_BANDWIDTH set to NON_HT_CBW40) as defined in Clause 20.

3.n6 **40 MHz sensitive channel:** any 20 MHz channel of the set of 20 MHz channels that the STA may operate on in the current regulatory environment.

3.n7 **aggregate MAC protocol data unit (A-MPDU)**: An A-MPDU is a structure containing multiple MPDUs, transported as a single PSDU by the PHY.

3.n8 **aggregate MAC service data unit (A-MSDU):** An A-MSDU is a structure containing multiple MSDUs, transported within single (unfragmented) or multiple (fragmented) Data MPDUs.

3.n9 **basic space time block coding modulation and coding scheme (basic STBC MCS):** An MCS value and STBC encoder specification used in the transmission of STBC encoded control frames and STBC encoded broadcast/multicast frames. The value is defined in 9.6.5 (HT Basic STBC MCS).

3.n10 **beamformee:** A STA that receives a PPDU that was transmitted using a beamforming steering matrix.

3.n11 **beamformer:** A STA that transmits a PPDU using a beamforming steering matrix.

3.n12 **calibration initiator:** A STA that initiates a calibration sequence

3.n13 **calibration responder:** A STA that transmits during a calibration sequence in response to a transmission by a calibration initiator

3.n14 **high throughput (HT):** the set of features as defined in 5.2.8 (HT STA). A STA supporting these features is an HT STA. A STA not supporting them is a non-HT STA.

3.n15 **high throughput access point 19 (HT-AP-19):** an HT AP that is operating on a 20 MHz channel or set of 20 MHz channels that belong to the channel set that is defined in Clause 19.

3.n16 **high throughput basic service set (HT BSS):** A BSS in which beacons transmitted by HT STA include the HT Capabilities element.

3.n17 **high throughput delayed (HT-delayed) block ack**: A Delayed Block Ack mechanism optimized for use by HT STAs. This Block Ack scheme is negotiated between two HT STAs.

3.n18 **high throughput immediate (HT-immediate) block ack**: An Immediate Block Ack mechanism optimized for use by HT STAs. This Block Ack scheme is negotiated between two HT STAs.

3.n19 **high throughput duplicate format (HT duplicate format)**: A PPDU format of the HT PHY in which signals in two halves of the occupied channel width contain the same information. This is the HT mode that supports the lowest rate.

3.n20 **high throughput frame (HT frame)**: A frame transmitted in a Clause 20 PHY PPDU with the TXVECTOR FORMAT parameter set to either HT_MF or HT_GF.

3.n21 **high throughput greenfield format (HT greenfield format)**: A PPDU format of the HT PHY using HT greenfield format preamble.

3.n22 **high throughput mixed format (HT mixed format):** A PPDU format of the HT PHY using the HT mixed format Preamble.

3.n23 **high throughput physical layer protocol data unit (HT PPDU):** Any Clause 20 PPDU except when the TXVECTOR FORMAT parameter is set to NON_HT and the CH_BANDWIDTH parameter is set to NON_HT_CBW20.

3.n24 **maximum ratio combining (MRC)**: A PHY-layer technique used to maximize received SNR using antenna signal combining.

3.n25 **minimum downlink to uplink time spacing (minimum DTT2UTT spacing):** The minimum time within a PSMP sequence between the end of a STA’s PSMP-DTT and the start of its PSMP-UTT.

3.n26 **modulation and coding scheme (MCS)**: A specification of HT PHY parameters that consists of modulation order (BPSK, QPSK, 16-QAM, 64-QAM) and FEC code rate (1/2, 2/3, 3/4, 5/6).

3.n27 **modulation and coding scheme feedback (MFB) requester**: A STA that transmits a PPDU that contains an HT Control field in which the MRQ field set to 1.

3.n28 **modulation and coding scheme feedback (MFB) responder:** A STA that responds to a PPDU containing an HT Control field in which the MRQ field is set to 1 with a PPDU containing an HT Control field in which the MFB field contains an MCS index or the value 127.

3.n29 **multiple input, multiple output (MIMO**[1]**)**: A PHY configuration in which both transmitter and receiver use multiple antennas for signaling over a point-to-point link.

3.n30 **multiple input, single output (MISO)**: A PHY configuration in which the transmitter has multiple antennas and the receiver has a single antenna.

3.n31 **non-AP STA**: A STA that is not also an AP.

3.n32 **non-HT duplicate:** A mode of operation of the PHY that duplicates a 20 MHz non-HT transmission in two adjacent 20 MHz channels, allowing a non-HT BSS on either channel to receive the transmission.

3.n33 **non-HT duplicate frame**: A frame transmitted in a Clause 20. PHY PPDU with the TXVECTOR FORMAT parameter set to NON_HT and the CH_BANDWIDTH parameter set to NON_HT_CBW40.

3.n34 **non-HT frame**: A frame transmitted in a Clause 20. PHY PPDU with the TXVECTOR FORMAT parameter set to NON_HT and the CH_BANDWIDTH parameter set to NON_HT_CBW20.

3.n35 **non-HT physical layer protocol data unit (non-HT PPDU):** A Clause 20 PHY PPDU with the TXVECTOR FORMAT parameter set to NON_HT and the CH_BANDWIDTH parameter set to NON_HT_CBW20.

3.n36 **non-HT SIGNAL field transmit opportunity protection (L-SIG TXOP)**: A protection mechanism in which protection is established by the non-HT SIG Length and Rate fields indicating a duration that is longer than the duration of the packet itself.

3.n37 **non-STBC frame:** A frame that is transmitted in a PPDU that has the TXVECTOR STBC parameter set to 0, or a frame that is received in a PPDU that has the RXVECTOR STBC parameter set to 0.

3.n38 **Null Data Packet (NDP)**: A PPDU that carries no Data field.

3.n39 **operating channel width:** indicates the channel width in which the STA is currently able to receive

3.n40 **phased coexistence operation (PCO):** A BSS mode with alternating 20 MHz and 40 MHz phases controlled by a PCO AP.

3.n41 **power save multi-poll (PSMP)**: A mechanism that provides a time schedule to be used by an AP its PSMP participants. The mechanism is controlled using the PSMP management action frame.

3.n42 **power save multi-poll burst (PSMP burst)**: A sequence of one or more PSMP sequences, separated by SIFS.

3.n43 **power save multi-poll sequence (PSMP sequence)**: A sequence of frames where the first frame is a PSMP frame that is followed by transmissions in zero or more PSMP-DTTs and then by transmissions in zero or more PSMP-UTTs. The schedule of the PSMP-DTTs and PSMP-UTTs is defined in the PSMP frame.

3.n44 **power saving multi-poll session (PSMP session)**: A PSMP session is the periodic generation of a PSMP burst aligned to its service period. The PSMP session exists while any periodic traffic stream

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[1] As presented in Document 11-04-1097-r0 and approved and minuted at the Berlin 2004 802.11 interim meeting, the standardized pronunciation of MIMO is ‘mie-mow.

exists that was established by a TSPEC with the APSD field set to 0 and the Schedule field set to 1 (representing Scheduled PSMP).

3.n45 **power saving multi-poll downlink transmission time (PSMP-DTT)**: A period of time described by a PSMP frame during which the AP transmits.

3.n46 **power saving multi-poll uplink transmission time (PSMP-UTT)**: A period of time described by a PSMP frame during which a non-AP STA may transmit.

3.n47 **power save multi-poll uplink transmission time spacing (PSMP-UTT spacing (PUS))**: The period of time between the end of one PSMP-UTT and the start of the following PSMP-UTT within the same PSMP sequence.

3.n48 **primary channel**: The common channel of operation for all STA that are members of the BSS, some members of the BSS may operate on additional channel(s).

3.n49 **reduced interframe spacing mode (RIFS mode)**: A transmission mode of the HT PHY consisting of a sequence of PPDUs each separated by RIFS instead of SIFS.

3.n50 **reverse direction (RD) initiator:** A STA that is a TXOP holder that transmits an MPDU with the RDG/More PPDU field set to 1.

3.n51 **reverse direction (RD) responder:** A STA that is not the RD initiator and whose MAC address matches the value of the Address1 field of a received MPDU that has the RDG/More PPDU field set to 1.

3.n52 **secondary beacon**: A beacon that is transmitted using the HT basic STBC MCS to enable discovery of the BSS by HT STAs that support the HT STBC feature in order to extend the range of the BSS.

3.n53 **secondary channel**: A 20 MHz channel associated with a primary channel used by HT STAs for the purpose of creating a 40 MHz channel.

3.n54 **secondary delivery traffic indication map (secondary DTIM):** A Secondary Beacon transmission that is a DTIM Beacon.

3.n55 **spatial stream**: A stream of bits transmitted over a separate spatial dimension

3.n56 **staggered preamble:** a PLCP preamble in a sounding PPDU that is not an NDP that includes one or more DLTFs and one or more ELTFs

3.n57 **staggered sounding:** the use a sounding PPDU that is not an NDP that includes one or more DLTFs and one ore more ELTFs

3.n58 **STBC frame:** A frame that is transmitted in a PPDU that has the TXVECTOR STBC parameter set to a non-zero value, or a frame that is received in a PPDU that has the RXVECTOR STBC parameter set to a non-zero value.

3.n59 **sounding PPDU**: A PPDU in which the Not Sounding field in the HT-SIG is set to zero.

3.n60 **subframe:** A portion of a frame containing a header and associated MSDU.

3.n61 **transmit opportunity (TXOP) responder:** A STA that transmits a frame in response to a frame received from a TXOP holder during a frame exchange sequence, but that does not acquire a TXOP in the process.

4. Abbreviations and acronyms

Insert the following new abbreviations and acronyms into Clause 4 in alphabetical order:

AGC	automatic gain control
A-MPDU	aggregate MAC protocol data unit
A-MSDU	aggregate MAC service data unit
ASEL	antenna selection
ASELC	antenna selection control
ASELI	antenna selection indication
CSD	cyclic shift diversity
CSI	channel state information
CSIT	channel state information at the transmitter
DLTF	data long training field
ECC	error correcting code
ELTF	extension long training field
FEC	forward error correction
HT	high throughput
HTC	high throughput control
HT-GF-STF	high throughput greenfield short training symbol
HT-LTF	high throughput long training field
HT-SIG	high throughput SIGNAL field
HT-STF	high throughput short training field
IDFT	inverse discrete Fourier transform
IE	information element
LDPC	low density parity check
L-LTF	non-HT long training field
L-SIG	non-HT SIGNAL field
L-STF	non-HT short training field

LTF	long training field
MCS	modulation coding scheme
MFB	MCS feedback
MFSI	MCS feedback sequence identifier
MIMO	multiple input, multiple output
MISO	multiple input, single output
MRC	maximum ratio combining
MRQ	MCS request
MSI	MRQ sequence identifier
MTBA	multiple TID block ack
MTBAR	multiple TID block ack request
NDP	Null Data Packet
PCO	phased coexistence operation
PSMP	power save multi-poll
PSMP-DTT	power save multi-poll downlink transmission time
PSMP-UTT	power save multi-poll uplink transmission time
PUS	PSMP-UTT spacing
RD	reverse direction
RDG	reverse direction grant
RIFS	reduced interframe spacing
RXASSI	receive antenna selection sounding indication
RXASSR	receive antenna selection sounding request
SISO	single input, single output
SM	spatial multiplexing
SN	sequence number
SNR	signal to noise ratio
SSN	starting sequence number

STBC	space-time block code
STBC/SM	space-time block code/spatial multiplexing
TRQ	training request
TXASSI	transmit antenna selection sounding indication
TXASSR	transmit antenna selection sounding request
TxBF	transmit beamforming

5. General description

Insert the following new subclause:

5.2.8 HT STA

The IEEE 802.11 HT STA provides PHY and MAC enhancements to support a throughput of 100 Mb/s and greater, as measured at the MAC data service access point (SAP). An HT STA supports HT features as identified in Clause 9 (MAC sublayer functional description) and Clause 20 (High Throughput (HT) PHY specification). An HT STA is also a QoS STA; the HT enhancements are available to HT STAs associated with an HT AP in a BSS. A subset of HT enhancements is available for use between two HT STAs that are members of the same IBSS.

The QoS enhancements are available to HT STAs when associated with a QoS access point. An HT STA may associate with a non-HT (Q)AP or a non-HT (Q)IBSS, to provide non-HT throughput rates.

An HT STA has PHY features consisting of the MCS set described in 20.3.5 (Modulation and Coding Scheme (MCS)) and modes of operation described in 20.1.3 (PPDU Formats). Some PHY features that distinguish an HT STA from a non-HT STA and an HT AP from a non-HT AP include: MIMO operation (STBC, transmit beamforming, and spatial multiplexing), LDPC encoding, and antenna selection. Some features are optional and some are mandatory. The allowed PPDU formats are non-HT format, HT mixed format, HT greenfield format, and 20 MHz and 40 MHz bandwidth operation.

An HT STA has features that are optional and mandatory. Some MAC features that distinguish an HT STA from a non-HT STA and an HT AP from a non-HT AP include: frame aggregation, Block Ack enhancements, PSMP feature, Reverse Direction, and protection mechanisms supporting coexistence with non-HT STAs and non-HT APs.

EDITORIAL NOTE—5.6 has been moved to 11.3 to match changes in REVma D7.0

6. MAC service definition

6.1 Overview of MAC services

6.1.2 Security services

Change 6.1.2 as follows:

Security services in IEEE 802.11 are provided by the authentication service and the WEP, TKIP, and CCMP mechanisms. The scope of the security services provided is limited to station-to-station data exchange. The data confidentiality service offered by an IEEE 802.11 TKIP implementation is the protection of the MSDU and by an IEEE 802.11 CCMP implementation is the protection of the MSDU or A-MSDU. For the purposes of this standard, TKIP and CCMP are viewed as logical services located within the MAC sublayer as shown in the reference model, Figure 10 (in 5.7). Actual implementations of the TKIP and CCMP services are transparent to the LLC and other layers above the MAC sublayer.

6.1.5 MAC data service architecture

Change the first two paragraphs of 6.1.5 as follows:

The MAC data plane architecture (i.e., processes that involve transport of all or part of an MSDU) is shown in Figure 18. During transmission, an MSDU goes through some or all of the following processes: A-MSDU aggregation, frame delivery deferral during power save mode, sequence number assignment, fragmentation, encryption, integrity protection, ~~and~~ frame formatting and A-MPDU aggregation. IEEE 802.1X may block the MSDU at the Controlled Port. At some point, the data frames that contain all or part of the MSDU are queued per AC/TS. This queuing may be at any of the three points indicated in Figure 18.

During reception, a received data frame goes through processes of possible A-MPDU de-aggregation, MPDU header and cyclic redundancy code (CRC) validation, duplicate removal, possible reordering if the Block Ack mechanism is used, decryption, defragmentation, integrity checking, and replay detection. After replay detection (or defragmentation if security is used) and possible A-MSDU de-aggregation, ~~the~~ one or more MSDUs ~~is~~ are delivered to the MAC_SAP or to the DS. The IEEE 802.1X Controlled/Uncontrolled Ports discard ~~the~~ any received MSDU if the Controlled Port is not enabled and if the MSDU does not represent an IEEE 802.1X frame. TKIP and CCMP MPDU frame order enforcement occurs after decryption, but prior to MSDU defragmentation; therefore, defragmentation will fail if MPDUs arrive out of order.

Replace figure 18-MAC data plane architecture as follows:

EDITORIAL NOTE—The changes comprise the addition the A-MSDU Aggregation, A-MPDU Aggregation, A-MSDU De-aggregation, A-MPDU De-aggregation boxes; and the removal of the "Per Access Category/TS queuing and three arrows.

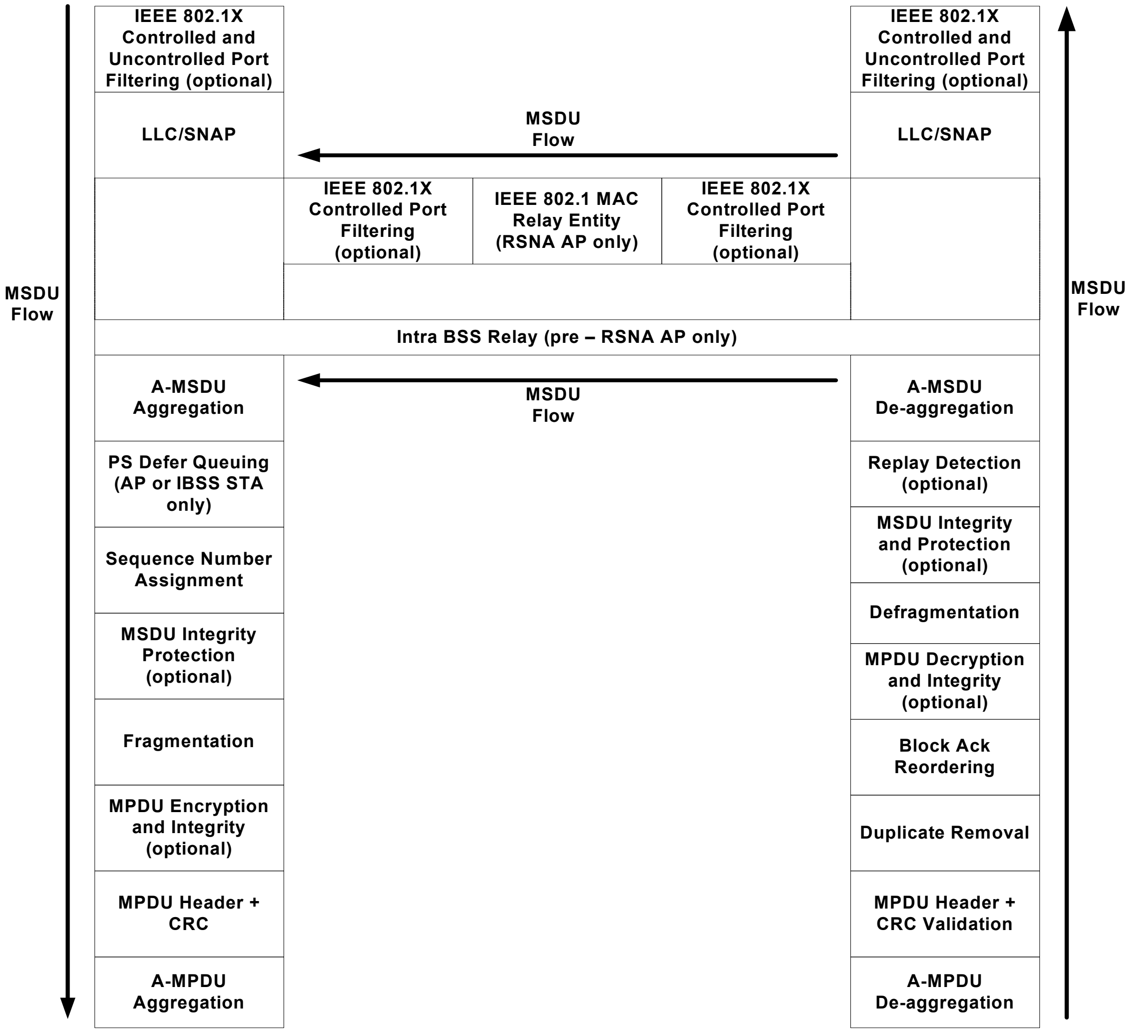

Figure 18—MAC data plane architecture

7. Frame formats

7.1 MAC frame formats

Change 7.1 numbered item a) as follows:

a) A *MAC header*, which comprises frame control, duration, address, ~~and~~ optional sequence control information, ~~and, for QoS data frames~~ optional QoS ~~c~~Control ~~information~~ (QoS Data frames only) and optional HT Control fields;

7.1.1 Conventions

Insert the following new paragraph immediately before the last paragraph:

A frame that contains the HT Control field, including the Control Wrapper frame, is referred to as a +HTC frame.

7.1.2 General frame format

Change the first paragraph of 7.1.2 as follows:

The MAC frame format comprises a set of fields that occur in a fixed order in all frames. Figure 18 depicts the general MAC frame format. The first three fields (Frame Control, Duration/ID, and Address 1) and the last field (FCS) in Figure 18 constitute the minimal frame format and are present in all frames (except NDP), including reserved types and subtypes. The fields Address 2, Address 3, Sequence Control, Address 4, QoS Control, HT Control, and Frame Body are present only in certain frame types and subtypes. Each field is defined in 7.1.3 (Frame fields). The format of each of the individual subtypes of each frame types is defined in 7.2 (Format of individual frame types). The components of management frame bodies are defined in 7.3 (Management frame body components). The formats of management frames of subtype Action are defined in 7.4 (Action frame format details).

Replace Figure 18—MAC frame format with the following figure:

EDITORIAL NOTE—The change comprises the insertion of the HT Control field.

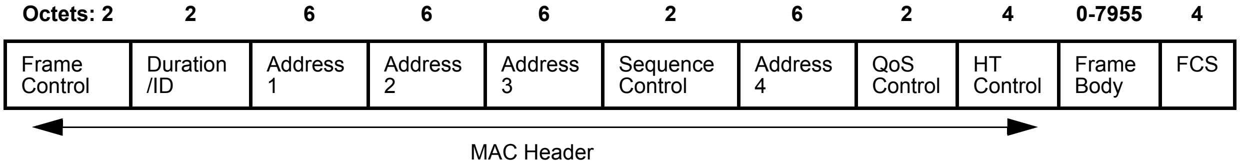

Figure 18—MAC frame format

7.1.3 Frame fields

7.1.3.1 Frame control field

7.1.3.1.2 Type and Subtype fields

Change Table 1 as follows (only the control frame type shown):

Table 1—Valid type and subtype combinations

Type value b3 b2	Type description	Subtype value b7 b6 b5 b4	Subtype description
00	Management	1010	Disassociation
00	Management	1011	Authentication
00	Management	1100	Deauthentication
00	Management	1101	Action
00	Management	1110	Action No Ack
00	Management	1111	Reserved
01	Control	0000-0110	Reserved
01	Control	0111	Control Wrapper
01	Control	1000	Block Ack Request (BlockAckReq)
01	Control	1001	Block Ack (BlockAck)
01	Control	1010	PS-Poll
01	Control	1011	RTS
01	Control	1100	CTS
01	Control	1101	ACK
01	Control	1110	CF-End
01	Control	1111	CF-End + CF-Ack

7.1.3.1.4 More Fragments field

Change 7.1.3.1.4 as follows:

The More Fragments field is 1 bit in length and is set to 1 in all data or management type frames that have another fragment of the current MSDU, A-MSDU or current MMPDU to follow. It is set to 0 in all other frames.

7.1.3.1.8 More Data field

Change 7.1.3.1.8 as follows:

The More Data field is 1 bit in length and is used to indicate to a STA in PS mode that more MSDUs, A-MSDUs or MMPDUs are buffered for that STA at the AP. The More Data field is valid in directed data or management type frames transmitted by an AP to a STA in PS mode. A value of 1 indicates that at least one additional buffered MSDU, A-MSDU or MMPDU is present for the same STA.

7.1.3.1.10 Order field

Change the first paragraph of 7.1.3.1.10 as follows:

The Order field is 1 bit in length and is set to 1 in any non-QoS Data frame that contains an MSDU, or fragment thereof, which is being transferred using the StrictlyOrdered service class. The presence of the HT Control field in frames is indicated by setting the Order field to 1 in any Data type or Management type frame that is transmitted with a value of HT_GF or HT_MM for the FORMAT parameter of the TXVECTOR except a non-QoS Data frame or a Control Wrapper frame. The Order~~This~~ field is set to 0 in all other frames. All non-HT QoS STAs [1] set ~~this~~the Order ~~sub~~field to 0.

7.1.3.2 Duration/ID field

Insert the following at the end of the subclause:

The Duration/ID fields in the MAC Headers of MPDUs in an A-MPDU all carry the same value.

NOTE—The reference point for the Duration/ID field is the end of the PPDU carrying the MPDU. Setting the Duration/ID field to the same value in the case of A-MPDU aggregation means that each MPDU consistently specifies the same NAV setting.

7.1.3.3 Address fields

7.1.3.3.4 DA field

Change 7.1.3.3.4 as follows:

The DA field contains an IEEE MAC individual or group address that identifies the MAC entity or entities intended as the final recipient(s) of the MSDU or A-MSDU (or fragment thereof) contained in the frame body field.

7.1.3.3.5 SA field

Change 7.1.3.3.5 as follows:

The SA field contains an IEEE MAC individual address that identifies the MAC entity from which the trans-

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[1] A non-HT QoS STA is a STA that implements the QoS facility, but does not implement any of the HT features.

fer of the MSDU or A-MSDU (or fragment thereof) contained in the frame body field was initiated. The individual/group bit is always transmitted as a zero in the source address.

7.1.3.4.1 Sequence Number field

Change 7.1.3.4.1 as follows:

The Sequence Number field is a 12-bit field indicating the sequence number of an MSDU, A-MSDU or MMPDU. Each MSDU, A-MSDU or MMPDU transmitted by a STA is assigned a sequence number. Sequence numbers are not assigned to control frames, as the Sequence Control field is not present.

Non-QoS STAs, as well as QoS STAs operating as non-QoS STAs because they are in a non-QoS BSS or non-QoS IBSS, assign sequence numbers, to management frames and data frames (QoS subfield of the Subtype field is set to 0), from a single modulo-4096 counter, starting at 0 and incrementing by 1 for each MSDU, A-MSDU or MMPDU.

QoS STAs associated in a QoS BSS maintain one modulo-4096 counter, per TID, per unique receiver (specified by the Address 1 field of the MAC header). Sequence numbers for QoS data frames are assigned using the counter identified by the TID subfield of the QoS Control field of the frame, and that counter is incremented by 1 for each MSDU or A-MSDU belonging to that TID. Sequence numbers for management frames, QoS data frames with a broadcast/multicast address in the Address 1 field, and all non-QoS data frames sent by QoS STAs are assigned using an additional single modulo-4096 counter, starting at 0 and incrementing by 1 for each MSDU, A-MSDU or MMPDU. Sequence numbers for QoS (+)Null frames may be set to any value.

Each fragment of an MSDU, A-MSDU or MMPDU contains a copy of the sequence number assigned to that MSDU, A-MSDU or MMPDU. The sequence number remains constant in all retransmissions of an MSDU, A-MSDU, MMPDU, or fragment thereof.

7.1.3.4.2 Fragment Number field

Change 7.1.3.4.2 as follows:

The Fragment Number field is a 4-bit field indicating the number of each fragment of an MSDU, A-MSDU or MMPDU. The fragment number is set to 0 in the first or only fragment of an MSDU, A-MSDU or MMPDU and is incremented by one for each successive fragment of that MSDU, A-MSDU or MMPDU. The fragment number remains constant in all retransmissions of the fragment.

7.1.3.5 QoS Control field

Insert the following sentence at the end of the first paragraph of 7.1.3.5

The presence of an A-MSDU in the Frame Body field is indicated by setting bit 7 of the QoS control field to 1, as shown in Table 4.

Change Table 4-Qos Control Field as follows:

EDITORIAL NOTE—The changes comprise using bit 7 to indicate A-MSDU present in only QoS Data subtypes.

Table 4—QoS Control ~~F~~field

Applicable frame (sub-)types	Bits 0-3	Bit 4	Bit 5-6	Bit 7	Bits 8-15
QoS CF-Poll and QoS CF-Ack+CF-Poll frames sent by HC ~~QoS (+)CF-Poll frames sent by HC~~	TID	EOSP	Ack Policy	Reserved	TXOP limit
QoS Data+CF-Poll and QoS Data+CF-Ack+CF-Poll frames sent by HC	TID	EOSP	Ack Policy	A-MSDU Present	TXOP limit
QoS Data and QoS Data+CF-Ack frames sent by HC	TID	EOSP	Ack Policy	A-MSDU Present	AP PS Buffer State
QoS Null frames sent by HC ~~QoS Data, QoS Null, and QoS Data+CF-Ack frames sent by HC~~	TID	EOSP	Ack Policy	Reserved	AP PS Buffer State
QoS Data and QoS Data+CF-Ack frames sent by non-AP STAs	TID	0	Ack Policy	A-MSDU Present	TXOP duration requested
	TID	1	Ack Policy	A-MSDU Present	Queue size
QoS Null frames sent by non-AP STAs ~~QoS data frames sent by non-AP STAs~~	TID	0	Ack Policy	Reserved	TXOP duration requested
	TID	1	Ack Policy	Reserved	Queue size

7.1.3.5.1 TID subfield

Change the first paragraph of 7.1.3.5.1 as follows:

The TID subfield identifies the TC or TS to which the corresponding MSDU, A-MSDU, or fragment thereof, in the Frame Body field belongs. The TID subfield also identifies the TC or TS of traffic for which a TXOP is being requested, through the setting of TXOP duration requested or queue size. The encoding of the TID subfield depends on the access policy (see 7.3.2.30) and is shown in Table 5. Additional information on the interpretation of the contents of this field appears in 6.1.1.2.

7.1.3.5.3 Ack Policy subfield

Change the first non-header row of table 6 to appear as follows:

Bits in QoS Control field		Meaning
Bit 5	Bit 6	
0	0	Normal Ack or Implicit Block Ack Request. In an MPDU that is not part of an A-MPDU: The addressed recipient returns an ACK or QoS +CF-Ack frame after a short interframe space (SIFS) period, according to the procedures defined in 9.2.8, 9.3.3 and 9.9.2.3. ~~The Ack Policy subfield is set to this value in all directed frames in which the sender requires acknowledgment.~~ For QoS Null (no data) frames, this is the only permissible value for the Ack Policy subfield. In an MPDU that is part of an A-MPDU: The addressed recipient returns a BlockAck MPDU, either individually or as part of an A-MPDU starting a SIFS after the PPDU carrying the frame, according to the procedures defined in 9.2.8, 9.3.3 and 9.9.2.3.

Change the third non-header row of table 6 to appear as follows:

0	1	No explicit acknowledgment, or scheduled acknowledgement under a PSMP session. When bit 6 of the frame control field is set to 1: There may be a response frame to the frame that is received, but it is neither the ACK nor any data frame of subtype +CF-Ack. For QoS CF-Poll and QoS CF-Ack+CF-Poll data frames, this is the only permissible value for the Ack Policy subfield. When bit 6 of the frame control field is set to 0: The acknowledgement for a frame indicating scheduled acknowledgement within a PSMP session when it appears in a PSMP-DTT is to be received in a later PSMP-UTT. The acknowledgement for a frame indicating scheduled acknowledgement within a PSMP session when it appears in a PSMP-UTT is to be received in a later PSMP-DTT.

7.1.3.5.5 Queue Size subfield

Change paragraph 2 of 7.1.3.5.5 as follows:

The queue size value is the total size, rounded up to the nearest multiple of 256 octets and expressed in units of 256 octets, of all MSDUs and A-MSDUs buffered at the QSTA (excluding the MSDU or A-MSDU of the present QoS data frame) in the delivery queue used for MSDUs and A-MSDUs with TID values equal to the value in the TID subfield of this QoS Control field. A queue size value of 0 is used solely to indicate the absence of any buffered traffic in the queue used for the specified TID. A queue size value of 254 is used for all sizes greater than 64 768 octets. A queue size value of 255 is used to indicate an unspecified or unknown size. If a QoS data frame is fragmented, the queue size value may remain constant in all fragments even if the amount of queued traffic changes as successive fragments are transmitted.

7.1.3.5.6 TXOP Duration Requested subfield

Change the 2nd paragraph of 7.1.3.5.6 as follows:

TXOP Duration Requested subfield values are not cumulative. A TXOP duration requested for a particular TID supersedes any prior TXOP duration requested for that TID. A value of 0 in the TXOP Duration Requested subfield may be used to cancel a pending unsatisfied TXOP request when its MSDU or A-MSDU is no longer queued for transmission. The TXOP duration requested is inclusive of the PHY and IFS overhead, and a STA should account for this when attempting to determine whether a given transmission fits within a specified TXOP duration.

7.1.3.5.7 AP PS Buffer State subfield

Change paragraphs 3 and 4 of 7.1.3.5.7 as follows:

The Highest-Priority Buffered AC subfield is 2 bits in length and is used to indicate the AC of the highest priority traffic remaining that is buffered at the AP, excluding the MSDU or A-MSDU of the present frame.

The AP Buffered Load subfield is 4 bits in length and is used to indicate the total buffer size, rounded up to the nearest multiple of 4096 octets and expressed in units of 4096 octets, of all MSDUs and A-MSDUs buffered at the QoS AP (excluding the MSDU or A-MSDU of the present QoS data frame). An AP Buffered Load field value of 15 indicates that the buffer size is greater than 57 344 octets. An AP Buffered Load subfield value of 0 is used solely to indicate the absence of any buffered traffic for the indicated highest priority buffered AC when the Buffer State Indicated bit is 1.

Insert the following new subclause:

7.1.3.5a HT Control field

The presence of the HT Control Field in a frame is determined by the Order bit of the Frame Control Field as defined in 7.1.3.1.10 (Order field).

The format of the 4-octet HT Control Field is shown in Figure n1 (HT Control field).

	B0 B15	B16 B17	B18 B19	B20 B21	B22 B23	B24	B25 B29	B30	B31
	Link Adaptation Control	Calibration Position	Calibration Sequence	Reserved	CSI/ Steering	NDP Announcement	Reserved	AC Constraint	RDG/ More PPDU
Bits	16	2	2	2	2	1	5	1	1

Figure n1—HT Control field

The Link Adaptation Control field is defined in Figure n2 (Link Adaptation Control field).

The format of the Link Adaptation Control field is defined in Figure n2 (Link Adaptation Control field). The subfields of the Link Adaptation Control field are defined in Table n1 (Link Adaptation Control subfields). The structure of the MAI field is defined in Figure n3 (MAI field), in which bit numbering relates to the HT Control field. The subfields of the MAI field are defined in Table n2 (Subfields of the MAI field).

	B0	B1	B2 B5	B6 B8	B9 B15
	reserved	TRQ	MAI	MFSI	MFB/ASELC
# Bits	1	1	4	3	7

Figure n2—Link Adaptation Control field

Table n1—Link Adaptation Control subfields

Field	Meaning	Definition
TRQ	Sounding Request	Set to 1 to request the responder to transmit a sounding PPDU. When set to 0, the responder is not requested to transmit a sounding PPDU. See 9.17.2 (Transmit beamforming with implicit feedback).
MAI	MCS request or Antenna Selection Indication	When set to 14, the MAI field contains an Antenna Selection Indication (ASELI). Otherwise the MAI field is interpreted, as shown in Figure n3 (MAI field).
MFSI	MFB Sequence Identifier	Set to the received value of MSI contained in the frame to which the MFB information refers. Set to 7 for unsolicited MFB
MFB/ASELC	MCS Feedback and Antenna Selection Command/ Data	When the MAI field is set to the value ASELI, this field is interpreted as defined in Figure n4 (ASELC subfield) and Table n3 (The ASEL Command and ASEL Data parts of the ASELC subfield). Otherwise, this field contains recommended MCS feedback. A value of 127 indicates that no feedback is present.

	B2	B3 B5
	MRQ	MSI
Bits	1	3

Figure n3—MAI field

Table n2—Subfields of the MAI field

Field	Meaning	Definition
MRQ	MCS Request	When the MRQ field is set to 1, MCS feedback is requested. When set to 0, no MCS feedback is requested.
MSI	MCS Request Sequence Identifier	When the MRQ field is set to 1, the MSI field contains a sequence number in the range 0 to 6 that identifies the specific request.When the MRQ field is set to 0, the MSI subfield is reserved.

In each MCS Request (i.e., where MRQ=1) the MFB requester includes a value for the MSI. The MFB responder includes the received MSI value in the MFSI field of the corresponding response frame. In the case of a delayed response, this allows the MFB requester to correlate the MCS Feedback with the related MCS request. When the MFB responder provides unsolicited MCS feedback, it sets MFSI to 7.

When a responder responds immediately, it may set the MFB to ‘all-ones’ to indicate that the requested feedback is not available. When a responder responds immediately to an MRQ and sets MFB to all-ones it also sets MFSI to 7. A responder may choose to provide feedback for a previous request at any time, in which case, the MFB and MFSI values correspond to the previous request, even though they may be provided in a frame which is an immediate response to a more current request.

A responder may choose to send a response frame with any of the following combinations of MFB and MFSI:

- MFB = 127, MFSI = 7: no information is provided for the immediately preceding request or for any other pending request
- MFB = 127, MFSI in the range 0 to 6: the responder is not now providing, and will never provide feedback for the request that had the MSI value that matches the MFSI value
- MFB in the range 0 to 126, MFSI in the range 0 to 6: the responder is providing feedback for the request that had the MSI value that matches the MFSI value

A STA may respond immediately to a current request for MCS feedback with a frame containing an MFSI value and MFB value that correspond to a request that proceeds the current request.

	B9 B11	B12 B15
	ASEL Command	ASEL Data
Bits	3	4

Figure n4—ASELC subfield

In the Transmit/Receive Antenna Selection Sounding Indication command, the value in the ASEL Data field contains the remaining number of sounding frames following the current one, if the HT Control field is carried in a sounding PPDU. The value in the ASEL Data field contains the number of NDPs following a non-NDP+ HTC, if NDP sounding frame is used. The NDP announcement field in HT Control Field is set to 1 to indicate NDP sounding.

The Calibration Position and Calibration Sequence fields are defined in Table n4 (Calibration Control subfields).

The default value of the Calibration Position field when not in a Calibration Sounding Exchange sequence is zero.

The Calibration Sequence field is incremented each time the calibration procedure is started between any two STAs. The field is included in each frame within the calibration procedure and its value is unchanged for the frame exchanges during the entire calibration procedure.

The CSI/Steering field indicates the type of feedback, as shown in Table n5 (CSI/Steering values).

The NDP Announcement indicates that a NDP will be transmitted after the frame (according to the rules described in 9.19 (Null Data Packet (NDP) as sounding PPDU)). The encoding of this field is shown in Table n6 (NDP Announcement values).

The AC Constraint field indicates whether the TID of RD data is constrained to a single TID or not, as defined in Table n7 (AC Constraint values).

The RDG/More PPDU Field of the HT Control field is interpreted differently when transmitted by an RD initiator or an RD responder, as defined in Table n8 (RDG/More PPDU values).

Table n3—The ASEL Command and ASEL Data parts of the ASELC subfield

ASEL Command	Interpretation of ASEL Command	ASEL Data
0	Transmit Antenna Selection Sounding Indication (TXASSI)	Number of remaining sounding PPDUs to be transmitted 0 to 15
1	Transmit Antenna Selection Sounding Request (TXASSR)	Reserved
2	Receive Antenna Selection Sounding Indication (RXASSI)	Number of remaining sounding PPDUs to be received 0 to 15
3	Receive Antenna Selection Sounding Request (RXASSR)	Total number sounding PPDUs required 0 to 15
4	Sounding Label	Sequence number of the sounding PPDU corresponding to a CSI Matrices frame in ASEL feedback 0 to 15
5	No feedback, ASEL training failure	Reserved
6	Transmit Antenna Selection Sounding Indication (TXASSI) requesting feedback of explicit CSI	Number of remaining sounding PPDUs to be transmitted 0 to 15
7	Reserved	Reserved

Table n4—Calibration Control subfields

Field	Meaning	Definition
Calibration Position	Position in Calibration Sounding Exchange Sequence	Set to 0 indicates this is not a calibration frame, Set to 1 indicates Calibration Start, Set to 2 indicates Sounding Response, Set to 3 indicates Sounding Complete.
Calibration Sequence	Calibration Sequence Identifier	The field is included in each frame within the calibration procedure and its value is unchanged for the frame exchanges during one calibration procedure. See 9.17.2.4.2 (Procedure).

7.1.3.6 Frame Body field

Change 7.1.3.6 as follows:

The Frame Body is a variable length field that contains information specific to individual frame types and subtypes. The minimum frame body is 0 octets. The maximum length frame body is defined by the maximum length (MSDU/A-MSDU + ICV + IV), where integrity check value (ICV) and initialization vector (IV) are the WEP fields defined in 8.2.1.

Table n5—CSI/Steering values

Value	Definition
0	No feedback required
1	CSI
2	Non-compressed Beamforming Feedback Matrix
3	Compressed Beamforming Feedback Matrix

Table n6—NDP Announcement values

Value	Definition
0	no NDP will follow
1	NDP will follow

Table n7—AC Constraint values

AC Constraint field value	Description
0	The response to a reverse direction grant may contain data frames from any TID
1	The response to a reverse direction grant may contain data frames only from the same AC as the last data frame received from the RD initiator

Table n8—RDG/More PPDU values

RDG/More PPDU value	Role of transmitting STA	Interpretation of value
0	RD initiator	No reverse grant
	RD responder	The PPDU carrying the frame is the last transmission by the RD responder
1	RD initiator	A reverse direction grant is present, as defined by the Duration/ID field
	RD responder	The PPDU carrying the frame is followed by another PPDU

7.1.4 Duration/ID field in data and management frames

Change the second unbulleted paragraph in 7.1.4 as follows:

Within all data or management frames sent in a CP by the QoS STAs outside of a controlled access phase (CAP) and outside of a PSMP sequence, following a contention access of the channel, the Duration/ID field is set to one of the following values:

Change item b) of 7.1.4 as follows:

b) For unicast data frames with the Ack Policy subfield set to No Ack or Block Ack, management frames of subtype Action No Ack, and for multicast/broadcast frames,

Change item c) of 7.1.4 as follows:

c) ~~The minimum of~~Any value between:

1) The time, not exceeding the value given by 2) below if TXOP Limit is non-zero, required for the transmission the pending MPDUs of the AC and the associated ACKs, if any, and applicable SIFS durations, and
2) The time limit imposed by the MIB attribute dot11EDCATableTXOPLimit (dot11EDCAQAPTableTXOPLimit for the AP) for that AC minus the already used time within the TXOP.

Add the following new text to the end of the subclause:

To ensure NAV protection for the entire PSMP sequence, the Duration/ID field of all frames sent by both AP and non-AP STA within a PSMP sequence is set to the remaining duration of the TXOP.

7.2 Format of individual frame types

7.2.1 Control frames

7.2.1.1 RTS frame format

Change the fourth paragraph of 7.2.1.1 as follows:

For all RTS frames sent by non-QoS STAs, the duration value is the time, in microseconds, required to transmit the pending data or management frame, plus one CTS frame, plus one ACK frame, plus three SIFS intervals. If the calculated duration includes a fractional microsecond, that value is rounded up to the next higher integer. For all RTS frames sent by STAs under EDCA, following a contention access of the channel, the duration value is set in the following manner:

- If the NAV protection is desired for only the first or sole frame in the TXOP, the duration value is set to the estimated time, in microseconds, required to transmit the pending frame, plus one CTS frame, plus one ACK frame if required, plus three SIFS intervals.
- Otherwise, the duration value is set to the remaining duration of the TXOP.

7.2.1.2 CTS frame format

Change the third paragraph of 7.2.1.2 as follows:

For all CTS frames sent in response to RTS frames, the duration value is the value obtained from the Duration field of the immediately previous RTS frame, minus the time, in microseconds, required to transmit the CTS frame and its SIFS interval. If the calculated duration includes a fractional microsecond, that value is rounded up to the next higher integer. See also 9.2.5.5a (Dual CTS protection).

Change the heading of 7.2.1.7 as follows:

7.2.1.7 ~~Block Ack Request (~~BlockAckReq~~)~~ frame format

Replace Figure 30 with the following figure:

EDITORIAL NOTE—The changes comprise renaming the "Block Ack Starting Sequence Control" field to "BAR Information".

Octets: 2	2	6	6	2	Variable	4
Frame Control	Duration/ID	RA	TA	BAR Control	BAR Information	FCS

MAC Header

Figure 30—BlockAckReq frame

Replace Figure 31 with the following figure:

EDITORIAL NOTE—The changes comprise the addition of BAR Ack Policy, Multi-TID and Compressed Bitmap fields from the reserved field and renaming the TID field to TID_INFO.

B0	B1	B2	B3 B11	B12 B15
BAR Ack Policy	Multi-TID	Compressed Bitmap	Reserved	TID_INFO
Bits: 1	1	1	9	4

Figure 31—BAR Control field

Delete paragraph 6 of 7.2.1.7 starting "The TID subfield…"

Delete paragraph 7 of 7.2.1.7 starting "The Block Ack Starting Sequence Control…"

Insert the following text and table at the end of 7.2.1.7

For HT-delayed operation, the BAR Ack Policy subfield has the meaning shown in Table n9 (BAR Ack Policy / BA Ack Policy fields for HT-delayed BlockAck). Otherwise this subfield is reserved.

The values of the Multi-TID and Compressed Bitmap fields determine which of three possible BlockAckReq frame variants is represented, as indicated in Table n10 (BlockAckReq frame variant encoding).The meaning of the TID_INFO subfield of the BAR Control field depends on the BlockAckReq frame variant type. The meaning of this subfield is explained within the subclause for each of the BlockAckReq frame variants.

The meaning of the BAR Information field depends on the BlockAckReq frame variant type. The meaning of this field is explained within the subclause for each of the BlockAckReq frame variants.

NOTE—Reference to "a BlockAckReq" frame without any other qualification from other subclauses applies to any of the variants, unless specific exclusions are called out.

Table n9—BAR Ack Policy / BA Ack Policy fields for HT-delayed BlockAck

Value	Meaning
0	Normal acknowledgement. The BAR Ack Policy field is set to this value in all individually addressed BlockAckReq, Compressed BlockAckReq and Multi-TID BlockAckReq frames in which the sender requires immediate acknowledgement. The BA Ack Policy field is set to this value in all individually addressed BlockAck, Compressed BlockAck and Multi-TID BlockAck frames in which the sender requires immediate acknowledgement. In the case of HT-delayed Block Ack, the addressee returns an ACK.
1	No Acknowledgement The addressee sends no immediate response upon receipt of the frame. The BAR Ack Policy is set to this value in all BlockAck Req, Compressed BlockAckReq and Multi-TID BlockAckReq frames in which the sender does not require immediate explicit acknowledgement. The BA Ack Policy is set to this value in all BlockAck, Compressed Block Ack and Multi-TID BlockAck frames in which the sender does not require immediate acknowledgement to the containing BlockAck/BlockAckReq frame (as appropriate).

Table n10—BlockAckReq frame variant encoding

Multi-TID	Compressed Bitmap	BlockAckReq frame variant
0	0	Basic BlockAckReq
0	1	Compressed BlockAckReq
1	0	reserved
1	1	Multi-TID BlockAckReq

Insert the following new subclause:

7.2.1.7.1 Basic BlockAckReq variant

The frame control field, Duration/ID field, RA field, TA field and FCS field for the Basic BlockAckReq frame have the same meaning as defined in 7.2.1.7 (Block Ack Request (BlockAckReq) frame format).

The BAR Ack Policy subfield of the BAR control field of the Basic BlockAckReq is reserved**.**

The Multi-TID subfield of the BAR control field of the Basic BlockAckReq frame has the value 0.

The Compressed Bitmap subfield of the BAR control field of the Basic BlockAckReq frame has the value 0.

The TID_INFO subfield of the BAR Control field of the Basic BlockAckReq frame contains the TID for which a Basic BlockAck frame is requested.

The BAR Information within the Basic BlockAckReq frame comprises the Block Ack Starting Sequence Control field, as shown in Figure n5 (Block Ack Starting Sequence Control field). The Starting Sequence number subfield is the sequence number of the first MSDU for which this Basic BlockAckReq is sent. The Fragment Number subfield is always set to 0.

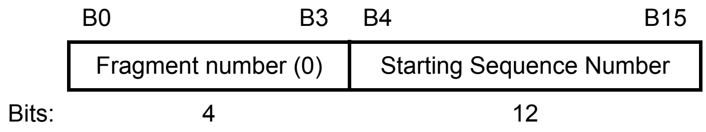

Figure n5—Block Ack Starting Sequence Control field

Insert the following new subclause:

7.2.1.7.2 Compressed BlockAckReq variant

The frame control field, Duration/ID field, RA field, TA field and FCS field for the Compressed BlockAckReq frame have the same meaning as defined in 7.2.1.7 (Block Ack Request (BlockAckReq) frame format).

The BAR Ack Policy subfield of the BAR control field of the Compressed BlockAckReq is defined in 7.2.1.7 (Block Ack Request (BlockAckReq) frame format). The Multi-TID subfield of the BAR control field of the Compressed BlockAckReq frame has the value 0.

NOTE—The BAR Ack policy field in BlockAckReq and BlockAck is only defined for HT-delayed BlockAck. It is reserved under HT-immediate BlockAck.

The Compressed Bitmap subfield of the BAR control field of the Compressed BlockAckReq frame has the value 1 and has the same meaning as defined in 7.2.1.7 (Block Ack Request (BlockAckReq) frame format).

The TID_INFO subfield of the BAR Control field of the Compressed BlockAckReq frame contains the TID for which a BlockAck frame is requested.

The BAR Information field within the Compressed BlockAckReq frame comprises the Block Ack Starting Sequence Control field, as shown in Figure n5 (Block Ack Starting Sequence Control field). The Starting Sequence number subfield is the sequence number of the first MSDU for which this BlockAckReq is sent. The Fragment Number subfield is set to 0.

Insert the following new subclause:

7.2.1.7.3 Multi-TID BlockAckReq variant

The frame control field, Duration/ID field, RA field, TA field and FCS field for the Multi-TID BlockAckReq frame have the same meaning as defined in 7.2.1.7 (Block Ack Request (BlockAckReq) frame format).

The BAR Ack Policy subfield of the Multi-TID BlockAckReq frame is reserved.

NOTE—The BAR Ack policy field in BlockAckReq and BlockAck is only defined for HT-delayed BlockAck. It is reserved under HT-immediate BlockAck.

The Multi-TID subfield of the BAR control field of the Multi-TID BlockAckReq frame has the value 1.

The Compressed Bitmap subfield of the BAR control field of the Multi-TID BlockAckReq frame has the value 1 and has the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The TID_INFO subfield of the BAR Control field of the Multi-TID BlockAckReq frame contains the number of TIDs present in the MTBAR as given by TID_INFO + 1, i.e., a value of 2 in the TID_INFO field means that there are 3 TID values present in the Multi-TID BlockAckReq frame's BAR Information field, as shown in Figure n6 (BAR Information field (MTBAR)).

The BAR Information field of the Multi-TID BlockAckReq frame comprises multiple sets of Per TID Info fields and Block Ack Starting Sequence Control fields, as shown in Figure n6 (BAR Information field (MT-BAR)). The Per TID Info field is shown in Figure n7 (Per TID Info field). The Block Ack Starting Sequence Control field is shown in Figure n5 (Block Ack Starting Sequence Control field). The Starting Sequence Number subfield contains the sequence number of the first MSDU for which this BlockAckReq is sent. The Fragment Number subfield is set to 0.

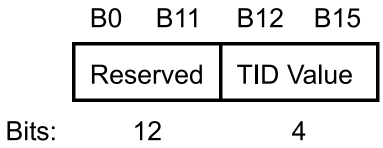

Figure n7—Per TID Info field

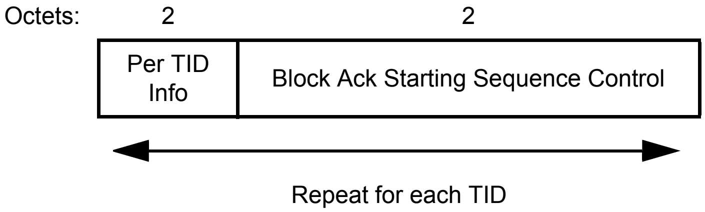

Figure n6—BAR Information field (MTBAR)

Change the heading of 7.2.1.8 as follows:

7.2.1.8 ~~Block Ack (~~BlockAck~~)~~ frame format

Replace Figure 33 (BlockAck frame) with the following figure:

EDITORIAL NOTE—The changes merge the Block Ack Starting Sequence Control and Block Ack Bitmap fields into the BA Information field.

Octets: 2	2	6	6	2	variable	4
Frame Control	Duration / ID	RA	TA	BA Control	BA Information	FCS

MAC Header

Figure 33—BlockAck frame

Replace Figure 32 (BA control field) with the following figure:

EDITORIAL NOTE—the changes comprise adding BA Ack Policy, Multi-TID and Compressed Bitmap fields from the former reserved field and renaming the TID field to TID_INFO.:

B0	B1	B2	B3 B11	B12 B15
BA Ack Policy	Multi-TID	Compressed Bitmap	Reserved	TID_INFO
Bits: 1	1	1	9	4

Figure 34—BA Control field

Delete paragraph 6 of 7.2.1.8 starting "The Block Ack Starting Sequence…"

Delete paragraph 7 of 7.2.1.8 starting "The Block Ack Bitmap…"

Insert the following text and tables at the end of 7.2.1.8:

For HT-delayed operation, the BA Ack Policy subfield has the meaning shown in Table n9 (BAR Ack Policy / BA Ack Policy fields for HT-delayed BlockAck). Otherwise this subfield is reserved.

The values of the Multi-TID and Compressed Bitmap fields determine which of three possible BlockAck frame variants is represented, as indicated in the Table n11 (BlockAck frame variant encoding).

NOTE—Reference to "a BlockAck" frame without any other qualification from other subclauses applies to any of the variants, unless specific exclusions are called out.

The meaning of the TID_INFO subfield of the BA Control field depends on the BlockAck frame variant type. The meaning of this subfield is explained within the subclause for each of the BlockAck frame variants.

The meaning of the BA Information field depends on the BlockAck frame variant type. The meaning of this field is explained within the subclause for each of the BlockAck frame variants.

Table n11—BlockAck frame variant encoding

Multi-TID	Compressed Bitmap	BlockAck frame variant
0	0	BlockAck
0	1	Compressed BlockAck
1	0	Reserved
1	1	Multi-TID BlockAck

Insert the following new subclause:

7.2.1.8.1 Basic BlockAck variant

The frame control field, Duration/ID field, RA field, TA field and FCS field for the Basic BlockAck frame have the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The BA Ack Policy subfield of the BA control field of the Basic BlockAck frame is reserved.

The Multi-TID subfield of the BA control field of the Basic BlockAck frame has the value 0.

The Compressed Bitmap subfield of the BA control field of the Basic BlockAck frame has the value 0 and has the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The TID_INFO subfield of the BA Control field of the Basic BlockAck frame contains the TID for which a BlockAck frame is requested.

The BA Information field within the Basic BlockAck frame comprises the Block Ack Starting Sequence Control field and the Block Ack Bitmap, as shown in Figure n8 (BA Information field (BlockAck)). The format of the Block Ack Starting Sequence Control Field is shown in Figure n5 (Block Ack Starting Sequence Control field). The Starting Sequence Number subfield is the sequence number of the first MSDU for which this Basic BlockAck is sent, and is set to the same value as in the immediately previously received Basic BlockAckReq frame.

Octets:	2	128
	Block Ack Starting Sequence Control	Block Ack Bitmap

Figure n8—BA Information field (BlockAck)

The Block Ack Bitmap field is 128 octets in length and is used to indicate the receiving status of up to 64 MSDUs. Bit position *n* of the Block Ack bitmap, if set to 1, acknowledges receipt of an MPDU with an MPDU sequence control value equal to (Block Ack Starting Sequence Control + *n*). Bit position *n* of the Block Ack bitmap, if set to 0, indicates that an MPDU with MPDU sequence control value equal to (Block Ack Starting Sequence Control + *n*) has not been received. For unused fragment numbers of an MSDU, the corresponding bits in the bitmap are set to 0.

Insert the following new subclause:

7.2.1.8.2 Compressed BlockAck variant

The frame control field, Duration/ID field, RA field, TA field and FCS field for the Compressed BlockAck frame have the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The BlockAck of compressed format is mandatory for all HT STAs.

BlockAck negotiated between HT STAs shall use the compressed format.

A block ack agreement established between two HT STAs using Delayed BlockAck Policy is referred to as an HT-delayed BlockAck.

A block ack agreement established between two HT STAs using Immediate BlockAck Policy is referred to as an HT-immediate BlockAck.

The BAR Ack Policy field in BlockAckReq and the BA Ack Policy field in BlockAck is only defined for HT-delayed BlockAck. It is reserved under HT-immediate BlockAck.

The BA Ack Policy subfield of the BA control field of the Compressed BlockAck frame has the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The Multi-TID subfield of the BA control field of the Compressed BlockAck frame has the value 0.

The Compressed Bitmap subfield of the BA control field of the Compressed BlockAck frame has the value 1 and has the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The TID_INFO subfield of the BA Control field of the Compressed BlockAck frame contains the TID for which a BlockAck frame is requested.

The BA Information field within the Compressed BlockAck frame comprises the Block Ack Starting Sequence Control field and the Block Ack bitmap, as shown in Figure n9 (BA Information field (Compressed BlockAck)). The Starting Sequence Number subfield is the sequence number of the first MSDU for which this BlockAck is sent, and is set to the same value as in the immediately previously received BlockAckReq frame.

The Fragment Number subfield is set to 0.

Octets:	2	8
	Block Ack Starting Sequence Control	Block Ack Bitmap

Figure n9—BA Information field (Compressed BlockAck)

The Block Ack bitmap within the Compressed BlockAck frame is 8 octets in length and is used to indicate the receiving status of up to 64 MSDUs. This is indicated by the value 1 in the Compressed Bitmap field of the BA Control Field. Each bit that is set to 1 in the compressed Block Ack Bitmap acknowledges the successful reception of a single MSDU in the order of sequence number with the first bit of the Block Ack Bitmap corresponding to the MSDU with the sequence number that matches the Block Ack Starting Sequence Control field Starting Sequence Number subfield value.

Insert the following new subclause:

7.2.1.8.3 Multi-TID BlockAck variant

The frame control field, Duration/ID field, RA field, TA field and FCS field for the Multi-TID BlockAck frame have the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The BA Ack Policy subfield of the BA control field of the Multi-TID BlockAck frame has the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

NOTE—The BAR Ack policy field in BlockAckReq and BlockAck is only defined for HT-delayed BlockAck. It is reserved under HT-immediate BlockAck.

The Multi-TID subfield of the BA control field of the Multi-TID BlockAck frame has the value 1 (see Figure n 34).

The Compressed Bitmap subfield of the BA control field of the Multi-TID BlockAck frame has the value 1 and has the same meaning as defined in 7.2.1.8 (Block Ack (BlockAck) frame format).

The TID_INFO subfield of the BA Control field of the Multi-TID BlockAck frame contains the number of instances Per TID Info, of the Block Ack Starting Sequence Control field and Block Ack bitmap present in the MTBA as given by TID_INFO + 1, i.e., a value of 2 in the TID_INFO field means that there are 3 copies of the Block Ack Starting Sequence Control field and Block Ack bitmap values present in the Multiple TID Block Acknowledgement frame's BA Information field. The TID_INFO value in the Multiple TID Block Acknowledgement frame's BA Information field may contain a value that is different from the TID_INFO value of the corresponding MTID BlockAckRequest frame.

The BA Information field within the Multi-TID BlockAck frame comprises 1 or more copies of the Per TID Info, Block Ack Starting Sequence Control field and the Block Ack bitmap, as shown in Figure n10 (BA Information field (MTBA)). The number of copies of the Per TID Info, Block Ack Starting Sequence Control field and the Block Ack bitmap that appear in the Multi-TID Block Ack frame's BA Information field is indicated by the TID_INFO field of the BA Control field. The Per TID Info field is shown in Figure n7 (Per TID Info field), the Block Ack Starting Sequence Control field is shown in Figure n5 (Block Ack Starting Sequence Control field). The Starting Sequence Number subfield is the sequence number of the first MSDU for which this BlockAck is sent, and is set to the same value as in the immediately previously received BlockAckReq frame. The Fragment Number subfield is set to 0. The first set of Block Ack Starting Sequence Control Field and Block Ack Bitmap that is transmitted corresponds to the lowest TID value, with subsequent sets following in increasing TID value order.

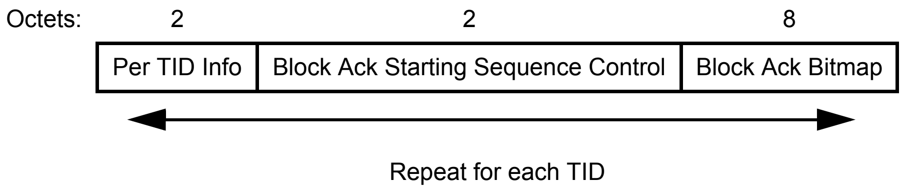

Figure n10—BA Information field (MTBA)

The Block Ack bitmap within the Multi-TID BlockAck frame contains an 8-octet compressed Block Ack Bitmap, as indicated by the value 1 in the Compressed Bitmap field of the BA Control field. Each bit that is set to 1 in the compressed Block Ack Bitmap acknowledges the successful reception of a single MSDU in the order of sequence number with the first bit of the Block Ack Bitmap corresponding to the MSDU with the sequence number that matches the Block Ack Starting Sequence Control field Starting Sequence Number subfield value.

7.2.1.9 Control Wrapper frame

The format of the Control Wrapper frame is shown in Figure n11 (Control Wrapper frame).

Octets: 2	2	6	2	4		4
Frame Control	Duration /ID	Address 1	Carried Frame Control	HT Control	Carried Frame	FCS

Figure n11—Control Wrapper frame

The Control Wrapper frame is used to carry any other control frame together with a High Throughput Control field.

The Frame control field is defined in 7.2.1 (Control frames). The value for the subtype subfield is the value from Table 1 of 7.1.3.1.2 (Type and Subtype fields) that corresponds to Control Frame Wrapper.

The value for the Duration/ID field of the Control Wrapper frame is generated by following the rules for the Duration/ID field of the control frame that is being carried.

The value for the Address1 field of the Control Wrapper frame is generated by following the rules for the Address1 field of the control frame that is being carried.

The Carried Frame Control field contains the value of the Frame Control field of the carried control frame.

The Carried Frame field contains the fields that follow the Address1 field of the control frame that is being carried, excluding the FCS field.

The HT Control field is defined in 7.1.3.5a (HT Control field).

The FCS field is defined in 7.1.3.7.

7.2.2 Data frames

Replace Figure 34-Data frame with the following figure:

EDITORIAL NOTE—The changes comprise the addition of the HT Control field and the change in the frame body length.

Octets: 2	2	6	6	6	2	6	2	4	0-7955	4
Frame Control	Duration / ID	Address 1	Address 2	Address 3	Sequence Control	Address 4	QoS Control	HT Control	Frame Body	FCS

MAC Header

Figure 34—Data frame

Change paragraphs 7 and 8 of 7.2.2 as follows:

The DA field is the destination of the MSDU or A-MSDU (or fragment thereof) in the Frame Body field. The

SA field is the address of the MAC entity that initiated the MSDU or A-MSDU (or fragment thereof) in the Frame Body field.

Insert the following new paragraph after paragraph 13 containing "The QoS Control field is defined in 7.1.3.5.":

The setting of the Order field determines whether the HT Control field is present, as specified in 7.1.3.1.10 (Order field). The HT Control field is defined in 7.1.3.5a (HT Control field)

Change paragraph 14 to 16 of 7.2.2 as follows:

The frame body consists of the MSDU, A-MSDU, or a fragment thereof, and a security header and trailer (if and only if the Protected Frame subfield in the Frame Control field is set to 1). The frame body is null (0 octets in length) in data frames of subtype Null (no data), CF-Ack (no data), CF-Poll (no data), and CF-Ack+CF-Poll (no data), regardless of the encoding of the QoS subfield in the Frame Control field.

For data frames of subtype Null (no data), CF-Ack (no data), CF-Poll (no data), and CF-Ack+CF-Poll (no data) and for the corresponding QoS data frame subtypes, the Frame Body field is omitted; these subtypes are used for MAC control purposes. For data frames of subtypes Data, Data+CF-Ack, Data+CF-Poll, and Data+CF-Ack+CF+Poll and for the corresponding four QoS data frame subtypes, the Frame Body field contains all of, or a fragment of, an MSDU or A-MSDU after any encapsulation for security.

The maximum length of the Frame Body field can be determined from the maximum MSDU or A-MSDU length plus any overhead from encapsulation for encryption (i.e., it is always possible to send a maximum length MSDU, with any encapsulations provided by the MAC layer within a single data MPDU). When the frame body carries an A-MSDU, the size of the frame body field may be limited by:

- the PHY's maximum PSDU length,
- if A-MPDU aggregation is used, the maximum MPDU length is limited to 4095 octets (see 7.4a (Aggregate MPDU (A-MPDU))).

Insert the following new subclause:

7.2.2.1 Aggregate MSDU format (A-MSDU)

An A-MSDU is a sequence of A-MSDU subframes as shown in Figure n12 (A-MSDU structure). Each subframe consists of a subframe header followed by an MSDU and 0-3 octets of padding as shown in Figure n13 (A-MSDU Subframe structure). Each subframe (except the last) is padded so that its length is a multiple of 4 octets. The last subframe has no padding.

NOTE—Padding is applied so that the Subframe Header, plus MSDU, plus Padding has a length that is a multiple of 4.

The subframe header contains three fields: Destination Address (DA), Source Address (SA), and Length [2]. The DA and SA fields are interpreted as defined in Table n12 (Address fields for unicast MPDU containing A-MSDU). The length field contains the length in octets of the MSDU.

A-MSDU Subframe 1	A-MSDU Subframe 2	…	A-MSDU Subframe n

Figure n12—A-MSDU structure

The MPDU containing the A-MSDU may be carried in any of the following Data subtypes: QoS Data, QoS

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[2] These fields are arranged in the same order as the IEEE 802.3 frame format.

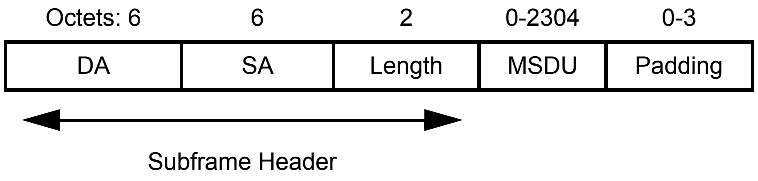

Figure n13—A-MSDU Subframe structure

Data + CF-Ack, QoS Data + CF-Poll, QoS Data + CF-Ack + CF-Poll. The A-MSDU structure is contained in the Frame Body field of the MPDU. If encrypted, the MPDU is encrypted as a single unit.

NOTE—The value of TID present in the QoS Control field of the MPDU carrying the A-MSDU indicates the TID for all MSDUs in the A-MSDU. Because this value of TID is common to all MSDUs in the A-MSDU, only MSDUs delivered to the MAC by an MA-UNITDATA.request with an integer priority parameter that maps to the same TID can be aggregated together using A-MSDU.

The DA and SA are passed between the MAC and its service client in the MAC service primitives. The mapping of DA, SA to the addresses in the MPDU header is described by Table n12 (Address fields for unicast MPDU containing A-MSDU).

An A-MSDU shall only contain MSDUs whose DA and SA parameter values map to the same RA and TA values. I.e., all the MSDUs are intended to be received by a single receiver, and necessarily they are all transmitted by the same transmitter. The rules for determining RA and TA are independent of whether the Frame Body carries an A-MSDU.

NOTE—it is possible to have different DA and SA in subframe headers of the same A-MSDU as long as they all map to the same Address 1 value.

Table n12—Address fields for unicast MPDU containing A-MSDU

To DS	From DS	Address 1	Address 2	Address 3	Address 4
0	0	DA	SA	BSSID	N/A
0	1	DA	BSSID	BSSID	N/A
1	0	BSSID	SA	BSSID	N/A
1	1	RA	TA	BSSID	BSSID

After A-MSDU aggregation, the A-MSDU is transported in the Frame Body of a QoS Data frame using one of the QoS Data subtypes that support this format (shown in Table 4).

NOTE—The maximum MPDU length that can be transported using A-MPDU aggregation is 4095 octets. Fragments of an MSDU, A-MSDU or MMPDU cannot be included in an A-MPDU. So an A-MSDU of length that exceeds 4065 octets (4095 - QoS Data MPDU overhead) cannot be transported in an A-MPDU.

7.2.3 Management frames

7.2.3.1 Beacon frame format

Change Table 8-Beacon frame body as follows:

Order	Information	Notes
8	CF Parameter Set	The CF Parameter Set information element is present only within Beacon frames generated by APs supporting a point coordination function (PCF). This element shall not be present if dot11HighThroughputOptionImplemented is true and the Dual CTS Protection field of the HT Information element is set to 1

Insert the following four additional rows (preserving their order) in Table 8-Beacon frame body just before the Vendor Specific IE and insert contiguous numbering in the "Order" column:

Order	Information	Notes
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true
	HT Information	The HT Information element is included by an AP when dot11HighThroughputOptionImplemented attribute is true
	Secondary Channel Offset	Secondary Channel Offset element may be present if dot11SpectrumManagementRequired is true and dot11FortyMHzOperationImplemented is true
	Extended Channel Switch Announcement	Extended Channel Switch Announcement element may be present if dot11ExtendedChannelSwitchImplemented is true.

7.2.3.4 Association Request frame format

Insert the following two additional rows in Table 10-Association Request frame body just before the Vendor Specific IE and insert contiguous numbering in the "Order" column:

Order	Information	Notes
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true
	Supported Regulatory Classes	Supported Regulatory Classes information element is present if dot11ExtendedChannelSwitchImplemented is true.

7.2.3.5 Association Response frame format

Insert the following three additional rows (preserving their order) in Table 11-Association Response frame body just before the Vendor Specific IE and insert contiguous numbering in the "Order" column:

Order	Information	Notes
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true
	HT Information	The HT Information element is included by an AP when dot11HighThroughputOptionImplemented attribute is true
	Supported Regulatory Classes	Supported Regulatory Classes information element is present if dot11ExtendedChannelSwitchImplemented is true.

7.2.3.6 Reassociation Request frame format

Insert the following two additional rows in Table 12-Reassociation Request frame body just before the Vendor Specific IE and insert contiguous numbering in the "Order" column:

Order	Information	Notes
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true
	Supported Regulatory Classes	Supported Regulatory Classes information element is present if dot11ExtendedChannelSwitchImplemented is true.

7.2.3.7 Reassociation Response frame format

Insert the following three additional rows (preserving their order) in Table 13-Reassociation Response frame body just before the Vendor Specific IE and insert contiguous numbering in the "Order" column:

Order	Information	Notes
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true
	HT Information	The HT Information element is included by an AP when dot11HighThroughputOptionImplemented attribute is true
	Supported Regulatory Classes	Supported Regulatory Classes information element is present if dot11ExtendedChannelSwitchImplemented is true.

7.2.3.8 Probe Request frame format

Insert the following additional row in Table 14-Probe Request frame body just before the Vendor Specific

IE and insert contiguous numbering in the “Order” column:

Order	Information	Notes
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true

7.2.3.9 Probe Response frame format

Insert the following four additional rows (preserving their order) in Table 15-Probe Response frame body just before the Vendor Specific IE and insert contiguous numbering in the “Order” column:

Order	Information	Notes
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true
	HT Information	The HT Information element is included by an AP when dot11HighThroughputOptionImplemented attribute is true
	Secondary Channel Offset	Secondary Channel Offset element may be present if dot11SpectrumManagementRequired is true and dot11FortyMHzOperationImplemented is true
	Extended Channel Switch Announcement	Extended Channel Switch Announcement element is present if dot11ExtendedChannelSwitchImplemented is true.

7.2.3.9a Measurement Pilot frame format

Insert the following two additional rows (preserving their order) in Table 15A-Measurement Pilot frame body just before the Vendor Specific IE and insert contiguous numbering in the “Order” column:

Order	Information	Notes
	Supported Rates	The supported rates element is present when dot11HighThroughputOptionImplemented attribute is true
	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true

Insert new subclause after 7.2.3.12 Action frame format

7.2.3.12a Action No Ack frame format

The frame body of a management frame of subtype Action No Ack contains the information shown in Table n13 (Action No Ack frame body).

NOTE— the selection of Action or Action No Ack is made per frame that uses these formats. Unless specified as using the Action No Ack management subtype, a frame described as an "action frame" uses only the Action subtype.

Table n13—Action No Ack frame body

Order	Information
1	Action
Last	One or more vendor-specific information elements may appear in this frame. This information element follows all other information elements.

7.3 Management frame body components

7.3.1 Fields that are not information elements

7.3.1.9 Status Code field

Insert the following row in Table 23—Status codes before the entry for "Reserved", enter the next available status code value into the "Status Code" field and update the numbering for "Reserved" appropriately.

Table 23—Status codes

Status code	Meaning
	Association denied due to requesting STA not supporting HT features

7.3.1.11 Action field

Insert the following row (ignoring the header row) in Table 24—Category Values in the correct position to preserve ordering by the "Code" column and update the "Reserved" range of codes appropriately.

Code	Meaning	See subclause
7	HT	7.4.7

7.3.1.14 Block Ack Parameter Set field

EDITORIAL NOTE—Figure 49 is changed in the following to replace the reserved value in B0 with "A-MSDU Supported".

Replace Figure 49 with the following

B0	B1	B2...B5	B6..B15
A-MSDU Supported	Block Ack Policy	TID	Buffer Size

Figure 49—Block Ack Parameter Set fixed field

Change the text after the first paragraph of 7.3.1.14 as follows:

The A-MSDU Supported subfield determines whether an A-MSDU may be carried in a QoS data MPDU sent under this Block Ack agreement. When set to 1, use of A-MSDU is permitted. When set to 0, use of A-MSDU is not permitted.

The Block Ack Policy subfield is set to 1 for immediate Block Ack and 0 for delayed Block Ack. ~~The Block~~

~~Ack Policy subfield value assigned by the originator of the QoS data frames is advisory.~~The TID subfield contains the value of the TC or TS for which the Block Ack is being requested.

The Buffer Size subfield indicates the number of buffers~~ of size 2304 octets available~~ for this particular TID.[19] Each buffer is capable of holding an MSDU or A-MSDU of maximum size as indicated by the A-MSDU Supported field .

Change footnote 19 in 7.3.1.14 as follows:

[19] For buffer size, the recipient of data advertises a scalar number that is the number of ~~maximum-size~~ fragment buffers of the maximum MSDU or A-MSDU size (indicated by the A-MSDU Supported Field) available for the BlockAck agreement that is being negotiated. Every buffered MPDU that is associated with this BlockAck agreement will consume one of these buffers regardless of whether the frame contains a whole MSDU, A-MSDU or a fragment ~~of an MSDU~~thereof. ~~In other words~~For example, ten maximum-size unfragmented MSDUs will consume the same amount of buffer space at the recipient as ~~10~~ten smaller fragments of a single MSDU of maximum size.

Insert the following new paragraph at the end of 7.3.1.14:

Fragmentation is not supported under compressed BlockAck.

7.3.1.17 QoS Info field

Change paragraph 10 of 7.3.1.17 as follows:

The Max SP Length subfield is 2 bits in length and indicates the maximum number of total buffered MSDUs, A-MSDUs and MMPDUs the AP may deliver to a non-AP STA during any SP triggered by the non-AP STA. This subfield is reserved when the APSD subfield in the Capability Information field is set to 0. This subfield salsa reserved when all four U-APSD flags are set to 0. If the APSD subfield in the Capability Information field is set to 1 and at least one of the four U-APSD flags is set to 1, the settings of the values in the Max SP Length subfield are defined in Table 25.

Change Table 25 as follows

Table 25—Settings of the Max SP Length subfield

Bit 5	Bit 6	Usage
0	0	AP may deliver all buffered MSDUs, A-MSDUs and MMPDUs.
1	0	AP may deliver a maximum of two MSDUs and MMPDUs per SP.
0	1	AP may deliver a maximum of four MSDUs and MMPDUs per SP.
1	1	AP may deliver a maximum of six MSDUs and MMPDUs per SP.

Insert the following new subclause:

7.3.1.24 Channel Width field

The Channel Width field is used in a HT Notify Channel Width frame (see 7.4.9.2 (Notify Channel Width frame format)) to indicate the channel width that the sending STA is able to receive on. The length of the field is 1 octet. The Channel Width field is illustrated in Figure n14 (Channel Width fixed field).

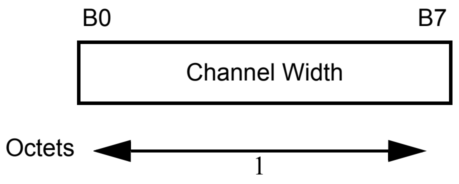

Figure n14—Channel Width fixed field

When the Channel Width field is set to 0, it indicates use of the 20 MHz primary channel. When set to 1, it indicates use of any channel width enabled under the Supported Channel Width Set.

Insert the following new subclause:

7.3.1.25 Spatial Multiplexing (SM) Power Control field

The SM Power Control field is used in an SM Power Save frame (see 7.4.9.3 (SM Power Save frame format)) by a STA to communicate changes in its SM power saving state. The field is 1 octet in length and is illustrated in Figure n15 (SM Power Control fixed field).

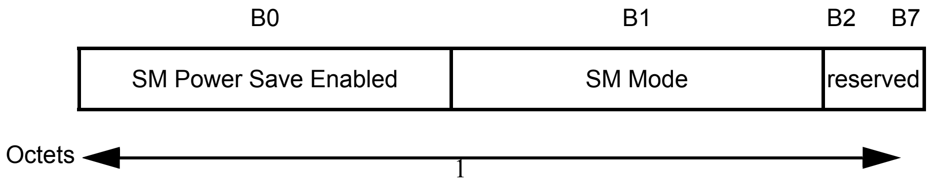

Figure n15—SM Power Control fixed field

The SM Power Save Enabled field indicates whether SM power saving is enabled at the STA. A value of 1 indicates enabled, and a value of 0 indicates disabled.

The SM Mode field indicates the mode of operation. A value of 1 indicates Dynamic SM Power Save mode, a value of 0 indicates Static SM Power Save mode. The modes are described in 11.2.3 (SM Power Save).

Insert the following new subclause:

7.3.1.26 PCO Phase Control field

The PCO Phase Control field is used in a Set PCO Phase frame (see 7.4.9.4 (Set PCO Phase frame format)) to indicate the phase of PCO operation (see 11.16 (Phased Coexistence Operation)). The length of the field is 1 octet. The PCO Phase control field is illustrated in Figure n16 (PCO Phase Control fixed field).

When the PCO Phase Control field is set to 0, it indicates the 20 MHz phase. When set to 1, it indicates the 40 MHz phase.

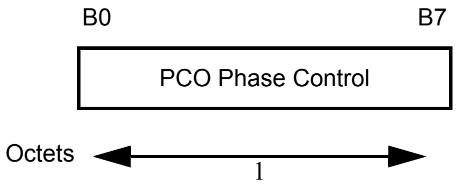

Figure n16—PCO Phase Control fixed field

Insert the following new subclause:

7.3.1.27 PSMP Parameter Set field

The PSMP Parameter Set field is used in a PSMP frame (see 7.4.9.5 (PSMP frame format)) to define the number of PSMP STA Info records held in the PSMP frame, to indicate whether the PSMP sequence is to be followed by another and to indicate the duration of the PSMP sequence.

The PSMP Parameter Set field is 2 octets in length. The structure of the PSMP Parameter Set field is defined in Figure n17 (PSMP Parameter Set fixed field).

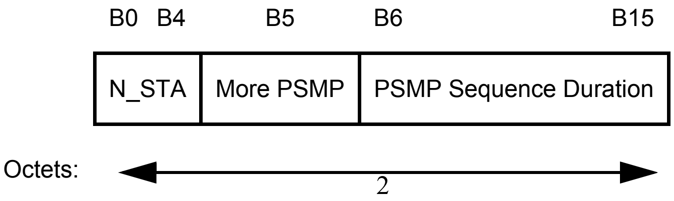

Figure n17—PSMP Parameter Set fixed field

The N_STA field indicates the number of STA Info fields present.

The More PSMP field when set to 1 indicates whether this PSMP sequence is followed by another PSMP sequence. When set to 0 it indicates that there is no PSMP sequence following the current PSMP sequence.

The PSMP Sequence Duration/ID field indicates the duration of the current PSMP sequence that is described by the PSMP frame, in units of 8 µs, relative to the end of the PSMP frame. Therefore, this field can describe a PSMP sequence with a duration of up to 8.184 ms. The next PSMP sequence that is part of the same PSMP burst starts a SIFS interval after the indicated duration.

Insert the following new subclause:

7.3.1.28 PSMP STA Info field

The PSMP STA Info field is used by the PSMP frame (see 7.4.9.5 (PSMP frame format). The PSMP STA Info field defines the allocation of time to the downlink (PSMP-DTT) and/or uplink (PSMP-UTT) associated with a single receiver address. There are three variants of the structure for the individually addressed, multicast and broadcast cases. The length of the PSMP STA Info field is 8 octets.

The structure of the STA Info field is defined in Figure n18 (PSMP STA Info fixed field (individually addressed)) to Figure n20 (PSMP STA Info fixed field (multicast)).

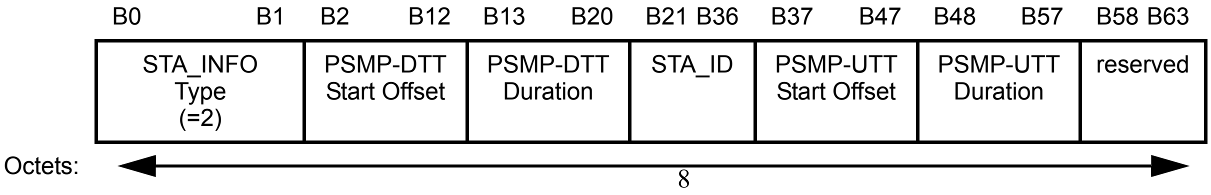

Figure n18—PSMP STA Info fixed field (individually addressed)

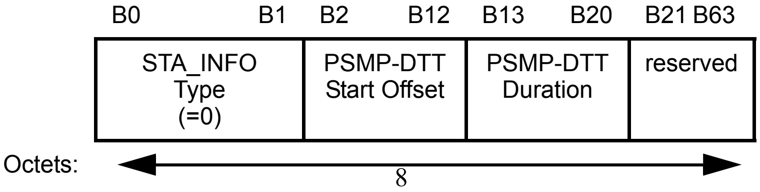

Figure n19—PSMP STA Info fixed field (broadcast)

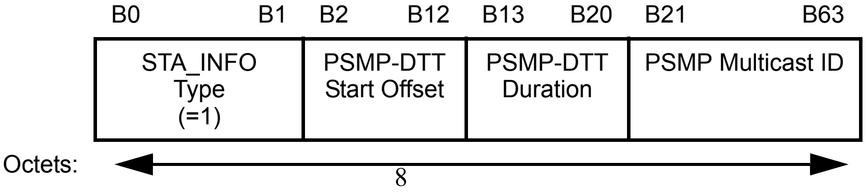

Figure n20—PSMP STA Info fixed field (multicast)

When STA_INFO Type is set to 0, the PSMP STA Info field is structured as defined in Figure n20 (PSMP STA Info fixed field (multicast)), and relates to the transmission of broadcast data by the AP. The STA_INFO Type field indicates the format of the remainder of the structure. When STA_INFO Type is set to 1, the PSMP STA Info field is structured as defined in Figure n20 (PSMP STA Info fixed field (multicast)), and relates to the transmission of multicast data by the AP. When STA_INFO Type is set to 2, the PSMP STA Info field is structured as defined in Figure n18 (PSMP STA Info fixed field (individually addressed)) related to the exchange of data with a single STA.

The PSMP-DTT Start Offset field indicates the start of the PPDU that has the DL data of the STA. The offset is specified relative to the end of the PSMP frame. It is given as an integer number of 4 µs.

The PSMP-DTT Duration field indicates the end of DL data of a STA relative to the start of the PPDU that contains the first frame destined to the STA. It contains a duration in units of 16 µs.

NOTE—The PSMP-DTT Duration field granularity (16 µs) affects power saving, while the PSMP-UTT granularity (4 µs) affects the utilization of the wireless medium, so it is appropriate to represent the latter more precisely.

If no PSMP-DTT is scheduled for a STA, but a PSMP-UTT is scheduled for that STA, then the PSMP-DTT Duration is set to 0 and the PSMP-DTT Start Offset is reserved.

The STA_ID field contains the AID of the STA to which the PSMP STA Info field is directed.

The PSMP Multicast ID (B21 to B63) field contains the least significant 43 bits of a 48 bit MAC address. Use of this field is described in 9.15.2.8 (PSMP broadcast and multicast rules). B63 contains the least significant bit of the multicast address.The PSMP-UTT Start Offset field indicates the start of the PSMP-UTT. The first PSMP-UTT is scheduled to begin after a SIFS interval from the end of the last PSMP-DTT described in the PSMP. The offset is specified relative to the end of the PSMP frame. It is specified in units of 4 µs.

The PSMP-UTT Duration field indicates the maximum length of a PSMP-UTT for a STA. PSMP-UTT Duration is specified in units of 4 µs. All transmissions by the STA within the current PSMP sequence lie within the indicated PSMP-UTT.

If no PSMP-UTT is scheduled for a STA, but a PSMP-DTT is scheduled for that STA, then the PSMP-UTT Start Offset and PSMP-UTT Duration fields are both set to 0.

Insert the following new subclause:

7.3.1.29 MIMO Control field

The MIMO Control field is used to manage the exchange of MIMO channel state or transmit beamforming feedback information. It is used in the MIMO CSI Matrices (see 7.4.9.6 (MIMO CSI Matrices frame format)), MIMO Non-compressed Beamforming (see 7.4.9.7 (MIMO Non-compressed Beamforming frame format))and MIMO Compressed Beamforming (see 7.4.9.8 (MIMO Compressed Beamforming frame format)) frames.

The MIMO Control field is 6 octets in length and is defined in Figure n21 (MIMO Control fixed field).

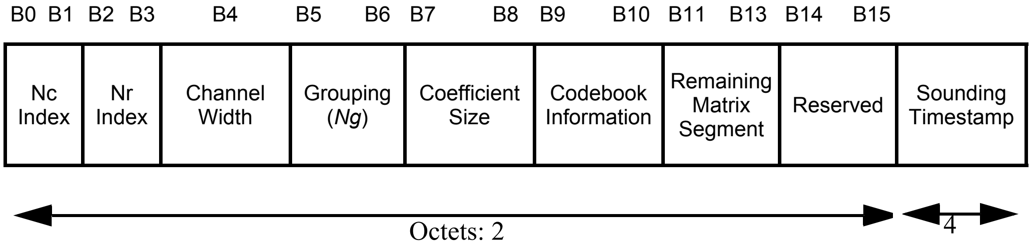

Figure n21—MIMO Control fixed field

The subfields of the MIMO Control field are defined in Table n14 (Subfields of the MIMO Control field).

Table n14—Subfields of the MIMO Control field

Subfield	Description
Nc Index	Indicates the number of columns in a matrix, less one Set to 0 for *Nc* = 1 Set to 1 for *Nc* = 2 Set to 2 for *Nc* = 3 Set to 3 for *Nc* = 4
Nr Index	Indicates the number of rows in a matrix, less one Set to 0 for *Nr* = 1 Set to 1 for *Nr* = 2 Set to 2 for *Nr* = 3 Set to 3 for *Nr* = 4
Channel Width	Indicates the width of the channel in which a measurement was made Set to 0 for 20 MHz Set to 1 for 40 MHz

Table n14—Subfields of the MIMO Control field *(continued)*

Subfield	Description
Grouping (Ng)	Number of Carriers grouped into one: Set to 0 for Ng=1 (No grouping) Set to 1 for Ng=2 Set to 2 for Ng=4 The value 3 is reserved
Coefficient Size	Indicates the number of bits in the representation of the real and imaginary parts of each element in the matrix. Set to 0 for Nb=4 Set to 1 for Nb=5 Set to 2 for Nb=6 Set to 3 for Nb=8
Codebook Information	Indicates the size of codebook entries: Set to 0 for 1 bit for ψ, 3 bits for φ Set to 1 for 2 bits for ψ, 4 bits for φ Set to 2 for 3 bits for ψ, 5 bits for φ Set to 3 for 4 bits for ψ, 6 bits for φ
Remaining Matrix Segment	Contains the remaining segment number for the associated measurement report.
Sounding Timestamp	Contains the lower four octets of the TSF timer value sampled at the instant that the MAC received the PHY-CCA.indication(IDLE) signal that corresponds to the end of the reception of the sounding packet that was used to generate feedback information contained in the frame.

Insert the following new subclause:

7.3.1.30 MIMO CSI Matrices Report field

The MIMO CSI Matrices Report field is used by the MIMO CSI Matrices frame (see 7.4.9.6 (MIMO CSI Matrices frame format)) to carry explicit channel state information to a transmit beamformer, as described in 9.17.3 (Explicit feedback beamforming).

The CSI Matrix fields in the MIMO CSI Matrices Report shown in Table n15 (MIMO CSI Matrices Report fixed field (20 MHz)) and Table n16 (MIMO CSI Matrices Report fixed field (40 MHz)) are matrices whose elements are taken from the CHAN_MAT parameter of RXVECTOR (see Table n56 (TXVECTOR and RX-VECTOR parameters)).

The structure of the field depends on the channel width. The CSI Matrices Report for 20 MHz has the structure defined in Table n15 (MIMO CSI Matrices Report fixed field (20 MHz)).

where

Nb	is the number of bits determined by the Coefficients Size field of the MIMO Control field
Nc	is the number of columns in a CSI matrix determined by the Nc Index field of the MIMO Control field
Nr	is the number of rows in a CSI matrix determined by the Nr Index field of the MIMO Control field

Table n15—MIMO CSI Matrices Report fixed field (20 MHz)

Field	Size	Meaning
SNR in Rx channel 1	8 bits	Signal to Noise Ratio in the first Rx chain of the STA sending the report.
...		
SNR in Rx channel *Nr*	8 bits	Signal to Noise Ratio in the *Nr*'th Rx chain of the STA sending the report.
CSI Matrix for Carrier -28	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix (see Figure n22 (CSI Matrix coding))
...		
CSI Matrix for carrier -1	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix
CSI Matrix for carrier 1	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix
...		
CSI Matrix for carrier 28	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix

The CSI Matrices Report for 40 MHz has the structure defined in Table n16 (MIMO CSI Matrices Report fixed field (40 MHz)).

Table n16—MIMO CSI Matrices Report fixed field (40 MHz)

Field	Size	Meaning
SNR in Rx channel 1	8 bits	Signal to Noise Ratio in the first Rx chain of the STA sending the report.
...		
SNR in Rx channel *Nr*	8 bits	Signal to Noise Ratio in the *Nr*'th Rx chain of the STA sending the report.
CSI Matrix for Carrier -58	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix (see Figure n22 (CSI Matrix coding))
...		
CSI Matrix for carrier -2	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix
CSI Matrix for carrier 2	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix
...		
CSI Matrix for carrier 58	$3+2\times Nb\times Nc\times Nr$ bits	CSI Matrix

The SNR values in Table n15 (MIMO CSI Matrices Report fixed field (20 MHz)) and Table n16 (MIMO CSI Matrices Report fixed field (40 MHz)) are encoded as an 8-bit two's complement value of 4 x (SNR_average - 22), where SNR_average is the dB value of linear power averaged over the tones represented. This encoding covers the SNR range from -10 to 53.75 in 0.25 dB steps.

Grouping is a method to group adjacent subcarriers to reduce the network overhead. With grouping, the size of the CSI Matrices Report is $Nr\times8+Ns\times(3+2\times Nb\times Nc\times Nr)$ bits, where the number of subcarriers sent *Ns* is a function of *Ng* and whether matrices for 40 MHz or 20 MHz are sent. The value of *Ns* and the specific carriers for which matrices are sent is shown in Table n17 (Number of matrices and carrier grouping). If the size of the CSI Matrices report is not an integer multiple of 8 bits, up to 7 zeros are appended to the end of the report to make its size an integer multiple of 8 bits.

Table n17—Number of matrices and carrier grouping

BW and Grouping	Ns	Carriers for which matrices are sent
20 MHz Ng=1	56	All data and pilot carriers: -28, -27,…-2, -1, 1, 2,…27, 28
20 MHz Ng=2	30	-28,-26,-24,-22,-20,-18,-16,-14,-12,-10,-8,-6,-4,-2,-1, 1,3,5,7,9,11,13,15,17,19,21,23,25,27,28
20 MHz Ng=4	16	-28,-24,-20,-16,-12,-8,-4,-1,1,5,9,13,17,21,25,28
40 MHz Ng=1	114	All data and pilot carriers: -58, -57, …, -3, -2, 2, 3,…, 57, 58
40 MHz Ng=2	58	-58,-56,-54,-52,-50,-48,-46,-44,-42,-40,-38,-36,-34,-32,-30, -28,-26,-24,-22,-20,-18,-16,-14,-12,-10,-8,-6,-4,-2, 2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50,52,54,56,58
40 MHz Ng=4	30	-58,-54,-50,-46,-42,-38,-34,-30,-26,-22,-18,-14,-10,-6, -2, 2,6,10,14,18,22,26,30,34,38,42,46,50,54,58

The CSI matrix H_{eff} for a single carrier has the structure defined in Figure n22 (CSI Matrix coding). The encoding rules for the elements of the *H* matrix are given in 20.3.11.2.1 (CSI Matrices feedback).

```
For each subcarrier include
{
    Carrier Matrix Amplitude of 3 bits
    For each of Nr rows in each CSI matrix in order: (1, …, Nr)
    {
        Include Nc complex coefficients of CSI matrix $H_{eff}$ in order: (1, …, Nc );
        each element of $H_{eff}$ includes the real part of the element (Nb bits) and
        imaginary part of the element (Nb bits) in that order
    }


}
```

Figure n22—CSI Matrix coding

Insert the following new subclause:

7.3.1.31 MIMO Non-compressed Beamforming Feedback Matrices Report field

The MIMO Non-compressed Beamforming Feedback Matrices Report field is used by the MIMO Non-compressed Beamforming Matrices frame to carry explicit feedback in the form of non-compressed beamforming matrices for use by a transmit beamformer, as described in 9.17.3 (Explicit feedback beamforming).

The structure of the field is dependent on the channel width. The Non-compressed Beamforming Feedback Matrices Report for 20 MHz has the structure defined in Table n18 (MIMO Non-compressed Beamforming Feedback Matrices Report fixed field (20 MHz)).

Table n18—MIMO Non-compressed Beamforming Feedback Matrices Report fixed field (20 MHz)

Field	Size	Meaning
SNR for stream 1	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream 1.
...		
SNR for stream *Nc*	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream *Nc*.
Beamforming Feedback Matrix for Carrier -28	2× Nb×Nc×Nr bits	Beamforming Feedback Matrix V (see Figure n23 (V Matrix coding (MIMO Non-compressed Beamforming)))
...		
Beamforming Feedback Matrix for carrier -1	2× Nb×Nc×Nr bits	Beamforming Feedback Matrix V
Beamforming Feedback Matrix for carrier 1	2× Nb×Nc×Nr bits	Beamforming Feedback Matrix V
...		
Beamforming Feedback Matrix for carrier 28	2× Nb×Nc×Nr bits	Beamforming Feedback Matrix V

where

Nb	is the number of bits determined by the Coefficients Size field of the MIMO Control field
Nc	is the number of columns in a beamforming matrix determined by the Nc Index field of the MIMO Control field
Nr	is the number of rows in a beamforming matrix determined by the Nr Index field of the MIMO Control field

The Non-compressed Beamforming Feedback Matrices Report for 40 MHz has the structure defined in Table n19 (MIMO Non-compressed Beamforming Feedback Matrices Report fixed field (40 MHz)).

The SNR values in Table n18 (MIMO Non-compressed Beamforming Feedback Matrices Report fixed field (20 MHz)) and Table n19 (MIMO Non-compressed Beamforming Feedback Matrices Report fixed field (40 MHz)) are encoded as an 8-bit two's complement value of 4 x (SNR_average - 22), where SNR_average is the dB value of linear power averaged over the tones represented. This encoding covers the SNR range from

Table n19—MIMO Non-compressed Beamforming Feedback Matrices Report fixed field (40 MHz)

Field	Size	Meaning
SNR for stream 1	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream 1.
...		
SNR for stream *Nc*	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream *Nc*.
Beamforming Feedback Matrix for Carrier -58	$2\times Nb\times Nc\times Nr$ bits	Beamforming Feedback Matrix V (see Figure n23 (V Matrix coding (MIMO Non-compressed Beamforming)))
...		
Beamforming Feedback Matrix for carrier -2	$2\times Nb\times Nc\times Nr$ bits	Beamforming Feedback Matrix V
Beamforming Feedback Matrix for carrier 2	$2\times Nb\times Nc\times Nr$ bits	Beamforming Feedback Matrix V
...		
Beamforming Feedback Matrix for carrier 58	$+2\times Nb\times Nc\times Nr$ bits	Beamforming Feedback Matrix V

-10 to 53.75 in 0.25 dB steps. The SNR in stream *i* corresponds to the SNR associated with the column *i* of the Beamforming Feedback matrix V. Each SNR corresponds to the predicted SNR at beamformee when the beamformer applies the matrix V.

Grouping is a method to group adjacent subcarriers to reduce the network overhead. With grouping, the size of the Non-compressed Beamforming Feedback Matrix Report is $Nc\times 8+Ns\times(2\times Nb\times Nc\times Nr)$ bits. The number of subcarriers sent *Ns* is a function of *Ng* and whether matrices for 40 MHz or 20 MHz are sent. The value of *Ns* and the specific carriers for which matrices are sent is shown in Table n17 (Number of matrices and carrier grouping). If the size of the Non-compressed Beamforming Feedback Matrix Report is not an integer multiple of 8 bits, up to 7 zeros are appended to the end of the report to make its size an integer multiple of 8 bits.

A beamforming matrix V for a single carrier has the structure defined in Figure n23 (V Matrix coding (MIMO Non-compressed Beamforming)).

```
For each subcarrier include
{
For each of Nr rows in each CSI matrix in order: (1, …, Nr)
    {
        Include Nc complex coefficients of the MIMO Non-compressed Beamforming
        matrix V in order: (1, …, Nc  );  each element of V includes the real
        part of the element (Nb bits) and imaginary part of the element (Nb bits)
        in that order
    }
}
```

Figure n23—V Matrix coding (MIMO Non-compressed Beamforming)

Encoding rules for elements of the V matrix are given in 20.3.11.2.2 (Non-compressed beamforming matrix feedback).

Insert the following new subclause:

7.3.1.32 MIMO Compressed Beamforming Matrices Report field

The MIMO Compressed Beamforming Matrices Report field is used by the MIMO Compressed Beamforming frame (see 7.4.9.8 (MIMO Compressed Beamforming frame format)) to carry explicit feedback information in the form of compressed beamforming matrices to a transmit beamformer, as described in 9.17.3 (Explicit feedback beamforming).

The size of the MIMO Compressed Beamforming Matrices Report field depends on the values in the MIMO Control field.

The MIMO Compressed Beamforming Matrices Report field contains the channel matrix elements indexed first by matrix angles in the order shown in Table n20 (Order of angles in the MIMO Compressed Beamforming Matrices Report field) and secondly by data subcarrier index from smallest frequency to highest frequency. The explanation on how these angles are generated from the beamforming matrix V is given in 20.3.11.2.3 (Compressed beamforming matrix feedback).

Table n20—Order of angles in the MIMO Compressed Beamforming Matrices Report field

Size of V(*Nr* x *Nc*)	**Number of angles (*Na*)**	**The order of angles in the Quantized Beamforming Matrices Feedback Information field**
2x1	2	ϕ11, ψ21
2x2	2	ϕ11, ψ21
3x1	4	ϕ11, ϕ21, ψ21, ψ31
3x2	6	ϕ11, ϕ21, ψ21, ψ31, ϕ22, ψ32
3x3	6	ϕ11, ϕ21, ψ21, ψ31, ϕ22, ψ32
4x1	6	ϕ11, ϕ21, ϕ31, ψ21, ψ31, ψ41
4x2	10	ϕ11, ϕ21, ϕ31, ψ21, ψ31, ψ41, ϕ22, ϕ32, ψ32, ψ42
4x3	12	ϕ11, ϕ21, ϕ31, ψ21, ψ31, ψ41, ϕ22, ϕ32, ψ32, ψ42, ϕ33, ψ43
4x4	12	ϕ11, ϕ21, ϕ31, ψ21, ψ31, ψ41, ϕ22, ϕ32, ψ32, ψ42, ϕ33, ψ43

The angles are quantized as defined in Table n21 (Quantization of angles). All angles are transmitted LSB to MSB.

The MIMO Compressed beamforming feedback matrices report for 20 MHz has the structure defined in Table n22 (MIMO Compressed Beamforming Feedback Matrices Report fixed field (20 MHz)), where *Na* is the number of angles used for beamforming feedback matrix V (see Table n20 (Order of angles in the MIMO Compressed Beamforming Matrices Report field)).

The MIMO Compressed beamforming feedback matrices report for 40 MHz has the structure defined in Table n23 (MIMO Compressed Beamforming Feedback Matrices Report fixed field (40 MHz)), where *Na* is the number of angles used for beamforming feedback matrix V (see Table n20 (Order of angles in the MIMO Compressed Beamforming Matrices Report field)).

Table n21—Quantization of angles

ψ axis	ϕ axis
$\psi = \frac{k\pi}{2^{b_\psi+1}} + \frac{\pi}{2^{b_\psi+2}}$ where $k = 0,1,...,2^{b_\psi} - 1$ b_ψ is the number of bits used to quantize ψ (defined by the Codebook Information field of the MIMO Control field, see 7.3.1.29 (MIMO Control field));	$\phi = \frac{k\pi}{2^{b_\phi-1}} + \frac{\pi}{2^{b_\varphi}}$ where $k = 0,1,...,2^{b_\phi} - 1$ b_ϕ is the number of bits used to quantize ϕ (defined by the Codebook Information field of the MIMO Control field, see 7.3.1.29 (MIMO Control field))

Table n22—MIMO Compressed Beamforming Feedback Matrices Report fixed field (20 MHz)

Field	Size	Meaning
SNR in stream 1	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream 1
...		
SNR in stream *Nc*	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream *Nc*
Beamforming Feedback Matrix V for Carrier -28	$Na\times(b_\psi+b_\phi)/2$ bits	Beamforming Feedback Matrix V
...		
Beamforming Feedback Matrix V for carrier -1	$Na\times(b_\psi+b_\phi)/2$ bits	Beamforming Feedback Matrix V
Beamforming Feedback Matrix V for carrier 1	$Na\times(b_\psi+b_\phi)/2$ bits	Beamforming Feedback Matrix V
...		
Beamforming Feedback Matrix V for carrier 28	$Na\times(b_\psi+b_\phi)/2$ bits	Beamforming Feedback Matrix V

The SNR values in Table n22 (MIMO Compressed Beamforming Feedback Matrices Report fixed field (20 MHz)) and Table n23 (MIMO Compressed Beamforming Feedback Matrices Report fixed field (40 MHz)) are encoded as an 8-bit two's complement value of 4 x (SNR_average - 22), where SNR_average is the dB value of linear power averaged over the tones represented. This encoding covers the SNR range from -10 to 53.75 in 0.25 dB steps. Each SNR value per tone in stream *i* (before being averaged) corresponds to the SNR associated with the column *i* of the beamforming feedback matrix V determined at the beamformee. Each SNR corresponds to the predicted SNR at the beamformee when the beamformer applies the matrix V.

Grouping is a method to group adjacent subcarriers to reduce the network overhead. With grouping, the size of the MIMO Compressed Beamforming Feedback Matrix Report is $Nc\times 8+Ns\times(Na\times(b_\psi+b_\phi)/2)$ bits,

Table n23—MIMO Compressed Beamforming Feedback Matrices Report fixed field (40 MHz)

Field	Size	Meaning
SNR in stream 1	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream 1
...		
SNR in stream *Nc*	8 bits	Average Signal to Noise Ratio in the STA sending the report for stream *Nc*
Beamforming Matrix V for Carrier -58	$Na\times(b_{\psi}+b_{\phi})/2$ bits	Beamforming Feedback Matrix V
Beamforming Feedback Matrix V for Carrier -58 + *Ng*	$Na\times(b_{\psi}+b_{\phi})/2$ bits	Beamforming Feedback Matrix V
...		
Beamforming Feedback Matrix V for carrier -2	$Na\times(b_{\psi}+b_{\phi})/2$ bits	Beamforming Feedback Matrix V
Beamforming Feedback Matrix V for carrier 2	$Na\times(b_{\psi}+b_{\phi})/2$ bits	Beamforming Feedback Matrix V
Beamforming Feedback Matrix V for carrier 2 + *Ng*	$Na\times(b_{\psi}+b_{\phi})/2$ bits	Beamforming Feedback Matrix V
...		
Beamforming Feedback Matrix V for carrier 58	$Na\times(b_{\psi}+b_{\phi})/2$ bits	Beamforming Feedback Matrix V

where the number of subcarriers sent *Ns* is a function of *Ng* and whether matrices for 40 MHz or 20 MHz are sent. *Ns* and the specific carriers for which matrices are sent is defined in Table n17 (Number of matrices and carrier grouping). If the size of the Compressed Beamforming Feedback Matrix Report is not an integer multiple of 8 bits, up to 7 zeros are appended to the end of the report to make its size an integer multiple of 8 bits.

See Figure n25 (Example of bit ordering for angles for 4x2 V with by= 2, bf= 4, 4 tone grouping for 40 MHz, where the matrix V per tone is encoded in 30 bits.) and Figure n24 (Example of bit ordering for angles for 2x2 V with by= 3, bf= 5, no grouping for 20 MHz, where the matrix V per tone is encoded in 8 bits.) for examples of this encoding.

bits	b1..b5	b6..b8	b9..b13	b14..b16	…	b441..b445	b446..b448
data	$\phi_{11}(f_{-28})$	$\psi_{21}(f_{-28})$	$\phi_{11}(f_{-27})$	$\psi_{21}(f_{-27})$	…	$\phi_{11}(f_{28})$	$\psi_{21}(f_{28})$

Figure n24—Example of bit ordering for angles for 2x2 V with b_{ψ}= 3, b_{ϕ}= 5, no grouping for 20 MHz, where the matrix V per tone is encoded in 8 bits.

Bits	b1..b4	b5..b8	…	b27..b28	b29..b30	b31..b34	…	b59..b60	…	b871..b874	…	b899..b900
data	$\phi_{11}(f_{-58})$	$\phi_{21}(f_{-58})$	…	$\psi_{32}(f_{-58})$	$\psi_{42}(f_{-58})$	$\phi_{11}(f_{-54})$	…	$\psi_{42}(f_{-54})$	…	$\phi_{11}(f_{58})$	…	$\psi_{42}(f_{58})$

Figure n25—Example of bit ordering for angles for 4x2 V with b_{ψ}= 2, b_{ϕ}= 4, 4 tone grouping for 40 MHz, where the matrix V per tone is encoded in 30 bits.

Insert the following new subclause:

7.3.1.33 Antenna Selection Indices field

The Antenna Selection Indices field is used within the Antenna Selection Indices Feedback frame to carry antenna selection feedback, as described in 9.18 (Antenna selection).

The Antenna Selection Indices field is 1 octet in length, and illustrated in Figure n26 (Antenna Selection Indices fixed field).

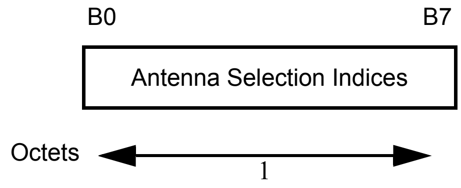

Figure n26—Antenna Selection Indices fixed field

Bit 0 through bit 7 in the Antenna Selection Indices field correspond to antennas with indices 0 through 7 respectively. A value of 1 in a bit represents the corresponding antenna is selected, and the value of 0 indicates the corresponding antenna is not selected.

7.3.2 Information elements

EDITORIAL NOTE—Numbers marked as <ANA> will be inserted once assigned by the ANA

Insert the following four rows (ignoring the header row) in Table 26—Element IDs in the correct position to preserve ordering by the "Element ID" column and update the "Reserved" range of codes appropriately.

Information Element	Element ID	Length (in octets)
HT Capabilities (see 7.3.2.49 (HT Capabilities element))	45	28
HT Information Element (see 7.3.2.50 (HT Information element))	61	>= 24
Secondary Channel Offset element (see 7.3.2.20a (Secondary Channel Offset element))	62	3
Extended Channel Switch Announcement	<ANA>	6

7.3.2.2 Supported Rates element

Change the first paragraph of 7.3.2.2 as follows:

The Supported Rates element specifies up to eight rates in the Operational-Rate-Set parameter, as described in the MLME-JOIN.request and MLME-START.request primitives and zero or more BSS membership selectors. The information field is encoded as 1 to 8 octets, where each octet describes a single Supported Rate or BSS membership selector. If the combined total of the number of rates in the Operational Rate Set and the number of BSS membership selectors exceeds eight, then an Extended Supported Rate element shall be generated to specify the remaining supported rates and BSS membership selectors. The use of the Extended Supported Rates element is optional otherwise. If the BSSBasicMembershipSelectorSet parameter contains at least one BSS membership selector, then at least one BSS membership selector value from the BSSBasicMembershipSelectorSet parameter shall be included in the Supported Rates element.

Add a new paragraph to follow the existing second paragraph of 7.3.2.2 as follows:

Within Beacon, Probe Response, Association Response, and Reassociation Response management frames, each BSS membership selector contained in the BSSBasicMembershipSelectorSet parameter is encoded as an octet with the MSB (bit 7) set to 1, and bits 6 through 0 are set to the encoded value for the selector as found in Table n24 (BSS membership selector value encoding) (e.g., an HT PHY BSS membership selector contained in the BSSBasicMembershipSelectorSet parameter is encoded as X'FF'). A BSS membership selector that has the MSB (bit 7) set to 1 in the supported rates element is defined to be basic. BSS membership selectors not contained in the BSSBasicMembershipSelectorSet parameter are encoded with the MSB set to 0, and bits 6 through 0 are set to the appropriate value for the selector as found in Table n24 (BSS membership selector value encoding) (e.g., an HT PHY BSS membership selector not contained in the BSSBasicMembershipSelectorSet parameter is encoded as X'7F'). The MSB of each Supported Rate octet in other management frame types is ignored by receiving STAs.

Change the existing third paragraph of 7.3.2.2 as follows:

The Supported Rate information in Beacon and Probe Response management frames is delivered to the management entity in a STA via the BSSBasicRateSet parameter in the MLME-SCAN.confirm primitive. The BSS membership selector information in Beacon and Probe Response management frames is delivered to the management entity in a STA via the BSSBasicMembershipSelectorSet parameter in the MLME-SCAN.confirm primitive. Together, these parameters are~~It is~~ used by the management entity in a STA to avoid associating with a BSS if the STA cannot receive and transmit all the data rates in the BSSBasicRateSet parameter (see Figure 56) or does not support all of the features represented in the BSSBasicMembershipSelectorSet parameter. A STA which was implemented before the existence of the BSSBasicMembershipSelectorSet parameter will interpret each BSS membership selector in the Supported Rates element which is contained in the BSSBasicMembershipSelectorSet of the transmitting STA as though it were a rate from the BSSBasicRateSet parameter. The value of each BSS membership selector will not match a rate which is known to the STA and therefore, the management entity in such a STA will avoid associating with the BSS because it determines that the STA cannot receive or transmit at what appears to be a required rate. A STA which is implemented after the existence of the BSSBasicMembershipSelectorSet parameter shall include each octet of the Supported rates element which is encoded with the MSB (bit 7) set to 1 and which it does not recognize as a rate in its BSSBasicMembershipSelectorSet parameter. The STA shall then determine if it can support all of the features represented in its BSSBasicMembershipSelectorSet parameter before attempting to join the network. If there are some BSSBasicMembershipSelectorSet values which are not recognized by the STA, then the STA shall not attempt to join the network.

Insert the following new subclause:

7.3.2.2.1 BSS membership selector values

The valid values for BSS membership selectors and their associated features and the meaning of the presence of each BSS membership selector value when indicated as “basic” within a supported rates element or extended supported rates element are shown in Table n24 (BSS membership selector value encoding)

7.3.2.14 Extended Supported Rates element

Change the first paragraph of 7.3.2.14 as follows:

The Extended Supported Rates element specifies the rates in the OperationalRateSet as described in the

Table n24—BSS membership selector value encoding

BSS membership selector value	Feature	Interpretation if this BSS membership selector value is included and indicated as “basic” in either the supported rates element or extended supported rates element	Interpretation if this BSS membership selector value is included, but is not indicated as “basic” in either the supported rates element or extended supported rates element
127	HT PHY	Support for the mandatory features of Clause 20 is required in order to join the BSS which was the source of the supported rates element or extended supported rates element	Not allowed

MLME_JOIN.request and MLME_START.request primitives and zero or more BSS membership selector values that are not carried in the Supported Rates element. The information field is encoded as 1 to 255 octets where each octet describes a single supported rate or BSS membership selector.

Add the following new paragraph after the second paragraph of 7.3.2.14 as follows:

Within Beacon, Probe Response, Association Response, and Reassociation Response management frames, each BSS membership selector contained in the BSSBasicMembershipSelectorSet parameter is encoded as an octet with the MSB (bit 7) set to 1, and bits 6 through 0 are set to the encoded value for the selector as found in Table n24 (BSS membership selector value encoding) (e.g., an HT PHY BSS membership selector contained in the BSSBasicMembershipSelectorSet parameter is encoded as X'FF'). A BSS membership selector that has the MSB (bit 7) set to 1 in the extended supported rates element is defined to be basic. BSS membership selectors not contained in the BSSBasicMembershipSelectorSet parameter are encoded with the MSB set to 0, and bits 6 through 0 are set to the appropriate value for the selector as found in Table n24 (BSS membership selector value encoding) (e.g., an HT PHY BSS membership selector not contained in the BSSBasicMembershipSelectorSet parameter is encoded as X'7F'). The MSB of each octet in the Extended Supported Rate element in other management frame types is ignored by receiving STAs.

Change the existing third and fourth paragraphs of 7.3.2.14 as follows:

Extended Supported Rate information in Beacon and Probe Response management frames is used by STAs in order to avoid associating with a BSS if they do not support all the data rates in the BSSBasicRateSet parameter or all of the BSS membership requirements in the BSSBasicMembershipSelectorSet parameter.

For stations supporting a combined total of eight or fewer data rates and BSS membership selectors, this element is optional for inclusion in all of the frame types that include the supported rates element. For stations supporting more than a combined total of eight data rates and BSS membership selectors, this element shall be included in all of the frame types that include the supported rates element. If the BSSBasicMembershipSelectorSet parameter contains at least one BSS membership selector, then at least one BSS membership selector value from the BSSBasicMembershipSelectorSet parameter shall be included in the Supported Rates element.

Insert the following subclause after 7.3.2.20:

7.3.2.20a Secondary Channel Offset element

The Secondary Channel Offset element is used by an AP in a BSS or a STA in an IBSS together with the Channel Switch Announcement element when changing to a new 40 MHz channel. The format of the Secondary Channel Offset element is shown in Figure n27 (Secondary Channel Offset element format).

The Secondary Channel Offset element is included in Channel Switch Announcement frames, as described in 7.4.1.5 (Channel Switch Announcement frame format), and may be included in Beacon frames, as described in 7.2.3.1 (Beacon frame format), and Probe Response frames, as described in 7.2.3.9 (Probe Response frame format).

Octets:	1	1	1
	Element ID	Length	Secondary Channel Offset

Figure n27—Secondary Channel Offset element format

The value of the Length field is variable, as this element may be extended in the future.

The Secondary Channel Offset field represents the position of the secondary channel relative to the primary channel. The Secondary Channel Offset field is set to the value 1 to indicate that the secondary channel is above the primary channel; the value 3 indicates that the secondary channel is below the primary channel; the value 0 indicates that no secondary channel is present and the value 2 is reserved.

7.3.2.21 Measurement Request element

7.3.2.21.6 Beacon Request

Insert two new rows to become the last rows of Table 29b as follows:

Report not required to be issued	254
Reserved	255

Change the last row of Table 29b as follows:

Reserved	11-25~~5~~3

7.3.2.21.8 STA Statistics Request

Insert the following five rows before the last row of Table 29c and update the value for the "reserved" row appropriately:

7.3.2.22 Measurement Report element

7.3.2.22.6 Beacon Report

Change the last paragraph of 7.3.2.22.6 as follows:

The Reported Frame Body field contains the frame body of the reported Beacon, Measurement Pilot, or Probe Response frame. All fixed fields and information elements are included in the order they appeared in the reported frame. Reported TIM elements shall be truncated such that only the first 4 octets of the element are

Table 29c—Group Identity for a STA Statistics Request

Statistics Group Name	Group Identity
STA Counters from dot11A-MSDU Group	11
STA Counters from dot11A-MPDU Group	12
STA Counters from dot11 BAR, Channel Width, PSMP Group	13
STA Counters from dot11Protection Group	14
STBC Group	15

reported and the element length field is modified to indicate the truncated length of 4. Reported IBSS DFS elements shall be truncated such that only the lowest and highest channel number map are reported and the element length field is modified to indicate the truncated length of 13. Reported RSN elements shall be truncated such that only the first 4 octets of the element are reported and the element length field is modified to indicate the truncated length of 4. If the Reported Frame Body would cause the Measurement Report element to exceed the maximum information element size then the Reported Frame Body shall be truncated so that the last information element in the Reported Frame Body field shall be a complete information element.

STA Statistics Report*Add the following rows to Table 31b just above the last row and update the numbering of the last row appropriately:*

Table 31b—Group Identity for a STA Statistics Report

Group Identity Requested	Statistics Returned
11	STA Counters from dot11A-MSDU Group: dot11TransmittedAMSDUCountCounter32, dot11FailedAMSDUCountCounter32, dot11RetryAMSDUCountCounter32, dot11MultipleRetryAMSDUCountCounter32, dot1TransmittedOctetsInAMSDUCountCounter64, dot11AMSDUAckFailureCount Counter32, dot11ReceivedAMSDUCountCounter32, dot1ReceivedOctetsInAMSDUCountCounter64
12	STA Counters from dot11A-MPDU Group: dot11TransmittedAMPDUCountCounter32, dot11TransmittedMPDUsInAMPDUCountCounter32, dot11TransmittedOctetsInAMPDUCountCounter64, dot11AMPDUReceivedCountCounter32, dot11MPDUInReceivedAMPDUCountCounter32, dot11ReceivedOctetsInAMPDUCountCounter64, dot11AMPDUDelimiterCRCErrorCountCounter32
13	STA Counters from dot11 BAR, Channel Width, PSMP Group: dot11ImplicitBARFailureCountCounter32, dot11ExplicitBARFailureCountCounter32, dot11ChannelWidthSwitchCountCounter32, dot11TwentyMHzFrameTransmittedCountCounter32, dot11FortyMHzFrameTransmittedCountCounter32, dot11TwentyMHzFrameReceivedCountCounter32, dot11FortyMHzFrameReceivedCountCounter32, dot11PSMPSuccessCountCounter32, dot11PSMPFailureCountCounter32
14	STA Counters from dot11Protection Group (RDG, DualCTS, LSIG): dot11GrantedRDGUsedCountCounter32, dot11GrantedRDGUnusedCountCounter32, dot11TransmittedFramesInGrantedRDGCountCounter32, dot11TransmittedOctetsInGrantedRDGCountCounter64, dot11DualCTSSuccessCountCounter32, dot11DualCTSFailureCountCounter32, dot11RTSLSIGSuccessCountCounter32, dot11RTSLSIGFailureCountCounter32
15	dot11 BF, STBC Group: dot11BeamformingFrameCountCounter32, dot11STBCCTSSuccessCountCounter32, dot11STBCCTSFailureCountCounter32, dot11nonSTBCCTSSuccessCountCounter32, dot11nonSTBCCTSFailureCountCounter32

7.3.2.25 RSN information element

7.3.2.25.1 Cipher suites

Insert the following new paragraph at the end of the subclause:

An HT STA shall not use the pairwise cipher suite selectors “Use group cipher suite” and TKIP to communicate with another HT STA.

7.3.2.27 Extended Capabilities information element

Change the last paragraph of 7.3.2.27 as follows:

The Capabilities field is a bit field indicating the capabilities being advertised by the STA transmitting the information element. ~~There are no capabilities defined for this field in this revision of the standard.~~ One octet of extended information has been defined. The format of that octet appears in Figure n28 (Capabilities field first octet).

Insert the following at the end of 7.3.2.27 as follows:

	B0	B1 B7
	HT Information Exchange Support	Reserved
Bits:	1	7

Figure n28—Capabilities field first octet

The HT Information Exchange Support field indicates support for the HT Information Exchange management frame type and its use. The HT Information Exchange Support field shall be set to 1 to indicate support for the communication of STA information through the transmission and reception of the HT Information Exchange management frame. The HT Information Exchange Support field shall be set to 0 to indicate a lack of support for the communication of STA information through the transmission and reception of the HT Information Exchange management frame. If a STA does not support the use of the HT Information Exchange management frame subtype, then the STA is not required to transmit the Extended Capabilities Information element.

7.3.2.30 TSPEC element

Change Table 37 as follows:

Table 37—Default EDCA Parameter Set element parameter values

AC	CWmin	CWmax	AIFSN	TXOP limit		
				For PHYs defined in Clause 15 and Clause 18	For PHYs defined in Clause 17~~ and~~, Clause 19 and Clause 20	Other PHYs
AC_BK	aCWmin	aCWmax	7	0	0	0
AC_BE	aCWmin	aCWmax	3	0	0	0
AC_VI	(aCWmin+1)/2 - 1	aCWmin	2	6.016 ms	3.008 ms	0
AC_VO	(aCWmin+1)/4 - 1	(aCWmin+1)/2 - 1	2	3.264 ms	1.504 ms	0

Change Table 41 as follows:

Table 41—Setting of Schedule Subfield

APSD	Schedule	Usage
0	0	No Schedule
1	0	Unscheduled APSD
0	1	~~Reserved~~ Scheduled PSMP
1	1	Scheduled APSD

7.3.2.37 Neighbor Report element

EDITORIAL NOTE—The change to Figure 112c comprises the addition of the "High Throughput" field in position B10, and the adjustment of the "reserved" field.

Replace Figure 112c with the following:

	B0 B1	B2	B3	B4 B9	B10	B11	B12 B31
	AP Reachability	Security	Key Scope	Capabilities	Mobility Domain	High Throughput	Reserved
Bits:	2	1	1	6	1	1	21

Figure 112c—BSSID Information field

Insert the following paragraph after the paragraph in 7.3.2.37 that starts "The Capabilities Subfield":

The High Throughput bit, when set to one, indicates that the AP represented by this BSSID is a HT AP including the HT Capabilities element in its Beacons, and that the contents of that HT Capabilities information element are identical to the HT Capabilities information element advertised by the AP sending the report.

Change the paragraph that starts "Bits 10-31 are reserved..." as follows:

Bits ~~10~~12-31 are reserved and shall be set to 0 on transmission and are ignored on reception.

Insert 3 rows in Table 43b just above the row for "reserved 3-220" and adjust the numbering of "reserved" appropriately:

Table 43b—Optional Extensions

Sub-Element ID	Name
3	HT Capabilities (see 7.3.2.49 (HT Capabilities element))
4	HT Information Element (see 7.3.2.50 (HT Information element))
5	Secondary Channel Offset element (see 7.3.2.20a (Secondary Channel Offset element))

Insert the following after the paragraph starting "The Measurement Pilot Interval sub-element" and ends "as specified in 7.3.1.19.":

The HT Capabilities sub-element contains the HT Capabilities subfield as shown in Figure 112ga.

	Sub-Element ID	Length	HT Capabilities Info	A-MPDU Parameters	Supported MCS set	HT Extended Capabilities	TxBF capabilities	ASEL capabilities
Octets:	1	1	2	1	16	2	4	1

Figure 112ga—HT Capabilities sub-element format

The HT Capabilities subfield contains the HT Capabilities as specified in 7.3.2.49 (HT Capabilities element).

The HT Information Element sub-element contains the HT subfield as shown in Figure 112gb.

				B0 B1	B2	B3	B4	B5 B7
	Element ID	Length	Primary Channel	Secondary Channel Offset	STA Channel Width	RIFS Mode	PSMP STAs Only	Service Interval Granularity
Octets:	1	1	1	1				

B0 B1	B2	B3	B4	B5 B15
Operating Mode	Non-greenfield STAs Present	Transmit Burst Limit	OBSS NON-HT STAs Present	Reserved
2				

B0 B5	B6	B7	B8	B9	B10	B11	B12B15	
Reserved	Dual Beacon	Dual CTS Protection	Secondary Beacon	L-SIG TXOP Protection Full Support	PCO Active	PCO Phase	Reserved	Basic MCS Set
2								16

Figure 112gb—HT Information element format

The HT Information Element subfield contains the HT Information Element as specified in 7.3.2.50 (HT Information element).

The Secondary Channel Offset sub-element contains the Secondary Channel Offset subfield as shown in Figure112gc.

	Sub-Element ID	Length	Secondary Channel Offset
Octets:	1	1	1

Figure 112gc—Secondary Channel Offset sub-element format

The Secondary Channel Offset subfield is 3 octets long and contains the Secondary Channel Offset element as specified in 7.3.2.20a (Secondary Channel Offset element).

Insert the following new subclause heading:

7.3.2.49 HT Capabilities element

Insert the following new subclause:

7.3.2.49.1 HT Capabilities element structure

An HT STA declares that it is an HT STA by transmitting the HT Capabilities element.

The HT Capabilities element contains a number of subfields that are used to advertise optional HT capabilities of an HT STA. The length of this element is not fixed to allow extension. The size of this element depends on the number of fields that are included. A STA shall ignore any contents beyond the format defined here. The HT Capabilities element is present in Beacon, Measurement Pilot, Association Request, Association Response, Reassociation Request, Reassociation Response, Probe Request and Probe Response frames. The HT Capabilities element is defined in Figure n29 (HT Capabilities element format.).

Octets:1	1	2	1	16	2	4	1
Element ID	Length	HT Capabilities Info	A-MPDU Parameters	Supported MCS set	HT Extended Capabilities	TxBF capabilities	ASEL capabilities

Figure n29—HT Capabilities element format.

The HT Capabilities Element ID = 45

Insert the following new subclause:

7.3.2.49.2 HT Capabilities Info field

The HT Capabilities Info field is 2 octets in length, and contains capability information bits. The structure of this field is defined in Figure n30 (HT Capabilities Info field).

B0	B1	B2 B3	B4	B5	B6	B7	B8 B9
LDPC coding capability	Supported channel width set	SM Power Save	Greenfield	Short GI for 20 MHz	Short GI for 40 MHz	Tx STBC	Rx STBC

B10	B11	B12	B13	B14	B15
HT-delayed BlockAck	Maximum A-MSDU length	DSSS/CCK Mode in 40 MHz	PSMP support	Forty MHz Intolerant	L-SIG TXOP Protection support

Figure n30—HT Capabilities Info field

The subfields of the HT Capabilities Info field are defined in Table n25 (Subfields of the HT Capabilities Info field)

Table n25—Subfields of the HT Capabilities Info field

Subfield	Definition	Encoding
LDPC coding capability	Indicates support for receiving LDPC coded packets	Set to 0 if not supported Set to 1 if supported
Supported channel width set	Indicates which channel widths the STA supports. See 11.15 (20/40 MHz Operation).	Set to 0 if only 20 MHz operation is supported Set to 1 if both 20 MHz and 40 MHz operation is supported
SM Power Save	Indicates the Spatial Multiplexing (SM) Power Save mode. See 11.2.3 (SM Power Save).	Set to 0 for Static SM Power Save mode Set to 1 for Dynamic SM Power Save mode Set to 3 for SM enabled The value 2 is reserved
Greenfield	Indicates support for the reception of PPDUs with HT Greenfield format. See 20.1.3 (PPDU Formats).	Set to 0 if not supported Set to 1 if supported
Short GI for 20 MHz	Indicates Short GI support for the reception of 20 MHz packets	Set to 0 if not supported Set to 1 if supported
Short GI for 40 MHz	Indicates Short GI support for the reception of 40 MHz packets	Set to 0 if not supported Set to 1 if supported
Tx STBC	Indicates support for the transmission of PPDUs using STBC	Set to 0 if not supported Set to 1 if supported
Rx STBC	Indicates support for the reception of PPDUs using STBC	Set to 0 for no support Set to 1 for support of one spatial stream Set to 2 for support of one and two spatial streams Set to 3 for support of one, two and three spatial streams
HT-delayed BlockAck	Indicates support for HT-delayed BlockAck operation. See 9.10.8 (HT-delayed BlockAck extensions).	Set to 0 if not supported Set to 1 if supported Support indicates that the STA is able to accept an ADDBA request for HT-delayed Block Ack
Maximum A-MSDU length	Indicates maximum A-MSDU length. See 9.7b (A-MSDU operation).	Set to 0 for 3839 octets Set to 1 for 7935 octets
DSSS/CCK Mode in 40 MHz	Indicates use of DSSS/CCK mode in a 40 MHz capable BSS operating in 20/40 MHz mode See 11.15 (20/40 MHz Operation).	In Beacon, Measurement Pilot and Probe Response frames: Set to 0 if the BSS does not allow use of DSSS/CCK in 40 MHz Set to 1 if the BSS does allow use of DSSS/CCK in 40 MHz Otherwise: Set to 0 if the STA does not use DSSS/CCK in 40 MHz Set to 1 if the STA uses DSSS/CCK in 40 MHz See 11.15.2 (Support of DSSS/CCK in 40 MHz) for operating rules

Table n25—Subfields of the HT Capabilities Info field *(continued)*

Subfield	Definition	Encoding
PSMP support	Indicates support for PSMP operation. See 9.15 (PSMP Operation).	In Beacon, Measurement Pilot and Probe Response frames transmitted by an AP: Set to 0 if the AP does not support PSMP operation Set to 1 if the AP supports PSMP operation In Beacon frames transmitted by a non-AP STA: Set to 0 Otherwise: Set to 0 if the STA does not support PSMP operation Set to 1 if the STA supports PSMP operation
Forty MHz Intolerant	When sent by an AP, indicates whether other BSSs receiving this information are required to prohibit 40 MHz transmissions. When sent by a STA, indicates whether the AP associated with this STA is required to prohibit 40 MHz transmissions by all members of the BSS. (See 9.20.4 (Switching between 40 MHz and 20 MHz))	Set to 0 by an AP if the AP allows use of 40 MHz transmissions in neighboring BSSs. Set to 1 by an AP if the AP does not allow use of 40 MHz transmissions in neighboring BSSs. Set to 0 by a STA to indicate to its associated AP that the AP is not required to restrict the use of 40 MHz transmissions within its BSS. Set to 1 by a STA to indicate to its associated AP that the AP is required to restrict the use of 40 MHz transmissions within its BSS.
L-SIG TXOP protection support	Indicates support for the L-SIG TXOP protection mechanism (see 9.13.5 (L-SIG TXOP protection))	Set to 0 if not supported Set to 1 if supported

Insert the following new subclause:

7.3.2.49.3 A-MPDU Parameters field

The structure of the A-MPDU Parameters field is shown in Figure n31 (A-MPDU Parameters field).

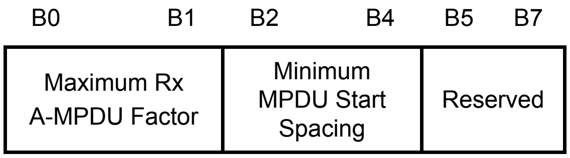

Figure n31—A-MPDU Parameters field

The subfields of the A-MPDU Parameters field are defined in Table n26 (Subfields of the A-MPDU Parameters field).

Table n26—Subfields of the A-MPDU Parameters field

Subfield	Definition	Encoding
Maximum Rx A-MPDU Factor	Indicates the maximum length of A-MPDU that the STA can receive.	The Maximum Rx A-MPDU defined by this field is equal to $2^{(13 + \text{Maximum Rx A-MPDU Factor})} - 1$ octets. Maximum Rx A-MPDU Factor is an integer in the range 0 to 3.
Minimum MPDU Start Spacing	Determines the minimum time between the start of adjacent MPDUs within an A-MPDU, measured at the PHY-SAP. See 9.7c.2 (Minimum MPDU Start Spacing).	Set to 0 for no restriction Set to 1 for 1/4 µs Set to 2 for 1/2 µs Set to 3 for 1 µs Set to 4 for 2 µs Set to 5 for 4 µs Set to 6 for 8 µs Set to 7 for 16 µs

Insert the following new subclause:

7.3.2.49.4 Supported MCS Set field

The Supported MCS Set field indicates which MCSs a STA supports. The structure of the field is defined in Figure n32 (Supported MCS Set field). Bits b80 to b89 represent the Highest Supported Data Rate that the STA is able to receive. The resolution of the Highest Supported Data Rate is 1 Mb/s. Bits b0 to b76 represent the Rx MCS Bitmask field.

The Rx Supported MCS Set is derived from the Supported MCS Set field as follows:

- When a bit in the Rx MCS Bitmask field is set to 0, the corresponding MCS is not supported.
- When a bit in the Rx MCS Bitmask field is set to 1 the corresponding MCS is supported by the STA on receive, if the integer part of the data rate of the corresponding MCS is less than or equal to the HighestSupportedDataRate in Mb/s or the value of HighestSupportedDataRate is set to 0.

See 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)) for the definition of MCS index values and corresponding data rates.

NOTE— An HT STA includes the mandatory MCS values in the Rx MCS Bitmask field.

	B0 B76	B77 B79	B80 B89	B90 B95	B96
	Rx MCS Bitmask	Reserved	Highest Supported Data Rate	Reserved	Tx MCS Set Defined
Bits	77	3	10	6	1

	B97	B98 B99	B100	B101 B127
	Tx Rx MCS Set Not Equal	Tx Maximum Number Spatial Streams Supported	Tx Unequal Modulation Supported	Reserved
Bits	1	2	1	27

Figure n32—Supported MCS Set field

Bits b96 to b100 define the transmit Supported MCS Set. The Tx MCS Set Defined bit b96 equal to 0 indicates that the Tx MCS Set is not defined in which case bits b97 to b100 are set to 0. The Tx MCS Set Defined bit b96 equal to 1 indicates that the Tx MCS Set is defined in which case bits b97 to b100 are set accordingly. When the Tx Rx MCS Set Not Equal bit b97 is set to 0, the Tx Supported MCS Set is equal to the Rx Supported MCS Set and bits b98 to b100 are set to 0. In the case the bit b97 is set to 1, the supported Tx MCS set is not equal to the Rx Supported MCS Set and bits b98 to b100 are set accordingly. Bits b98 to b99 define the Tx Maximum Number of Spatial Streams Supported (00 - 1 spatial stream; 01 - 2 spatial streams; 10 - 3 spatial streams; 11 - 4 spatial streams). Bit b100 indicates Tx Unequal Modulation Supported (0 - unequal modulation not supported; 1 - unequal modulation supported).

Insert the following new subclause:

7.3.2.49.5 HT Extended Capabilities field

The structure of the HT Extended Capabilities field is defined in Figure n33 (HT Extended Capabilities field).

	B0	B1 B2	B3 B7	B8 B9	B10	B11	B12 B15
	PCO	PCO Transition Time	Reserved	MCS feedback	+HTC Support	RD Responder	Reserved
Bits:	1	2	5	2			6

Figure n33—HT Extended Capabilities field

The subfields of the HT Extended Capabilities field are defined in Table n27 (Subfields of the HT Extended Capabilities field).

Table n27—Subfields of the HT Extended Capabilities field

Subfield	Definition	Encoding
PCO	Indicates support for PCO	Set to 0 if not supported Set to 1 if supported A PCO capable AP sets this field to 1 to indicate that it can operate its BSS as PCO BSS. A PCO capable non-AP STA sets this field to 1 to indicate that it can operate as a PCO STA when the Transition Time field in its HT Extended Capabilities field meets the intended transition time of the PCO capable AP.
PCO Transition Time	Indicates that the STA can switch between 20 MHz channel width and 40 MHz channel width within the specified time. The value contained in this field is dynamic - the value of these bits may change at any time during the lifetime of the association of any STA. An AP/STA may stay on 40 MHz channel width to transmit 20 MHz frames in 20 MHz phase.	Set to 1 for 400 µs Set to 2 for 1.5 ms Set to 3 for 5 ms Set to 0 for no transition. In this case the PCO STA does not change its operating channel width and is able to receive 40 MHz PPDUs during the 20 MHz phase (see 11.16 (Phased Coexistence Operation)).
MCS feedback	Indicates the capability of the STA to provide MCS feedback	Set to 0 if the STA does not provide MCS Feedback Set to 2 if the STA provides only unsolicited MCS Feedback Set to 3 if the STA can provide MCS Feedback in response to MRQ as well as unsolicited MCS Feedback The value 1 is reserved
+HTC Support	Indicates support of the High Throughput Control field. See 9.7a (High Throughput Control field (+HTC) operation)	Set to 0 if not supported Set to 1 if supported
RD Responder	Indicates support for acting as a reverse direction responder - i.e. the STA may use an offered reverse direction grant to transmit data to an RD initiator using the RD protocol described in 9.14 (Reverse Direction protocol).	Set to 0 if not supported Set to 1 if supported

Insert the following new subclause:

7.3.2.49.6 Transmit Beamforming Capability

The structure of the TxBF Capability field is defined in Figure n34 (TxBF Capability field). The fields of the TxBF Capability field are defined in Table n28 (Subfields of the TxBF Capability Field).

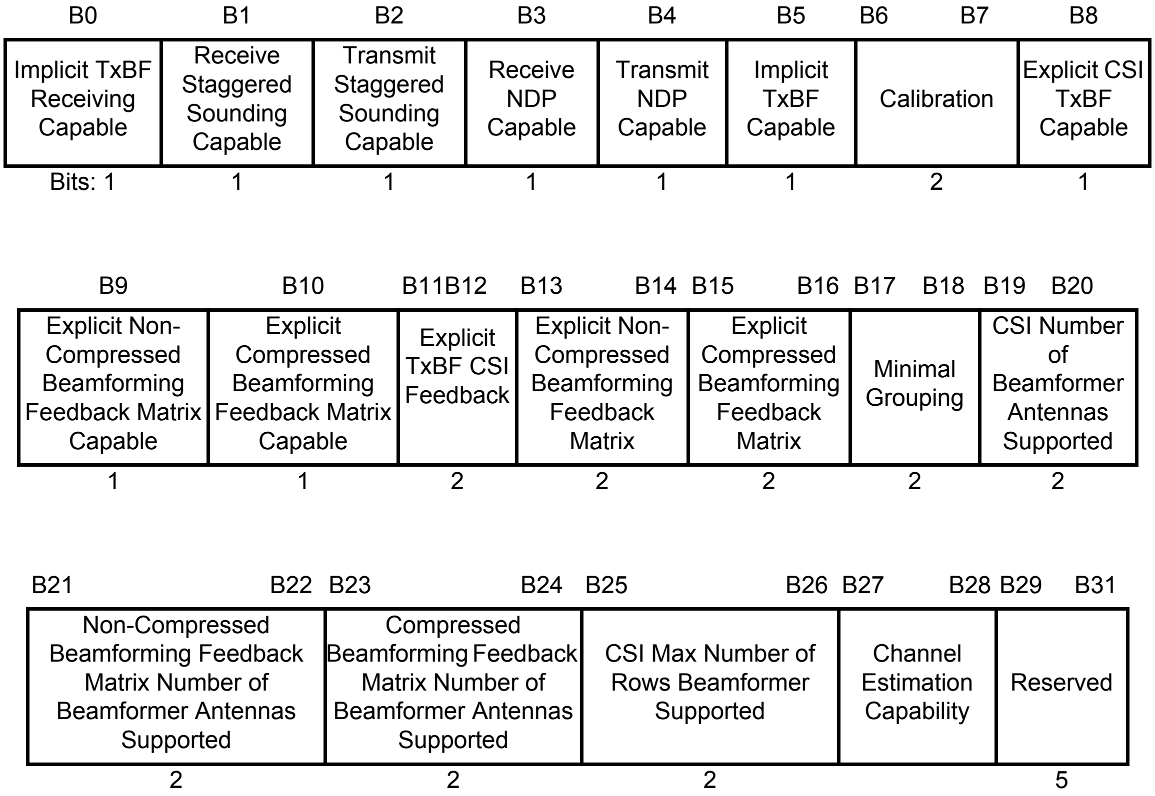

Figure n34—TxBF Capability field

Table n28—Subfields of the TxBF Capability Field

TxBF Capability field	Definition	Encoding
Implicit TxBF Receiving Capable	Indicates whether or not this STA can receive TxBF steered frames using implicit feedback	Set to 0 if not supported Set to 1 if supported
Receive Staggered Sounding Capable	Indicates whether or not this STA can receive staggered sounding frames.	Set to 0 if not supported Set to 1 if supported
Transmit Staggered Sounding Capable	Indicates whether or not this STA can transmit staggered sounding frames.	Set to 0 if not supported Set to 1 if supported
Receive NDP Capable	Indicates whether or not this receiver can interpret Null Data Packets as sounding frames.	Set to 0 if not supported Set to 1 if supported

Table n28—Subfields of the TxBF Capability Field *(continued)*

TxBF Capability field	Definition	Encoding
Transmit NDP Capable	Indicates whether or not this STA can transmit Null Data Packets as sounding frames.	Set to 0 if not supported Set to 1 if supported
Implicit TxBF Capable	Indicates whether or not this STA can apply Implicit transmit beamforming.	Set to 0 if not supported Set to 1 if supported
Calibration	Indicates that the STA can participate in a calibration procedure initiated by another STA that is capable of generating an immediate response Sounding PPDU, and can provide a MIMO CSI Matrices Report in response to the receipt of a Sounding PPDU.	Set to 0 if not supported Set to 1 if the STA can respond to a calibration request using the CSI Matrices Report, but cannot initiate calibration The value 2 is reserved Set to 3 if the STA can both initiate and respond to a calibration request
Explicit CSI TxBF Capable	Indicates whether or not this STA can apply transmit beamforming using CSI explicit feedback in its transmission	Set to 0 if not supported Set to 1 if supported
Explicit Non-Compressed Beamforming Feedback Matrix Capable	Indicates whether or not this STA can apply transmit beamforming using non-compressed beamforming feedback matrix explicit feedback in its transmission	Set to 0 if not supported Set to 1 if supported
Explicit Compressed Beamforming Feedback Matrix Capable	Indicates whether or not this STA can apply transmit beamforming using compressed beamforming feedback matrix explicit feedback in its transmission	Set to 0 if not supported Set to 1 if supported
Explicit BF CSI Feedback	Indicates whether or not this receiver can return CSI explicit feedback.	Set to 0 if not supported Set to 1 for delayed feedback Set to 2 for immediate feedback Set to 3 for delayed and immediate feedback
Explicit Non-Compressed Beamforming Matrix Feedback	Indicates whether or not this receiver can return non-compressed beamforming feedback matrix explicit feedback.	Set to 0 if not supported Set to 1 for delayed feedback Set to 2 for immediate feedback Set to 3 for delayed and immediate feedback
Explicit Compressed Beamforming Feedback Matrix	Indicates whether or not this STA can apply transmit beamforming using explicit compressed beamforming feedback matrix.	Set to 0 if not supported Set to 1 for delayed feedback Set to 2 for immediate feedback Set to 3 for delayed and immediate feedback
Minimal Grouping	Indicates the minimal grouping used for explicit feedback reports	Set to 0 if the STA supports groups of 1 (no grouping) Set to 1 indicates groups of 1, 2 Set to 2 indicates groups of 1, 4 Set to 3 indicates groups of 1, 2, 4
CSI Number of Beamformer Antennas Supported	Indicates the maximum number of beamformer antennas the beamformee can support when CSI feedback is required	Set to 0 for single TX antenna sounding Set to 1 for 2 TX antenna sounding Set to 2 for 3 TX antenna sounding Set to 3 for 4 TX antenna sounding

Table n28—Subfields of the TxBF Capability Field *(continued)*

TxBF Capability field	Definition	Encoding
Non-Compressed Beamforming Matrix Number of Beamformer Antennas Supported	Indicates the maximum number of beamformer antennas the beamformee can support when non-compressed beamforming feedback matrix is required	Set to 0 for single TX antenna sounding Set to 1 for 2 TX antenna sounding Set to 2 for 3 TX antenna sounding Set to 3 for 4 TX antenna sounding
Compressed Beamforming Feedback Matrix Number of Beamformer Antennas Supported	Indicates the maximum number of beamformer antennas the beamformee can support when compressed beamforming feedback matrix is required	Set to 0 for single TX antenna sounding Set to 1 for 2 TX antenna sounding Set to 2 for 3 TX antenna sounding Set to 3 for 4 TX antenna sounding
CSI Max Number of Rows Beamformer Supported	Indicates the maximum number of rows of CSI explicit feedback from the beamformee that the beamformer can support when CSI feedback is required	Set to 0 for a single row of CSI Set to 1 for 2 rows of CSI Set to 2 for 3 rows of CSI Set to 3 for 4 rows of CSI
Channel Estimation Capability	Indicates the maximum number of space time streams (columns of the MIMO channel matrix) for which channel dimensions can be simultaneously estimated. When staggered sounding is supported this limit applies independently to both the data portion and to the extension portion of the long training fields.	Set 0 for 1 space time stream Set 1 for 2 space time streams Set 2 for 3 space time streams Set 3 for 4 space time streams If the reception of staggered sounding is not supported, the value indicated by this field is equal to the maximum number of supported space time streams. If the reception of staggered sounding is supported: Value 0: (1,0), (1,1) Value 1: (1,0), (2,0), (1,1), (1,2), (2,1), (2,2) Value 2: (1,0), (2,0), (3,0), (1,1), (1,2), (1,3), (2,1), (2,2), (3,1) Value 3: (1,0), (2,0), (3,0), (4,0), (1,1), (1,2), (1,3), (2,1), (2,2), (3,1) where the notation (a, b) indicates: a: supported channel estimation dimensions using long training symbol(s) that will be used for demodulating data symbols. b: supported channel estimation dimensions using long training symbol(s) that will not be used for demodulating data symbols

Insert the following new subclause:

7.3.2.49.7 Antenna Selection Capability

The structure of the ASEL Capability field is defined in Figure n35 (Antenna Selection Capability field).

The fields of the Antenna Selection Capability field are defined in Table n29 (Subfields of the Antenna Selection Capability Field).

	B0	B1	B2	B3	B4	B5	B6	B7
	Antenna Selection Capable	Explicit CSI Feedback Based TX ASEL Capable	Antenna Indices Feedback Based TX ASEL Capable	Explicit CSI Feed-back Capable	Antenna Indices Feedback Capable	RX ASEL Capable	Transmit Sounding PPDUs Capable	Reserved
Bits:	1	1	1	1	1	1	1	1

Figure n35—Antenna Selection Capability field

Table n29—Subfields of the Antenna Selection Capability Field

Antenna Selection Capability field	Definition	Encoding
Antenna Selection Capable	Indicates whether or not this STA supports Antenna Selection	Set to 0 if not supported Set to 1 if supported
Explicit CSI Feedback Based TX ASEL Capable	Indicates whether or not this STA has TX ASEL capability based on explicit CSI feedback	Set to 0 if not supported Set to 1 if supported
Antenna Indices Feedback Based TX ASEL Capable	Indicates whether or not this STA has TX ASEL capability based on antenna indices feedback	Set to 0 if not supported Set to 1 if supported
Explicit CSI Feedback Capable	Indicates whether or not this STA can compute CSI and feedback in support of Antenna Selection	Set to 0 if not supported Set to 1 if supported
Antenna Indices Feedback Capable	Indicates whether or not this STA can conduct antenna indices selection computation and feedback the results in support of Antenna Selection	Set to 0 if not supported Set to 1 if supported
RX ASEL Capable	Indicates whether or not this STA has RX Antenna Selection capability	Set to 0 if not supported Set to 1 if supported
Transmit Sounding PPDUs Capable	Indicates whether or not this STA can transmit sounding PPDUs for Antenna Selection training per request	Set to 0 if not supported Set to 1 if supported

Insert the following new subclause.

7.3.2.50 HT Information element

The AP controls the operation of HT STA in its BSS using the HT Information Element. The structure of this element is defined in Figure n36 (HT Information element format). The length of this element is not fixed to allow extension [3]. The size of this element depends on the number of fields that are included. A STA that receives an HT Information element longer than defined in Figure n36 (HT Information element format) shall

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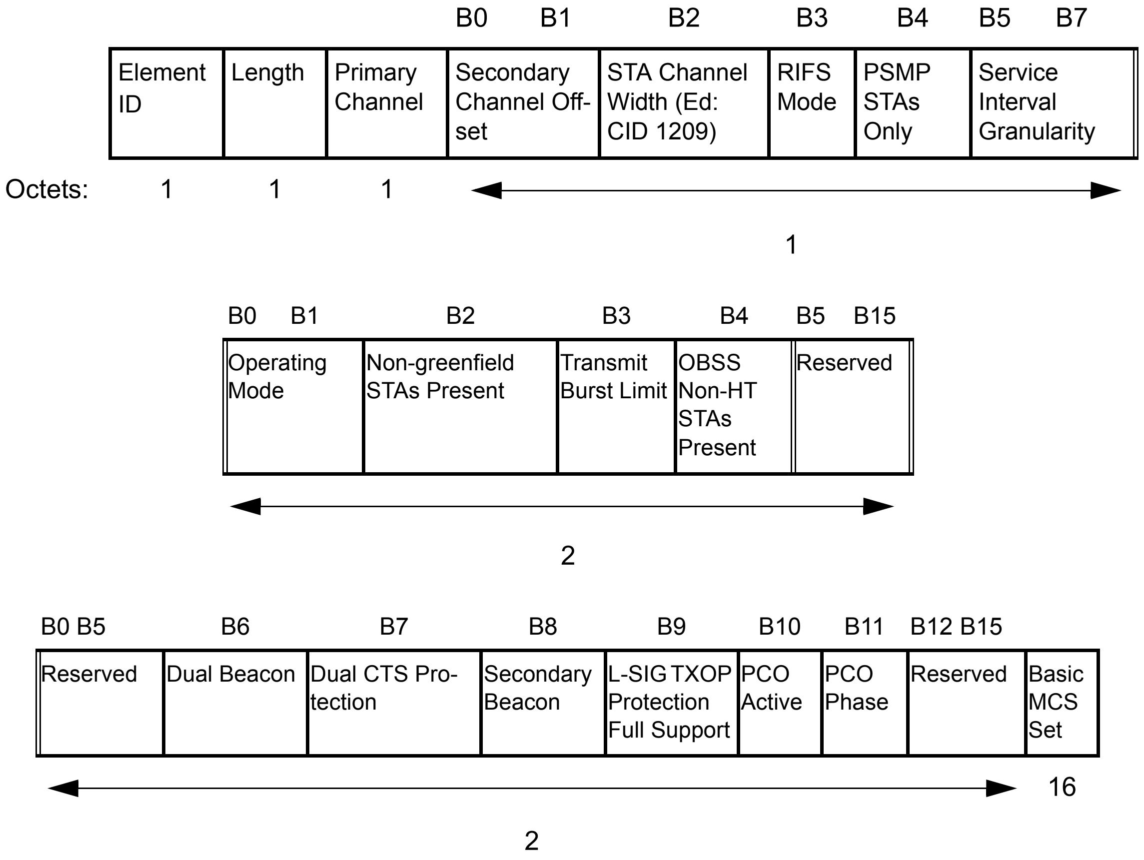
[3] Additional fields may be described in later revisions of this standard, but the fields will always appear in the order shown, with new fields appearing at the end of the existing fields.

ignore the excess.



				B0 B1	B2	B3	B4	B5 B7
	Element ID	Length	Primary Channel	Secondary Channel Offset	STA Channel Width (Ed: CID 1209)	RIFS Mode	PSMP STAs Only	Service Interval Granularity
Octets:	1	1	1	1				

B0 B1	B2	B3	B4	B5 B15
Operating Mode	Non-greenfield STAs Present	Transmit Burst Limit	OBSS Non-HT STAs Present	Reserved
2				

B0 B5	B6	B7	B8	B9	B10	B11	B12 B15	
Reserved	Dual Beacon	Dual CTS Protection	Secondary Beacon	L-SIG TXOP Protection Full Support	PCO Active	PCO Phase	Reserved	Basic MCS Set
2								16

Figure n36—HT Information element format

The Element ID field contains the value 61 (representing HT Information).

The fields of the HT Information Element are defined in Table n30 (HT Information element).

Table n30—HT Information element

Field	Definition	Encoding
Primary Channel	Indicates the channel number of the primary channel. See 11.15.1 (Basic functionality in BSS 20/40 MHz mode).	Channel number of the primary channel
Secondary Channel Offset	Indicates the offset of the secondary channel relative to the primary channel.	Set to 1 if the secondary channel is above the primary channel Set to 3 if the secondary channel is below the primary channel Set to 0 if no secondary channel is present The value 2 is reserved

Table n30—HT Information element *(continued)*

Field	Definition	Encoding
STA Channel Width	Defines the channel widths that may be used to transmit to the STA (subject also its Supported Channel Width Set). See 9.20.4 (Switching between 40 MHz and 20 MHz)	Set to 0 for a 20 MHz channel width Set to 1 allows use of any channel width in the Supported channel width set
RIFS Mode	Indicates whether use of RIFS is permitted within the BSS. See 9.2.3.6 (RIFS) and 9.13.3.2 (RIFS protection)	Set to 0 if use of RIFS is prohibited Set to 1 if use of RIFS is permitted
PSMP STAs Only	Indicates whether an AP accepts Association requests only from PSMP capable STAs	Set to 0 if Association requests are accepted regardless of PSMP capability Set to 1 if Association requests are accepted from only PSMP capable STA
Service Interval Granularity	Duration of the shortest Service Interval. Used for scheduled PSMP only. See 11.4.4b (PSMP Management)	Set to 0 for 5 ms Set to 1 for 10 ms Set to 2 for 15 ms Set to 3 for 20 ms Set to 4 for 25 ms Set to 5 for 30 ms Set to 6 for 35 ms Set to 7 for 40 ms
Operating Mode	Indicates the operating mode of the BSS from which protection requirements of HT transmissions may be determined. See 9.13 (Protection mechanisms). The beacon is always sent in non-HT mode.	Set to 0 under the following conditions: — all STAs in the BSS are 20/40 MHz HT, or — in a 20/40 MHz BSS, or — if all STAs in the BSS are 20 MHz HT STAs in a 20 MHz BSS . Set to 1 (HT non-member protection mode) if there may be non-HT STAs in both the primary and the secondary channel Set to 2 if only HT STAs are associated in the BSS, however and at least one 20 MHz HT STA is associated. Set to 3 (HT mixed mode) when one or more non-HT STAs are associated with this BSS. NOTE—The operating mode can also be set based upon observation of legacy STAs or BSSs. How this is done is beyond the scope of the 802.11 standard.
Non-greenfield STAs Present	Indicates if any HT STAs that are not Greenfield capable have associated. Determines when a non-AP STA should use greenfield protection. Present in Beacon and Probe response frames transmitted by an AP. Otherwise reserved. See 9.13.3.3 (Greenfield protection)	Set to 0 if all HT STAs that are associated are greenfield capable Set to 1 if one or more HT STAs that are not greenfield capable are associated

Table n30—HT Information element *(continued)*

Field	Definition	Encoding
Transmit Burst Limit	Indicates whether the duration of a transmit burst is limited. For this purpose, the transmit burst is a sequence of one or more PPDUs that are either HT greenfield format, or are preceded by an IFS less than SIFS (see 9.13.3.4 (Transmit burst limit)	Set to 0 to indicate no limit Set to 1 to indicate the limit defined in 9.13.3.4 (Transmit burst limit)
OBSS Non-HT STAs Present	Indicates if the use of protection for non-HT STAs by overlapping BSSs is determined to be desirable. Present in Beacon and Probe response frames transmitted by an AP.Otherwise reserved. 9.13.3.5 (Use of OBSS Non-HT STAs Present).	Set to 1 if the use of protection for non-HT STAs by overlapping BSSs is determined to be desirable. Examples of when this bit may be set to 1 include, but are not limited to, when — one or more non-HT STAs are associated — a non-HT BSS is overlapping (a non-HT BSS may be detected by the reception of a Beacon where the supported rates only contain Clause 15, 17, 18 or 19 rates) — a management frame (excluding a Probe Request) is received where the supported rate set includes only Clause 15, 17, 18 and 19 rates. Set to 0 otherwise.
Dual Beacon	Indicates whether the AP transmits a a secondary beacon	Set to 0 if no secondary beacon is transmitted Set to 1 if a secondary beacon is transmitted by the AP
Dual CTS Protection	Dual CTS Protection is used by the AP to set a NAV at STAs that do not support STBC and at STAs that can associate solely through the secondary (STBC frame) beacon. See 9.2.5.5a (Dual CTS protection)	Set to 0 if Dual CTS protection is not required Set to 1 if Dual CTS protection is required
Secondary Beacon	Indicates whether the beacon containing this element is a primary or a secondary beacon. The secondary beacon has half a beacon period shift relative to the primary beacon. Defined only in a Beacon transmission. Otherwise reserved. See 11.1.2.1 (Beacon generation in infrastructure networks)	Set to 0 in a primary beacon Set to 1 in a secondary beacon
L-SIG TXOP Protection Full Support	Indicates whether all HT STA in the BSS support L-SIG TXOP Protection. See 9.13.5 (L-SIG TXOP protection)	Set to 0 if one or more HT STA in the BSS do not support L-SIG TXOP Protection Set to 1 if all HT STA in the BSS support L-SIG TXOP Protection
PCO Active	Indicates whether PCO is active in the BSS Present in Beacon/Probe Response frames. Otherwise reserved. Non-PCO STAs regard the BSS as a 20/40 MHz BSS and may associate with the BSS without regard to this field. See 11.16 (Phased Coexistence Operation)	Set to 0 if PCO is not active in the BSS Set to 1 if PCO is active in the BSS

Table n30—HT Information element *(continued)*

Field	Definition	Encoding
PCO Phase	Indicates the PCO phase of operation Defined only in a Beacon and Probe Response frames when PCO Active is 1. Otherwise reserved. See 11.16 (Phased Coexistence Operation)	Set to 0 indicates switch to or continue 20 MHz phase Set to 1 indicates switch to or continue 40 MHz phase
Basic MCS Set	Indicates the MCS values that are supported by all HT STAs in the BSS. Present in Beacon/Probe Response frames. Otherwise reserved.	The Basic MCS Set is a bitmap of size 128 bits. Bit 0 corresponds to MCS 0. A bit is set to 1 to indicate support for that MCS and 0 otherwise.

Insert the following new subclause 7.3.2.51

7.3.2.51 Extended Channel Switch Announcement element

The Extended Channel Switch Announcement element is used by an AP in a BSS or a STA in an IBSS to advertise when it is changing to a new channel and a new regulatory class. The announcement includes both the regulatory class and the channel number of the new channel, or, in the case of 40 MHz operation, the primary channel of the new channel pair. The format of the Extended Channel Switch Announcement element is shown in Figure n37 (Extended Channel Switch Announcement element).

	Element ID	Length	Channel Switch Mode	New Regulatory Class	New Channel Number	Channel Switch Count
Octets:	1	1	1	1	1	1

Figure n37—Extended Channel Switch Announcement element

The Length field is set to 4.

The Channel Switch Mode field indicates any restrictions on transmission until a channel switch. An AP in an infrastructure BSS or a STA in an IBSS sets the Channel Switch Mode field to either 0 or 1 on transmission. A Channel Switch Mode set to 1 means that the STA in a BSS to which the frame containing the element is addressed transmits no further frames within the BSS until the scheduled channel switch. A STA in an IBSS may treat a Channel Switch Mode field set to 1 as advisory. A Channel Switch Mode set to 0 does not impose any requirement on the receiving STA.

The New Regulatory Class field shall be set to the number of the regulatory class to which the STA is changing, as defined in Annex J.

The New Channel Number field shall be set to the number of the channel to which the STA is changing. The channel number shall be a channel from the STA's new Regulatory Class as defined in Annex J. In the case where the STA is moving to a 40 MHz channel (i.e., a pair of 20 MHz channels), the channel number refers to the primary channel. The position of the secondary channel (above or below the primary channel) is uniquely specified by the New Regulatory Class field.

The Channel Switch Count field either shall be set to the number of TBTTs until the STA sending the Channel Switch Announcement element switches to the new channel or shall be set to 0. A value of 1 indicates that the switch shall occur immediately before the next TBTT. A value of 0 indicates that the switch shall occur at any time after the frame containing the element is transmitted.

The Extended Channel Switch Announcement element may be included in Extended Channel Switch Announcement frames, as described in 7.4.1.6 (Extended Channel Switch Announcement frame format), and may be included in Beacon frames, as described in 7.2.3.1 (Beacon frame format), and Probe Response frames, as described in 7.2.3.9 (Probe Response frame format). The use of Extended Channel Switch Announcement element and Extended Channel Switch Announcement frame is described in 11.9.7 (Selecting and advertising a new channel) and 11.9.8.4 (Channel management at the AP).

Insert the following new subclause 7.3.2.52:

7.3.2.52 Supported Regulatory Classes element

The Supported Regulatory Classes element is used by a STA to advertise the Regulatory Classes that it supports. The format of the Supported Regulatory Classes element is shown in Figure n38 (Supported Regulatory Classes element).

	Element ID	Length	Current Regulatory Class	Alternate Regulatory Classes
Octets:	1	1	1	Length-1

Figure n38—Supported Regulatory Classes element

The length of the Supported Regulatory Classes element is between 1 and 32 octets. The Current Regulatory Class octet indicates the Regulatory Class in use. The Alternate Regulatory Classes field contains (Length-1) regulatory class values, each in a single octet subfield. These values represent alternative regulatory classes that the STA supports, excluding the Current Regulatory Class value. The values in the Alternate Regulatory Classes field are in increasing order.

The Supported Regulatory Classes element may be included in Association Request frames, as described in 7.2.3.4 (Association Request frame format); in Association Response frames, as described in 7.2.3.5 (Association Response frame format); in Reassociation Request frames, as described in 7.2.3.6 (Reassociation Request frame format); and in Reassociation Response frames, as described in 7.2.3.7 (Reassociation Response frame format).

7.4 Action frame format details

7.4.1 Spectrum management action details

Change 7.4.1 as follows:

~~Five~~ Several Action frame formats are defined for spectrum management. An Action Value field, in the octet field immediately after the Category field, differentiates the ~~five~~ formats. The Action Value field values associated with each frame format are defined in Table 44.

Table 44—spectrum management action value field values

Action Value field value	Description
0	Measurement Request
1	Measurement Response
2	TPC Request
3	TPC Report
4	Channel Switch Announcement
5	Extended Channel Switch Announcement
~~5~~6-255	Reserved

7.4.1.5 Channel Switch Announcement frame format

Replace Figure 117 with the following figure:

EDITORIAL NOTE—The changes comprise insertion of the Secondary Channel Offset element field at the end of the existing structure.

	Category	Action Value	Channel Switch Announcement element	Secondary Channel Offset element
Octets	1	1	5	3

Figure 117—Channel Switch Announcement frame body format

Insert the following new paragraph at the end of 7.4.1.5:

The Secondary Channel Offset element is defined in 7.3.2.20a. This element is present when switching to a 40 MHz channel. It may be present when switching to a 20 MHz channel (in which case the secondary channel offset is set to 0).

Insert the following new subclause:

7.4.1.6 Extended Channel Switch Announcement frame format

The Extended Channel Switch Announcement frame uses the Action frame body format and is transmitted by an AP in a BSS or a STA in an IBSS to advertise a channel switch. The format of the Extended Channel Switch Announcement frame body is shown in Table n39 (Extended Channel Switch Announcement frame format)

The Category field shall be set to 0 (representing spectrum management).

The Action Value field shall be set to 5 (representing an Extended Channel Switch Announcement frame).

	Category	Action	Extended Channel Switch Announcement Element
Octets:	1	1	6

Figure n39—Extended Channel Switch Announcement frame format

The Extended Channel Switch Announcement element shall be set as described 7.3.2.51 (Extended Channel Switch Announcement element).

7.4.3 DLS Action frame details

7.4.3.1 DLS Request frame format

Change the first paragraph of 7.4.3.1 as follows:

The DLS Request frame is used to set up a direct link with a peer MAC. The frame body of the DLS Request frame contains the information shown in Table 51, with some fields being optionally present as indicated in the Notes column of the table.

Change Table 51 by inserting a new column to the right headed "Notes"

Insert the following additional row at the end of Table 51:

Order	Information	Notes
9	HT Capabilities	The HT Capabilities element shall be present when the dot11HighThroughputOptionImplemented attribute is true

7.4.3.2 DLS Response frame format

Change the first paragraph of 7.4.3.2 as follows:

The DLS Response frame is sent in response to a DLS Request frame. The frame body of a DLS Response frame contains the information shown in Table 52, with some fields being optionally present as indicated in the Notes column of the table.

Change Table 52 by inserting a new column to the right headed "Notes"

Insert the following additional row at the end of Table 52:

Order	Information	Notes
9	HT Capabilities	The HT Capabilities element shall be present when the dot11HighThroughputOptionImplemented attribute is true

Insert the following new heading:

7.4.9 HT Action frame details

Insert the following new subclause:

7.4.9.1 HT Action field

Several action frame formats are defined to support HT features. The Action field values associated with each frame format within the HT category are defined in Table n31 (HT Action field values). The frame formats are defined in 7.4.9.2 (Notify Channel Width frame format) to 7.4.9.10 (HT Information Exchange frame format).

Table n31—HT Action field values

Action field value	Meaning
0	Notify Channel Width
1	SM Power Save
2	PSMP action frame
3	Set PCO Phase
4	MIMO CSI Matrices
5	MIMO Non-compressed Beamforming
6	MIMO Compressed Beamforming
7	Antenna Selection Indices Feedback
8	HT Information Exchange
9-255	Reserved

Insert the following new subclause:

7.4.9.2 Notify Channel Width frame format

The format of the Notify Channel Width management action frames is defined in Table n32 (Notify Channel Width).

Table n32—Notify Channel Width

Order	Information
1	Category
2	Action
3	Channel Width (see 7.3.1.24 (Channel Width field)

This frame can be sent by both non-AP STA and AP. If an AP wishes to receive 20 MHz packets, it broadcasts this management action frame to all STAs. In addition, the AP indicates its current STA Channel Width in the HT Information Element in the beacon.

The Category field is set to 7 (representing HT).

The Action field is set to 0 (representing Notify Channel Width).

Insert the following new subclause:

7.4.9.3 SM Power Save frame format

The SM Power Save management action frame is of Category HT.

The frame body of the SM Power Save management action frame is defined in Table n33 (SM Power Save).

Table n33—SM Power Save

Order	Information
1	Category
2	Action
3	SM Power Control (see 7.3.1.25 (Spatial Multiplexing (SM) Power Control field))

The Category field is set to 7 (representing HT).

The Action field is set to 1 (representing SM Power Save).

Insert the following new subclause:

7.4.9.4 Set PCO Phase frame format

Set PCO Phase is a management action frame of category HT that announces the phase change between 20 MHz and 40 MHz. The format of its frame body is defined in Table n34 (Set PCO Phase). The operation of the PCO feature is defined in 11.16 (Phased Coexistence Operation).

The Category field is set to 7 (representing HT).

The Action field is set to 3 (representing Set PCO Phase).

Table n34—Set PCO Phase

Order	Information
1	Category
2	Action
3	PCO Phase Control (see 7.3.1.26 (PCO Phase Control field))

This frame may be only sent by a PCO AP. In order to indicate a change of PCO phase, a PCO AP either broadcasts a Set PCO Phase frame or sets the PCO phase field of the HT Information element in the beacon.

Insert the following new subclause:

7.4.9.5 PSMP frame format

PSMP (Power Save Multi-Poll) is a management action frame of category HT.

The DA field of this frame is the broadcast address or a multicast address. (See 9.15.2.8 (PSMP broadcast and multicast rules)).

The PSMP Parameter Set is used to describe the PSMP-DTT and PSMP-UTT that immediately follows the PSMP frame.

The frame body of this frame is defined in Table n35 (Format of the PSMP Management Action field). The PSMP Parameter Set field is followed by zero or more STA Info fields.

Table n35—Format of the PSMP Management Action field

Order	Information
1	Category
2	Action
3	PSMP Parameter Set (see 7.3.1.27 (PSMP Parameter Set field))
4 to (N_STA+3)	PSMP STA Info (see 7.3.1.28 (PSMP STA Info field)) Repeated N_STA times (N_STA is a subfield of the PSMP Parameter Set)

The Category field is set to 7 (representing HT).

The Action field is set to 2 (representing PSMP).

In a PSMP frame, the STA_ID fields of all its STA Info fields with STA_INFO Type set to 2 shall be unique, i.e., each STA identified in the PSMP frame is identified exactly once.The PSMP STA Info fields within a PSMP frame are ordered by STA_INFO Type as follows: broadcast (STA_INFO Type=0), multicast (STA_INFO Type=1) and then individually addressed (STA_INFO Type=2).

Insert the following new subclause:

7.4.9.6 MIMO CSI Matrices frame format

The MIMO CSI Matrices frame is a management action or a management Action No Ack frame of category HT. The format of its frame body is defined in Table n36 (MIMO CSI Matrices).

Table n36—MIMO CSI Matrices

Order	Information
1	Category
2	Action
3	MIMO Control (see 7.3.1.29 (MIMO Control field))
4	MIMO CSI Matrices Report (see 7.3.1.30 (MIMO CSI Matrices Report field))

The Category field is set to 7 (representing HT).

The Action field is set to 4 (representing MIMO CSI Matrices).

In a MIMO CSI Matrices frame, the fields of the MIMO Control field (see 7.3.1.29 (MIMO Control field)) are used as described in Table n14 (Subfields of the MIMO Control field). The Codebook Information subfield is reserved in this frame.

Insert the following new subclause:

7.4.9.7 MIMO Non-compressed Beamforming frame format

The MIMO Non-compressed Beamforming frame is a management action or a management Action No Ack frame of category HT. The format of the frame body is defined in Table n37 (MIMO Non-compressed Beamforming).

Table n37—MIMO Non-compressed Beamforming

Order	Information
1	Category
2	Action
3	MIMO Control (see 7.3.1.29 (MIMO Control field))
4	MIMO Non-compressed Beamforming Feedback Matrices Report (see 7.3.1.31 (MIMO Non-compressed Beamforming Feedback Matrices Report field))

The Category field is set to 7 (representing HT).

The Action field is set to 5 (representing MIMO Non-compressed Beamforming).

In a MIMO Non-compressed Beamforming frame, the fields of the MIMO Control field (see 7.3.1.29 (MIMO Control field)) are used as described in Table n14 (Subfields of the MIMO Control field). The Codebook Information subfield is reserved in this frame.

Insert the following new subclause:

7.4.9.8 MIMO Compressed Beamforming frame format

The MIMO Compressed Beamforming frame is a management action or a management Action No Ack frame of category HT. The format of its frame body is defined in Table n38 (MIMO Compressed Beamforming).

Table n38—MIMO Compressed Beamforming

Order	Information
1	Category
2	Action
3	MIMO Control (see 7.3.1.29 (MIMO Control field))
4	MIMO Compressed Beamforming Matrices Report (see 7.3.1.32 (MIMO Compressed Beamforming Matrices Report field))

The Category field is set to 7 (representing HT).

The Action field is set to 6 (representing MIMO Compressed Beamforming).

The fields of the MIMO Control field (see 7.3.1.29 (MIMO Control field)) are used as defined in

In a MIMO Compressed Beamforming frame, the fields of the MIMO Control field (see 7.3.1.29 (MIMO Control field)) are used as described in Table n14 (Subfields of the MIMO Control field). The Coefficient Size subfield is reserved in this frame.

Insert the following new subclause:

7.4.9.9 Antenna Selection Indices Feedback frame format

The Antenna Selection Indices Feedback management action frame is of category HT. The format of its frame body is defined in Table n39 (Antenna Selection Indices Feedback).

The Category field is set to the value 7 (representing HT).

The Action field is set to the value 7 (representing Antenna Selection Indices Feedback).

Table n39—Antenna Selection Indices Feedback

Order	Information
1	Category
2	Action
3	Antenna Selection Indices (see 7.3.1.33 (Antenna Selection Indices field))

Insert the following new subclause:

7.4.9.10 HT Information Exchange frame format

The HT Information Exchange management action frame is of category HT. The format of its frame body is defined in Table n40 (HT Information Exchange)

Table n40—HT Information Exchange

Order	Information
1	Category
2	Action
3	HT Information

The category field is set to the value 7 (representing HT).

The action field is set to 8 (representing HT Information Exchange).

The HT Information field contains at least one octet, formatted as shown in Figure n40 (HT Information field).

	B0	B1	B2	B3 B7
	Information Request	Forty MHz Intolerant	STA Channel Width	Reserved
Bits:	1	1	1	5

Figure n40—HT Information field

The Information Request bit is used to indicate that a transmitting STA is requesting the recipient to transmit an HT Information Exchange management action frame with the transmitting STA as the recipient. When the Information Request bit is set to 1, the recipient of the HT Information field shall transmit an HT Information Exchange management action frame with the transmitting STA as the recipient. When the Information Request bit is set to 0, the recipient of the HT Information field may transmit an HT Information Exchange management action frame with the transmitting STA as the recipient, but should not.

The Forty MHz Intolerant bit indicates whether the transmitting STA is intolerant of 40 MHz operation.

When the Forty MHz Intolerant bit is set to 1, it indicates that the STA that has transmitted the management action frame containing the HT Information field is intolerant of 40 MHz operation.

The STA Channel Width bit indicates the current operating width of the transmitting STA. An HT-AP that indicated a value of 0 in its most recently transmitted STA Channel Width field shall not transmit a 40 MHz mask PPDU.

An HT-AP that indicated a value of 0 in its most recently transmitted Secondary Channel Offset field shall shall not transmit a 40 MHz mask PPDU.

Insert the following new subclause:

7.4a Aggregate MPDU (A-MPDU)

Insert the following new subclause:

7.4a.1 Aggregate MPDU format (A-MPDU)

An A-MPDU consists of a number of A-MPDU subframes as shown in Figure n41 (A-MPDU format).

Octets:	variable	Variable		variable
	A-MPDU Subframe 1	A-MPDU Subframe 2	…	A-MPDU Subframe n

Figure n41—A-MPDU format

Each A-MPDU subframe consists of an MPDU delimiter followed by an MPDU. Except when it is the last subframe in an A-MPDU, padding octets are appended to make each subframe a multiple of 4 octets in length. The A-MPDU maximum length is 65535 octets. The length of an A-MPDU addressed to a particular STA may be further constrained as described in 9.7c.1 (A-MPDU length limit rules).

The MPDU delimiter is 4 octets in length. The structure of the MPDU Delimiter field is defined in Figure n42 (A-MPDU subframe format).

Octets:	4				Variable	0-3
Bits:	B0 B3	B4 B15	B16 B23	B24 B31		
	Reserved	MPDU length	CRC	Delimiter Signature	MPDU	Pad

MPDU Delimiter

Figure n42—A-MPDU subframe format

The fields of the MPDU Delimiter field are defined in Table n41 (MPDU Delimiter fields).

The purpose of the MPDU delimiter is to delimit the MPDUs within the A-MPDU such that the structure of the A-MPDU can usually be recovered when one or more MPDU delimiters are received with errors

Table n41— MPDU Delimiter fields

MPDU delimiter Field	Size (bits)	Description
Reserved	4	0
MPDU length	12	Length of the MPDU in octets
CRC	8	8-bit CRC of the preceding 16-bits.
Delimiter Signature	8	Pattern that may be used to detect an MPDU delimiter when scanning for a delimiter. The unique pattern is set to the ASCII value for character ‘N’.

A delimiter with MPDU length zero is valid. This shall be used to introduce padding between MPDUs to satisfy the Minimum MPDU Start Spacing limit requirement (see 9.7c.2 (Minimum MPDU Start Spacing)).

Insert the following new subclause:

7.4a.2 A-MPDU Delimiter CRC field

The A-MPDU Delimiter CRC field is an 8-bit CRC value. It is used as a Frame Check Sequence (FCS) to protect the Reserved and MPDU length fields. The CRC field is the one’s complement of the remainder generated by the modulo 2 division of the protected bits by the polynomial $x^8 + x^2 + x^1 + 1$, where the shift-register state is preset to all-ones.

NOTE—the order of transmission of bits within the CRC field is defined in 7.1.1.

Figure n43 (A-MPDU delimiter CRC calculation) illustrates the CRC calculation for the A-MPDU delimiter.

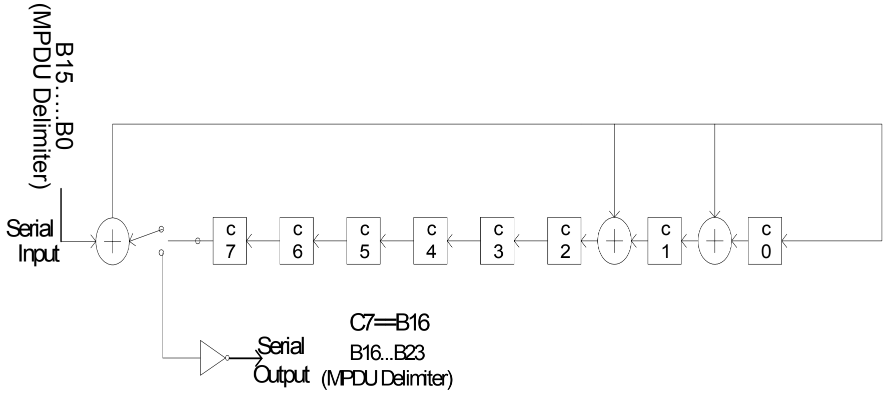


Figure n43—A-MPDU delimiter CRC calculation

Insert the following new subclause:

7.4a.3 A-MPDU de-aggregation

This subclause contains a description of the de-aggregation process. Other implementations are also possible.

The receiver checks the MPDU delimiter for validity based on the CRC. It may also check that the length indicated is within the PSDU HT-LENGTH indicated in RXVECTOR.

If the MPDU delimiter is valid, the MPDU is extracted from the A-MPDU. The next MPDU delimiter is expected at the first multiple of 4 octets immediately after the current MPDU. This process is continued until the end of the PPDU is reached.

If the MPDU delimiter is not valid, the de-aggregation process skips forward 4 octets and checks to see if the new location contains a valid MPDU delimiter. It continues searching until either a valid delimiter is found, or the end of the PSDU is reached based on the RXVECTOR PSDU HT length field. [4]

An A-MPDU parsing (de-aggregation) algorithm is expressed (as a C programming language snippet) in Figure n44 (A-MPDU parsing).

```
void Parse_A_MPDU (int length)
{
  int offset = 0; /* Octet offset from start of PPDU */
  while (offset+4 < length)
  {
    if (valid_MPDU_delimiter(offset) &&
        get_MPDU_length(offset) <= (length -(offset+4)))
    { /* Valid delimiter */

      /* Receive the MPDU */
      Receive_MPDU(offset+4, get_MPDU_length(offset));

      /* advance by MPDU length rounded up to a multiple of 4 */
      offset += 4 + 4*((get_MPDU_length(offset)+3)/4);
    }
    else /* Invalid delimiter */
    {
      /* Advance 4 octets and try again */
      offset += 4;
    }
  }
}
```

NOTE1—this algorithm is not optimized for efficiency.

NOTE2—the Delimiter Signature can be used to reduce the amount of computation required while scanning for a valid delimiter. In this case the receiver tests each possible delimiter for a matching Delimiter Signature field. Only when a match is discovered does it then check the CRC.

Figure n44—A-MPDU parsing

Insert the following new subclause:

7.4a.4 A-MPDU contents

An A-MPDU is a sequence of MPDUs carried in a single PPDU with the TXVECTOR/RXVECTOR AGGREGATION parameter set to 1.

All the MPDUs within an A-MPDU are addressed to the same receiver address.

The Duration/ID fields in the MAC Headers of all MPDUs in an A-MPDU carry the same value.

---

[4] This procedure will occasionally wrongly interpret a random bit-pattern as a valid delimiter. When this happens, the MAC will attempt to interpret a random MPDU. The MAC will discard it with a high probability based on a bad MAC CRC check.

The A-MPDU shall only contain MPDUs as described in Table n42 (A-MPDU contents using HT-immediate BlockAck), Table n43 (A-MPDU contents using HT-delayed BlockAck), and Table n44 (A-MPDU contents MPDUs using MTBA/PSMP).

Table n42—A-MPDU contents using HT-immediate BlockAck

MPDU	Description	Comments
BlockAck	BlockAck MPDUs	At most one BlockAck established under HT-immediate BA Policy may be present, in which case it occurs at the start of the A-MPDU. Any number of Block Ack frames established under HT-delayed BA Policy with the BA Ack Policy field set to 1 may be present.
QoS Data	Data MPDUs sent under a Block Ack agreement.	One TID per aggregation
Action No Ack	Any management frame of subtype Action No Ack	

Table n43—A-MPDU contents using HT-delayed BlockAck

MPDU	Description	Comments
BlockAck	BlockAck MPDUs with the BA Ack Policy field set to No Ack	
QoS Data	Data MPDUs sent under a Block Ack agreement	One TID per aggregation
Action No Ack	Any management frame of subtype Action No Ack	
BlockAck-Req	BlockAckReq frames with the BA Ack Policy field set to No Ack. No implicit BlockAckReq allowed	

Table n44—A-MPDU contents MPDUs using MTBA/PSMP

MPDU	Description	Comments
MTBA	Contains acknowledgement for data received under MTBA Ack Policy in the previous PSMP-UTT/PSMP-DTT	At most one
QoS Data	Data MPDUs with the Ack Policy field set to PSMP Ack.	Multiple TIDs allowed
MTBA R	A Multi-TID BlockAckReq frame for data transmitted during a PSMP sequence	At most one with the BA Ack Policy field set to No Ack
Action No Ack	Any management frame of subtype Action No Ack	

An A-MPDU with explicit feedback response shall contain only one control frame of any subtype mentioned in Table n45 (A-MPDU contents MPDUs using explicit feedback).

Table n45—A-MPDU contents MPDUs using explicit feedback

MPDU	Description
CTS	Clear to Send
Ack	Acknowledgement
BlockAck	Block ACK MPDUs
MTBA	Contains acknowledgement for data received under MTBA ack policy in the previous PSMP-UTT/PSMP-DTT
Management frame of subtype Action No Ack	Management frame of subtype Action No Ack +HTC carries a Management Action Body with explicit feedback response

The contents of an A-MPDU carrying frames for which no acknowledgement is required are defined in Table n46 (A-MPDU contents using No Ack).

Table n46—A-MPDU contents using No Ack

MPDU	Description	Comments
QoS Data	Data MPDUs with the Ack Policy field set to No Ack and which are not part of a BA agreement.	One TID per aggregation

7.5 Frame usage

Delete subclause 7.5 in its entirety (including Table 58)

8. Security

8.2 Pre-RSNA Security methods

Insert the following new paragraphs at the end of the subclause:

The TKIP security mechanism was intended for short-term deployment pending the development of stronger ciphers. The development of the definition of the HT STA coincides with the existence of stronger ciphers and hence, there are restrictions on the use of encryption algorithms for an HT STA.

When keys are negotiated, only one pairwise key is negotiated for each pairing of STA. In order to ensure the security of exchanged data, each key may be utilized by a maximum of one encryption algorithm. These facts contribute to the definition of the restrictions on security algorithm usage.

HT STA should not use WEP or TKIP when communicating with other STA that support stronger ciphers.

HT STA shall not use pre-RSNA security methods to protect unicast frames if the RA or address1 of the frame corresponds to an HT STA.

NOTE—frames exchanged between HT STA are not required to be encrypted.

8.3 RSNA data confidentiality protocols

8.3.1 Overview

Remove the phrase "NOTE—" from the start of the last paragraph of this subclause and reformat appropriate to body text.

Insert the following new paragraph at the end of the subclause:

An HT STA shall not use TKIP as the pairwise cipher suite when communicating with another HT STA.

8.3.3 CTR with CBC-MAC Protocol (CCMP)

8.3.3.3 CCMP cryptographic encapsulation

8.3.3.3.2 Construct AAD

Change the third paragraph of 8.3.3.3.2 as follows:

The AAD is constructed from the MPDU header. The AAD does not include the header Duration field, because the Duration field value can change due to normal IEEE 802.11 operation (e.g., a rate change during retransmission). The AAD does not include the Duration/IDfield or the HT Control field, because the contents of these fields can change during normal operation [1]. The HT Control field can also be inserted or removed during to normal operation [2]. For similar reasons, several subfields in the Frame Control field are masked to 0. AAD construction is performed as follows:

a) FC – MPDU Frame Control field, with
    1) Subtype bits (bits 4 5 6) masked to 0

---

[1] e.g., Due to a rate change preceding re-transmission.

[2] e.g., ATXOP holder transmits an A-MPDU containing +HTC Data MPDUs with a feedback request. This transmission is followed by a BA response, so the feedback request has been delivered. But some of the Data MPDUs should be retransmitted. In this case, there is no need to attach the HT Control field to those MPDUs.

   2) Retry bit (bit 11) masked to 0
   3) PwrMgt bit (bit 12) masked to 0
   4) MoreData bit (bit 13) masked to 0
   5) Protected Frame bit (bit 14) always set to 1
   6) Order bit (bit 15) masked to 0

b) A1 – MPDU Address 1 field.

c) A2 – MPDU Address 2 field.

d) A3 – MPDU Address 3 field.

e) SC – MPDU Sequence Control field, with the Sequence Number subfield (bits 4–15 of the Sequence Control field) masked to 0. The Fragment Number subfield is not modified.

f) A4 – MPDU Address field, if present in the MPDU.

g) QC – QoS Control field, if present, a 2-octet field that includes the MSDU priority. The QC TID is used in the construction of the AAD, and the remaining QC fields are set to 0 for the AAD calculation (bits 4 to 15 are set to 0).

8.3.3.3.5 CCM originator processing

Change item c) of the second paragraph of this subclause as follows:

c) *Frame body:* the frame body of the MPDU (1–7919~~2296~~ octets; 7919~~2296~~ = 7935~~2312~~ – 8 MIC octets – 8 CCMP header octets).

8.3.3.4.3 PN and replay detection

Change bullets e-g of 8.3.3.4.3 as follows:

e) For each PTKSA, GTKSA, and STKSA, the recipient shall maintain a separate replay counter for each IEEE 802.11 MSDU or A-MSDU priority and shall use the PN recovered from a received frame to detect replayed frames, subject to the limitation of the number of supported replay counters indicated in the RSN Capabilities field (see 7.3.2.25). A replayed frame occurs when the PN extracted from a received frame is less that or equal to the current replay counter value for the frame's MSDU or A-MSDU priority. A transmitter shall not use IEEE 802.11 MSDU or A-MSDU priorities without ensuring that the receiver supports the required number of replay counters. The transmitter shall not reorder frames within a replay counter, but may reorder frames across replay counters. One possible reason for reordering frames is the IEEE 802.11 MSDU or A-MSDU priority.

f) The receiver shall discard MSDUs or A-MSDUs whose constituent MPDU PN values are not sequential. A receiver shall discard any MPDU that is received with its PN less than or equal to the replay counter and shall increment the value of dot11RSNAStatsCCMPReplays for this key.

g) For MSDUs or A-MSDUs sent using the Block Ack feature, reordering of received MSDUs or A-MSDUs according to the Block Ack receiver operation (described in 9.10.4) is performed prior to replay detection.

8.6.3 Mapping PTK to CCMP keys

Change the 2nd paragraph of 8.6.3 as follows:

A STA shall use the temporal key as the CCMP key for MSDUs or A-MSDUs between the two communicating STAs.

8.7.2 RSNA frame pseudo-code

Change 8.7.2 as follows:

STAs transmit protected MSDUs to a RA when temporal keys are configured and an MLME.SETPROTECTION. request primitive has been invoked for transmit to that RA. STAs expect to receive protected MSDUs and A-MSDUs from a TA when temporal keys are configured and an MLME.SETPROTECTION.request primitive has been invoked for receive from that TA. MSDUs or A-MSDUs that do not match these conditions are sent in the clear and are received in the clear.

Change heading 8.7.2.1 as follows:

8.7.2.1 Per-MSDU/Per-A-MSDU Tx pseudo-code

Change 8.7.2.1 as follows

```
if dot11RSNAEnabled = true then
    if MSDU or A-MSDU has an individual RA and Protection for RA is off for Tx then
        transmit the MSDU or A-MSDU without protections
    else if (MPDU has individual RA and Pairwise key exists for the MPDU’s RA) or (MPDU has a multicast or broadcast RA and network type is IBSS and IBSS GTK exists for MPDU’s TA) then
        // If we find a suitable Pairwise or GTK for the mode we are in…
        if key is a null key then
            discard the entire MSDU or A-MSDU and generate one or more an MA-UNITDATA.confirm primitives to notify LLC that the MSDUs ~~was~~were undeliverable due to a null key
        else
            // Note that it is assumed that no entry will be in the key
            // mapping table of a cipher type that is unsupported.
            Set the Key ID subfield of the IV field to zero.
            if cipher type of entry is AES-CCM then
                Transmit the MSDU or A-MSDU, to be protected after fragmentation using AES-CCM
            else if cipher type of entry is TKIP then
                Compute MIC using Michael algorithm and entry’s Tx MIC key.
                Append MIC to MSDU
                Transmit the MSDU, to be protected with TKIP
            else if cipher type of entry is WEP then
                Transmit the MSDU, to be protected with WEP
            endif
        endif
    else // Else we didn’t find a key but we are protected, so handle the default key case or discard
        if GTK entry for Key ID contains null then
            discard the MSDU or A-MSDU and generate ~~an~~one or more MAUNITDATA. confirm primitives to notify LLC that the ~~entire~~ MSDUs ~~was~~were undeliverable due to a null GTK
        else if GTK entry for Key ID is not null then
            Set the Key ID subfield of the IV field to the Key ID.
```

```
            if MPDU has an individual RA and cipher type of entry is not TKIP
        then
                discard the entire MSDU or A-MSDU and generate ~~an~~one or more MAUNITDATA. confirm primitives to notify LLC that the ~~entire~~ MSDUs ~~was~~were undeliverable due to a null key
            else if cipher type of entry is AES-CCM then
                Transmit the MSDU or A-MSDU, to be protected after fragmentation using AES-CCM
            else if cipher type of entry is TKIP then
                Compute MIC using Michael algorithm and entry's Tx MIC key.
                Append MIC to MSDU
                Transmit the MSDU, to be protected with TKIP
            else if cipher type of entry is WEP then
                Transmit the MSDU, to be protected with WEP
            endif
        endif
    endif
endif
```

8.7.2.2 Per-MPDU Tx pseudo-code

Change 8.7.2.2 as follows:

```
if dot11RSNAEnabled = TRUE then
    if MPDU is member of an MSDU that is to be transmitted without protections
        transmit the MPDU without protections
    else if MSDU or A-MSDU that MPDU is a member of is to be protected using AES-CCM
        Protect the MPDU using entry's key and AES-CCM
        Transmit the MPDU
    else if MSDU that MPDU is a member of is to be protected using TKIP
        Protect the MPDU using TKIP encryption
        Transmit the MPDU
    else if MSDU that MPDU is a member of is to be protected using WEP
        Encrypt the MPDU using entry's key and WEP
        Transmit the MPDU
    else
        // should not arrive here
    endif
endif
```

8.7.2.4 Per-MSDU Rx pseudo-code

Change 8.7.2.4 as follows:

```
if dot11RSNAEnabled = TRUE then
    if the frame was not protected then
        Receive the MSDU or A-MSDU unprotected
        Make MSDU(s) available to higher layers
```

```
        else// Have a protected MSDU or A-MSDU
            if Pairwise key is an AES-CCM key then
                Accept the MSDU or A-MSDU if its MPDUs had sequential PNs (or if it consists of only one MPDU), otherwise discard the MSDU or A-MSDU as a replay attack and increment dot11RSNAStatsCCMPReplays
                Make MSDU(s) available to higher layers
            else if Pairwise key is a TKIP key then
                Compute the MIC using the Michael algorithm
                Compare the received MIC against the computed MIC
                discard the frame if the MIC fails increment
                dot11RSNAStatsTKIPLocalMICFailures
                and invoke countermeasures if appropriate
                compare TSC against replay counter, if replay check fails increment
                dot11RSNAStatsTKIPReplays
                otherwise accept the MSDU
                Make MSDU available to higher layers
            else if dot11WEPKeyMappings has a WEP key then
                Accept the MSDU since the decryption took place at the MPDU
                Make MSDU available to higher layers
            endif
        endif
    endif
```

9. MAC sublayer functional description

9.1 MAC architecture

9.1.5 Fragmentation/defragmentation overview

Change paragraphs 1-3 of 9.1.5 as follows:

The process of partitioning an MSDU, an A-MSDU or an MMPDU into smaller MAC level frames, MPDUs, is called *fragmentation*. Fragmentation creates MPDUs smaller than the original MSDU, A-MSDU or MMPDU length to increase reliability, by increasing the probability of successful transmission (as defined in 9.1.1) of the MSDU, A-MSDU or MMPDU in cases where channel characteristics limit reception reliability for longer frames. STAs may use fragmentation to use the medium efficiently in consideration of the duration available in granted TXOPs, as long as the rules in 9.4 are followed. Fragmentation is accomplished at each immediate transmitter. The process of recombining MPDUs into a single MSDU, A-MSDU or MMPDU is defined as *defragmentation*. Defragmentation is accomplished at each immediate recipient.

Only ~~MPDUs~~ MSDUs, A-MSDUs or MMPDUs with a unicast receiver address ~~shall~~maybe fragmented. HT-immediate or HT-delayed BlockAck agreements negotiated between HT STAs use only the compressed BlockAck variant that does not permit the acknowledgment of fragments. An MSDU, A-MSDU or MMPDU to be transmitted by a HT STA to another HT STA may be fragmented in which case each fragment can only be acknowledged using a Data MPDU-ACK exchange. An MSDU or A-MSDU transmitted under HT-immediate or HT-delayed BlockAck agreement shall not be fragmented, even if its length exceeds the dot11FragmentationThreshold. An MSDU or A-MSDU transmitted within an A-MPDU shall not be fragmented, even if its length exceeds the dot11FragmentationThreshold. Broadcast/multicast frames shall not be fragmented even if their length exceeds dot11FragmentationThreshold.

When an individually addressed MSDU is received from the LLC, or a number of MSDUs are aggregated to produce a directed A-MSDU or an individually addressed MMPDU is received from the MLME that would result in a length greater than dot11FragmentationThreshold ~~when~~ after the MAC header and FCS are added, the MSDU, A-MSDU or MMPDU shall be fragmented, unless as described above if the MSDU or A-MSDU is transmitted under an HT-immediate or HT-delayed BlockAck agreement, or is to be included in an A-MPDU. To avoid fragmentation following aggregation, a STA should limit the size of A-MSDU aggregates to less than the dot11FragmentationThreshold. ~~The MSDU or MMPDU is divided into MPDUs.~~ Each fragment is a frame no larger than dot11FragmentationThreshold. It is possible that any fragment may be a frame smaller than dot11FragmentationThreshold. An illustration of fragmentation is shown in Figure 160.

9.1.6 MAC data service

Change 9.1.6 as follows:

The MAC data service provides the transport of MSDUs between MAC peer entities as characterized in 6.1.1.

The transmission process is started by receipt of an MA-UNITDATA.request primitive containing an MSDU and the associated parameters. This may cause one or more data MPDUs containing the MSDU to be transmitted following A-MSDU aggregation, fragmentation and security encapsulation, as appropriate.

The MA-UNITDATA.indication primitive is generated in response to one or more received data MPDUs containing an MSDU following validation, address filtering, decryption, decapsulation, ~~and~~ defragmentation and A-MSDU de-aggregation, as appropriate.

9.2 DCF

9.2.3 IFS

Change Paragraph of 1 of 9.2.3 as follows:

The time interval between frames is called the IFS. A STA shall determine that the medium is idle through the use of the CS function for the interval specified. ~~Five~~Six different IFSs are defined to provide priority levels for access to the wireless media; Figure 156 shows some of these relationships.

Change a list of items after the first paragraph of 9.2.3 as follows (strikeout if the old letters is not shown for clarity):

a) RIFS reduced interframe space

b) SIFS short interframe space

c) PIFS PCF interframe space

d) DIFS DCF interframe space

e) AIFS arbitration interframe space (used by the QoS facility)

f) EIFS extended interframe space

9.2.3.1 SIFS

Change paragraph 3 of 9.2.3.1 as follows:

SIFS is the shortest of the IFSs between transmissions from different STAs. SIFS shall be used when STAs have seized the medium and need to keep it for the duration of the frame exchange sequence to be performed. Using the smallest gap between transmissions within the frame exchange sequence prevents other STAs, which are required to wait for the medium to be idle for a longer gap, from attempting to use the medium, thus giving priority to completion of the frame exchange sequence in progress.

9.2.3.5 EIFS

Insert the following new paragraph at the end of 9.2.3.5.

EIFS shall not be invoked if the NAV is updated by the frame that would have caused an EIFS, such as in the case when the MAC FCS fails and L-SIG TXOP function employs signal field information to update the NAV.EIFS shall not be invoked for an A-MPDU if one or more of its frames are received correctly.

Insert the following new subclause:

9.2.3.6 RIFS

RIFS (Reduced Interframe Spacing) is a means of reducing overhead and thereby increasing network efficiency.

RIFS may be used in place of SIFS to separate multiple transmissions from a single transmitter, when no SIFS-separated response transmission is expected. The value of RIFS is defined by the aRIFS PHY characteristic (see Table n77 (MIMO PHY characteristics)).The RIFS is the time from the end of the last symbol of the previous frame to the beginning of the first symbol of the preamble of the subsequent frame as seen at the air interface. An IEEE 802.11 implementation shall not allow the space between frames that are defined to be separated by a RIFS time, as measured on the medium, to vary from value by more than aRIFSTime±10%. Both frames separated by RIFS must each be HT format

There are additional restrictions regarding when RIFS may be employed defined in 9.14 (Reverse Direction protocol) and 9.15 (PSMP Operation). See also 9.13.3.2 (RIFS protection).

9.2.5 DCF access procedure

9.2.5.3 Recovery procedures and retransmit limits

Change paragraphs 2 to 3 of 9.2.5.3 as follows:

Error recovery shall be attempted by retrying transmissions for frame exchange sequences that the initiating STA infers have failed. Retries shall continue, for each failing frame exchange sequence, until the transmission is successful, or until the relevant retry limit is reached, whichever occurs first. STAs shall maintain a SRC and a LRC for each MSDU, A-MSDU or MMPDU awaiting transmission. These counts are incremented and reset independently of each other.

After an RTS frame is transmitted, the STA shall perform the CTS procedure, as defined in 9.2.5.7. If the RTS transmission fails, the SRC for the MSDU, A-MSDU or MMPDU and the SSRC are incremented. This process shall continue until the number of attempts to transmit that MSDU, A-MSDU or MMPDU reaches dot11ShortRetryLimit.

Change paragraphs 5 and 6 of 9.2.5.3 as follows:

Retries for failed transmission attempts shall continue until the SRC for the MPDU of type Data or MMPDU is equal to dot11ShortRetryLimit or until the LRC for the MPDU of type Data or MMPDU is equal to dot11LongRetryLimit. When either of these limits is reached, retry attempts shall cease, and the MPDU of type Data (and any MSDU or A-MSDU of which it is a part) or MMPDU shall be discarded.

A STA in PS mode, in an ESS, initiates a frame exchange sequence by transmitting a PS-Poll frame to request data from an AP. In the event that neither an ACK frame nor a data frame is received from the AP in response to a PS-Poll frame, then the STA shall retry the sequence, by transmitting another PS-Poll frame, at its convenience. If the AP sends a data frame in response to a PS-Poll frame, but fails to receive the ACK frame acknowledging this data frame, the next PS-Poll frame from the same STA may cause a retransmission of the last MSDU or A-MSDU. This duplicate MSDU or A-MSDU shall be filtered at the receiving STA using the normal duplicate frame filtering mechanism. If the AP responds to a PS-Poll by transmitting an ACK frame, then responsibility for the data frame delivery error recovery shifts to the AP because the data are transferred in a subsequent frame exchange sequence, which is initiated by the AP. The AP shall attempt to deliver one MSDU or A-MSDU to the STA that transmitted the PS-Poll, using any frame exchange sequence valid for an individually addressed MSDU or A-MSDU. If the PS STA that transmitted the PS-Poll returns to Doze state after transmitting the ACK frame in response to successful receipt of this MSDU or A-MSDU, but the AP fails to receive this ACK frame, the AP will retry transmission of this MSDU or A-MSDU until the relevant retry limit is reached. See Clause 11 for details on filtering of extra PS-Poll frames.

9.2.5.4 Setting and resetting the NAV

Change the first paragraph of 9.2.5.4 as follows:

~~STAs receiving a~~ A STA that receives at least one valid ~~frame~~MPDU within a received PSDU shall update ~~their~~its NAV with the information received in ~~the~~any valid Duration field from within that PSDU, for all frames where the new NAV value is greater than the current NAV value~~,~~ except ~~the NAV shall not be updated~~for those where the RA is equal to the ~~receiving STA's~~ MAC address. ~~Upon receipt~~ of ~~a PS-Poll frame, a~~ the STA ~~shall update its NAV settings as appropriate under the data rate selection rules using a duration value equal to the time, in microseconds, required to transmit one ACK frame plus one SIFS interval, but only when the new NAV value is greater than the current NAV value. If the calculated duration includes a fractional microsecond, that value is rounded up the next higher integer. Various additional conditions may set or reset the~~

~~NAV, as described in 9.3.2.2. When the NAV is reset, a PHY-CCARESET.request shall be issued.~~ This NAV update operation is performed at the end of the reception of the PPDU.

Change the last paragraph in 9.2.5.4 as follows:

When Dual CTS Protection is not required by the AP of a BSS, then a~~A~~ STA that used information from an RTS frame as the most recent basis to update its NAV setting is permitted to reset its NAV if no PHY-RX-START.indication is detected from the PHY during a period with a duration of (2 x aSIFSTime) + (CTS_Time) + aPHY-RX-START-Delay + (2 x aSlotTime) starting at the PHY-RXEND.indication corresponding to the detection of the RTS frame. The "CTS_Time" shall be calculated using the length of the CTS frame and the data rate at which the RTS frame used for the most recent NAV update was received. When Dual CTS Protection is required by the AP of a BSS (as indicated by the Dual CTS Protection field of the HT Information element), then a STA that used information from an RTS frame as the most recent basis to update its NAV setting is permitted to reset its NAV if no PHY-RXSTART.indication is detected from the PHY during a period with a duration of (3 x aSIFSTime) + (CTS_Time_STBC + CTS_Time_nSTBC) + aPHY-RX-START-Delay + (3 x aSlotTime) starting at the PHY-RXEND.indication corresponding to the detection of the RTS frame. The value of CTS_Time_STBC shall be calculated using the length of the CTS frame and the rate corresponding to the basic STBC MCS. The value of CTS_Time_nSTBC shall be calculated using the length of the CTS frame and the data rate at which the RTS frame used for the most recent NAV update was received, or at the lowest basic rate if the RTS frame used for the most recent NAV update was an STBC frame.

9.2.5.5 Control of the channel

Change paragraph 1 of 9.2.5.5 as follows:

The SIFS is used to provide an efficient MSDU delivery mechanism. Once the STA has contended for the channel, that STA shall continue to send fragments until either all fragments of a single MSDU, A-MSDU or MMPDU have been sent, an acknowledgment is not received, or the STA is restricted from sending any additional fragments due to a dwell time boundary. Should the sending of the fragments be interrupted due to one of these reasons, when the next opportunity for transmission occurs the STA shall resume transmission. The algorithm by which the STA decides which of the outstanding MSDUs or A-MSDUs shall next be attempted after an unsuccessful transmission (as defined in 9.2.5.2) attempt is beyond the scope of this standard, but any such algorithm shall comply with the restrictions listed in 9.7.

Change paragraphs 9 to 11 of 9.2.5.5 as follows:

After a STA contends for the channel to retransmit a fragment of an MSDU or A-MSDU, it shall start with the last fragment that was not acknowledged. The destination STA shall receive the fragments in order (because the source sends them in order and they are individually acknowledged). It is possible, however, that the destination STA may receive duplicate fragments. It shall be the responsibility of the receiving STA to detect and discard duplicate fragments.

A STA shall transmit after the SIFS only under the following conditions during a fragment burst:

— The STA has just received a fragment that requires acknowledgment.

— The source STA has received an acknowledgment for a previous fragment, has more fragment(s) for the same MSDU or A-MSDU to transmit, and there is enough time before the next dwell boundary to send the next fragment and receive its acknowledgment.

The following rules shall also apply:

— When a STA has transmitted a frame other than an initial or intermediate fragment, that STA shall not transmit on the channel following the acknowledgment for that frame, without performing the backoff procedure.

— When an MSDU or A-MSDU has been successfully delivered or all retransmission attempts have been exhausted, and the STA has a subsequent MSDU or A-MSDU to transmit, then that STA shall perform a backoff procedure.

Insert the following new subclause:.

9.2.5.5a Dual CTS protection

If the Dual CTS Protection subfield of the HT Information element has value 1 in the beacons transmitted by its AP, a non-AP STA shall start every TXOP with an RTS addressed to the AP. The AP shall respond with a dual CTS (CTS1 followed by CTS2) separated by PIFS or SIFS . Table n47 (Dual CTS rules) describes the sequence of CTS transmissions and the required timing.

Table n47—Dual CTS rules

Type of RTS	CTS description	Timing
RTS (non-STBC frame)	CTS1: Same rate or MCS as the RTS (non-STBC) CTS2: basic STBC MCS (STBC frame)	PIFS shall be used as the interval between CTS1 and CTS2. If the medium becomes busy within a PIFS time following CTS1, then CTS2 shall not be transmitted as part of this frame exchange.
RTS (STBC frame)	CTS1: basic STBC MCS (STBC frame) CTS2: Lowest Basic Rate (non-STBC frame)	SIFS shall be used as the interval between CTS1 and CTS2. The STA resumes transmission a SIFS+CTS2+SIFS after receiving CTS1, instead of after SIFS. The time it takes to transmit CTS2 is known in advance according to the above rules.

The dual CTS response only applies to the AP; a non-AP STA shall respond to an RTS request with a single CTS. A non-AP STA shall start a TXOP with an RTS that is an STBC frame if its STBC Tx and Rx capabilities allow to receive and transmit STBC frames using a single spatial stream.

If dual CTS Protection is enabled, the AP shall protect STBC TXOPs with a CTS-to-self that is a non-STBC frame and non-STBC TXOPs with an CTS-to-self that is an STBC frame. The AP shall continue PIFS after the CTS, to allow for a collision detect.

The protection frames shall set a NAV for the whole duration of the transmission, covering dual CTS transmissions.

NOTE—When a HT STA sends a RTS to the AP that is a non-STBC frame, the AP returns a CTS that is a non-STBC frame to the STA and then immediately transmits a CTS that is an STBC frame. The original non-AP STA is now free to transmit. But a non-HT station that has set its NAV based on the original RTS may reset its NAV and then decrement its backoff counter - given that a SIFS + the duration of CTS2 is longer than a DIFS (i.e. the STA does not detect PHY-RXSTART.indication within the period specified in 9.2.5.4). Thus the NAV reservation will not always work.

If dual CTS protection is enabled and a STA obtains a TXOP and does not have any frames to transmit before the expiration of the TXOP duration, the STA may indicate truncation of the TXOP by transmitting a CF-End frame at the lowest basic rate, if the remaining duration of the TXOP after the transmission of the last frame, can accommodate its CF-End frame duration at the lowest basic rate, a CF-End frame that is an STBC frame duration at the basic STBC MCS, a CF-End frame that is a non-STBC frame at the lowest basic rate, and three SIFS durations. With a CF-End frame transmission the STA explicitly indicates the completion or truncation of its TXOP. The transmission of a CF-End frame shall be interpreted by the other STAs that are capable of receiving it as a NAV reset.

On receiving a CF-End frame from a STA with a matching BSSID, an AP shall respond with dual CF-End frames, one CF-End frame that is an STBC frame at the basic STBC MCS and one CF-End frame that is a non-STBC frame at the lowest basic rate, after a SIFS duration. Dual CF-End frames eliminate unfairness towards STAs that are not of the same mode as the one that owns the TXOP being truncated.

If the TXOP is owned by the AP and dual CTS Protection is enabled in the system, the AP may send dual CF-End frames if it runs out of frames to transmit, provided that the remaining TXOP duration after the transmission of the last frame, can accommodate a STBC CF-End frame duration at the lowest STBC basic rate, a CF-End frame that is a non-STBC frame at the lowest basic rate, and two SIFS durations.

The spacing between the dual CF-End frames sent by the AP shall be SIFS. The first CF-End frame shall use the same encoding (STBC frame versus non-STBC frame) used for transmissions in the TXOP being truncated and the second CF-End frame shall use the other encoding.

An STBC capable STA shall choose between control frame operation using either STBC frames or non-STBC frames. In the non-STBC frame case, it discards control frames that are STBC frames it receives. In the STBC frame case, it discards control frames that are non-STBC frames received from its own BSS. This choice is a matter of local policy.

Change the heading of 9.2.6 as follows:

9.2.6 Individually Addressed MPDU transfer procedure

Change the four paragraphs of 9.2.6 as follows:

A STA shall use an RTS/CTS exchange for individually addressed frames~~ only~~ when the length of the ~~MPDU~~ PSDU is greater than the length threshold indicated by the dot11RTSThreshold attribute.

The dot11RTSThreshold attribute shall be a managed object within the MAC MIB, and its value may be set and retrieved by the MLME. The value 0 shall be used to indicate that all MPDUs shall be delivered with the use of RTS/CTS. Values of dot11RTSThreshold larger than the maximum ~~MSDU~~ PSDU length shall indicate that all ~~MPDUs~~PSDUs shall be delivered without RTS/CTS exchanges.

When an RTS/CTS exchange is used, the ~~asynchronous data frame~~PSDUshall be transmitted starting one SIFS period after the end of the CTS frame~~ and a SIFS period~~. No regard shall be given to the busy or idle status of the medium when transmitting this ~~data frame~~PSDU.

When an RTS/CTS exchange is not used, the ~~asynchronous data frame~~PSDU shall be transmitted following the success of the basic access procedure. With or without the use of the RTS/CTS exchange procedure, the STA that is the destination of an ~~asynchronous~~ data frame shall follow the ACK procedure.

Insert the following new subclause heading:

9.2.8a BlockAck procedure

Upon successful reception of a frame of a type that requires an immediate BlockAck response, the receiving STA shall transmit a BlockAck frame after a SIFS period, without regard to the busy/idle state of the medium.

9.2.9 Duplicate detection and recovery

Change paragraphs 2 and 3 of 9.2.9 as follows:

Duplicate frame filtering is facilitated through the inclusion of a Sequence Control field (consisting of a sequence number and fragment number) within data and management frames as well as TID subfield in the QoS Control field within QoS data frames. MPDUs that are part of the same MSDU or A-MSDU shall have the same sequence number, and different MSDUs or A-MSDUs shall (with a high probability) have a different sequence number.

The sequence number, for management frames and for data frames with QoS subfield of the Subtype field set to 0, is generated by the transmitting STA as an incrementing sequence of integers. In a QSTA, the sequence numbers for QoS (+)Data frames are generated by different counters for each TID and receiver pair and shall be incremented by one for each new MSDU or A-MSDU corresponding to the TID/receiver pair.

9.2.10 DCF timing relations

Change paragraph 2 of 9.2.10 as follows:

All timings that are referenced from the end of the transmission are referenced from the end of the last symbol of the PPDU carrying a frame on the medium. The beginning of transmission refers to the first symbol of the preamble of the PPDU carrying the next frame on the medium.

Change paragraph 13 of 9.2.10 as follows:

The following equations define the MAC Slot Boundaries, using attributes provided by the PHY, which are such that they compensate for implementation timing variations. The starting reference of these slot boundaries is again the end of the last symbol of the PPDU carrying the previous frame on the medium.

9.4 Fragmentation

Change paragraphs 1 to 5 of 9.4 as follows:

The MAC may fragment and reassemble individually addressed MSDUs, A-MSDUs or MMPDUs. The fragmentation and defragmentation mechanisms allow for fragment retransmission.

The length of each fragment shall be an equal number of octets for all fragments except the last, which may be smaller. The length of each fragment shall ~~always~~ be an even number of octets, except for the last fragment of an MSDU, A-MSDU or MMPDU, which may be either an even or an odd number of octets. The length of a fragment shall never be larger than dot11FragmentationThreshold unless WEP is invoked for the MPDU. If WEP is active for the MPDU, then the MPDU shall be expanded by IV and ICV (see 8.2.1); this may result in a fragment larger than dot11FragmentationThreshold.

A fragment is an MPDU, the payload of which carries all or a portion of an MSDU, A-MSDU or MMPDU. When data are to be transmitted, the number of octets in the fragment (before processing by the security mechanism) shall be determined by dot11FragmentationThreshold and the number of octets in the MPDU that have yet to be assigned to a fragment at the instant the fragment is constructed for the first time. Once a fragment is transmitted for the first time, its frame body content and length shall be fixed until it is successfully delivered to the immediate receiving STA. A STA shall be capable of receiving fragments of arbitrary length.

If a fragment requires retransmission, its frame body content and length shall remain fixed for the lifetime of the MSDU, A-MSDU or MMPDU at that STA. After a fragment is transmitted once, contents and length of that fragment are not allowed to fluctuate to accommodate the dwell time boundaries. Each fragment shall contain a Sequence Control field, which is comprised of a sequence number and fragment number. When a STA is transmitting an MSDU, A-MSDU or MMPDU, the sequence number shall remain the same for all fragments of that MSDU, A-MSDU or MMPDU. The fragments shall be sent in order of lowest fragment number to highest fragment number, where the fragment number value starts at zero, and increases by one for each successive fragment. The Frame Control field also contains a bit, the More Fragments bit, that is equal to zero to indicate the last (or only) fragment of the MSDU, A-MSDU or MMPDU.

The source STA shall maintain a transmit MSDU timer for each MSDU or A-MSDU being transmitted. The attribute dot11MaxTransmitMSDULifetime specifies the maximum amount of time allowed to transmit an MSDU or A-MSDU. The timer starts on the initial attempt to transmit the first fragment of the MSDU or A-MSDU. If the timer exceeds dot11MaxTransmitMSDULifetime, then all remaining fragments are discarded by the source STA and no attempt is made to complete transmission of the MSDU or A-MSDU.

9.5 Defragmentation

Change 9.5 as follows:

Each fragment contains information to allow the complete MSDU, A-MSDU or MMPDU to be reassembled from its constituent fragments. The header of each fragment contains the following information that is used by the destination STA to reassemble the MSDU, A-MSDU or MMPDU:

- Frame type
- Address of the sender, obtained from the Address2 field
- Destination address
- *Sequence Control field:* This field allows the destination STA to check that all incoming fragments belong to the same MSDU, A-MSDUor MMPDU, and the sequence in which the fragments should be reassembled. The sequence number within the Sequence Control field remains the same for all fragments of an MSDU, A-MSDU or MMPDU, while the fragment number within the Sequence Control field increments for each fragment.
- *More Fragments indicator:* Indicates to the destination STA that this is not the last fragment of the MSDU, A-MSDU or MMPDU. Only the last or sole fragment of the MSDU, A-MSDU or MMPDU shall have this bit set to 0. All other fragments of the MSDU, A-MSDU or MMPDU shall have this bit set to 1.

The destination STA shall reconstruct the MSDU, A-MSDU or MMPDU by combining the fragments in order of fragment number subfield of the Sequence Control field. If ~~WEP~~ encryption has been applied to the fragment, it shall be decrypted before the fragment is used for defragmentation of the MSDU, A-MSDU or MMPDU. If the fragment with the More Fragments bit set to 0 has not yet been received, then the destination STA knows that the MSDU, A-MSDU or MMPDU is not yet complete. As soon as the STA receives the fragment with the More Fragments bit set to 0, the STA knows that no more fragments may be received for the MSDU, A-MSDU or MMPDU.

All STAs shall support the concurrent reception of fragments of at least three MSDUs, A-MSDUs or MMPDUs. Note that a STA receiving more than three fragmented MSDUs, A-MSDUs or MMPDUs concurrently may experience a significant increase in the number of frames discarded.

The destination STA shall maintain a Receive Timer for each MSDU, A-MSDU or MMPDU being received, for a minimum of three MSDUs, A-MSDUs or MMPDUs. The STA may implement additional timers to be able to receive additional concurrent MSDUs, A-MSDUs or MMPDUs. The receiving STA shall discard all fragments that are part of an MSDU, A-MSDU or MMPDU for which a timer is not maintained. There is also an attribute, aMaxReceiveLifetime, that specifies the maximum amount of time allowed to receive an MSDU , A-MSDU or MMPDU. The receive MSDU, A-MSDU or MMPDU timer starts on the reception of the first fragment of the MSDU, A-MSDU or MMPDU. If the receive ~~MSDU or MMPDU~~ timer exceeds aMaxReceiveLifetime, then all received fragments of this MSDU, A-MSDU or MMPDU are discarded by the destination STA. If additional fragments of a ~~directed~~individually addressed MSDU, A-MSDU or MMPDU are received after its aMaxReceiveLifetime is exceeded, those fragments shall be acknowledged and discarded.

To properly reassemble MPDUs into an MSDU, A-MSDU or MMPDU, a destination STA shall discard any duplicated fragments received. A STA shall discard duplicate fragments as described in 9.2.9. However, an acknowledgment shall be sent in response to a duplicate fragment of an~~directed~~ individually addressed MSDU, A-MSDU or MMPDU.

9.6 Multirate support

Change 9.6 as follows:

Some PHYs have multiple data transfer rate capabilities that allow implementations to perform dynamic rate switching with the objective of improving performance. The algorithm for performing rate switching is beyond the scope of this standard, but in order to ensure coexistence and interoperability on multirate-capable PHYs, this standard defines a set of rules to be followed by all STAs.

Frames carried in a non-HT PPDU shall be transmitted using a rate from the Supported Rates, Extended Supported Rates or BSSBasicRateSet. Frames carried in a HT PPDU shall be transmitted using an MCS from the Supported MCS Set or BSSBasicMCSset, or using the BSSBasicSTBCMCS when the frame is a control frame that is an STBC frame.

~~Control f~~Frames ~~that initiate a frame exchange~~ shall be transmitted at rates which are in accordance with this subclause ~~at one of the rates/MCS in the BSSBasicRateSet/BSSBasicMCSset parameter~~ except in the following cases:

- When the transmitting STA's protection mechanism for non-ERP receivers is enabled and the ~~control~~ frame is a protection mechanism frame and it is a frame which initiates an exchange. In this case the frame shall be transmitted at a rate according to the rules for determining the rates of transmission of protection frames in 9.13 (Protection mechanisms), or
- When the Dual CTS protection is enabled and the frame is a protection mechanism frame and it is a frame which initiates an exchange. In this case the frame shall be transmitted at a rate according to the rules for determining the rates of transmission of protection frames in 9.2.5.5a (Dual CTS protection).
- ~~When the control frame is a BlockAckReq or BlockAck frame~~

~~In the former case, the control frame shall be transmitted at a rate according to the separate rules for determining the rates of transmission of protection frames in 9.13. In the latter case, the control frame shall be transmitted in accordance with this subclause.~~

~~All frames with multicast and broadcast in the Address 1 field that have a UP of zero shall be transmitted at one of the rates included in the BSSBasicRateSet parameter, regardless of their type or subtype.~~

~~All data frames of subtype (QoS) (+)CF-Poll sent in the CP shall be transmitted at one of the rates in the BSSBasicRateSet parameter so that they will be understood by all STAs in the BSS, unless an RTS/CTS exchange has already been performed before the transmission of the data frame of subtype CF-Poll and the Duration field in the RTS frame covers the entire TXOP. All other data, BlockAckReq, and BlockAck frames and/or management MPDUs with unicast in the Address 1 field shall be sent using any data rate subject to the following constraints. No STA shall transmit a unicast frame at a rate that is not supported by the receiver STA, as reported in any Supported Rates and Extended Supported Rates element in the management frames transmitted by that STA. For frames of type (QoS) Data+CF-Ack, (QoS) Data+CF-Poll+CF-Ack, and (QoS) CF-Poll+CF-Ack, the rate chosen to transmit the frame should be supported by both the addressed recipient STA and the STA to which the ACK frame is intended. The BlockAck control frame shall be sent at the same rate and modulation class as the BlockAckReq frame if it is sent in response to a BlockAckReq frame.~~

~~Under no circumstances shall a STA initiate transmission of a data or management frame at a data rate higher than the greatest rate in the OperationalRateSet, a parameter of the MLME-JOIN.request primitive.~~

~~In the case where the supported rate set of the receiving STA is not known, the transmitting STA shall transmit at a rate contained in the BSSBasicRateSet parameter or a rate at which the transmitting STA has received a frame from the receiving STA.~~

~~To allow the transmitting STA to calculate the contents of the Duration/ID field, a STA responding to a received frame shall transmit its Control Response frame (either CTS or ACK), other than the BlockAck control frame, at the highest rate in the BSSBasicRateSet parameter that is less than or equal to the rate of the immediately previous frame in the frame exchange sequence (as defined in 9.12) and that is of the same modulation class (see 9.6.1) as the received frame. If no rate contained in the BSSBasicRateSet parameter meets these conditions, then the control frame sent in response to a received frame shall be transmitted at the highest mandatory rate of the PHY that is less than or equal to the rate of the received frame, and that is of the same modulation class as the received frame. In addition, the Control Response frame shall be sent using the same PHY options as the received frame, unless they conflict with the requirement to use the BSSBasicRateSet parameter.~~

~~An alternative rate for the control response frame may be used, provided that the duration of the control response frame at the alternative rate is the same as the duration of the control response frame at the originally chosen rate and the alternative rate is in either the BSSBasicRateSet parameter or the mandatory rate set of the PHY and the modulation of the control response frame at the alternative rate is the same type as that of the received frame.~~

For the Clause 17, Clause 18, and Clause 19 PHYs, the time required to transmit a frame for use in the Duration/ID field is determined using the PLME-TXTIME.request primitive (see 10.4.6) and the PLMETXTIME.confirm primitive (see 10.4.7), both defined in 17.4.3, 18.3.4, 19.8.3.1, 19.8.3.2, or 19.8.3.3 depending on the PHY options. In QoS STAs, the Duration/ID field may cover multiple frames and may involve using the PLME-TXTIME.request primitive several times. For Clause 20 PHYs, the time required to transmit a frame for use in the Duration/ID field is determined using the PLME-TXTIME.request primitive (see 10.4.6) and the PLME-TXTIME.confirm primitive (see 10.4.7), both defined in 17.4.3, 18.3.4, 19.8.3.1, 19.8.3.2, 19.8.3.3 or 20.4.3 (TXTIME calculation) depending on the PHY options.

9.6.1 Modulation classes

Add the following row to the end of Table 64:

Modulation Class	Description of Modulation
8	HT PHY (Clause 20)

Insert the following new subclause heading:

9.6.2 Rate selection for Data and Management frames

Insert the following new subclause:

9.6.2.1 Rate selection for data and management frames with multicast and broadcast addresses

All data and management frames with a group address in the Address 1 field shall be transmitted using one of the rates included in the BSSBasicRateSet parameter if the BSSBasicRateSet is not empty.

All data and management frames with a group address in the Address 1 field other than Beacons, shall be transmitted using one of the MCSs included in the BSSBasicMCSSet parameter if the BSSBasicRateSet is empty and the BSSBasicMCSSet is not empty.

Beacons shall be transmitted using one of the mandatory PHY rates if the BSSBasicRateSet parameter is empty and the BSSBasicMCSSet is not empty.

All data and management frames with a group address in the Address 1 field shall be transmitted using one of the mandatory PHY rates if both the BSSBasicRateSet parameter and the BSSBasicMCSSet parameter are empty (e.g., a scanning STA that is not yet associated with a BSS).

When a STA has the MIB attribute dot11TxSTBCOptionEnabled set to true, it shall use the basic STBC MCS when it transmits secondary STBC Beacon frames and broadcast/multicast frames.

Insert the following new subclause:

9.6.2.2 Rate selection for polling frames

All data frames of subtype (QoS) (+)CF-Poll sent in the CP shall be transmitted at a rate from the BSSBasicRateSet parameter or from the BSSBasicMCSset parameter so that they will be understood by all STAs in the BSS, unless an RTS/CTS protection exchange has already been performed before the transmission of the data frame of subtype (QoS) (+)CF-Poll and the Duration/ID field in the RTS frame covers the entire TXOP in which case the rate shall accord with the rate selection rules in 9.6.1c.

Insert the following new subclause:

9.6.2.3 Rate selection for +CF-Ack frames

For frames of type (QoS) Data+CF-Ack, (QoS) Data+CF-Poll+CFAck, and (QoS) CF-Poll+CF-Ack, the rate or MCS chosen to transmit the frame shall be supported by both the addressed recipient STA and the STA to which the ACK frame is intended.

Insert the following new subclause:

9.6.2.4 Rate selection for other Data and Management frames

All data and management frames not identified in 9.6.2.1 (Rate selection for data and management frames with multicast and broadcast addresses), 9.6.2.2 (Rate selection for polling frames) or 9.6.2.3 (Rate selection for +CF-Ack frames) shall be sent using any data rate subject to the following constraints:

- A STA shall not transmit a frame using a rate or MCS that is not supported by the receiver STA or STAs, as reported in any Supported Rates element, Extended Supported Rates element or Supported MCS field and in the management frames transmitted by the receiver STA or STAs.
- A STA shall not initiate transmission of a frame at a data rate higher than the greatest rate in the OperationalRateSet or the HTOperationalMCSset, which are parameters of the MLME-JOIN.request primitive.

In the case where the supported rate set of the receiving STA or STAs is not known, the transmitting STA shall transmit using a rate in the BSSBasicRateSet parameter or using an MCS in the BSSBasicMCSset parameter or using a rate or MCS that the transmitting STA has observed in a PPDU transmitted by the STA that is the intended receiver.

These rules also apply to A-MPDUs that aggregate MPDUs of type Data with any other types of MPDU.

Insert the following new subclause heading:

9.6.3 Rate selection for control frames

Insert the following new subclause:

9.6.3.1 Rate selection for control frames that initialize a TXOP

If a control frame that initiates a TXOP is carried in a non-HT PPDU, the transmitting STA shall transmit the frames using one of the rates in the BSSBasicRate set parameter or using a rate from the mandatory rate set of the attached PHY if the BSSBasicRateSet parameter is empty.

If a control frame that initiates a TXOP is carried in a HT PPDU, the transmitting STA shall transmit the frames using an MCS supported by the receiver STA, as reported in the Supported MCS field in the HT Capabilities element in management frames transmitted by that STA or using a rate or MCS that the transmitting STA has observed in a PPDU transmitted by the STA that is the intended receiver.

To provide protection against other HT STA, an HT STA should select an MCS from the BasicMCSset for HT PPDU control frames that initiate a TXOP.

This is useful when, for example, using L-SIG TXOP Protection when L-SIG TXOP Full Support bit is set to 0. The L-SIG Duration will provide protection against non-HT STAs and the MPDU portion sent in BasicMCS will provide protection against HT STAs.

Selection between HT PPDU format and non-HT PPDU format for control frame transmission shall be determined by the rules in 9.6.7 (HT PPDU/non-HT PPDU selection for control frames).

Insert the following new subclause:

9.6.3.2 Rate selection for control frames that are not control response frames

If a control frame that is not a control response frame is not the first frame transmitted within a TXOP and the control frame is carried in a non-HT PPDU, the transmitting STA shall transmit the control frame using the highest rate in the BSSBasicRateSet parameter that is less than or equal to the rate or non-HT reference rate (see 9.6.9 (Non-HT basic rate calculation)) of the previously transmitted frame that was directed to the same receiving STA. If no rate in the BSSBasicRateSet parameter meets these conditions, the control frame shall be transmitted at the highest mandatory rate of the PHY that is less than or equal to the rate or non-HT reference rate (see 9.6.9 (Non-HT basic rate calculation)) of the previously transmitted frame that was directed to the same receiving STA.

If a control frame that is not a control response frame is not the first frame transmitted within a TXOP and is carried in an HT PPDU, the transmitting STA shall transmit the frames using an MCS supported by the receiver STA, as reported in the Supported MCS field in the HT capabilities element in management frames transmitted by that STA or using a rate or MCS that the transmitting STA has observed in a PPDU transmitted by the STA that is the intended receiver.

The decision to transmit the control frame within an HT PPDU or a non-HT PPDU shall be made as defined in 9.6.7 (HT PPDU/non-HT PPDU selection for control frames).

Insert the following new subclause:

9.6.3.3 Rate selection for control response frames

To allow the transmitting STA to calculate the contents of the Duration/ID field, a STA responding to a received frame shall transmit its Control response frame according to the following rules:

- When the Control response frame (CTS, ACK or Immediate BlockAck including response to implicit BlockAckReq) is carried in a non-HT PPDU or in an HT PPDU that has a value of NON_HT_CBW40 for the TXVECTOR parameter CH_BANDWIDTH, then it shall be transmitted at the highest rate in the BSSBasicRateSet parameter that is less than or equal to the rate/non-HT reference rate (see 9.6.9 (Non-HT basic rate calculation)) of the immediately previous frame in the frame exchange sequence (as defined in 9.12 (Frame exchange sequences)). If no rate in the BSSBasicRateSet parameter meets these conditions, then the Control response frame shall be transmitted at the highest mandatory rate of the PHY that is less than or equal to the rate of the received frame, and that is of the same modulation class as the received frame.

- If the Control Response frame is carried in an HT PPDU that does not have a value of NON_HT_CBW40 for the TXVECTOR parameter CH_BANDWIDTH, then it shall be transmitted at the MCS as determined by the procedure defined in 9.6.6 (Control response frame MCS computation).

- If the received frame is of a modulation class other than HT PHY and the Control Response frame is carried in a non-HT PPDU, then the Control Response frame shall be transmitted using the same modulation class as the received frame. In addition, the Control Response frame shall be sent using the same value for the TXVECTOR parameter PREAMBLE_TYPE as the received frame.

- If the received frame is of the modulation class HT PHY and the Control Response frame is carried in a non-HT PPDU, then the Control Response frame shall be transmitted using one of the ERP-OFDM PHY or OFDM PHY modulation classes.

Selection between HT and non-HT PPDU for control response frame transmission shall be performed as defined in 9.6.7 (HT PPDU/non-HT PPDU selection for control frames).

For a non-HT PPDU control response frame or a control response frame that is transmitted in an HT PPDU with the TXVECTOR parameter CH_BANDWIDTH equal to NON_HT_CBW40, an alternative rate to that determined by following the procedure of 9.6 (Multirate support).1f may be used provided that the duration of the control response frame at the alternative rate is the same as the duration of the control response frame at the original chosen rate and the alternative rate is in either the BSSBasicRateSet parameter or the mandatory rate set of the PHY and the modulation class of the control response frame at the alternative rate is the same class as that of the original selected rate.

For an HT PPDU control response frame that is transmitted in a PPDU with the TXVECTOR parameter CH_BANDWIDTH not equal to NON_HT_CBW40, an alternative MCS to that determined by following the procedure of 9.6.6 (Control response frame MCS computation) may be used provided that the duration of the control response frame at the alternative MCS is the same as the duration of the control response frame at the original chosen MCS and the alternative MCS is in the CandidateMCSSet that was generated according to the procedure of 9.6.6 (Control response frame MCS computation).

Insert the following new subclause:

9.6.4 HT Basic MCS Set

The Basic MCS Set field of the HT Information element indicates which MCS values are supported by all STAs in a BSS. An AP shall refuse a association or reassociation request from a STA that does not support all the rates in the Basic MCS Set.

If the contents of the Basic MCS Set is all zeros, Non-HT basic rates shall be used.

Insert the following new subclause:

9.6.5 HT Basic STBC MCS

The basic STBC MCS is the MCS of lowest rate in the Basic MCS Set used with STBC encoder with one spatial stream and two space time streams. If the STBC Rx and Tx capabilities indicated in the HT Capabilities info field do not allow the use of an STBC encoder, the basic STBC MCS value is replaced by the MCS of lowest rate in the Basic MCS Set.

Insert the following new subclause:

9.6.6 Control response frame MCS computation

If the control response frame format is to be transmitted within an HT PPDU with the TXVECTOR parameter CH_BANDWIDTH not equal to NON_HT_CBW40 in accordance with rules in 9.6.7 (HT PPDU/non-HT PPDU selection for control frames), the responding STA shall choose an MCS from a set of MCS called the CandidateMCSSet. The CandidateMCSSet is determined using the following rules:

a) If the frame eliciting the response was an STBC frame , instead of establishing a CandidateMCSSet, the rules for STBC exchanges found in 9.2.5.5a (Dual CTS protection) are used to determine the MCS of the response transmission.

b) If any of the following four conditions is true:

    1) the frame eliciting the response included a HT Control field with the MRQ field set to 1, or

    2) the frame eliciting the response included HT Control field with the TRQ field set to 1, or

    3) the PPDU containing the frame eliciting the response had the RXVECTOR SOUNDING parameter set to SOUNDING, or

    4) the frame eliciting the response had an L-SIG Duration value (see 9.13.5 (L-SIG TXOP protection)) and initiates a TXOP,

    then the CandidateMCSSet is the MCS Set consisting of the logical AND of the Rx Supported MCS Set of the STA (defined in 7.3.2.49.4 (Supported MCS Set field)) of the STA that sent the frame that is eliciting the response and the set of MCSs that the responding STA is capable of transmitting.

c) If none of the above conditions is true, then the CandidateMCSSet is the BSSBasicMCSSet. If the BSSBasicMCSSet is empty, then the CandidateMCSSet shall consist of the set of mandatory HT PHY MCSs.

The selection of the value for the CH_BANDWIDTH parameter of the TXVECTOR of the response transmission shall obey the rules defined in 9.13.3 (Protection mechanisms for HT transmissions).

MCS values from the CandidateMCSSet that do not satisfy those rules shall be eliminated from the CandidateMCSSet.

The choice of a response MCS is made as follows:

a) If the frame eliciting the response is within a non-HT PPDU or an HT-PPDU with TXVECTOR parameter CH_BANDWIDTH equal to NON_HT_CBW40,

    1) Eliminate from the CandidateMCSSet all MCSs that have a Data Rate greater than or equal to the Data Rate of the received PPDU (the mapping of MCS to Data Rate is defined in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)).

    2) Find the highest indexed MCS from the CandidateMCSSet. The index of this MCS is the index of the MCS that shall be used for the response transmission.

b) If the frame eliciting the response is within an HT-PPDU with the TXVECTOR parameter CH_BANDWIDTH not equal to NON_HT_CBW40,

    1) Eliminate from the CandidateMCSSet all MCSs that have an index that is higher than the index of the MCS of the received frame.

2) Determine the highest N_{SS} value of all of the MCS in the CandidateMCSSet that is equal to or less than the N_{SS} value of the MCS of the received frame and eliminate all MCSs from the CandidateMCSSet that have an N_{SS} value that is not equal to this N_{SS} value.

3) Find the highest-indexed MCS of the CandidateMCSSet for which the modulation value of each stream is less than or equal to the modulation value of each stream of the MCS of the received frame and for which the code ratio value of each stream is less than or equal to the code ratio value of each stream of the MCS from the received frame. The index of this MCS is the index of the MCS that shall be used for the response transmission.

If there is no MCS that meets the condition in step 3), then repeat step 3) including the set of MCS with the next highest N_{SS} values from the CandidateMCSSet and continue likewise until step 3) produces a non-empty result.

Insert the following new subclause:

9.6.7 HT PPDU/non-HT PPDU selection for control frames

A control frame shall be carried in a non-HT PPDU or an HT PPDU with the TXVECTOR parameter CH_BANDWIDTH equal to NON_HT_CBW40 except under the conditions listed below.

A control frame shall be carried in an HT PPDU with the TXVECTOR parameter CH_BANDWIDTH not equal to NON_HT_CBW40 when the control frame meets any of the following conditions:

a) the PPDU containing the control frame has a TXVECTOR SOUNDING parameter set to SOUNDING, or

b) the control frame contains an L-SIG Duration value (see 9.13.5 (L-SIG TXOP protection)), or

c) the control frame is sent using an STBC frame.

A control frame shall be carried in HT PPDU with the TXVECTOR parameter CH_BANDWIDTH not equal to NON_HT_CBW40 when the control frame is a response to a frame that meets the following conditions:

a) the frame eliciting the response included an HT Control field with the TRQ field set to 1 and the NDP announcement field was set to 0 and this responder sets the Implicit TxBF Receiving Capable field to 1, or

b) the frame eliciting the response was an RTS frame carried in HT PPDU, or

c) the frame eliciting the response was an STBC frame and the Dual CTS Protection field was set to 1 (see 9.2.5.5a (Dual CTS protection)).

A control frame may be carried in HT PPDU with the TXVECTOR parameter CH_BANDWIDTH not equal to NON_HT_CBW40 when the control frame meets any of the following conditions:

a) the control frame contains a HT Control field with the MRQ field set to 1, or

b) the control frame contains a HT Control field with the TRQ field set to 1.

A BlockAck may be aggregated with data (using A-MPDU) within a HT PPDU.

NOTE—If improved protection from non-HT STAs is desired, aggregation of BlockAck should not be used.

Insert the following new subclause:

9.6.8 Channel Width selection for control frames

An HT STA which transmits a control response frame shall send the frame using the same channel width as that on which it received the frame that elicited the response transmission. This means that if the responding STA receives a non-HT duplicate frame which was transmitted in 40 MHz, as a 20 MHz non-HT PPDU, the responding STA shall respond in 20 MHz.

This rule shall be used in combination with rules in 9.6.7 to determine the format of the control response frames.

For frames that are intended to provide protection, channel width is selected according to rules defined in 9.13 (Protection mechanisms).

An HT STA that uses a non-HT duplicate frame to establish protection of its TXOP shall only send a CF-End in a non-HT duplicate frame except during the 40 MHz phase of PCO operation. During the 40 MHz phase of PCO operation, the rules in subclause 11.16 (Phased Coexistence Operation) apply.

Insert the following new subclause:

9.6.9 Non-HT basic rate calculation

This subclause defines how to convert an HT MCS to a non-HT basic rate for the purpose of determining the rate of the response frame. It consists of two steps as follows:

a) Use the modulation and coding rate determined from the HT MCS (defined in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))) to a non-HT reference rate by lookup into Table n48 (Non-HT reference rate) [1]. In the case of an MCS with unequal modulation, the modulation of stream 1 is used.

b) The non-HT Basic Rate is the highest rate in the BSSBasicRateSet that is less than or equal to this non-HT reference rate.

Table n48—Non-HT reference rate

Modulation	Coding rate (R)	Non-HT reference rate (Mb/s)
BPSK	1/2	6
BPSK	3/4	9
QPSK	1/2	12
QPSK	3/4	18
16-QAM	1/2	24
16-QAM	3/4	36
64-QAM	2/3	48
64-QAM	3/4	54
64-QAM	5/6	54

9.7 MSDU transmission restrictions

Change paragraphs 2 to 6 of 9.7 as follows:

A non-QoS STA shall ensure that no more than one MSDU, A-MSDU or MMPDU from a particular SA to a particular individual RA is outstanding at a time. Note that a simpler, more restrictive invariant to maintain

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[1] For example if an HT PPDU transmission uses 64-QAM and coding rate of ¾, the related non-HT reference rate is 54 Mb/s.

is that no more than one MSDU with a particular individual RA may be outstanding at a time.

For all transmissions not using the acknowledgement policy of Block Ack of frames that are not sent within the context of a block ack agreement, a QoS STA shall ensure that no more than one MSDU or A-MSDU~~or MMPDU~~ with a particular TID or MMPDU from a particular SA to a particular individual RA is outstanding at any time. This restriction is not applicable for MSDUs that are to be transmitted using the Block Ack mechanism.~~Note that a~~

NOTE—A simpler, more restrictive invariant to maintain is that no more than one MSDU with any particular TID with a particular individual RA may be outstanding at any time. ~~This restriction is not applicable for MSDUs that are to be transmitted using the Block Ack mechanism.~~

In a STA where the optional StrictlyOrdered service class has been implemented, that STA shall ensure that there is no group-addressed (multidestination) MSDU of the StrictlyOrdered service class outstanding from the SA of any other outstanding MSDU (either individual or group-addressed). This is because a group addressed MSDU is implicitly addressed to a collection of peer STAs that could include any individual RA.

It is recommended that the STA select a value of dot11MaxTransmitMSDULifetime that is sufficiently large that the STA does not discard MSDUs or A-MSDUs due to excessive Transmit MSDU timeouts under normal operating conditions.

An A-MSDU shall contain only MSDUs of a single service class, and inherits that service class for the purpose of the following rules. For MSDUs or A-MSDUs belonging to the service class of QoSAck, when the receiver is a QSTA, the QoS data frames that are used to send these MSDUs or A-MSDUs shall have the Ack Policy subfield in the QoS Control field set to Normal Ack or Block Ack. For MSDUs or A-MSDUs belonging to the service class of QoSNoAck when the receiver is a QSTA, the QoS data frames that are used to send these MSDUs or A-MSDUs shall have the Ack Policy subfield in the QoS Control field set to No Ack.

Insert the following new subclause:

9.7a High Throughput Control field (+HTC) operation

A STA that supports HTC shall set the +HTC Support subfield of the HT Extended Capabilities field of the HT Capabilities element to 1 in all HT Capabilities elements that it transmits.

A STA shall set the +HTC Support subfield of the HT Extended Capabilities field of the HT Capabilities element to 1 in all HT Capabilities elements that it transmits, if the STA is announcing capability of any features that require HTC signaling.

A High Throughput Control field shall only be present in a frame addressed to a receiver that declares support for +HTC in the HT Extended Capabilities field of its HT Capabilities element (see 7.3.2.49 (HT Capabilities element)).

An HT STA that does not support +HTC shall decode the Order field (see 7.1.3.1.10 (Order field)) of the Frame control field and perform the CRC on the extended length of the MPDU in order to properly respect any Duration/ID field setting.

A STA receiving a Control Wrapper frame shall respond to the frame according to the subtype of the wrapped frame.***Insert the following new subclause:***

9.7b A-MSDU operation

Support for A-MSDU is mandatory at the receiver, where the A-MSDU is carried in a single (i.e., non A-MPDU) QoS Data MPDU under Normal Ack policy. Use of A-MSDU carried in a QoS Data MPDU under a Block Ack agreement is determined per Block Ack agreement.

A STA shall only transmit an A-MSDU within a QoS Data MPDU under a Block Ack agreement if the recipient indicates support for A-MPDU by setting the A-MPDU Supported field to 1 in its ADDBA response frame.

The A-MSDU lifetime is defined as the maximum lifetime of its constituent MSDUs. An A-MSDU may be transmitted until its lifetime expires or it is received correctly at the receiver.

NOTE 1—This implicitly allows an MSDU that is a constituent of an A-MSDU to potentially be transmitted after the expiration of its lifetime.

NOTE 2—Selecting any other value for the time-out would result in loss of MSDUs. Selecting the Maximum value avoids this at the cost of transmitting MSDUs that have exceeded their lifetime.

A STA shall not transmit an A-MSDU to a STA that exceeds its Maximum A-MSDU Length capability.

NOTE 3—Support for A-MSDU aggregation does not affect the maximum size of MSDU transported by the MA-UNITDATA primitives.

An A-MSDU is composed of MSDUs with the same TID value. The channel access rules for a QoS Data MPDU carrying an A-MSDU (or fragment thereof) are the same as a Data MPDU carrying an MSDU (or fragment thereof) of the same TID.

Insert the following new subclause heading:

9.7c A-MPDU operation

Insert the following new subclause:

9.7c.1 A-MPDU length limit rules

An HT STA indicates a value of Maximum Rx AMPDU Factor field in its HT Capabilities element that defines the maximum A-MPDU length that it can receive. The STA may limit the A-MPDU length during association using this field. The STA shall be capable of receiving A-MPDUs of length up to the indicated limit. When it receives an A-MPDU of length greater than the limit, it shall receive the first $2^{(13 + \text{Maximum Rx A-MPDU Factor})} - 1$ octets and discard any remainder.

An HT STA shall not transmit an A-MPDU that is longer than $2^{(13 + \text{Maximum Rx A-MPDU Factor})} - 1$ octets, using the limit declared by the intended receiver.

NOTE—the A-MPDU length limit applies to the maximum length of the PSDU that may be received. If the A-MPDU includes any padding delimiters (i.e. delimiters with the length field set to 0) in order to meet the MPDU Start Spacing requirement, this padding is included in this length limit.

Insert the following new subclause:

9.7c.2 Minimum MPDU Start Spacing

An HT STA shall not allow transmission of more than one MPDU start within the time limit described in the Minimum MPDU Start Spacing field. This time is measured at the PHY-SAP; the number of octets between the start of two consecutive MPDUs in A-MPDU shall be equal or greater than:

$$t_{MMSS} \times r / 8$$

where

t_{MMSS} is the time (in units of μs) defined in the Encoding column of Table n26 (Subfields of the A-MPDU Parameters field) for the value of the Minimum MPDU Start Spacing field, and

r is the value of the PHY Data Rate (in units of Mb/s) defined in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)) based on the TXVECTOR parameters: MCS and SHORT_GI.

Insert the following new subclause:

9.7c.3 Transport of A-MPDU by the PHY data service

An A-MPDU is transmitted in a PSDU associated with a PHY-TXSTART.request with the TXVECTOR AGGREGATION parameter set to 1. A received PSDU is determined to be an A-MPDU when the associated PHY-RXSTART.indication RXVECTOR AGGREGATION parameter is set to 1.

Insert the following new subclause:

9.7d PPDU Duration Constraint

An HT STA shall not transmit a PPDU that has a duration (as determined by the PHY-TXTIME.confirm primitive defined in 10.4.6 (PLME-TXTIME.request)) that is greater than aPPDUMaxTime.

Insert the following subclause heading:

9.9 HCF

9.9.1 HCF contention-based channel access (EDCA)

9.9.1.2 EDCA TXOPs

Change the second paragraph of 9.9.1.2 as follows:

The TXOP limit duration values are advertised by the AP in the EDCA Parameter Set information element in Beacon and Probe Response frames transmitted by the AP. A TXOP limit value of 0 indicates that a single MSDU or MMPDU or A-MSDU or A-MPDU along with any ACK or BlockAck response frame as well as any NDP that are announced within the TXOP, in addition to a possible RTS/CTS exchange or CTS to itself (or a dual CTS sequence as defined in 9.2.5.5a (Dual CTS protection)), may be transmitted at any rate for each TXOP. A CF-End frame may be transmitted to cancel remaining NAV time if the prediction of the expected frame exchange duration was not accurate.

Change paragraph 4 of 9.9.1.2 as follows:

A STA shall fragment a unicast MSDU or A-MSDU so that the transmission of the first MPDU of the TXOP does not cause the TXOP limit to be exceeded at the PHY rate selected for the initial transmission attempt of that MPDU. The TXOP limit may be exceeded, when using a lower PHY rate than selected for the initial transmission attempt of the first MPDU, for a retransmission of an MPDU, for the initial transmission of an MPDU if any previous MPDU in the current MSDU has been retransmitted, or for broadcast/multicast MSDUs. When the TXOP limit is exceeded due to the retransmission of an MPDU at a reduced PHY rate, the STA shall not transmit more than one MPDU in the TXOP.

9.9.1.4 Multiple frame transmission in an EDCA TXOP

Change the first paragraph of 9.9.1.4 as follows:

Multiple frames may be transmitted in an acquired EDCA TXOP following the rules in 9.9.1.3 if there ~~are~~is more than one frame pending in the AC for which the channel has been acquired. However, those frames that are pending in other ACs shall not be transmitted in this EDCA TXOP. If a STA has in its transmit queue an additional frame of the same AC as the one just transmitted and the duration of transmission of that frame plus any expected acknowledgment for that frame is less than the remaining medium occupancy timer value, then the STA may commence transmission of that frame at SIFS after the completion of the immediately preceding frame exchange sequence. An HT STA may transmit multiple MPDUs from the same AC as an A-MPDU as long as the duration of transmission of the A-MPDU plus any expected BlockAck response is less than the remaining medium occupancy timer value. Following the BlockAck response, the HT STA may commence transmission of another MPDU or A-MPDU at SIFS after the completion of the immediately preceding frame exchange sequence. The HT STA may retransmit unacknowledged MPDUs within the same TXOP or in a subsequent TXOP. The intention of using the multiple frame transmission shall be indicated by the STA through the setting of the duration/ID values in one of the following two ways (see 7.1.4):

a) Long enough to cover the response frame, the next frame, and its response frame.

b) Long enough to cover the transmission of a burst of MPDUs and/or A-MPDUs subject to the limit set by dot11EDCATableTXOPLimit.

9.9.1.6 Retransmit procedures

Change paragraphs 1 to 4 of 9.9.1.6 as follows:

QoS STAs shall maintain a short retry counter and a long retry counter for each MSDU, A-MSDU or MMPDU that belongs to a TC requiring acknowledgment. The initial value for the short and long retry counters shall be zero. QoS STAs also maintain a short retry counter and a long retry counter for each AC. They are defined as QSRC[AC] and QLRC[AC], respectively, and each is initialized to a value of zero.

After transmitting a frame that requires acknowledgment, the STA shall perform the acknowledgment procedure, as defined in 9.2.8. The short retry count for an MSDU, A-MSDU or MMPDU and the QSRC[AC] shall be incremented every time transmission of a MAC frame of length less than or equal to dot11RTSThreshold fails for that MSDU, A-MSDU or MMPDU. This short retry count and the QoS STA QSRC[AC] shall be reset when a MAC frame of length less than or equal to dot11RTSThreshold succeeds for that MSDU, A-MSDU or MMPDU. The long retry count for an MSDU, A-MSDU or MMPDU and the QLRC[AC] shall be incremented every time transmission of a MAC frame of length greater than dot11RTSThreshold fails for that MSDU, A-MSDU or MMPDU. This long retry count and the QLRC[AC] shall be reset when a MAC frame of length greater than dot11RTSThreshold succeeds for that MSDU, A-MSDU or MMPDU. All retransmission attempts for an MPDU that has failed the acknowledgment procedure one or more times shall be made with the Retry field set to 1 in the data or management frame.

Retries for failed transmission attempts shall continue until the short retry count for the MSDU, A-MSDU or MMPDU is equal to dot11ShortRetryLimit or until the long retry count for the MSDU, A-MSDU or MMPDU is equal to dot11LongRetryLimit. When either of these limits is reached, retry attempts shall cease, and the MSDU, A-MSDU or MMPDU shall be discarded.

For internal collisions occurring with the EDCA access method, the appropriate retry counters (short retry counter for MSDU, A-MSDU or MMPDU and QSRC[AC] or long retry counter for MSDU, A-MSDU or MMPDU and QLRC[AC]) are incremented. For transmissions that use Block Ack, the rules in 9.10.3 also apply. STAs shall retry failed transmissions until the transmission is successful or until the relevant retry limit is reached.

Add the following paragraph at the end of 9.9.1.6:

When A-MSDU aggregation is used, the HT STA maintains a single timer for the whole A-MSDU. The timer is restarted each time an MSDU is added to the A-MSDU. This ensures that no MSDU in the A-MSDU is discarded before a period of dot11EDCATableMSDULifetime has elapsed.

9.9.2 HCCA

9.9.2.2 TXOP structure and timing

Change paragraph 2 of 9.9.2.2 as follows:

A TXOP or transmission within a TXOP shall not extend across TBTT, dot11CFPMaxDuration (if during CFP), dot11MaxDwellTime (if using an FH PHY), or dot11CAPLimit. The HC shall ensure that the full duration of any granted TXOP meets these requirements so that non-AP STAs may use the time prior to the TXOP limit of a polled TXOP without checking for these constraints. Subject to these limitations, all decisions regarding what MSDUs, A-MSDUs and/or MMPDUs are transmitted during any given TXOP are made by the STA that holds the TXOP.

9.9.2.3 HCCA transfer rules

Change paragraph 1 of 9.9.2.3 as follows:

A TXOP obtained by receiving a QoS (+)CF-Poll frame uses the specified TXOP limit consisting of one or more frame exchange sequences with the sole time-related restriction being that the final sequence shall end not later than the TXOP limit. In QoS CF-Poll and QoS CF-Ack+CF-Poll frames, the TID subfield in the QoS Control field indicates the TS for which the poll is intended. The requirement to respond to that TID is nonbinding, and a QSTA may respond with any frame. Upon receiving a QoS (+)CF-Poll frame, a non-AP QSTA may send any frames, i.e., QoS data frames belonging to any TID as well as management frames in the obtained TXOP. MSDUs and A-MSDUs may be fragmented in order to fit within TXOPs.

Change paragraph 3 of 9.9.2.3 as follows:

If a STA has set up at least one TS for which the Aggregation subfield in the associated TSPEC is set to 0, the QAP shall use only QoS CF-Poll or QoS CF-Ack+CF-Poll frames to poll the STA and shall never use QoS (+)Data+CF-Poll to poll the STA. It should be noted that although QoS (+)CF-Poll is a data frame, but it should be transmitted at one of the rates in the BSSBasicRateSet parameter in order to set the NAV of all STAs that are not being polled (see 9.6). If a CF-Poll is piggybacked with a QoS data frame, then the frame containing all or part of an MSDU or A-MSDU may be transmitted at the rate that is below the negotiated minimum PHY rate.

9.9.3 Admission Control at the HC

9.9.3.2 Controlled-access admission control

Change the second paragraph of 9.9.3.2 as follows:

The normative behavior of the scheduler is as follows:

- The scheduler shall be implemented so that, under controlled operating conditions, all STAs with admitted TS are offered TXOPs that satisfy the service schedule.

9.10 Block Acknowledgment (Block Ack)

9.10.1 Introduction

Change paragraph 3 of 9.10.1 as follows:

The Block Ack mechanism does not require the setting up of a TS; however, QoS STAs using the TS facility may choose to signal their intention to use Block Ack mechanism for the scheduler's consideration in assigning TXOPs. Acknowledgments of frames belonging to the same TID, but transmitted during multiple TXOPs, may also be combined into a single BlockAck frame. This mechanism allows the originator to have flexibility regarding the transmission of data MPDUs. The originator may split the block of frames across TXOPs, separate the data transfer and the Block Ack exchange, and interleave blocks of MPDUs carrying all or part of MSDUs or A-MSDUs for different TIDs or RAs.

9.10.2 Setup and modification of the Block Ack parameters

Change the first paragraph of 9.10.2 as follows (note the insertion of a new paragraph break, which cannot indicated with insertion marks):

A STA that intends to use the Block Ack mechanism for the transmission of QoS data frames to a ~~peer~~STA should first check whether the intended~~ peer~~ STA is capable of participating in Block Ack mechanism by discovering and examining its Delayed Block Ack and Immediate Block Ack capability bits. If the intended ~~peer~~ STA is capable of participating, the originator sends an ADDBA Request frame indicating the TID for which the Block Ack is being set up. The Block Ack Policy and Buffer Size fields in the ADDBA Request frame are advisory and may be changed by the recipient for an ADDBA setup between a non-HT STA. The Buffer Size field in the ADDBA Request frame is advisory and may be changed by the recipient for an ADDBA setup between HT STAs. When the Block Ack Policy subfield value is set to 1 by the originator of an ADDBA request frame between HT STAs, then the ADDBA response frame accepting the ADDBA request frame shall not contain any value other than 1 in the Block Ack Policy subfield.The receiving STA shall respond by an ADDBA Response frame. The receiving STA, which is the intended ~~peer~~STA, has the option of accepting or rejecting the request. When the STA accepts, then a Block Ack agreement exists between the originator and recipient.

When the STA accepts, it indicates the type of Block Ack and the number of buffers that it shall allocate for the support of this ~~block~~Block Ack agreement within the ADDBA response frame. Each Block Ack agreement that is established by a STA may have a different buffer allocation. If the receiving STA rejects the request, then the originator shall not use the Block Ack mechanism.

Insert after the above change the following new paragraph and note:

The A-MSDU Supported field indicates whether an A-MSDU may be sent under the particular Block Ack agreement. The originator sets this field to 1 to indicate that it might transmit A-MSDUs with this TID. The recipient sets this field to 1 to indicate that it is capable of receiving A-MSDU with this TID.

NOTE—The recipient is free to respond with any A-MSDU supported setting. If the value in the ADDBA response frame is not acceptable to the originator, it can delete the Block Ack agreement and transmit data using normal acknowledgement.

9.10.3 Data and acknowledgment transfer

Insert the following new paragraph in 9.10.3 after paragraph 8 (which begins with "The BlockAck frame contains acknowledgements"):

The Starting Sequence Number field of the BlockAck frame shall equal the value extracted from the Starting Sequence Number field from the BlockAckReq frame to which it is a response.

9.10.4 Receive buffer operation

Change paragraphs 3-6 of 9.10.4 as follows:

If a BlockAckReq frame is received, all complete MSDUs with lower sequence numbers than the starting sequence number contained in the BlockAckReq frame shall be ~~indicated to the MAC client using the MAUNI-DATA. indication primitive~~ passed up the MAC protocol stack (see Figure 18). Upon arrival of a BlockAckReq frame, the recipient shall ~~indicate~~pass up the MSDUs starting with the starting sequence number sequentially until there is an incomplete MSDU in the buffer.

If, after an MPDU is received, the receive buffer is full, the complete MSDU with the earliest sequence number shall be ~~indicated to the MAC client using the MA-UNIDATA.indication primitive~~ passed up the MAC protocol stack.

All comparisons of sequence numbers are performed circularly modulo 2^{12}.

NOTE—The sequence number space is considered divided into two parts, one of which is "old" and one of which is "new" by means of a boundary created by adding half the sequence number range to the current start of receive window (modulo 2^12).

The recipient shall ~~always~~ indicate the reception of MSDU ~~to its MAC client~~ using the MA-UNITDATA.indication primitive in order of increasing sequence number.

Insert the following new subclause:

9.10.6 Use of compressed bitmap

The Compressed Bitmap BA field shall be set to 1 in all BlockAck and BlockAckReq and MTBA and MT-BAR sent from one HT STA to another HT STA.

Insert the following new heading:

9.10.7 HT-immediate BlockAck extensions

Insert the following new subclause:

9.10.7.1 Introduction to HT-immediate BlockAck extensions

9.10.7.2 (HT-immediate BlockAck architecture) to 9.10.7.9 (Originator's support of recipient STAs' partial state) define an HT extension to the BlockAck feature (defined in 9.10.1 to 9.10.5) called HT-immediate BlockAck.

The HT-immediate extensions simplify immediate BlockAck use with A-MPDUs and reduce recipient resource requirements.

Insert the following new subclause:

9.10.7.2 HT-immediate BlockAck architecture

The HT-immediate BlockAck rules are explained in terms of the architecture shown in Figure n45 (HT-immediate BlockAck architecture) and explained in this subclause.

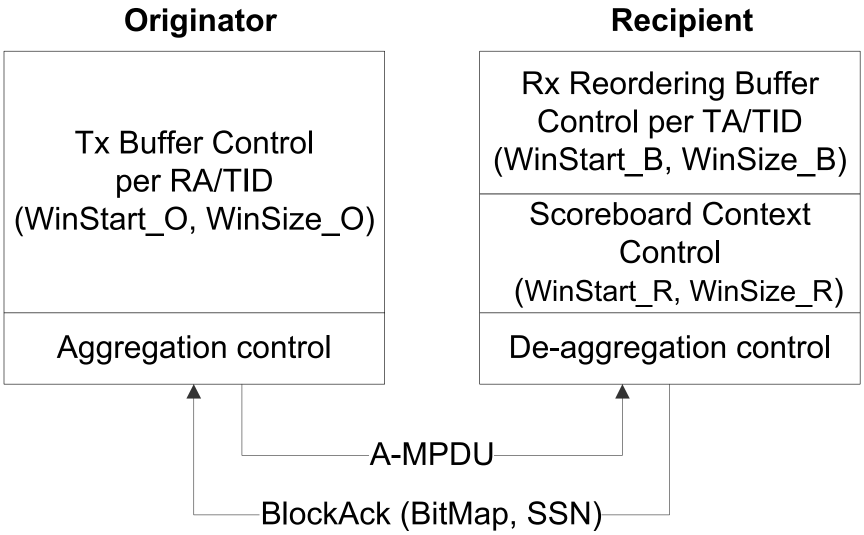


Figure n45—HT-immediate BlockAck architecture

The Originator contains a Tx Buffer control that uses WinStart_O and WinSize_O to submit MPDUs for transmission, and releases the Tx Buffers upon receiving BlockAck frames from the recipient.

WinStart_O is the starting sequence number of the transmit window, and WinSize_O is the number of buffers negotiated in the BlockAck agreement.

The Aggregation control creates A-MPDUs. It may adjust the Ack Policy field of transmitted QoS Data frames according to the rules defined in this subclause in order to solicit BlockAck responses.

The recipient contains a Rx Reordering Buffer per TA/TID and the related control state. The Rx Reordering Buffer is responsible for reordering MSDUs so that MSDUs are eventually indicated by the MA-UNITDATA.indication primitive in order of received sequence number (SN). It maintains its own state independent of the Scoreboard Context control to perform this reordering as specified in 9.10.7.6 (Rx reordering buffer control).

For each HT-immediate BlockAck agreement, the recipient chooses either full state or partial state operation (this is known only to the recipient). A STA may simultaneously use full state operation for some agreements and partial state operation for other agreements. The Scoreboard Context Control stores an acknowledgement bitmap plus the current context of the bitmap for each established HT-immediate BlockAck agreement under full state operation or the current context of the acknowledgement bitmap under partial state operation. This entity provides the bitmap and the value for the Starting Sequence Number (SSN) field to be sent in BlockAck responses to the Originator.

The de-aggregation control entity separates frames contained in an A-MPDU.

Each received MPDU is analyzed by the scoreboard context control, as well as by the Rx reordering buffer control.

Each HT-immediate BlockAck agreement is uniquely identified by a tuple of Address1, Address2 and TID from the ADDBA response frame that successfully established the HT-immediate BlockAck agreement. The STA that corresponds to Address1 of the ADDBA response frame is the originator. The STA that corresponds to Address2 of the ADDBA response frame is the recipient. Data MPDUs which contain the same values for Address1, Address2 and TID as a successful ADDBA response frame are related with the HT-immediate

BlockAck agreement which was established by the successful receipt of that ADDBA response frame provided that the HT-immediate BlockAck agreement is still active.

Insert the following new subclause:

9.10.7.3 Scoreboard context control during full state operation

For each HT-immediate BlockAck agreement that uses full state operation, a recipient STA shall maintain a block acknowledgement record as defined in 9.10.3. This record includes a bitmap, indexed by sequence number (SN), a 12-bit unsigned integer starting sequence number WinStart_R representing the lowest SN position in the bitmap, a variable WinEnd_R and the maximum Transmission Window size, WinSize_R, which is set to the value of the Buffer Size subfield of the associated ADDBA response frame that established the BlockAck agreement. WinEnd_R is defined as the highest SN in the current Transmission Window. A STA implementing full state operation for an HT-immediate BlockAck agreement shall maintain the block acknowledgement record for that agreement according to the following rules:

a) At HT-immediate BlockAck agreement establishment:
    1) WinStart_R = SSN from the ADDBA request frame that elicited the ADDBA response frame that established the HT-immediate BlockAck agreement
    2) WinEnd_R = WinStart_R + WinSize_R -1.

b) For each received data MPDU that is related with a specific full-state operation HT-immediate BlockAck agreement, the block acknowledgement record for that agreement is modified as follows, where SN is the value of the Sequence Number field of the received data MPDU:
    1) If WinStart_R ≤ SN ≤ WinEnd_R
        i) set to one the bit in position SN within the bitmap
    2) If WinEnd_R < SN < WinStart_R+2^{11}
        i) reset to zero bits corresponding to MPDUs with Sequence Number field values from WinEnd_R+1 to SN - 1
        ii) set WinStart_R = SN - WinSize_R + 1
        iii) set WinEnd_R = SN
        iv) set to one, the bit at position SN in the bitmap
    3) If WinStart_R+2^{11} ≤ SN < WinStart_R
        i) Make no changes to the record

    NOTE—a later-arriving data MPDU may validly contain a SN that is lower than an earlier-arriving one. This can happen because the transmitter may choose to send data MPDUs in a non-sequential SN order or because a previous data MPDU transmission with lower SN is not successful and is being retransmitted.

c) For each received Block Ack Request frame that is related with a specific full-state operation HT-immediate BlockAck agreement, the block acknowledgement record for that agreement is modified as follows, where SSN is the value from the Starting Sequence Number field of the received Block Ack Request frame:
    1) If WinStart_R ≤ SSN ≤ WinEnd_R
        i) set WinStart_R = SSN
        ii) reset to zero bits corresponding to MPDUs with Sequence Number field values from WinEnd_R + 1 through WinStart_R + WinSize_R – 1 inclusive
        iii) set WinEnd_R = WinStart_R + WinSize_R – 1.
    2) If WinEnd_R < SSN < WinStart_R+2^{11}
        i) set WinStart_R = SSN
        ii) set WinEnd_R = WinStart_R + WinSize_R - 1

   iii) reset to zero bits corresponding to MPDU with Sequence Number field values from WinStart_R to WinEnd_R

3) If WinStart_R+2^{11} ≤ SSN < WinStart_R
   i) Make no changes to the record

Comparisons in the above inequalities are circular modulo 2^{12}.

Insert the following new subclause:

9.10.7.4 Scoreboard context control during partial state operation

For an HT-immediate BlockAck agreement that uses partial state operation, a recipient STA shall maintain a temporary block acknowledgement record as defined in 9.10.3. This temporary record includes a bitmap, indexed by sequence number (SN), a 12-bit unsigned integer starting sequence number WinStart_R (the lowest SN represented in the bitmap), a variable WinEnd_R (the highest SN in the bitmap), the originator address, TID and the maximum Transmission Window size, WinSize_R, which is set to the value of the Buffer Size subfield of the associated ADDBA Response frame that established the BlockAck agreement. During partial state operation of scoreboard context control the recipient retains the current record for an HT-immediate BlockAck agreement at least as long as it receives data from the same originator. If a frame for an HT-immediate BlockAck agreement from a different originator is received, then the temporary record may be discarded if the resources that its existence requires are needed to store the temporary record corresponding to the newly arriving frame. Memory management is made easier if all Block Ack agreements use the same Buffer Size because the memory allocated for one Block Ack agreement that uses partial state operation might be re-used for a different Block Ack agreement at a later time, however, there are no restrictions on the Buffer Size allocation for different Block Ack agreements.

A STA implementing partial state operation for an HT-immediate BlockAck agreement shall maintain the temporary block acknowledgement record for that agreement according to the following rules:

a) During partial state operation, WinStart_R is determined by the Sequence Number field value (SN) of received data MPDUs and by the Starting Sequence Number field value (SSN) of received Block Ack Request frames as described below.

b) For each received data MPDU that is related with a specific partial-state operation HT-immediate BlockAck agreement, when no temporary record for the agreement related with the received data MPDU exists at the time of receipt of the data MPDU, a temporary block acknowledgement record is created as follows, where SN is the value of the Sequence Number field of the received data MPDU:
   1) WinEnd_R = SN from the received data MPDU.
   2) WinStart_R = WinEnd_R - WinSize_R + 1.
   3) Create a bitmap of size WinSize_R, with the first bit corresponding to sequence number WinStart_R and the last bit corresponding to sequence number WinEnd_R, setting all bits in the bitmap to 0
   4) Set to 1 the bit in the position in the bitmap which corresponds to SN.

c) For each received data MPDU that is related with a specific partial-state operation HT-immediate BlockAck agreement, when a temporary record for the agreement related with the received data MPDU exists at the time of receipt of the data MPDU, the temporary block acknowledgement record for that agreement is modified in the same manner as the acknowledgement record for a full-state agreement described in subclause 9.10.7.3 (Scoreboard context control during full state operation).

d) For each received Block Ack Request frame that is related with a specific partial-state operation HT-immediate BlockAck agreement, when no temporary record for the agreement related with the received frame exists at the time of receipt of the frame, a temporary block acknowledgement record is created as follows, where SSN is the starting value of the Sequence Number field of the received BlockAckReq frame:

1) WinStart_R = SSN from the received BlockAckReq frame

2) WinEnd_R = WinStart_R + WinSize_R -1.

3) Create a bitmap of size WinSize_R, setting all bits in the bitmap to 0

e) For each received BlockAckReq frame that is related with a specific partial-state operation HT-immediate BlockAck agreement, when a temporary record for the agreement related with the received frame exists at the time of receipt of the frame, the temporary block acknowledgement record for that agreement is modified in the same manner as the acknowledgement record for a full-state agreement described in subclause 9.10.7.3 (Scoreboard context control during full state operation).

Comparisons in the above inequalities are circular modulo 2^{12}.

Insert the following new subclause:

9.10.7.5 Generation and transmission of BlockAck during partial-state operation and full-state operation

When responding with a BlockAck frame to either a received BlockAckReq frame or a received A-MPDU with ACK Policy set to Normal Ack (i.e. implicit Block Ack request) during either full-state operation or partial-state operation, any adjustment to the value of WinStart_R according to the procedures defined within 9.10.7.3 (Scoreboard context control during full state operation) and 9.10.7.4 (Scoreboard context control during partial state operation) shall be performed before the generation and transmission of the response BlockAck frame. The Starting Sequence Number of the Block Ack Starting Sequence Control field of the BlockAck frame shall be set to any circular modulo 2^{12} value in the range from (WinEnd_R - 63) to WinStart_R inclusive. The values in the recipient's record of status of MPDUs beginning with the MPDU for which the Sequence Number field value is equal to WinStart_R and ending with the MPDU for which the Sequence Number field value is equal to WinEnd_R shall be included in the bitmap of the BlockAck frame.

When responding with a BlockAck frame to either a received BlockAckReq frame or a received A-MPDU with ACK Policy set to Normal Ack (i.e., implicit Block Ack request) during either full-state or partial-state operation, if the adjusted value of WinStart_R is greater than the value of the SSN of the BlockAck frame, then within the bitmap of the BlockAck frame, the status of MPDUs with sequence numbers that are less than the adjusted value of WinStart_R (using a circular modulo 2^{12} comparison) may be set to any value.

When responding with a BlockAck frame to either a received BlockAckReq frame or a received A-MPDU with ACK Policy set to Normal Ack (i.e., implicit Block Ack request) during either full-state or partial-state operation, if the adjusted value of WinEnd_R is less than the value of the SSN of the BlockAck frame plus 63, then within the bitmap of the BlockAck frame, the status of MPDUs with sequence numbers that are greater than the adjusted value of WinEnd_R (using a circular modulo 2^{12} comparison) shall be reported as unsuccessfully received (i.e., the corresponding bit in the bitmap shall be set to 0).

If a BlockAckReq is received and no matching partial state is available, the recipient shall send a "null" BlockAck in which the bitmap is set to all zeroes.

NOTE—the sequence number space is considered divided into two parts, one of which is "old" and one of which is "new" by means of a boundary created by adding half the sequence number range to the current start of receive window (modulo 2^12).

Insert the following new subclause:

9.10.7.6 Rx reordering buffer control

The following behavior applies to STA which use either partial state operation or full state operation for an HT-immediate BlockAck agreement.

An RX reordering buffer shall be maintained for each HT-immediate BlockAck agreement. Each RX reordering buffer includes a record comprising:

a) buffered MSDUs which have been received, but not yet passed up the MAC architecture stack

b) a WinStart_B parameter, indicating the value of the Sequence Number field (SN) of the next-in-sequence expected-but-not-yet-received MSDU

c) a WinEnd_B parameter, indicating the highest SN expected to be received in the current reception window

d) a WinSize_B parameter, indicating the size of the reception window

WinStart_B is initialized to the Starting Sequence Number field value (SSN) of the ADDBA request frame that elicited the ADDBA response frame that established the HT-immediate BlockAck agreement.

WinEnd_B is initialized to WinStart_B + WinSize_B – 1, where WinSize_B is set to the value of the Buffer Size subfield of the ADDBA Response frame that established the BlockAck agreement.

For each received data MPDU that is related with a specific HT-immediate BlockAck agreement, the RX reordering buffer record is modified as follows, where SN is the value of the Sequence Number field of the received MPDU:

a) If WinStart_B ≤ SN ≤ WinEnd_B
    1) Store the received MPDU in the buffer
    2) Pass MSDUs up the MAC architecture stack that are stored in the buffer in order of increasing value of the Sequence Number field starting with the MSDU that has SN=WinStart_B and proceeding sequentially until there is no buffered MSDU for the next sequential value of the Sequence Number field.
    3) Set WinStart_B to the value of the Sequence Number field of the last MSDU that was passed up the MAC architecture stack plus one
    4) Set WinEnd_B = WinStart_B + WinSize – 1

b) If WinEnd_B < SN < Winstart_B+2^{11}
    1) Store the received MPDU in the buffer
    2) set WinEnd_B = SN
    3) set WinStart_B = WinEnd_B – WinSize_B + 1
    4) Any complete MSDUs stored in the buffer with Sequence Number field values that are lower than the new value of WinStart_B are passed up the MAC architecture stack in order of increasing Sequence Number field value. Gaps may exist in the Sequence Number field values of the MSDUs that are passed up the MAC architecture stack.
    5) MSDUs stored in the buffer shall be passed up the MAC architecture stack in order of increasing value of the Sequence Number field starting with SN=WinStart_B and proceeding sequentially until there is no buffered MSDU for the next sequential Sequence Number field value
    6) Set WinStart_B to the Sequence Number field value (SN) of the last MSDU that was passed up the MAC architecture stack plus one
    7) Set WinEnd_B = WinStart_B + WinSize_B – 1

c) If $\text{WinStart\_B}+2^{11} \leq \text{SN} < \text{WinStart\_B}$
   1) Discard the MPDU, do not store the MPDU in the buffer, do not pass the MSDU up the MAC architecture stack

For each received Block Ack Request frame that is related with a specific HT-immediate BlockAck agreement, the RX reordering buffer record is modified as follows, where SSN is the Starting Sequence Number field value of the received Block Ack Request frame:

a) If $\text{WinStart\_B} < \text{SSN} < \text{WinStart\_B}+2^{11}$
   1) set WinStart_B = SSN
   2) set WinEnd_B = WinStart_B + WinSize_B - 1
   3) Any complete MSDUs stored in the buffer with Sequence Number field values that are lower than the new value of WinStart_B shall be passed up the MAC architecture stack in order of increasing Sequence Number field value. Gaps may exist in the Sequence Number field values of the MSDUs that are passed up the MAC architecture stack.
   4) MSDUs stored in the buffer shall be passed up the MAC architecture stack in order of increasing Sequence Number field value starting with SN=WinStart_B and proceeding sequentially until there is no buffered MSDU for the next sequential Sequence Number field value.
   5) Set WinStart_B to the Sequence Number field value (SN) of the last MSDU that was passed up the MAC architecture stack plus one
   6) Set WinEnd_B = WinStart_B + WinSize_B – 1

b) If $\text{WinStart\_B}+2^{11} \leq \text{SSN} < \text{WinStart\_B}$
   1) Do not make any changes to the RX reordering buffer record

Any MSDU that has been passed up the MAC architecture stack shall be deleted from the RX reordering buffer.

The recipient shall always pass MSDUs up the MAC architecture stack in order of increasing Sequence Number field value.

Comparisons in the above inequalities are circular modulo 2^{12}.

Insert the following new subclause:

9.10.7.7 Originator’s behavior

A block of data may be sent in a single A-MPDU where each data MPDU has its Ack Policy field set to Normal Ack. The originator expects to receive a BlockAck response if at least one data frame is received without error.

Alternatively, The originator may send an A-MPDU where each data MPDU has its Ack Policy field set to Block Ack under an HT-immediate block ack agreement if it does not require a BlockAck response immediately following the A-MPDU.

If the BlockAck is lost, the originator may use BlockAckReq to solicit immediate an BlockAck or it may retransmit the data frames.

After sending data within an A-MPDU with the Ack Policy field set to Normal Ack, the originator may send a BlockAckReq when it discards a data MPDU due to exhausted MSDULifetime. The purpose of the BlockAckReq, in this case, is to shift the recipient window past the hole in the SN space created by the discarded data.

A BlockAckReq sent using HT-immediate operation shall be sent as an non-A-MPDU frame.

A BlockAckReq sent using HT-delayed operation may be transmitted within an A-MPDU provided that its BAR Ack Policy subfield is set to No Acknowledgement.

All frames within an A-MPDU shall have the same Ack Policy setting.

The originator may transmit any MPDU within the current transmission window in any order. However, except for retransmissions, the originator should attempt to maintain a sequentially increasing Sequence Number field value (SN) order of MPDUs for transmission. The originator may transmit an MPDU with an SN that is beyond the current transmission window (SN > WinEnd_O), in which case the originator's transmission window (and the recipient's window) will be moved forward. The originator should not transmit MPDUs which are lower than (i.e., SN < WinStart_O) the current transmission window.

The originator may send a BlockAckReq when a data MPDU that was previously transmitted within an A-MPDU that had the Ack Policy field set to Normal Ack is discarded due to exhausted MSDULifetime. The purpose of this BlockAckReq is to shift the recipient's WinStart_B value past the hole in the SN space that is created by the discarded data MPDU and to thereby allow the earliest possible forwarding of buffered frames up the MAC protocol stack.

Comparisons in the above paragraph are circular modulo 2^{12}.

Insert the following new subclause:

9.10.7.8 Maintaining BlockAck state at the originator

If the originator successfully receives a BlockAck in response to the BlockAckReq, it shall maintain BlockAck state as defined in 9.10.3.

If the originator receives a BlockAck in response to HT-immediate BlockAckReq, it shall in addition:

- Not update the status of MPDUs with Sequence Number field values between WinStart_O and SSN of the received BlockAck. Note that it is possible for the Starting Sequence Number field value (SSN) of the received BlockAck to be greater than WinStart_O because of the failed reception of a non-zero number of MPDUs beginning with the MPDU with Sequence Number field value equal to WinStart_O at a recipient STA which is using partial state operation, and
- Not update the status of MPDUs that have been already positively acknowledged.

NOTE—The last can happen while getting responses from a partial state recipient.

Insert the following new subclause:

9.10.7.9 Originator's support of recipient STAs' partial state

A recipient may choose to employ either full state operation or partial state operation for each individual Block Ack agreement. An originator is unaware of the recipient STA's choice of full state or partial state operation. In order to maximize the throughput when communicating with STAs that have chosen to employ partial state operation, the originator should solicit a BlockAck as the last activity associated with that Block Ack agreement in the current TXOP.

Insert the following new subclause:

9.10.8 HT-delayed BlockAck extensions

9.10.8.1 Introduction to HT-delayed BlockAck extensions

9.10.8.2 (HT-delayed BlockAck negotiation) and 9.10.8.3 (Operation of HT-delayed BlockAck) define an HT extension to the BlockAck feature (defined in 9.10.1 to 9.10.5) to support operation on delayed Block Ack agreements established between HT STAs.

The HT-delayed extensions simplify the use of delayed BlockAck in an A-MPDU and reduce resource requirements.

Insert the following new subclause:

9.10.8.2 HT-delayed BlockAck negotiation

HT-delayed BlockAck is an optional feature. An HT STA declares support for HT-delayed BlockAck in the HT Capabilities element in frames that it transmits and that contain that element.

An HT STA shall not attempt to create a BlockAck agreement under HT-delayed BlockAck Policy unless the recipient HT STA declares support for this feature.

Insert the following new subclause:

9.10.8.3 Operation of HT-delayed BlockAck

The BlockAck response to an HT-delayed BlockAckReq is transmitted after an unspecified delay, and when the recipient of the BlockAckReq next has the opportunity to transmit. This response may be transmitted in a later TXOP owned by the recipient of the BlockAckReq or in the current or a later TXOP owned by the sender of the BlockAckReq using the reverse direction feature (see 9.14 (Reverse Direction protocol)).

The No Ack feature of the BlockAckReq and BlockAck frame may be used under an HT-delayed BlockAck agreement.

A BlockAckReq or BlockAck frame containing a BAR Ack Policy or BA Ack Policy field set to 1 indicates that no acknowledgement is expected to these control frames. Otherwise, an Ack MPDU response is expected after a SIFS.

Setting of the BAR Ack Policy and BA Ack Policy fields may be performed independently for BlockAckReq and BlockAck frames associated with the same HT-delayed BlockAck agreement. All four combinations of the values of these fields are valid.

Setting of the BAR Ack Policy and BA Ack Policy fields is dynamic, and can change from PPDU to PPDU.

9.12 Frame exchange sequences

Change 9.12 by moving it to informative Annex S.

EDITORIAL NOTE—The changes to 9.12 are shown in Annex S of this document.

Insert the following new subclause heading (the existing 9.13 is renumbered 9.13.2 below):

9.13 Protection mechanisms

Insert the following new subclause:

9.13.1 Introduction

These protection mechanisms ensure that a STA defers transmission for a period of time. These mechanisms are used to insure that non-ERP STAs do not interfere with ERP-frame exchanges between ERP STAs and that non-HT STA do not interfere with HT-frame exchanges between HT STAs. Thereby, allowing non-ERP and/or non-HT STAs to coexist with ERP and/or HT STAs.

Change the following subclause heading from 9.13 to 9.13.2 as shown:

9.13.2 Protection mechanism for non-ERP receivers

Insert the following new subclause heading:

9.13.3 Protection mechanisms for HT transmissions

9.13.3.1 General

HT transmissions shall be protected if there are other STAs (HT or non-HT) that cannot interpret HT transmissions correctly. The fields Operating Mode and Non-greenfield STAs Present in the HT Information element within the Beacon and Probe Response frames are used to determine if protection is required for transmission.

When the Operating Mode field is set to 0 or 2 and Non-greenfield STAs Present field is set to 0, no protection is required since all associated HT stations in the BSS are capable of decoding HT mixed format and HT greenfield format transmissions.

When the Operating Mode field is set to 0 or 2 and the Non-greenfield STAs Present field is set to 1, HT transmissions that use the greenfield preamble shall be protected.

NOTE 1—When the Operating Mode field is set to 0 or 2 and Non-greenfield STAs Present field is set to 0, no protection is required for 40 MHz transmissions since enough of the preamble is sent on both 20 MHz halves of the 40 MHz transmission to ensure that a 20 MHz STA is able to decode the preamble and infer the duration of the transmission.

NOTE 2—When the BSS is operating in the 2.4 GHz band and when the Operating Mode field is set to 0 or 2, there are no non-HT STAs in the BSA and thus the Use Protection subfield of the ERP Information Element is set to 0.

When the Operating Mode field is set to 1 and the Use Protection field in the ERP Information Element is set to 0, HT transmissions may be protected accoding to implementation dependent criteria. When the Operating Mode field is set to 1, the Use Protection field in the ERP Information Element is set to 0 and the Non-greenfield STAs Present field is set to 1, HT transmissions using HT greenfield format shall be protected. When the Operating Mode field is set to 1 and the Use Protection field in the ERP Information Element is set to 1, HT transmissions shall be protected using the mechanisms described in Table n49 (Protection requirements for Operating Modes of 1 and 3)

When the Operating Mode field is set to 3, HT transmissions shall be protected. The type of protection that is required depends on the type of transmission as well as the type of the non-HT STAs that are present in the BSS. The specific mechanisms that are to be used for protection for Operating Mode set to 3 are described in Table n49 (Protection requirements for Operating Modes of 1 and 3)

Table n49—Protection requirements for Operating Modes of 1 and 3

Type of Transmission	Use Protection = 0 or ERP IE is not present (Operating Mode = 3)	Use Protection = 1 (Operating Mode = 1 or 3)
20 MHz transmission:	HT transmissions using HT greenfield format and/or using RIFS within the HT transmission burst shall be protected using the sequences defined below.	All HT transmissions shall be protected using mechanisms such as RTS/CTS or CTS-to-Self prior to the HT transmissions. The frames that are used for providing the protection shall be sent at a Clause 15 or Clause 18 rate.
40 MHz transmission:	HT transmissions using HT greenfield format and/or using RIFS within the HT transmission burst shall be protected using the sequences defined below.	All HT transmissions shall be protected using mechanisms such as RTS/CTS or CTS-to-Self prior to the HT transmissions. The frames that are used for providing the protection shall be sent at a Clause 15 or Clause 18 rate.

If the transmission requires protection and Use Protection field within the ERP Information Element is set to 0 or the ERP Information Element is not present in the Beacon, HT transmissions shall be protected in one of the following ways:

a) Control frames such as RTS/CTS or CTS-to-self prior to the HT transmissions:
   1) For 20 MHz transmissions, use the rates defined in Clause 17 or Clause 19
   2) For 40 MHz transmissions, use the non-HT duplicate frames defined in Clause 20.

   NOTE—The rate for protection frames are selected based on the rules described in 9.6.3.1 (Rate selection for control frames that initialize a TXOP) and 9.6.3.2 (Rate selection for control frames that are not control response frames).

b) Using a non-HT preamble, transmit first a PPDU that requires a response frame. The remaining TXOP following the first PPDU exchange may contain GF and/or RIFS sequences.

c) L-SIG TXOP protection

d) Using a mixed format preamble, transmit first a PPDU that requires a response that is sent as a non-HT frame or non-HT duplicate frame. The remaining TXOP following the first PPDU exchange may contain HT greenfield format and/or RIFS sequences.

Insert the following new subclause:

9.13.3.2 RIFS protection

An AP shall set the RIFS mode field of the HT information element to 0 if the Operating Mode is set to 3.

If the Operating Mode is set to 1, the AP may set the RIFS mode field to 0 according to implementation-specific criteria (i.e. such as to protect legacy overlapping BSSs in the primary or secondary channels).

Otherwise the RIFS mode field shall be set to 1.

A STA that is associated with a BSS may protect RIFS sequences when the Operating Mode field of the HT Information element transmitted by its AP is set to 1 (there may be non-HT STAs in either the primary or secondary channel or both).

A STA that is associated with a BSS shall protect RIFS sequences when the Operating Mode field of the HT Information element transmitted by its AP is set to 3 (mixed). .

RIFS shall only be used when the RIFS Mode field of the HT Information element is set to 1.

Insert the following new subclause:

9.13.3.3 Greenfield protection

A STA that is associated with a BSS shall protect Green Field PPDUs using any of the protection mechanisms described in 9.13.6 (Protection mechanisms for A-MPDU exchange sequences) when its AP transmits an HT Information element with the Non-greenfield STAs Present field set to 1.

Insert the following new subclause:

9.13.3.4 Transmit burst limit

The Transmit Burst Limit field of the HT Information element indicates whether the duration of a transmit burst should be limited.

A transmit burst is a sequence of one or more PPDUs either transmitted with the FORMAT parameter of the TXVECTOR set to HT_GF or separated by an IFS shorter than SIFS from the preceding PPDU.

When the Transmit Burst Limit field is set to 1 in HT Information elements transmitted within a STA's BSS, the STA shall ensure that it limits the duration of a transmit burst to the value defined in Table n50 (Transmit burst limit value) depending on the band in which it is operating.

NOTE—This behavior ensures that a non-HT STA will receive a valid PPDU preamble (either HT_MF or NON_HT) at least once during each period indicated by the Transmit burst limit value.

An HT AP shall set the Transmit Burst Limit field to 1 in HT Information elements it transmits when it has one or more non-HT STAs associated that are using APSD.

Table n50—Transmit burst limit value

Operating band	Transmit burst limit value (ms)
2.4 GHz	6.16
All other bands	3.08

Insert the following new subclause:

9.13.3.5 Use of OBSS Non-HT STAs Present

The OBSS Non-HT STAs Present field allows HT devices to report the presence of other non-HT STAs that cannot interpret HT transmissions correctly. See 9.13.3 (Protection mechanisms for HT transmissions).

A second HT AP that detects a first HT AP’s beacon with the OBSS Non-HT STAs Present field set to 1 may, in conjunction with radio resource measurements and/or heuristics, cause HT greenfield format and RIFS sequence transmissions of the second AP’s BSS to be protected by setting the Operating Mode field to 3. If the NonERP_Present bit is set to 1 in the first AP’s beacon, then the Use_Protection bit may also be set to 1 by the second AP. See subclause T.2 (Summary of the use of HT Protection Signalling) of Annex T.

HT STAs may also scan for the presence of non-HT devices either autonomously or after the STA’s AP transmits a HT Information element with the Operating Mode field set to 1. Non-HT devices may be detected as follows :

- one or more non-HT STAs are associated , or
- a non-HT BSS is overlapping (a non-HT BSS may be detected by the reception of a Beacon where the supported rates only contain Clause 15, 17, 18 or 19 rates), or
- reception of a management frame (excluding a Probe Request) where the supported rate set includes only Clause 15, 17, 18 and 19 rates, or
- reception of a Beacon containing an HT Information element with the OBSS Non-HT STAs Present field set to 1.

When non-HT devices are detected, the STA may enable protection of its HT greenfield format and RIFS sequence transmissions.

Insert the following new subclause heading:

9.13.4 Setting the L-LENGTH and L-RATE parameters for HT_MF PPDUs

L_LENGTH and L_DATARATE are used to control the duration that non-HT STAs defer transmission equaling a period of time corresponding to the length of the HT PPDU (or the L-SIG Duration when L-SIG TXOP protection is used as defined in 9.13.5 (L-SIG TXOP protection)) beyond the non-HT portion of the HT MM preamble.

The L_DATARATE parameter in TXVECTOR in Table n63 shall be set to the value 6 Mb/s.

STA that is transmitting a PPDU with the FORMAT parameter set to HT_MF in TXVECTOR in Table n63, and that is not operating by the L-SIG TXOP PROTECTION rules described in 9.13.5 (L-SIG TXOP protection) shall set the value of the L_LENGTH parameter to the following value:

$$\begin{aligned}\text{L\_LENGTH [Bytes]} &= \lceil (\text{TXTIME} - (\text{aPreambleLength} + \text{aPLCPHeaderLength}))/\text{aSymbolLength} \rceil \times \\ &\quad (\text{Bytes per OFDM Symbol for L\_DATARATE}) \\ &= \lceil (\text{TXTIME} - 20)/4 \rceil \times 3\end{aligned}$$

where

The symbol $\lceil x \rceil$ denotes the smallest integer greater than or equal to *x*.

TXTIME is the duration (µs) of the HT PPDU defined in subclause 10.4.6 (PLME-TXTIME.request).

aSymbolLength is the duration of a symbol (µs), defined in 10.4.3 (PLME-CHARACTERISTICS.confirm)

(aPreambleLength + aPLCPHeaderLength) is the duration (µs) of the non-HT PLCP preamble and signal field defined in subclause 10.4.3 (PLME-CHARACTERISTICS.confirm).
L_DATARATE of 6Mb/s equates to 3 Bytes per OFDM Symbol

A STA that is operating under L-SIG TXOP protection shall set the L_LENGTH parameter according to rules described in 9.13.5 (L-SIG TXOP protection).

The maximum value of L_LENGTH shall be 4095.

Insert the following new subclause heading:

9.13.5 L-SIG TXOP protection

9.13.5.1 General rules

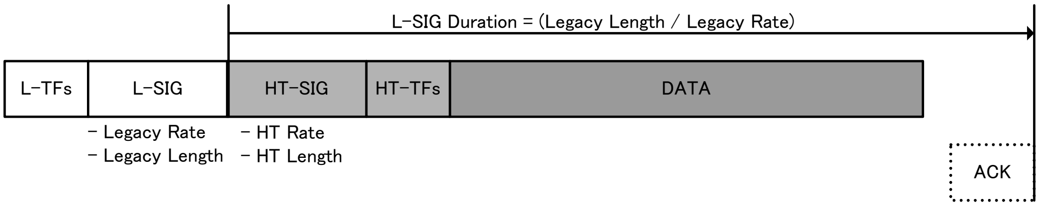


Figure n46—Basic Concept of L-SIG TXOP Protection

Figure n46 (Basic Concept of L-SIG TXOP Protection) illustrates the basic concept of L-SIG TXOP Protection.

In a mixed format preamble, the Rate subfield in the L-SIG field of HT frames shall be set to 6 Mb/s. The Length subfield of the L-SIG field of HT frames with an HT mixed format PHY preamble shall contain a value that (together with the Rate subfield) represents a duration corresponding to the length of the rest of the packet, with exceptions defined in this subclause.

An HT STA shall indicate whether it supports L-SIG TXOP Protection in its L-SIG TXOP Protection Support capability field in Association Requests and Probe Responses.

The AP determines whether all HT STAs associated with its BSS support L-SIG TXOP Protection and indicates this in the L-SIG TXOP Protection Full Support field of its HT Information Element. This field shall be set to 1 only if the L-SIG TXOP Protection field is set to 1 by all HT STA in the BSS.

A STA shall not transmit a frame using L-SIG TXOP Protection directed to a recipient that does not support L-SIG TXOP Protection. When the STA is associated with an AP, support at a recipient that is associated with the same AP is indicated if the L-SIG TXOP Protection Full Support field is set to 1 in the HT Information element broadcast in Beacons transmitted by the AP with which the STAs are associated. L-SIG TXOP support at the recipient may additionally be determined through examination of HT Capability elements exchanged during association or exchanged during DLS setup.

Under L-SIG TXOP Protection operation, the L-SIG field with an HT mixed format PHY preamble represents a duration value equivalent (except in the case of the initial frame that establishes the TXOP, as described below) to the sum of:

a) the value of Duration/ID field contained in the MAC header, and

b) the duration remaining in the current packet (from the end of the symbol containing the L-SIG field to the end of the last symbol of the packet).

A duration value determined from the Rate and Length subfields of an L-SIG field that is not equal to the remaining duration of the frame is called an L-SIG Duration.The TXVECTOR L_LENGTH (defined in 20.2.2 (TXVECTOR and RXVECTOR parameters)), when L-SIG TXOP Protection is used, shall contain a value of:

$$\begin{aligned} L\_Length[\text{Bytes}] &= \left\lceil (\text{L-SIG Duration})[\text{usec}] / \text{aSymbolLength}[\text{usec}] \right\rceil \times (\text{Bytes per OFDM Symbol at 6[Mbps]})[\text{Bytes}] \\ &= \left\lceil (\text{L-SIG Duration})/4 \right\rceil \times 3 \end{aligned}$$

where

$\lceil x \rceil$ denotes the lowest integer greater than or equal to x.

aSymbolLength is the duration of symbol, defined in 10.4.3.

The maximum value of L_LENGTH shall be 4095

Non-HT STAs are not able to receive any PPDU that starts during the L-SIG duration. Therefore, no frame shall be transmitted to a non-HT STA during an L-SIG protected TXOP.

L-SIG TXOP Protection should not be used and the implementers of L-SIG TXOP Protection are advised to include a NAV based fallback mechanism, if it is determined that the mechanism fails to effectively suppress non-HT transmissions. How this is determined is outside the scope of this standard.

An HT STA may transmit a CF-End when the TXOP is not completely used by the TXOP owner, in a BSS whose beacon contains an HT Information element with the Operating Mode field set to 0.

NOTE—this will reset the NAV at the HT-STA.

TXOP truncation shall not be used when the BSS operating mode is 3 in combination with L-SIG TXOP Protection, because the non-HT STA receiving state cannot be reset through the transmission of a MAC frame. This implies that CF-End frames shall not be transmitted to truncate the NAV of non-HT STAs that is established through the use of L-SIG TXOP Protection. This avoids potential unfairness or a capture effect involving non-HT STAs.

Insert the following new subclause:

9.13.5.2 L-SIG TXOP protection rules at the TXOP holder

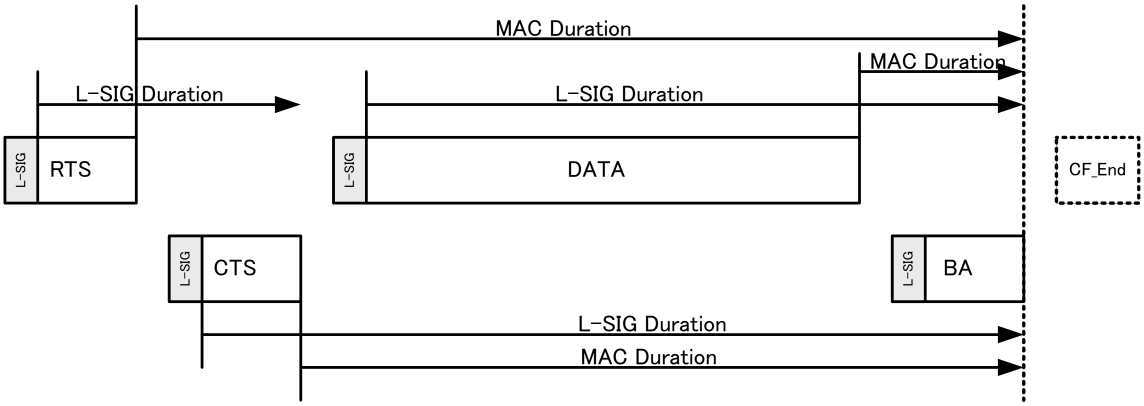


Figure n47—Example of L-SIG Duration Setting

Figure n47 (Example of L-SIG Duration Setting) illustrates an example of how L-SIG Durations are set when using L-SIG TXOP Protection.

An L-SIG TXOP protected sequence starts with an initial handshake, which is the exchange of two short frames (each inside a HT MM PPDU) that establish protection. RTS/CTS is an example of this. Any initial frame exchange may be used that is valid for the start of a TXOP, provided the duration of the response frame within this sequence is predictable. The term L-SIG TXOP protected sequence includes these initial frames and any subsequent frames transmitted within the protected duration.

Under L-SIG TXOP Protection operation, the L-SIG Duration of the initial PPDU that establishes protection shall be:

$$\text{L-SIG Duration} = \left(T_{Init\_PPDU} - \left(\text{aPreambleLength} + \text{aPLCPHeaderLength}\right)\right) + \text{SIFS} + T_{Res\_PPDU}$$

where T_{Init_PPDU} is the length in time (μs) of the entire initial PPDU, and T_{Res_PPDU} is the length in time (μs) of the expected response PPDU.

$\left(\text{aPreambleLength} + \text{aPLCPHeaderLength}\right)$ is the length in time (μs) of the non-HT PCLP header defined in subclause 10.4.3.

When the initial PPDU that establishes protection requires no response (e.g. a CTS to self), the L-SIG Duration shall contain a value:

$$\text{L-SIG Duration} = T_{Init\_MACDur} + T_{Init\_PPDU} - \left(\text{aPreambleLength} + \text{aPLCPHeaderLength}\right)$$

Where T_{Init_MACDur} is the Duration/ID value carried in the MAC Header of the initial PPDU.

An HT STA using L-SIG TXOP protection should use an accurate prediction of the TXOP duration inside the Duration/ID field of the MAC header to avoid inefficient use of the channel capability.

If the initial frame handshake succeeds (i.e., upon reception of a response frame with L-SIG TXOP Protection addressed to the TXOP holder), all HT mixed format PPDUs transmitted inside an L-SIG TXOP Protection protected TXOP shall contain an L-SIG Duration that extends to the endpoint indicated by the MAC Duration/ID field.

During the 40 MHz phase of PCO operation, the TXOP holder should send a CF_End frame using a 40 MHz HT PPDU, otherwise the TXOP holder should send a CF_End frame carried in a basic rate non-HT PPDU, SIFS after the L-SIG TXOP protected period. This enables STAs to terminate the EIFS procedure to avoid potential unfairness or a capture effect.

The AP may send a CF-End frame in response to the CF-End frame sent by the TXOP holder.

Insert the following new subclause:

9.13.5.3 L-SIG TXOP protection rules at the TXOP responder

On receiving an initial PPDU containing an L-SIG Duration addressed to itself, a TXOP responder that asserted the L-SIG TXOP Protection Support field upon association, shall generate an L-SIG TXOP Protection response frame with the L-SIG Duration equivalent to:

$$\text{L-SIG Duration} = T_{Init\_MACDur} - \text{SIFS} - \left(\text{aPreambleLength} + \text{aPLCPHeaderLength}\right)$$

where

T_{Init_MACDur} is the Duration/ID value carried in the MAC Header of the received initial PPDU.

After transmission of an L-SIG TXOP Protection initial response frame, the TXOP responder’s HT mixed format PPDU transmissions shall contain an L-SIG Duration that extends to the endpoint indicated by the MAC Duration/ID field.

A STA shall only transmit a response frame containing an L-SIG Duration in response to a frame that also contained an L-SIG duration.

Insert the following new subclause:

9.13.5.4 L-SIG TXOP protection NAV update rule

An HT STA that asserted the L-SIG TXOP Protection Support field upon association that receives an L-SIG protected PPDU containing valid L-SIG Parity and HT-SIG CRC fields and that contains no valid MPDU from which a Duration/ID value can be determined shall, at the end of the PPDU, update its NAV to a value equal to L-SIG duration - HT-SIG duration.This NAV update operation takes place at the termination of the time/length value represented in the HT-SIG field.

Insert the following subclause heading:

9.13.6 Protection mechanisms for A-MPDU exchange sequences

Insert the following new subclause:

9.13.6.1 Duration/ID rules for A-MPDU and TXOP

The Duration/ID field in all frames within an A-MPDU shall contain the remaining duration of TXOP (referenced to the end of the PPDU carrying the frame). The Duration/ID field of all frames sent in the TXOP by the TXOP holder or TXOP responder shall contain the time remaining in the TXOP.

Insert the following new subclause:

9.13.6.2 Truncation of TXOP

In the case when a STA gains access to the channel using EDCA, and then runs out of frames to transmit, a STA that is a TXOP holder may transmit a CF-End provided that the remaining duration is long enough to transmit this frame. By transmitting the CF-End frame, the STA is explicitly indicating the completion of its TXOP.

A non-AP STA that is not the TXOP holder shall not transmit a CF-End frame.

The reception of a CF-End frame shall be interpreted STAs as a NAV reset, i.e., they reset their NAV timer to zero at the end of the PPDU containing this frame. After receiving a CF-End with a matching BSSID, an AP may respond with a CF-End after SIFS.

NOTE—The transmission of a single CF-End MPDU by the TXOP holder resets the NAV of STAs hearing the TXOP holder. There may be STAs that could hear the TXOP responder that had set their NAV that do not hear this NAV reset. Those STAs are be prevented from contending for the medium until the original NAV reservation expires.

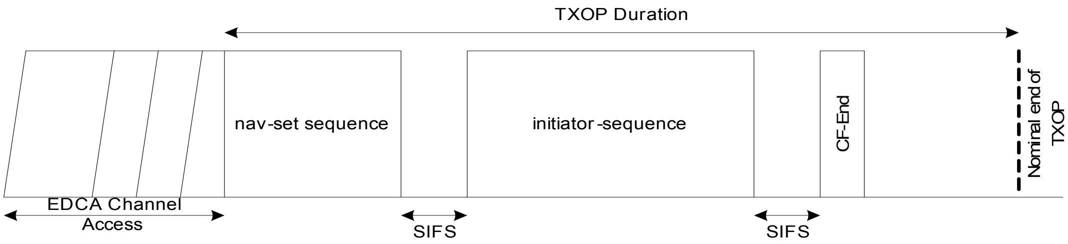


Figure n48—Example of TXOP truncation

Figure n48 (Example of TXOP truncation) shows an example of TXOP truncation. In this example, the STA accesses the medium using EDCA channel access and then transmits a nav-set sequence (e.g., RTS/CTS) (using the terminology of 9.12 (Frame exchange sequences)) after a SIFS, it then transmits an initiator-sequence, which may involve the exchange of multiple PPDUs between the TXOP holder and a TXOP responder. At the end of the second sequence, the TXOP holder has no more data that it can send that fits within the TXOP, so it truncates the TXOP by transmitting a CF-End frame.

HT STAs and non-HT STAs that receive the CF-End frame reset their NAV and can start contending for the medium without further delay.

TXOP truncation shall not be used in combination with L-SIG TXOP Protection, because a CCA cannot be reset through the transmission of a MAC frame.

This avoids potential unfairness or a capture effect for non-HT STAs.

Insert the following subclause heading

9.14 Reverse Direction protocol

Insert the following new subclause:

9.14.1 RD exchange sequence

During a Reverse Direction (RD) exchange sequence, the RD initiator STA may transmit PPDUs and obtain response PPDUs from a single (RD responder) STA during the exchange.

Support of the reverse direction feature is an option for an HT STA. It is optional in the sense that a TXOP holder is never required to generate a reverse direction grant, and a STA receiving a reverse direction grant is never required to use the grant.

Support of the reverse direction feature as a RD responder is indicated using the RD Responder subfield of the HT Extended Capabilities field of the HT Capabilities element. A STA shall set the RD Responder subfield to 1 in frames that it transmits containing the HT Capabilities element if and only if dot11RDResponderOptionImplemented is true.

The reverse direction mechanism enables the generation of a response burst containing one or more PPDUs. The RDG/More PPDU field in the HT Control field is used to indicate non-final PPDUs in transmissions by a responder.

Under the reverse direction rules, the RD responder shall not generate a response containing more than one PPDU if the RDG/More PPDU field is set to 0 in the last PPDU sent by the RD initiator.

The response starts a SIFS after the end of the PPDU containing one or more +HTC MPDUs in which the RDG/More PPDU field was set to 1. Any PPDUs in a response burst are separated by SIFS or RIFS. The RIFS rules in the reverse direction are the same as in the forward direction: the use of RIFS is limited as defined in 9.13.3.2 (RIFS protection).

When a PPDU is not the final PPDU of a response burst, an HT Control field carrying the RDG/More PPDU field set to 1 shall be present in every MPDU within the PPDU capable of carrying the HT Control field. The last PPDU of a response burst shall have the RDG/More PPDU field set to 0 in all +HTC MPDUs contained in that PPDU.

During a response burst, only the RD responder may transmit—i.e., there are no transmissions by any other STA, including the RD initiator. See Figure n49 (Example of RD exchange sequence showing response burst) for an example of this.

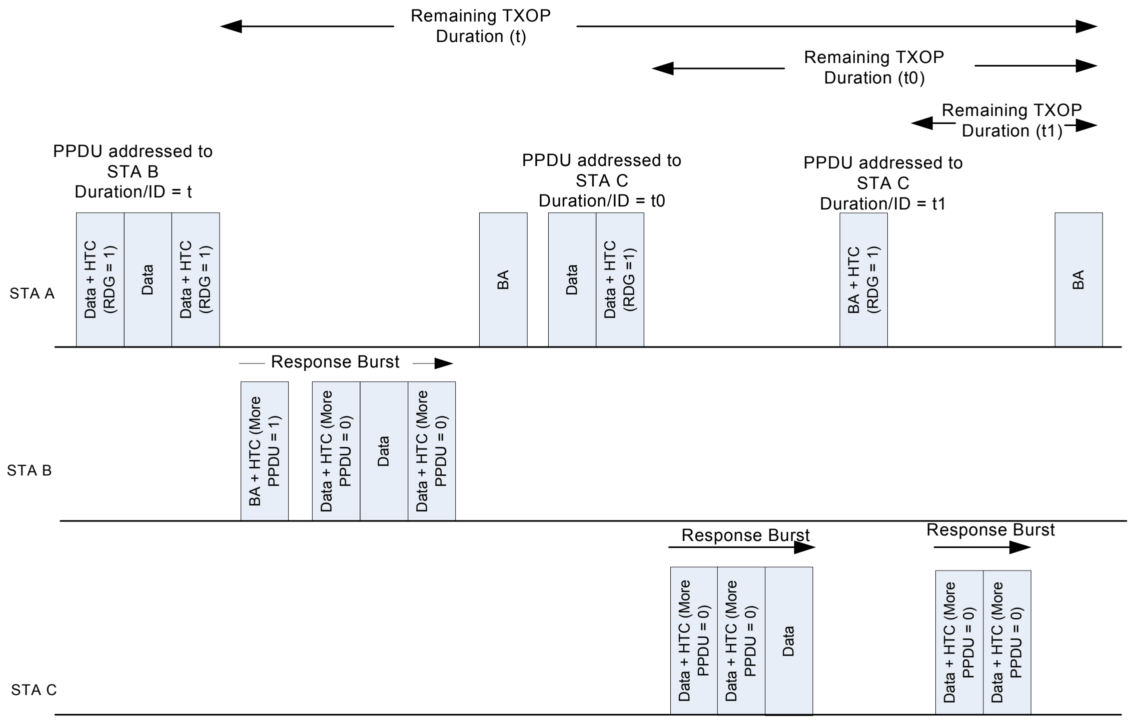


Figure n49—Example of RD exchange sequence showing response burst

The frame exchange can be summarized as follows:

a) STA A (RD initiator) sends a PPDU to STA B (RD responder). The Ack policy of the MPDUs in this PPDU is set to Implicit Bloc Ack Request. This PPDU includes a reverse direction grant (RDG = 1). The Duration/ID value indicates the remaining duration of the TXOP, t µs.

b) STA B (RD responder) responds with a Block Ack and sets More PPDU = '1' and indicates that more PPDUs will follow after SIFS/RIFS time, at the end of Block Ack.

c) STA B (RD responder) sends the response PPDU to STA A, with Ack policy set to Implicit Block Ack Request and More PPDU = '0' to indicate that this is the last PPDU in the response burst.

d) STA A (RD initiator) regains control of the TXOP and sends a Block Ack to STA B to acknowledge the MPDUs transmitted by STA B in the response burst.

e) STA A (RD initiator) sends a PPDU to STA C (RD responder). The Ack policy of the MPDUs in this PPDU is set to Block Ack. This PPDU includes a reverse direction grant (RDG = 1). The Duration/ID value indicates the remaining duration of the TXOP, t0 µs.

f) STA C (RD responder) sends the response PPDU to STA A, with Ack policy set to Implicit Block Ack Request and More PPDU = '0' to indicate that this is the last PPDU in the response burst.

g) STA A (RD initiator) regains control of the TXOP and sends a Block Ack to STA C to acknowledge the MPDUs transmitted by STA C. This PPDU includes a reverse direction grant (RDG = 1). The Duration/ID value indicates the remaining duration of the TXOP, t1 µs.

h) STA C (RD responder) sends the response PPDU to STA A, with Ack policy set to Implicit Block Ack Request and More PPDU = '0'. STA C aggregates Data frames in the response PPDU.

i) STA A (RD initiator) sends a Block Ack to STA C to acknowledge the MPDUs transmitted by STA C in the response burst.

The RD responder shall ensure that its PPDU transmission(s) and any expected responses fit entirely within the remaining TXOP duration, as indicated in the Duration/ID field of the PPDU carrying the RDG.

NOTE—The transmission of a response by the RD responder does not comprise a new channel access but a continuation of the RD initiator's TXOP. An RD responder ignores the NAV when responding to an RD grant.

The recipient of an RDG may decline to accept the RDG by not transmitting any frames following the PPDU that contains the RDG/More PPDU field set to 1 when no response is otherwise required, or by transmitting a frame with the RDG/More PPDU field set to 0 or that contains no HT Control field. An RD initiator is not required to examine the RD Responder subfield of a potential responder before deciding whether to send a PPDU to that STA in which the RDG/More PPDU field is set to 1.

An RD initiator may include multiple reverse direction transmit sequences addressed to multiple recipients within a single TXOP.

The RD initiator may transmit a CF-end frame according to the rules for TXOP truncation in 9.13.6.2 (Truncation of TXOP) following a reverse direction transmit sequence.

An RD initiator may transmit a +CF-ACK frame that is not part of an A-MPDU in response to a QoS Data MPDU that is not part of an A-MPDU when the target of the +CF-ACK is equal to the Address 1 field of the frame containing the +CF-ACK.

An RD responder may transmit a +CF-ACK frame that is not part of an A-MPDU in response to a QoS Data +HTC MPDU with the RDG/More PPDU field set to 1 that is not part of an A-MPDU.

Insert the following new subclause:

9.14.2 RD rules

Transmission of a frame by an RD initiator with the RDG/More PPDU field set to 1 (either transmitted by itself, or as part of an aggregation) indicates that the remaining TXOP duration is available for a response burst.

An RD initiator that sets the RDG field to 1 shall set the AC Constraint field to 1 if the TXOP was gained through the EDCA channel access mechanism, and shall set it to 0 if the TXOP was gained through HCCA or any other access mechanism that is not EDCA.

If the AC Constraint field is set to 1, the RD responder shall transmit Data frames of only the same AC as the last frame received from the RD initiator for which an AC can be determined. For a BAR or BA frame, the AC is determined by examining the TID field. For a management frame, the AC is AC_VO. The RD initiator shall not transmit a +HTC MPDU with the RDG/More PPDU field set to 1 from which the AC cannot be determined. If the AC Constraint field is set to 0, the RD responder may transmit Data frames of any TID.

During an RDG, the RD responder shall not transmit any frames that are not addressed to the RD initiator as the RA.

The RDG/More PPDU field shall be set to the same value in all HT Control fields present in a PPDU.

Subject to TXOP constraints, after transmitting a PPDU containing the RDG/More PPDU field set to 1:

— *Normal Continuation*: The RD initiator may transmit its next PPDU a minimum of a SIFS after receiving a response PPDU with the RDG/More PPDU field set to 0.

— *Error Recovery*: Error recovery of the RDG mechanism is the responsibility of the RD initiator. The RD initiator may transmit its next PPDU when the medium is sensed idle for PIFS (this is a continuation of the current TXOP). If the RD initiator receives a PPDU that does not carry the RDG/More PPDU field, it shall not transmit until the medium has been sensed idle for a PIFS.

NOTE 1—after transmitting a PPDU containing a reverse direction grant, if the response is corrupted so that the state of the RDG/More PPDU field is unknown, the RD initiator of the RD exchange is not allowed to transmit after a SIFS audition. Transmission may occur a PIFS after de-assertion of carrier sense, unless a later response PPDU is correctly received containing the RDG/More PPDU field set to 0.

NOTE 2—after transmitting a PPDU requiring a response but not containing a reverse direction grant, the state of the RDG/More PPDU field in the response does not affect the behavior of the RD initiator.

Insert the following new subclause:

9.14.3 RD response constraints

The first PPDU of any response burst shall contain any frames required to provide an immediate response.

A PPDU that is not the last PPDU of a response burst shall not contain a frame requiring an immediate response.

The RD initiator shall interpret the presence of a frame in a response PPDU requiring an immediate response as an implicit indication that the field RDG/More PPDU is set to 0.

The RD responder shall not set the More PPDU field to '1' in any MPDU in a PPDU that contains an MPDU that requires an immediate response.

After transmitting a PPDU containing one or more +HTC MPDUs in which the RDG/More PPDU field set to 0, the RD responder shall not transmit any more PPDUs within the current response burst.

If the RD responder transmits a PPDU that expects a transmission by the RD initiator after SIFS, and no such transmission is detected, the RD responder shall wait for either another reverse direction grant or its own TXOP before it can retry the exchange.

Insert the following subclause heading

9.15 PSMP Operation

Insert the following new subclause:

9.15.1 Signalling support for PSMP STAs Only

The AP may support a BSS containing only STAs that are PSMP capable. This approach may allow separation of multimedia and data-oriented BSSs. If the AP intends to allow the association of only PSMP capable

STAs only it shall set the PSMP STAs Only field in the HT Information element to 1. A PSMP aware STA may decide to associate or not with such a BSS thereby possibly shortening its scanning time.

Insert the following new subclause heading:

9.15.2 Frame transmission mechanism during PSMP

Insert the following new subclause:

9.15.2.1 PSMP frame transmission (PSMP-DTT and PSMP-UTT)

The PSMP frame shall be sent using the control frame rate defined in 9.6.3 (Rate selection for control frames).

The attribute aDTT2UTTTime is the minimum time between PSMP-DTT and PSMP-UTT phases of the same STA. This value represents the minimum time the STA is provided to react to MTBA and Data frame received during the PSMP-DTT with Data and MTBA frames transmitted in the PSMP-UTT. In a PSMP sequence, if the traffic conditions are such that the time between the PSMP-DTT and PSMP-UTT of a STA is less than the Minimum DTT2UTT Spacing, the AP shall delay the start of entire PSMP-UTT phase to meet this requirement.

A PSMP sequence (scheduled or unscheduled) may be used to transmit Broadcast/Multicast frames along with unicast frames. Unicast frames shall be scheduled after Broadcast/Multicast frames.

Unicast entries in the PSMP frame should have their PSMP-DTT and PSMP-UTT Start Offsets scheduled to minimize the number of on/off transitions or to maximize the delay between their PSMP-DTT and PSMP-UTT periods. Entries that have only PSMP-DTT should be scheduled closer to the start of the PSMP-DTTs. Entries that have only PSMP-UTT should be scheduled towards the end of PSMP-UTTs. Entries that have both PSMP-DTT and PSMP-UTT should be scheduled closer to the transition point from Downlink to Uplink transmissions.

Frames of different TID may be transmitted within a PSMP-DTT or PSMP-UTT allocation of a (Scheduled or Unscheduled) PSMP sequence without regard to Access Category.

Insert the following new subclause heading:

9.15.2.2 PSMP Down link transmission (PSMP-DTT)

During a PSMP sequence, a STA shall be able to receive frames during its scheduled PSMP-DTT and is not required to be able receive frames at other times.

The AP shall ensure that any transmissions within a PSMP sequence to a STA participating in the PSMP sequence occur wholly within the STA’s PSMP-DTT.

The PSMP-DTT may contain one or more PPDUs, each of which may contain an A-MPDU or single MPDU. The MPDUs contained within these PPDUs may be Data or MTBA.

PPDUs may be separated using RIFS or SIFS. The use of RIFS is limited as defined in 9.13.3.2 (RIFS protection).

Each PSMP-DTT contains frames addressed to a single receiver address. Adjacent PSMP-DTTs may be separated by RIFS or SIFS as specified above. This means that PPDUs to different RA may be separated by RIFS or SIFS. This is shown in Figure n50 (Multiple RA packet transmission with RIFS or SIFS).

In a PSMP sequence, multiple RA are supported by separate PPDUs separated by RIFS or SIFS as described above. This is shown in Figure n50 (Multiple RA packet transmission with RIFS or SIFS).

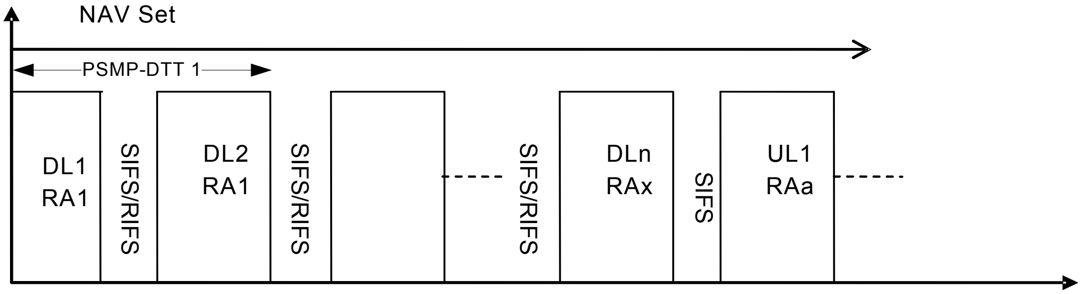


Figure n50—Multiple RA packet transmission with RIFS or SIFS

Insert the following new subclause heading:

9.15.2.3 PSMP Up link transmission (PSMP-UTT)

If a STA has frames to send, it shall start transmission without performing CCA and regardless of NAV at the start of its PSMP-UTT Offset.

The STA shall complete its transmission within the allocated PSMP-UTT, even if it has more data queued than can be transmitted during its allocated PSMP-UTT.

NOTE—PSMP-UTT is a scheduled transmission period for the STA and transmission within a PSMP-UTT does not imply that the STA is a TXOP holder. This disallows a STA from using TXOP truncation during PSMP-UTT.

The uplink schedule in a PSMP frame shall allow an interval between the end of one PSMP-UTT and the start of the following PSMP-UTT within the same PSMP sequence of PUS (PSMP-UTT spacing).

PUS shall be either aIUStime or SIFS.

The aIUStime value shall only be used when the use of RIFS is permitted. The use of RIFS is limited as defined in 9.13.3.2 (RIFS protection).

PPDUs transmitted within a PSMP-UTT may be separated using RIFS or SIFS. The use of RIFS is limited as defined in 9.13.3.2 (RIFS protection).

An AP may transmit a PSMP frame (called a PSMP recovery frame) during a PSMP-UTT in scheduled or unscheduled PSMP when both of the following conditions are met:

- the channel remains idle for a PIFS time from the start of the PSMP-UTT, and
- the PSMP-UTT Duration is longer than the total time of the PSMP recovery frame plus PIFS.

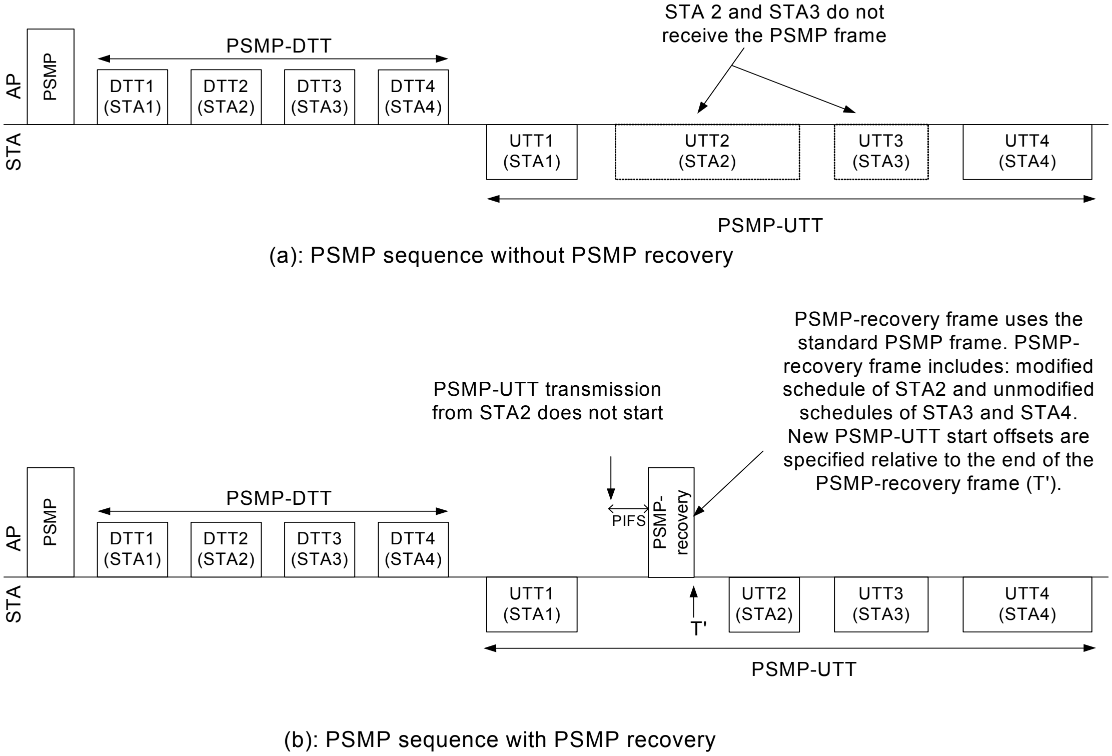
The PSMP recovery frame shall only modify the schedule of the STA that is scheduled to use this PSMP-UTT. The schedules of other STAs shall remain unchanged. The PSMP recovery frame may include: (a) a modified PSMP-UTT (and/or PSMP-DTT) for the currently scheduled STA by adjusting the time remaining after PIFS and PSMP recovery frame and (b) unmodified PSMP-UTTs for other STAs that were originally scheduled after this PSMP-UTT in the PSMP sequence.

NOTE—the PSMP-UTT (or PSMP-DTT) Start Offset is specified relative to the end of the PSMP recovery frame to compensate for the time already lapsed.

If the currently scheduled PSMP-UTT Duration is shorter than the total time of PSMP recovery frame plus PIFS, no PSMP recovery frame is transmitted.

Figure n51 (Illustration of PSMP sequence with and without PSMP recovery) illustrates a PSMP sequence with and without PSMP recovery. The PSMP recovery frame uses the standard PSMP frame format

.



(a): PSMP sequence without PSMP recovery

(b): PSMP sequence with PSMP recovery

Figure n51—Illustration of PSMP sequence with and without PSMP recovery

Insert the following new subclause:

9.15.2.4 PSMP burst

After transmission of an initial PSMP sequence, additional PSMP sequences can be transmitted by the AP in order to support resource allocation and error recovery. An initial PSMP sequence followed by one or more PSMP sequences is termed a PSMP burst. This is shown in Figure n52 (PSMP burst).

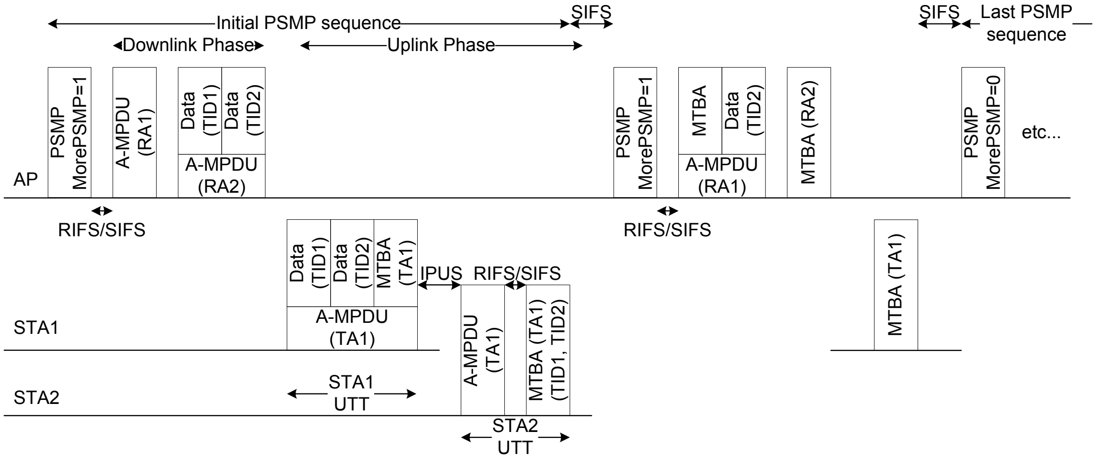


Figure n52—PSMP burst

A STA shall not transmit a +HTC MPDU in which the RD/More PPDU field is set to 1 during a PSMP burst.

An AP may transmit a CF-End to end the PSMP burst.

NOTE—A non-AP STA does not transmit a CF-End during the PSMP burst because it is not a TXOP holder during its PSMP-UTT.

During the PSMP-DTT or PSMP-UTT, a STA shall only transmit a frame that is one of the following:

- Multi-TID BlockAck
- Multi-TID BlockAckReq
- QoS Data
- PSMP (a PSMP recovery frame as described in 9.15.2.3 (PSMP Up link transmission (PSMP-UTT)))

Insert the following new subclause:

9.15.2.5 Resource allocation within a PSMP Burst

If the allocated PSMP-UTT Duration is not long enough for its queued data, the STA transmits only the part of the queued data that fits within the allocated PSMP-UTT Duration and may transmit a resource request to the AP within that PSMP-UTT. The resource request is communicated by setting either the Queue Size field or the TXOP Duration Request field of the QoS Control Field that is carried in a QoS Data frame (see Figure n53 (PSMP burst showing resource allocation)).

If a STA receives an PSMP-UTT that is not long enough to transmit data from its queues, it may transmit within the PSMP-UTT a QoS Null containing information about the state of its transmit queues.

The HT AP may use this information to schedule a PSMP-UTT either in the current PSMP burst or a later PSMP burst .

The AP may allocate a PSMP-UTT Duration in the next PSMP sequence based on the resource request from the STA sufficient to allow transmission of the remaining queued data.

The PSMP burst supports retransmission as well as additional resource allocation (see Figure n54 (PSMP burst showing retransmission and resource allocation)). The frames transmitted in PSMP-DTT are acknowledged by MTBA in PSMP-UTT phase within the current PSMP sequence. The frames transmitted in PSMP-

UTT may be acknowledged by MTBA in PSMP-DTT phase within the next PSMP sequence. Any failed transmissions during PSMP-DTT and PSMP-UTT may be respectively retransmitted in PSMP-DTT and PSMP-UTT period of the next PSMP sequence.

Figure n53 (PSMP burst showing resource allocation) and Figure n54 (PSMP burst showing retransmission and resource allocation) illustrate the operation of resource allocation. The box labeled “Queued data” represents the duration that would be required to transmit data queued for transmission at the STA.

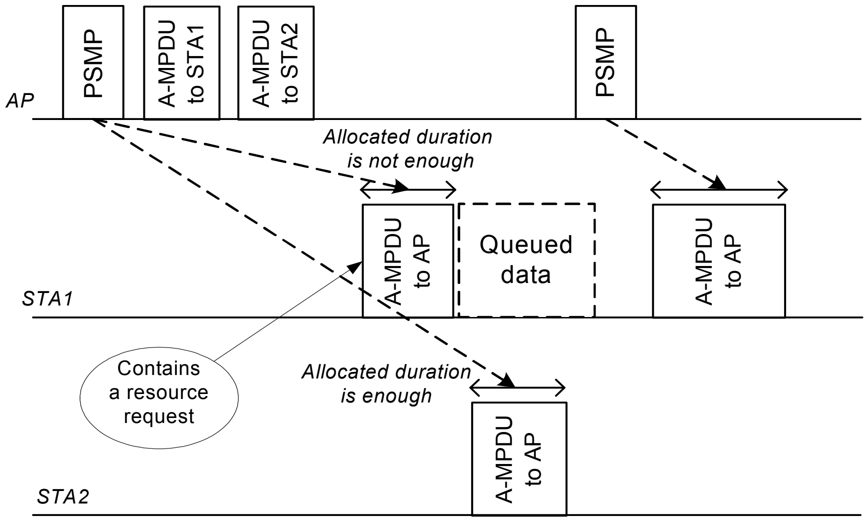


Figure n53—PSMP burst showing resource allocation

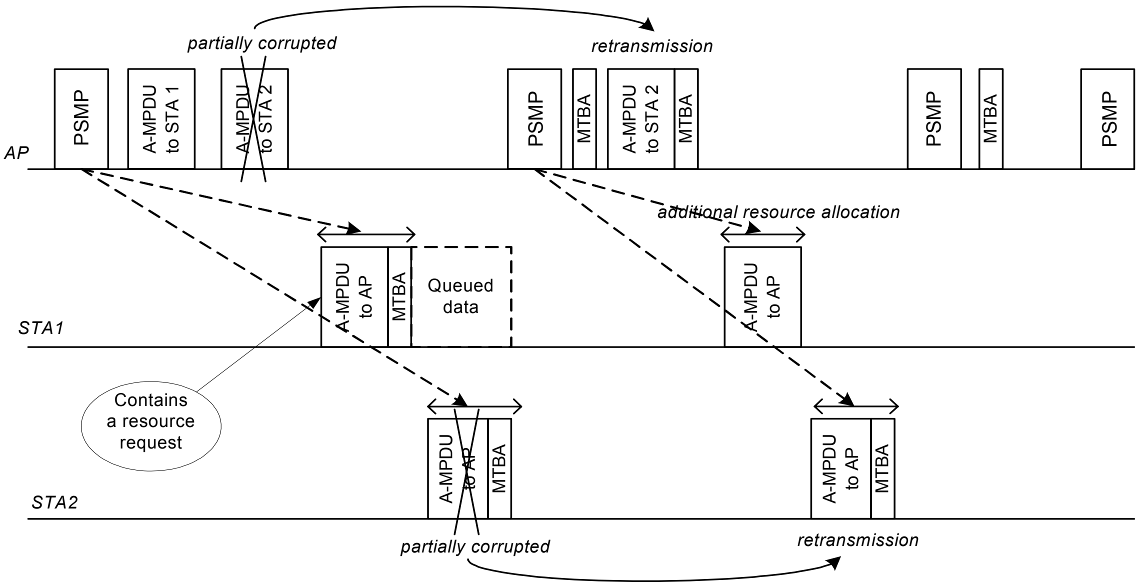


Figure n54—PSMP burst showing retransmission and resource allocation

Insert the following new subclause:

9.15.2.6 PSMP-UTT retransmission

An AP transmits MTBA responses, if any, to a STA's PSMP-UTT data transmissions in the PSMP-DTT of a subsequent PSMP sequence. The AP may reserve a PSMP-UTT in a subsequent PSMP sequence to allow the STA to retransmit failed frames. The STA may retransmit failed frames in a PSMP sequence of the current PSMP burst if a PSMP-UTT reservation is present or in a subsequent service period.

A STA that cannot complete its retransmissions in the last PSMP sequence of the PSMP burst because not enough time is allocated in its PSMP-UTT may transmit the data outside any PSMP sequence. Frames transmitted outside the scheduled service period under EDCA are subject to the Access Category prioritization.

NOTE—In the case of uplink frames transmitted outside the scheduled SP, the MTBA that acknowledges these frames is delivered in the PSMP-DTT within the next SP.

Insert the following new subclause heading:

9.15.2.7 PSMP Acknowledgement rules

Data transmitted within a PSMP sequence (PSMP-DTT and PSMP-UTT) shall be acknowledged using MT-BA.

Data sent and received by a non-AP STA within a PSMP sequence may be contained in an A-MPDU that contains MPDUs of multiple TIDs. Frames of differing TID may be transmitted in the same PSMP-DTT or PSMP-UTT and are not subject to Access Category prioritization.

If a Block Ack agreement exists for a data frame, then such frames transmitted during either a PSMP-DTT or a PSMP-UTT with an individual receiver address shall be a QoS data subtype and shall have one of the following Ack Policy values: Scheduled Ack Under MTBA/PSMP or Block Ack. If no Block Ack agreement exists for a data frame, then such frames transmitted during either a PSMP-DTT or a PSMP-UTT with an individual receiver address shall be a QoS data subtype and shall have the Ack Policy field set to No Ack. The Ack Policy field of a QoS data frame transmitted during a PSMP sequence shall not be set to either Normal ACK or Implicit Block ACK.

Acknowledgement may be requested implicitly using the Scheduled Acknowledgement Under PSMP Agreement setting of the Ack Policy field in Data frames or explicitly with MTBAR. In both cases the response is a single MTBA.

A non-AP STA shall use the PSMP-UTT of the current PSMP sequence to transmit an MTBA relating to data received in PSMP-DTTs belonging to the current and previous PSMP sequences. The AP shall use the PSMP-DTT of a subsequent PSMP sequence to transmit an MTBA response to data received in a PSMP-UTT. The next PSMP sequence may be concatenated in the same Service Interval, forming a PSMP burst. The number of PSMP sequences in PSMP burst is locally determined by the AP. The AP might receive an MTBA in the PSMP-UTT of the current PSMP sequence. If the MTBA indicates lost frames, the AP may schedule and retransmit those frames in a PSMP sequence within the current PSMP burst or in the next service period. If the AP does not receive an expected MTBA it may reschedule and retransmit any unacknowledged frames.

An AP may transmit a BlockAck of a delayed BlockAck agreement in a PSMP-DTT within a SP using MTBA format.

Insert the following new subclause heading:

9.15.2.8 PSMP broadcast and multicast rules

Insert the following new subclause:

9.15.2.8.1 Rules at the AP

This subclause defines rules that shall be followed by a PSMP Capable AP for the transmission of multicast and broadcast data during a PSMP sequence.

A STA_INFO record with STA_INFO Type set to 0 (Broadcast) may contain Data frames with the Address1 field set to any group address. A PSMP frame shall not contain more than one of these records.

Each separate multicast group address for which data is transmitted during a PSMP sequence shall either:

- not have its own STA_INFO record present in the PSMP frame and transmit Data frames with the matching Address1 field only during the PSMP-DTT associated with the STA_INFO record with STA_INFO Type set to 0 (Broadcast), or
- have a single STA_INFO record with STA_INFO Type set to 1 (Multicast) present in the PSMP frame and transmit Data frames with the matching Address1 field only during the PSMP-DTT indicated in this record or during the PSMP-DTT corresponding to a STA_INFO record with STA_INFO Type set to 0, when present.

The DA of the PSMP shall be set to the broadcast address; except if the PSMP contains only a single non-null PSMP-DTT and this PSMP-DTT contains frames for a multicast address, in which case the DA of the PSMP frame may be set to this multicast address.

Insert the following new subclause:

9.15.2.8.2 Rules at the STA

This subclause defines rules that shall be followed by a PSMP Capable STA for the reception of multicast and broadcast data during a PSMP sequence.

The STA shall be awake to receive during any PSMP-DTT identified by broadcast STA_INFO record and all PSMP-DTTs identified by a multicast STA_INFO record where the PSMP Multicast ID field matches the least significant bits of any address within its dot11GroupAddressesTable.

Insert the following new subclause:

9.15.3 Scheduled PSMP

A PSMP capable STA may request the creation of a PSMP Session by transmitting a TSPEC in which the APSD field is set to 0, the Schedule field is set to 1 and the Aggregate field is set to 1, indicating Scheduled PSMP (as described in 11.4.4b (PSMP Management)).

An AP shall not respond back to a TSPEC request in which the APSD and Schedule subfields indicate Scheduled PSMP if the TSPEC request did not indicate Scheduled PSMP. An AP can respond back to a TSPEC request that indicates Scheduled PSMP with a response indicating either Scheduled PSMP or S-APSD.

A response to a TSPEC request containing the Schedule and APSD subfields set to the value Scheduled PSMP creates a PSMP session, which exists for the lifetime of the TS.

While one or more PSMP sessions exist with the same SP, the AP shall periodically initiate a PSMP sequence by transmitting a PSMP frame using the service period indicated to the STA in response to the received TSPEC. The AP shall not schedule a PSMP-DTT or a PSMP-UTT for a STA outside its service period.

The start time of a PSMP sequence should be aligned with the start time of the SP. An AP may gain access to the channel after a PIFS in order to start transmission of a PSMP sequence.

Insert the following new subclause:

9.15.4 Unscheduled PSMP

The unscheduled PSMP mechanism extends the U-APSD mechanism. All the behavior defined in (11.2.1.4, 11.2.1.5 and 11.2.1.9) related to U-APSD also applies to unscheduled PSMP with the following exceptions:

- PSMP allows the STA to sleep during a PSMP sequence during PSMP-DTT and PSMP-UTTs in which it has no interest, and
- in addition to the EOSP mechanism, the AP can indicate the end of a SP through the transmission of a PSMP frame with the More PSMP field set to 0, or by transmission of a CF-End frame when a PSMP frame was expected.

An unscheduled SP begins when an AP receives a trigger frame from a non-AP STA. The trigger frame is one of the following:

- a QoS Data or QoS Null frame associated with an AC the STA has configured to be trigger-enabled, or
- a PS-Poll frame, or
- an A-MPDU can be sent as a trigger frame containing QoS Data associated with an AC the STA has configured to be trigger-enabled.

NOTE—If an A-MPDU is sent as a trigger containing Data frames with Ack Policy set to Implicit BlockAck, the response to the A-MPDU is a BlockAck frame. If the A-MPDU is sent as a trigger containing only Data frames with Ack Policy set to Block Ack, the STA will not receive a BlockAck. It has to send an BlockAckReq, an A-MPDU containing Data frames with Ack Policy set to Implicit BlockAck for the same TID to receive a BlockAck.

Data frames for all delivery enabled ACs may be transmitted to the STA in the same PSMP sequence. A STA can signal the queue size or TXOP duration required to transmit its queued data to the AP in the QoS control field of the trigger frame. This information can be used by the AP to estimate uplink resources in UTT, for the STA to transmit the queued data. An HT AP may start an unscheduled PSMP sequence that includes STAs that are PSMP capable at any time that these STAs are awake.

An unscheduled SP ends after the AP has attempted to transmit at least one MSDU or MMPDU associated with a delivery-enabled AC and destined for the non-AP STA, but no more than the number indicated in the Max Service Period Length field if the field has a non-zero value.

Insert the following new subclause heading:

9.16 Link adaptation

Insert the following new subclause:

9.16.1 Introduction

To fully exploit MIMO channel variations and transmit beamforming on a MIMO link, a STA can request that another STA provide full MIMO channel sounding and MCS feedback.

Link Adaptation may be supported by immediate response or unsolicited response as follows:

- *Immediate:* An immediate response when the MFB responder's +HTC frame with the MFB field containing the estimated MCS is sent in the TXOP obtained by the TXOP holder. This approach allows the MFB requester to obtain the benefit of link adaptation within the same TXOP.
- *Unsolicited:* A delayed response in which a +HTC frame with the MRQ field set to 1 is transmitted in a TXOP obtained by the MFB requester and a +HTC frame with the MFB field containing the estimated MCS is transmitted in a subsequent TXOP obtained by the MFB responder. Unsolicited MFBs may also be sent independent of any preceding MRQ.

Insert the following new subclause:

9.16.2 Link adaptation using the HT Control field

The MFB requester may set the MRQ field to 1 in the MAI field of the HT Control field of a +HTC frame to request the MFB responder to provide MCS feedback. The MFB requester may set the MSI field in the MAI field to any value in the range 0 to 6 every time it transmits a +HTC frame with the MRQ field set to 1. How the MFB requester chooses the MSI value is implementation dependent. The MFB requester may use the field as a sequence number of the MRQ or it may implement any other encoding of the field. If the HT Control field is included in more than one frame (i.e., more than one +HTC frame) within the same PPDU, the MRQ field and the MSI field in each +HTC frame shall be set to the same value. The appearance of more than one instance of an HT Control field with the MRQ field set to 1 within a single PPDU shall be interpreted by the receiver as a single request for MCS feedback.

An MFB requester should transmit +HTC frames with the MRQ field set to 1 in of the following two ways:

- within a Sounding PPDU, or
- with the NDP Announcement field in the +HTC frame set to 1 and following the +HTC frame by an NDP transmission.

The number of HT-LTFs sent in the sounding PPDU or in the NDP is determined by the total number of spatial dimensions to be sounded, including extra spatial dimension (if any) beyond those used by the data portion of the frame.

When transmitting a sounding PPDU containing a +HTC MPDU with the MRQ field set to 1, the NUM_EXTEN_SS parameter in the TXVECTOR shall not be set to a value greater than the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted by the STA that is the intended receiver of the sounding PPDU. When the sounding PPDU is an NDP, the number of spatial streams corresponding to MCS parameter of the TXVECTOR shall not exceed the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted from the STA that is the intended receiver of the NDP.

When the MFB requester sets the MRQ field to 1, in order to obtain information from more dimensions than the number of spatial streams actually used for PPDU transmission, the frame indicating the MRQ should be contained in a sounding PPDU (indicated by sounding bits in the HT-SIG).

On receipt of an +HTC frame with the MRQ field set to 1, the MFB responder initiates computation of the MCS estimate and associates the result of this computation with the MSI value. Hardware and buffer capability may limit the number of MCS estimate computations that a MFB responder is capable of computing simultaneously. When a new MRQ is received either from a different MFB requester or from the same MFB requester with a different MSI value, and the MFB responder is not able to complete the computation for MRQ, the MFB responder may either discard the new request or may abandon an existing request and initiate an MCS estimate computation for the new MRQ.

If the MFB responder discards or abandons the computation for an MRQ, it should indicate this to the MFB requester by setting the MFB to "all-ones" in the next transmission of a frame addressed to the MFB requester that includes the HT Control field. The value of the MFSI is set to the MSI value of the sounding frame for which the computation was abandoned.

After the MCS estimate computation is completed, the MFB responder should include the MCS feedback in the MFB field in the next transmission of a frame addressed to the MFB requester that includes an HT Control field. The value of the MFSI is set to the MSI value of the sounding frame from which the MCS estimate was computed.When the MFB requester sets the MRQ field to 1 and sets the MSI value to a value that matches the MSI value of a previous request for which the responder has not yet provided feedback, the responder shall discard or abandon the computation for the MRQ that corresponds to the previous use of that MSI value.

If a STA sends an unsolicited MFB, it shall set the MFSI to the value 7.

If the HT Control field is included in more than one frame within the same A-MPDU, the MFB responder may provide the MFB corresponding to different MFSI values in different frames.

If an MRQ is included in the last PPDU in a TXOP and there is not enough time for a response, the recipient may transmit the response MFB in a subsequent TXOP.

An MCS feedback capable STA (identified by the MCS Feedback field in Extended HT Capabilities Info field set to 3) shall support the following:

- MFB estimate computation and feedback on the receipt of MCS request (MRQ=1 in HTC) in a sounding PPDU that does not contain extension HT-LTFs;
- MFB estimate computation and feedback on the receipt of MCS request (MRQ=1 in HTC) in a staggered sounding PPDU if this STA declares support for Receive Staggered Sounding by setting the Receive Staggered Sounding Capable subfield of the Transmit Beamforming Capability field to 1;
- MFB estimate computation and feedback on the receipt of NDP (see 9.19 (Null Data Packet (NDP) as sounding PPDU)) if this STA declares support for receiving NDP sounding by setting the Receive NDP Capable subfield of the Transmit Beamforming Capability field to 1. The sender shall set the MRQ bit to 1 in the frame where the NDP Announcement bit will be set to 1.

NOTE—Bidirectional request/responses are permitted. In this case, a STA acts as the MFB requester for one direction of a duplex link transmitting MRQ, and a MFB responder for the other direction, transmitting MFB and including both within the same HT Data frame.

If the MCS feedback is in the same PPDU as a MIMO Non-compressed Beamforming management action frame or a MIMO Compressed Beamforming management action frame, the MFB responder shall estimate the recommended MCS under the assumption that the MFB requester will use the beamforming matrices contained in the management action frame.

STAs that set the MCS Feedback field to 0 in the HT Extended Capabilities field of the HT Capability element that they transmit do not respond to MRQs.

Insert the following new subclause:

9.16.3 Immediate response frame exchange for HT Control

Certain frame exchanges are defined as immediate response exchanges. These include RTS/CTS, Data/ACK, HT-immediate BlockAckReq/BlockAck and Immediate BlockAckReq/BlockAck. If an HT STA includes the HT Control field in the initial frame of an immediate response exchange and the responding HT STA includes the HT Control field in the immediate response frame, the immediate response exchange effectively permits the exchange of HT Control field elements.

If the MFB requester sets MRQ = 1 in the HT Control Field, and the MFB responder completes the MCS estimate in time, it can provide an MFB in the HT Control field in the immediate response. If the MCS estimate is not available in time and if the HT Control field is included in the immediate response frame[2], the MFB responder may set MFB to the default value “all-ones” following the MFSI/MSI rules. Subsequently, when the MCS estimate corresponding to the MRQ becomes available at the MFB responder, the MFB responder should include the MCS feedback in the MFB field in the next transmission of a frame addressed to the MFB requester that includes the HT Control field. The value of the MFSI is set to the MSI value to indicate to the MFB requester the correspondence between the MRQ and the MFB.

Insert the following subclause heading

9.17 Transmit beamforming

Insert the following new subclause:

9.17.1 Introduction

In order for a beamformer to calculate an appropriate steering matrix for transmit spatial processing when transmitting to a specific beamformee, the beamformer needs to have an accurate estimate of the channel that it is transmitting over. There are two methods defined using:

- Implicit feedback;
- Explicit feedback.

When using implicit feedback, the beamformer receives long training symbols, which allow the MIMO channel between the beamformee and beamformer to be estimated.

If the channel is reciprocal, the beamformer can use the training symbols that it receives from the beamformee to make a channel estimate suitable for computing the transmit steering matrix. Generally, reciprocity requires calibrated radios in MIMO systems. See 9.17.2 (Transmit beamforming with implicit feedback).

When operating explicit feedback, the beamformee makes a direct estimate of the channel from training symbols sent to the beamformee by the beamformer. The beamformee may prepare Channel State Information or Beamforming Matrices feedback based on an observation of these training symbols. The beamformee quantizes the feedback and sends it to the beamformer. The beamformer can use the feedback as the basis for determining transmit steering vectors. See 9.17.3 (Explicit feedback beamforming).

(Insert the following new heading:

9.17.2 Transmit beamforming with implicit feedback

Insert the following new subclause:

9.17.2.1 General

Transmit beamforming with implicit feedback can operate in a unidirectional or a bidirectional manner. In unidirectional implicit transmit beamforming, only the beamformer sends beamformed transmissions. In bidirectional implicit transmit beamforming, both STAs send beamformed transmissions, i.e., a STA may act as both beamformer and beamformee.

Calibration of receive/transmit chains should be done to improve performance of transmit beamforming using implicit feedback. Over-the-air calibration is described in 9.17.2.4 (Calibration). For implicit transmit beamforming, only the beamformer, which is sending the beamformed transmissions, needs to be calibrated.

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[2] The HT Control field may be included in the immediate response frame for other reasons, since HT Control field supports other features, including MRQ in the opposite direction.

A STA that is capable of acting in the role of an implicit beamformer shall set the Implicit TxBF Capable subfield of the TxBF Capabilities field of the HT Capabilities element to 1 in all HT Capabilities elements that it transmits. A STA that is capable of acting in the role of an implicit beamformee shall set the Implicit TxBF Receiving Capable subfield of the Transmit Beamforming field of the HT Capabilities element to 1 in all HT Capabilities elements that it transmits. A STA that indicates implicit beamformer capability as described above shall also indicate the capability to act in the role of an implicit beamformee by setting the Implicit TxBF Receiving Capable subfield of the TxBF Capabilities field of the HT Capabilities element to 1.

Sounding PPDU types supported by a STA that is capable of acting in the role of an implicit beamformee in a transmit beamforming PPDU exchange using implicit feedback (i.e., can transmit staggered sounding and/or NDP) shall be advertised in the TxBF Capabilities subfield of the HT Capabilities elements that are transmitted by the STA. Sounding PPDU types supported by a STA that is capable of acting in the role of an implicit beamformer in a transmit beamforming PPDU exchange using implicit feedback (i.e., can receive staggered sounding and/or NDP) shall be advertised in the TxBF Capabilities field of the HT Capabilities information elements that are transmitted by the STA.

A STA that advertises itself as Implicit TxBF Receiving Capable shall be capable of transmitting a sounding PPDU for which the SOUNDING parameter is set to ‘SOUNDING’ and the NUM_EXTEN_SS is set to 0 in the TXVECTOR in the PHY-TXSTART.request, as a response to TRQ=1, independently of the values of the Transmit Staggered Sounding Capable and the Transmit NDP Capable subfields. A STA that advertises itself as Implicit TxBF Capable shall be capable of receiving a sounding PPDU for which the SOUNDING parameter is ‘SOUNDING’ and the NUM_EXTEN_SS is 0 in the RXVECTOR in the PHY-RXSTART.indication, independently of the values of the Receive Staggered Sounding Capable and the Receive NDP Capable subfields.

A STA that performs one of the roles related to transmit beamforming with implicit feedback shall support the associated capabilities shown in Table n51 (Transmit beamforming support required with implicit feedback).

Table n51—Transmit beamforming support required with implicit feedback

Role	Required Support
Beamformee: A receiver of transmit beamformed PPDUs	Shall transmit sounding PPDUs as a response to TRQ=1.
Beamformer: A transmitter of beamformed PPDUs	Can receive sounding PPDUs. Can compute steering matrices from MIMO channel estimates obtained from long training symbols in sounding PPDUs received from the beamformee.
A responder in a calibration exchange	Can receive and transmit sounding PPDUs. Can respond with a MIMO CSI Matrices frame that contains channel measurement information obtained during reception of a sounding PPDU.
An initiator in a calibration exchange	Can receive and transmit sounding PPDUs. Can receive a MIMO CSI Matrices frame sent by a calibration responder.

When a beamformee transmits a sounding PPDU, the SOUNDING parameter in the TXVECTOR in the PHY-TXSTART.request shall be set to SOUNDING. If the STA is capable of implicit TxBF and the requesting STA is capable of receiving implicit TxBF, the sounding PPDU may be steered.

A PPDU containing one or more +HTC MPDUs in which the TRQ field is set to 1 shall not be sent to a STA that sets the Implicit TxBF Receiving Capable subfield of the Transmit Beamforming field of the HT Capabilities element to 0.

If a PPDU containing one or more +HTC MPDUs in which the TRQ bit is set to 1 requires an immediate response, the response from the beamformee shall either be included in a sounding PPDU, or the NDP Announcement bit of the HT Control field shall be set to 1 and the PPDU shall be followed by an NDP. In this case, response with NDP is allowed only when RDG/More PPDU subfield is set to 1 in the HT Control field that also contains TRQ= 1, as specified in 9.19.1 (NDP Rules). If the PPDU in which the TRQ bit is set to 1 does not require an immediate response, the beamformee shall either transmit a sounding PPDU in the next TXOP obtained by the beamformee, or the beamformee shall transmit a PPDU in the next TXOP obtained by the beamformee in which the NDP Announcement subfield of the HT Control field is set to 1 and that PPDU shall be followed by an NDP. The use of NDP as a sounding PPDU is described in subclause 9.19 (Null Data Packet (NDP) as sounding PPDU).

When transmitting a sounding PPDU sent in a response to a +HTC MPDU with the TRQ field set to 1, the NUM_EXTEN_SS parameter of the TXVECTOR shall not be set to a value greater than the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted by the STA, that is the intended receiver of the sounding PPDU. When the sounding PPDU is an NDP, the number of spatial streams corresponding to the MCS parameter of the TXVECTOR shall not exceed the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted by the STA that is the intended receiver of the NDP.

NOTE—A STA that acts as a beamformer using implicit feedback expects to receive a sounding PPDU in response to its previous training request. The STA can compute steering matrices from the channel estimates obtained from the received sounding PPDU.

At the end of the TXOP, the final PPDU from the beamformer shall not have the TRQ set to 1 in the frame that request an immediate response if there is not enough time left in the TXOP to receive the response.

Insert the following new subclause heading:

9.17.2.2 Unidirectional implicit transmit beamforming

Figure n55 (An example of a PPDU exchange sequence for unidirectional transmit beamforming with implicit feedback) shows an example of a PPDU exchange used in unidirectional implicit transmit beamforming, using the Clause 20 PHY. In this example, sounding PPDUs are used that carry MPDUs (i.e., an example of implicit beamforming using NDPs is not shown here.) STA A is the beamformer that initiates the PPDU exchange, and STA B is the beamformee.

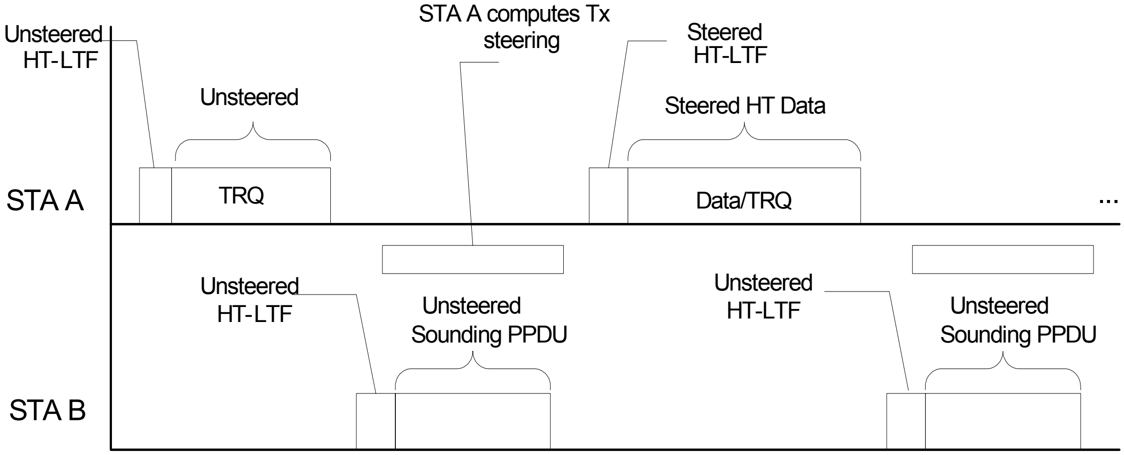

Figure n55—An example of a PPDU exchange sequence for unidirectional transmit beamforming with implicit feedback

The PPDU exchange can be summarized as follows:

a) STA A initiates the frame exchange sequence by sending an unsteered PPDU to STA B. The PPDU includes a training request (TRQ= 1) in a +HTC MPDU.

b) STA B sends a sounding PPDU in response to the training request from STA A.

c) On receiving the sounding PPDU, STA A uses the resulting channel estimate to compute steering matrices, and uses these to send a steered PPDU back to STA B.

d) The steered PPDU transmitted in step c) and subsequent steered PPDUs transmitted by STA A may include training requests (TRQ=1) in a +HTC MPDU. In response to each training request, STA B returns a sounding PPDU to STA A, which enables STA A to update its steering vectors. If the steering vectors resulting from step c) or subsequent sounding PPDUs are deemed stale due to delay, the sequence can be restarted by returning to step a).

Step d) in the above PPDU exchange represents steady state unidirectional TxBF operation.

Insert the following new subclause:

9.17.2.3 Bidirectional implicit transmit beamforming

Figure n56 (Example of a PPDU exchange sequence for bidirectional transmit beamforming with implicit feedback) shows an example of a PPDU exchange used in bidirectional implicit transmit beamforming, using Clause 20 PHY. In this example, sounding PPDUs are used that carry MPDUs. STA A initiates the frame exchange, and STA A and STA B alternate in the roles of beamformer and beamformee.

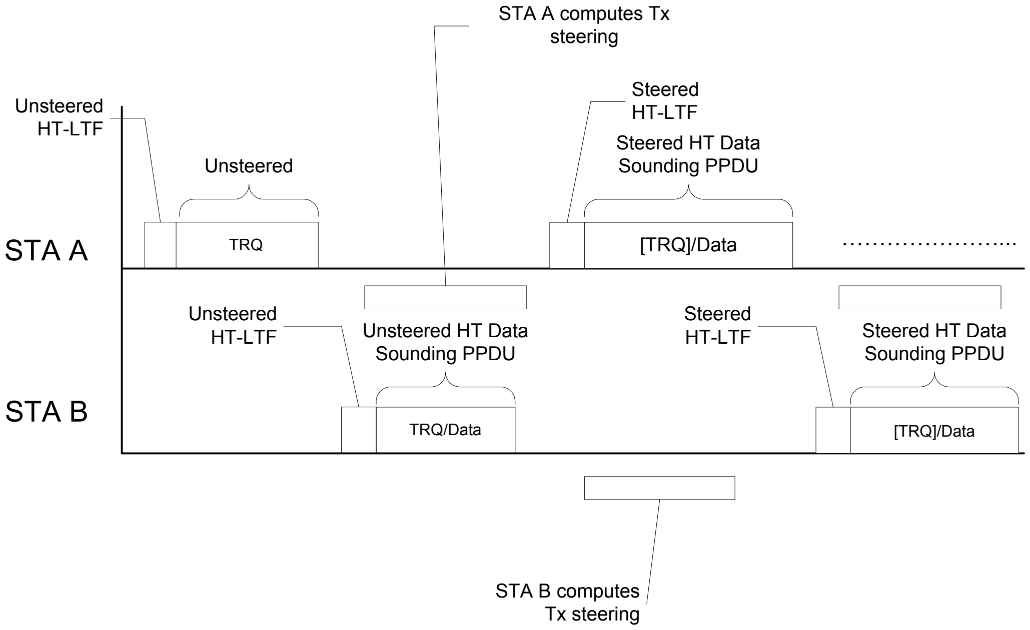

Figure n56—Example of a PPDU exchange sequence for bidirectional transmit beamforming with implicit feedback

The PPDU exchange can be summarized as follows:

a) STA A initiates the frame exchange sequence by sending an unsteered PPDU to STA B. The PPDU includes a training request (TRQ= 1) in a +HTC MPDU.

b) STA B sends a sounding PPDU in response to the training request. In addition, this PPDU includes a training request in a +HTC MPDU to enable implicit transmit beamforming in the reverse direction

c) On receiving the sounding PPDU, STA A uses the resulting channel estimate to compute steering matrices, and uses these to send a steered PPDU back to STA B. This steered PPDU is also a sounding PPDU in response to the training request from STA B.

d) On receiving the sounding PPDU, STA B uses the resulting channel estimate to compute steering matrices, and uses these to send a steered PPDU back to STA A. The steered PPDU transmitted in step c) and subsequent steered PPDUs transmitted by STA A may include training requests in HTC. In response to each training request, STA B returns a sounding PPDU to STA A, which enables STA A to update its steering vectors. If the steering vectors resulting from step c) or subsequent sounding PPDUs are deemed stale due to delay, the sequence can be restarted by returning to step a).

e) The steered PPDU transmitted in step d) and subsequent steered PPDUs transmitted by STA B may include training requests in HTC. In response to each training request, STA A returns a sounding PPDU to STA B, which enables STA B to update its steering vectors. If the steering vectors resulting from step d) or subsequent sounding PPDUs are deemed stale due to delay, the sequence can be restarted by returning to step a).

Steps d) and e) in the above PPDU exchange represent steady state bidirectional TxBF operation.

Insert the following new subclause heading:

9.17.2.4 Calibration

Insert the following new subclause:

9.17.2.4.1 Introduction

Differences in transmit and receive chains in a STA degrade the inherent reciprocity of the over-the-air Time Division Duplex channel, and cause degradation of performance of implicit beamforming techniques. Calibration acts to remove or reduce differences in transmit and receive chains and enforce reciprocity in the observed baseband-to-baseband channels between two STAs.

A STA acting as a beamformer should be calibrated to achieve the better performance. A STA acting only as a beamformee does not need to be calibrated. If calibration is desired, it is performed using the over-the-air calibration procedure described below.

The calibration procedure involves the computation of correction matrices that effectively ensure that the observed channel matrices in the two directions of the link are transposes of each other and thus renders the resultant channel reciprocal. See subclause 20.3.11.1 (Implicit feedback beamforming) for a more detailed description. Preferably, if it is able to do so, a STA should calibrate upon association. Calibration is applicable to any STA with more than one RF chain. A STA with one or more RF chains may participate in a calibration exchange with another STA initiating the exchange.

Insert the following new subclause:

9.17.2.4.2 Procedure

A STA that sets the Implicit TxBF Capable subfield of the TxBF Capability field to 1 shall support calibration and shall set the Calibration subfield of the TxBF Capability field to 3 (indicating full support of calibration) in all HT Capabilities elements that it transmits. A STA that does not set the Implicit TxBF Capable subfield of the TxBF Capability field to 1 may support calibration and shall set the Calibration subfield of the TxBF Capabilities field to the value that indicates its calibration capability in the TxBF Capability fields in all HT Capabilities elements that it transmits (see Table n28 (Subfields of the TxBF Capability Field)), when the

TxBF Capabilities field exists.

In order to support calibration, a STA that advertises that it is capable of responding to a calibration request shall be capable of transmitting a MIMO CSI Matrices Measurement frame in which the value of the Grouping subfield of the MIMO Control field is 0 (no grouping) and the Coefficients Size subfield of the MIMO Control field is 3 (Nb=8 bits) in response to a CSI feedback request indicated by the CSI/Steering subfield of the HT Control field set to 1 and the Calibration Position subfield of the HT Control field set to 1 or 3, independently of the advertised values of the Explicit BF CSI Feedback subfield in the Transmit Beamforming Capability subfield in the HT Capabilities element. A STA that advertises that it is capable of initiating a calibration request shall be capable of receiving a MIMO CSI Matrices Measurement frame in which the value of the Grouping subfield of the MIMO Control field is set to 0 (no grouping) and the Coefficients Size subfield of the MIMO Control field is set to 3 (Nb=8 bits) as a response to CSI feedback request indicated by the CSI/Steering subfield of the HT Control field set to 1 with the Calibration Position subfield set to 1 or 3, independently of the advertised values of the Explicit CSI TxBF Capable subfield in the Transmit Beamforming Capability subfield in the HT Capabilities element.

A STA shall only initiate a calibration training frame exchange sequence with another STA that supports calibration.

Figure n57 (Calibration procedure with sounding PPDU containing an MPDU), illustrates the calibration PPDU exchange using sounding PPDUs that contain an MPDU. Figure n58 (Calibration procedure with NDP) illustrates the calibration PPDU exchange using NDPs.

The calibration procedure begins with a Calibration Sounding PPDU exchange sequence shown as Step 1 in Figure n57 (Calibration procedure with sounding PPDU containing an MPDU). The Calibration Sequence subfield in the HT Control field shall be incremented each time a new calibration procedure is started.

STA A (the calibration initiator) shall transmit a Calibration Start frame (Calibration Position field set to 1) with the TRQ field in the HT Control field set to 1. This frame initiates a calibration procedure. It shall be a QoS Null Data frame, with the ACK Policy field set to Normal ACK.

In response, STA B (the calibration responder) shall transmit a Calibration Sounding Response frame (Calibration Position field set to 2), a SIFS interval after the end of the Calibration Start frame, using a sounding PPDU. This allows STA A to estimate the MIMO channel from STA B to STA A. In the Calibration Sounding Response frame, the Calibration Sequence subfield in HT Control field shall be set to the same value that is indicated in the Calibration Start frame. The Calibration Sounding Response frame shall have a frame type of ACK+HTC.

In response, STA A shall transmit a Calibration Sounding Complete frame (Calibration Position field set to 3) that contains the CSI/Steering subfield of the HT Control field set to 1, a SIFS interval after the end of the Calibration Sounding Response frame, using a sounding PPDU. This allows STA B to estimate the MIMO channel from STA A to STA B. In this Calibration Sounding Complete frame, the Calibration Sequence subfield in the HT Control field shall be set to the same value that is indicated in the Calibration Sounding Response frame. The Calibration Sounding Complete frame shall be a QoS Null+HTC with the ACK Policy field set to Normal ACK.

A frame in which the Calibration Position field is set to 2 or 3 shall be transmitted in a sounding PPDU (a PPDU for which the SOUNDING parameter is set to SOUNDING), The number of long training fields used to obtain MIMO channel estimation that are sent in the sounding PPDU shall be determined by the number of transmit chains (N_{TX}) used in sending these long training fields at the STA transmitting the sounding PPDU. The transmit chains used at the calibration initiator are those for which calibration is required.

The calibration responder may train up to maximum available transmit chains to maximize the quality of the resulting calibration, though the number of spatial time stream for data symbols shall be determined by the rule described in 9.6 (Multirate support).

When transmitting a sounding PPDU sent during step 1 of a calibration sounding exchange, the NUM_EXTEN_SS parameter of the TXVECTOR shall not be set to a value greater than the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted by the STA that is the intended receiver of the PPDU. When the sounding PPDU is an NDP, the number of spatial streams corresponding to the MCS parameter of the TXVECTOR shall not exceed the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted by the STA that is the intended receiver of the NDP.

Sounding packets in which Calibration Position fields set to 2 or 3 shall use the spatial mapping matrices defined in 20.3.12.2 (Sounding PPDU for calibration). The calibration responder shall not remove the spatial mapping from the CSI to be fed back to the initiator of the frame exchange. Before computing the correction matrices, the calibration initiator of this frame exchange shall itself be responsible for accounting for the spatial mapping in both its local channel estimate as well as in the quantized fed back to it. The row order in the CSI feedback matrix transmitted from STA B shall correspond to the association of the rows of the spatial mapping matrix (see Equation (21-75)) to its transmit antennas. For example, the receive antenna at STA B associated with the i-th row in the CSI feedback matrix in each subcarrier is the same as its transmit antenna associated with the i-th row in the spatial mapping matrix used for transmitting the sounding response with Calibration Position set to 2.

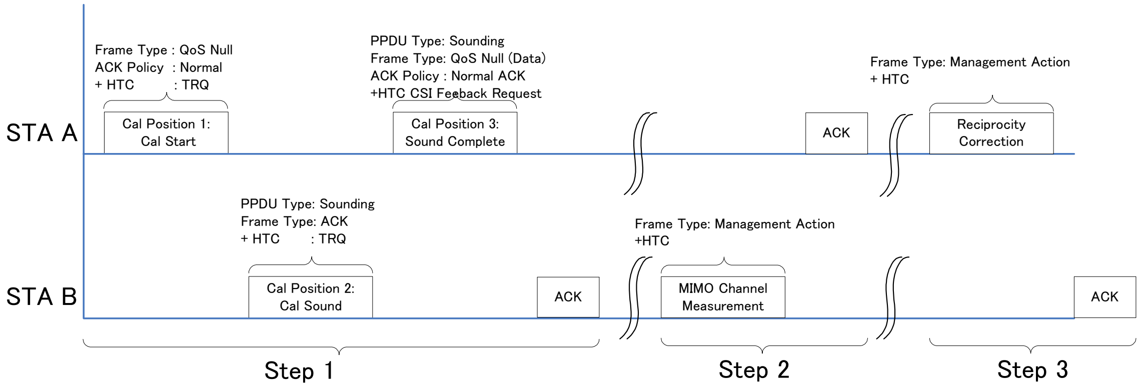

Figure n57—Calibration procedure with sounding PPDU containing an MPDU

The remaining message exchange in the calibration procedure is not time critical.

When the MIMO channel measurements become available at STA B, STA B shall send one or more MIMO CSI Matrices frames that contain the MIMO CSI Matrices Report (Step 2 in Figure n57 (Calibration procedure with sounding PPDU containing an MPDU)). This CSI Matrices Report shall have full precision, i.e, Ng=1 (no grouping) and Nb=3 (8 bits). In these MIMO CSI Matrices frames, the Calibration Sequence subfields in HT Control fields shall be set to the same value that is indicated in the Calibration Sounding Complete frame. These MIMO CSI Matrices frame shall have a frame type of Management Action +HTC.

STA B should finish transmission of the first MIMO CSI Matrices frame, within aMaxCSIMatricesReportDelay (ms) after the reception of the Sounding Complete (Calibration Position 3) frame.

The Remaining Matrix Segment field in a MIMO CSI Matrices frame shall be set to indicate the number of remaining MIMO CSI Matrices frames to be sent to complete the MIMO CSI Matrices Report. For example, if two MIMO CSI Matrices frames will be sent, the Remaining Matrix Segment field in the first MIMO CSI

Matrices frame is set to 1, and in the last MIMO CSI Matrices frame is set to 0.

A STA that has started but not completed the calibration procedure and that receives some other request that requires the buffering of CSI (such as another calibration initiation frame, MCS feedback request, CSI feedback request for link adaptation, or feedback request for explicit TxBF) may ignore the request.

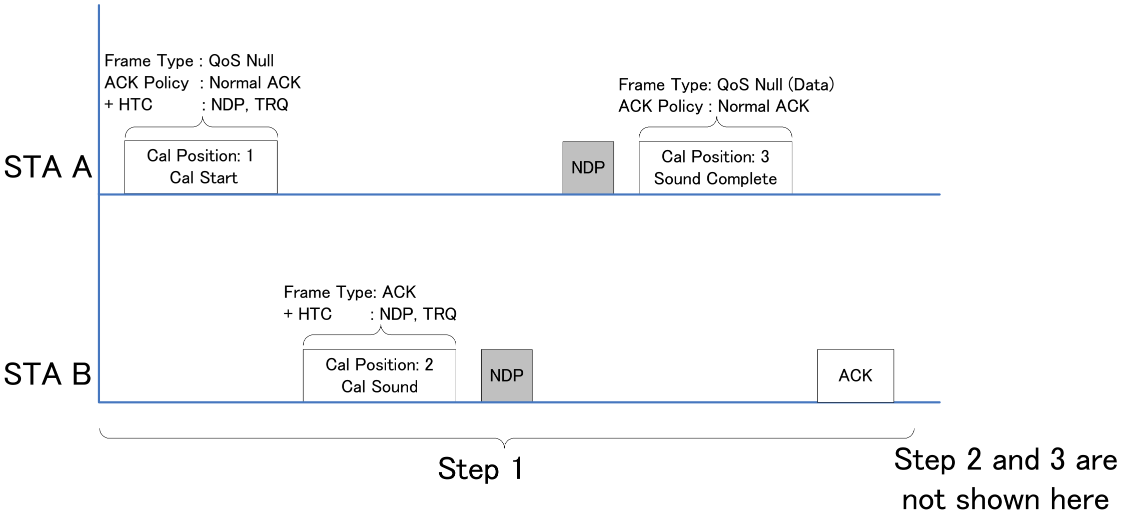

Figure n58—Calibration procedure with NDP

Figure n58 (Calibration procedure with NDP) , illustrates the calibration PPDU exchange using NDPs.

The calibration procedure begins with a Calibration Sounding PPDU exchange sequence, shown as Step 1 in Figure n58 (Calibration procedure with NDP). The Calibration Sequence subfield in the HT Control field shall be incremented each time a new calibration procedure is started.

STA A transmits a Calibration Start frame (Calibration Position field set to 1) with TRQ field in HT Control field set to 1, NDP Announcement field set to 1, and CSI/Steering subfield in HT Control field set to 1. This frame initiates a calibration procedure. The Calibration Start frame shall have a frame type of QoS Null+HTC, with the ACK Policy set to Normal ACK. The Duration/Id field in this Calibration Start frame shall cover the Calibration Sounding Response frame plus the following NDP from STA B plus a SIFS time plus the Calibration Sound Complete frame.

In response, STA B shall transmit a Calibration Sounding Response frame (Calibration Position field set to 2) with NDP Announcement field set to 1, after a SIFS interval. STA B shall send an NDP as a sounding PPDU within SIFS after the Calibration Sounding Response frame. This allows STA A to estimate the MIMO channel from STA B to STA A. In this Calibration Sounding Response frame, the Calibration Sequence subfield in HT Control field shall be set to the same value that is indicated in the Calibration Start frame. The Calibration Response frame shall have a frame type of ACK+HTC.

According to the NDP Announcement in the Calibration Start frame, STA A shall transmit NDP as a sounding PPDU after SIFS interval. This NDP allows STA B to estimate the MIMO channel from STA A to STA B. The NDP shall be followed by a Calibration Sounding Complete frame (Calibration Position field set to 3) a SIFS after the NDP from STA A. In the Calibration Sounding Complete frame, the Calibration Sequence subfield in the HT Control field shall be set to the same value that is indicated in the Calibration Response frame. The Calibration Sounding Complete frame shall be a QoS Null+HTC with the ACK Policy field set to Normal ACK.

After Step 1, calibration procedure shall be followed by Step 2, of Figure n57 (Calibration procedure with sounding PPDU containing an MPDU).

Sounding packets, which are indicated by NDP announcement field with Calibration Position fields set to 2 or 3 shall use the spatial mapping matrices defined in subclause 20.3.12.2 (Sounding PPDU for calibration). The calibration responder shall not remove the spatial mapping from the CSI to be fed back to the initiator of the frame exchange. Before computing the correction matrices, the calibration initiator of this frame exchange shall itself be responsible for accounting for the spatial mapping in both its local channel estimate as well as in the quantized CSI fed back to it.

Insert the following new subclause:

9.17.3 Explicit feedback beamforming

A beamformer uses feedback response information that it receives from the beamformee to calculate a beamforming matrix for Transmit beamforming. This feedback response information may have one of three formats:

a) *Channel State Information*: the beamformee sends the MIMO channel coefficients to the beamformer;

b) *Non-compressed beamforming matrices*: the beamformee sends calculated beamforming matrices to the beamformer;

c) *Compressed beamforming matrices*: the beamformee sends compressed beamforming matrices to the beamformer.

The supported formats shall be advertised in the beamformee's HT Capability information element.

A beamformer shall discard the feedback response information if the TSF time when the PHY_CCA.indication(IDLE) primitive corresponding to the feedback response information frame's arrival minus the value from the Sounding Timestamp field in the feedback response information frame is greater than dot11MaxCSIFeedbackDelay.

A beamformee's responding capabilities shall be advertised in HT Capability information elements contained in beacon, measurement pilot, probe request and response, and association request and response frames that are transmitted by the beamformee. Devices that are capable of acting as a beamformee shall advertise one or both of the following response capabilities:

a) *Immediate*: the beamformee is capable of sending feedback response information a SIFS after receiving a sounding PPDU and/or is capable of sending feedback response information aggregated in a PPDU that contains a MAC response within the beamformer's TXOP

b) *Delayed*: the beamformee is not capable of sending the feedback response information a SIFS time after receiving a sounding PPDU and shall not send the feedback response information a SIFS time after receiving a sounding PPDU, but it is capable of sending the feedback response information in a TxOP that it obtains.

The sounding frame types supported by the beamformee, staggered and/or NDP, shall be advertised in HT capability information elements which are transmitted by the beamformee.

A STA that advertises itself as any of Explicit TXBF CSI feedback capable or Explicit Non-compressed Beamforming Feedback matrix Capable or Explicit Compressed Beamforming Feedback Matrix Capable shall submit explicit feedback based on the receipt of a +HTC sounding PPDU in which the CSI/Steering field has a non-zero value and that does not contain extension HT-LTFs. The generation of feedback in response to the receipt of such a frame shall always be supported by a beamformee that advertises any of Explicit TXBF CSI Feedback Capable or Explicit Non-compressed Beamforming Feedback matrix capable or Explicit Compressed Beamforming Feedback Matrix Capable, independently of the values of the Receive Staggered Sounding and the Receive NDP capabilities.

A beamformer shall set the NOT_SOUNDING parameter of the TXVECTOR to zero in the PHY-TX-START.request primitive corresponding to each packet that is used for sounding.

A beamformer transmitting a sounding PPDU shall not set the NUM_EXTEN_SS parameter of the TXVECTOR to a value greater than the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted by the STA that is the intended receiver of the PPDU. When the sounding PPDU is an NDP, the number of spatial streams corresponding to the MCS parameter of the TXVECTOR shall not exceed the limit indicated by the Channel Estimation Capability subfield in the Transmit Beamforming Capability information element transmitted by the STA that is the intended receiver of the NDP.

A beamformer shall set the response type format indicated in the CSI/steering field of the HT Control field of any sounding frame excluding the NDP and of any PPDU with the NDP sounding announcement field set to 1 to one of the non-zero values (CSI, Compressed Beamforming Feedback Matrix or Non-compressed Beamforming Feedback matrix) that corresponds to a type which is supported by the beamformee.

A beamformee shall use the response type format (CSI, Compressed Beamforming Feedback Matrix or Non-compressed Beamforming Feedback matrix) indicated in the CSI/Steering field of the HT Control field of any sounding frame excluding the NDP and of any PPDU with the NDP sounding announcement field set to 1 to return the response feedback information.

The receipt of a PHY-RXSTART.indication with the RXVECTOR NOT_SOUNDING parameter value set to 0 indicates a sounding packet. A non-NDP sounding packet that is directed to a receiver's MAC address and that contains a non-zero CSI/steering field of the HT Control field shall be interpreted as a response feedback request.

A NDP sounding packet announced by a PPDU (9.19 (Null Data Packet (NDP) as sounding PPDU)) with the NDP sounding announcement field set to 1 and with a non-zero CSI/steering field shall be interpreted as a response feedback request.

The type of response feedback information requested is indicated in the CSI/Steering field of the HT Control field of a non-NDP sounding frame and in the CSI/Steering field of the HT Control field of a NDP-announcement PPDU.

A beamformee shall not return CSI feedback information that is generated from a received frame that is not interpreted as a response feedback request.

A beamformee that advertises itself as immediate feedback capable shall transmit immediate or aggregated feedback response information in a frame that is appropriate for the current frame exchange sequence as follows:

- If a MAC response is required (CTS, ACK, BA), the feedback response information may be aggregated with the MAC response, otherwise the feedback response information shall be sent a SIFS after the reception of the sounding PPDU. If NDP sounding is used, then the transmission of a frame containing feedback response information may follow the NDP, but the MAC response frame is transmitted a SIFS after reception of the PPDU that elicited the MAC response.
- If the immediate feedback capable beamformee cannot transmit the aggregated or immediate CSI/Steering response information in a SIFS time after the end of the received sounding packet, it may transmit the feedback response information in an aggregate with an ACK or BA in the same TxOP.

The beamformee shall not respond with feedback information and shall not aggregate the feedback response information with an ACK or BA if there is not enough time remaining in the TXOP to deliver the aggregated response.

The beamformee shall resume transmissions of subsequently queued frames (if any) if a PHY_RXSTART.indication does not occur during the ACKTimeout interval after the end of the transmission of a sounding packet and if the time remaining in the TXOP is sufficient for the transmission of the next frame.

A beamformee transmitting immediate and aggregated feedback response shall use an Action No Ack +HTC frame (defined in 7.2.3.12a (Action No Ack frame format)).

A beamformee transmitting delayed feedback response information shall use a Management Action frame to send this information within a separate TXOP which is obtained using the highest priority AC (see 9.1.3.1).

If necessary, the MIMO CSI Matrices Report field, MIMO Non-compressed Beamforming Feedback Matrices field or MIMO Compressed Beamforming Feedback Matrices field may be split into up to 8 frames. The length of each segment shall be equal number of octets for all segments except the last, which may be smaller. The Remaining Matrix Segment subfield in the MIMO Control field shall be set to the number of remaining segment to be transmitted. The Remaining Matrix Segment subfield in the MIMO Control field of the last segment shall be set to 0. When a Report is not segmented, its Remaining Matrix Segment subfield shall be set to 0.

The beamformee shall insert the Sounding Timestamp field in each frame that contains the feedback response information.

A STA that has been granted a reverse direction grant may act as a beamformer during the reverse direction grant time period, provided that the RD rules are obeyed.

A beamformee that advertises itself as delayed feedback capable shall not transmit immediate or aggregated feedback response information, unless it also advertises itself as immediate feedback capable.

A beamformer may use the following worst case parameters to estimate the duration of the expected frame that contains the feedback response information: Basic MCS, mixed format, Minimal Grouping.

An Explicit Feedback Request may be combined with an MRQ. If the response contains a Beamforming Matrix, the returned MCS shall be derived from the same information that was used to generate this particular beamforming matrix. If the response contains channel coefficients, the returned MCS shall be derived from an analysis of the sounding frame that was used to generate the channel coefficients. The MFB field set to 127 (meaning no feedback) may be used when the beamformee is unable to generate the MCS in time for inclusion in the response transmission frame. A CSI capable STA may be incapable of generating MCS feedback.

Explicit feedback shall only be calculated from a sounding PPDU.

Insert the following subclause heading:

9.18 Antenna selection

Insert the following new subclause:

9.18.1 Introduction

Antenna selection is a time-variant mapping of the signals at the RF chains onto a set of antenna elements, when the number of RF chains is smaller than the number of antenna elements at a STA and/or AP. The mapping can be chosen based on instantaneous or averaged channel state information. Antenna selection requires the training of the full size channel associated with all antenna elements, which is obtained by transmitting or receiving sounding PPDUs over all antennas. These sounding PPDUs should be sent within a single TXOP.

To avoid channel distortions, these sounding PPDUs shall be transmitted consecutively. The training information is exchanged by the HT control field, transparent in PHY. When both transmitter and receiver have antenna selection capabilities, training of TX and RX antennas can be done one after another. It is constrained such that the number of antenna elements in any STA is no more than eight and the number of RF chains is no more than four.

Insert the following new subclause:

9.18.2 Procedure

A STA shall only initiate an ASEL training frame exchange sequence with another STA that supports ASEL, as determined by the Antenna Selection Capable field (see 7.3.2.49.7 (Antenna Selection Capability)).

A STA that is capable of supporting antenna selection should set each subfield of the ASEL capabilities field of the HT Capabilities element to 1 depending on its capabilities in all HT Capabilities elements that are transmitted (See 7.3.2.49.7 (Antenna Selection Capability)).

The frame exchange sequence for a transmitter conducting antenna selection is shown in Figure n59 (Frame exchange sequence of transmit antenna selection).

a) (Optional) Receiver may initiate the transmit antenna selection training by sending a TX ASEL sounding request.

b) The transmitter sends out consecutive sounding PPDUs separated by SIFS in a TXOP using burst transmission with no ACK over different antenna sets, with setting TX ASEL sounding indication. A single sounding PPDU is transmitted over one antenna set; the NUM_EXTEN_SS parameter of the TXVECTOR shall be determined by the number of RF chains that is to be used during the transmission of data after the antennas have been selected.

   If the transmitter allows antenna indices feedback (by setting the ASEL command field to 0), then the antenna sets from which the sounding PPDUs are transmitted shall be disjoint. If the transmitter uses NDP sounding PPDUs for the AS sounding, then the spatial mapping matrix Q_k shall be set equal to the identity matrix starting with the first NDP. If the transmitter uses non-NDP sounding PPDUs for the AS sounding, then the spatial mapping matrix Q_k shall be an FFT matrix. An FFT matrix of size N is defined as a square matrix of dimension NxN with entries w_{im} , i=$0,..N-1$, $m=0,..N-1$ where

   $$w_{im} = \frac{1}{\sqrt{N}} \exp\left(-j2\pi im / N\right).$$

   NOTE—For example, in the case of sounding over all disjointed antenna sets, the number of consecutive sounding PPDUs equals the smallest integer that is greater than or equal to the number of antennas divided by the number of RF chains. These sounding PPDUs should be sent within a single TXOP.

c) The receiver estimates the subchannel corresponding to each sounding PPDU.

d) If the ASEL Command field in the sounding frames is set to 6, then after receiving all the sounding PPDUs, the receiver shall explicitly feedback the full size channel state information. If the ASEL Command field in the sounding frames is set to 0, then after receiving all the sounding PPDUs, the receiver may either explicitly feedback the full size channel state information, or conduct antenna selection computation and feedback the selected antenna indices in a subsequent TXOP. The feedback format is defined in 7.4.9.9 (Antenna Selection Indices Feedback frame format).

   1) When providing channel information, an Action No Ack +HTC frame (defined in 7.2.3.12a (Action No Ack frame format)) is used to carry the MIMO CSI Matrices frame feedback defined in 7.4.9.6 (MIMO CSI Matrices frame format). Multiple CSI Matrices frames may be required to provide the complete feedback information, in which case the value of the Sounding Timestamp field within each of these MIMO CSI Matrices frames shall correspond to the arrival time of the sounding frame that was used to generate the feedback information contained in the frame.

2) When providing antenna indices an Action No Ack +HTC frame (defined in 7.2.3.12a (Action No Ack frame format)) is used to carry antenna selection indices feedback as defined in 7.4.9.9 (Antenna Selection Indices Feedback frame format). One octet of the antenna selection indices field is used to carry the selected antenna indices feedback.

In the case that the receiver does not correctly receive the sounding PPDUs, or the current feedback becomes stale, the receiver sends one frame +HTC setting MAI to 14 and the command part in ASELC to 6 to indicate the failure of antenna selection training process.

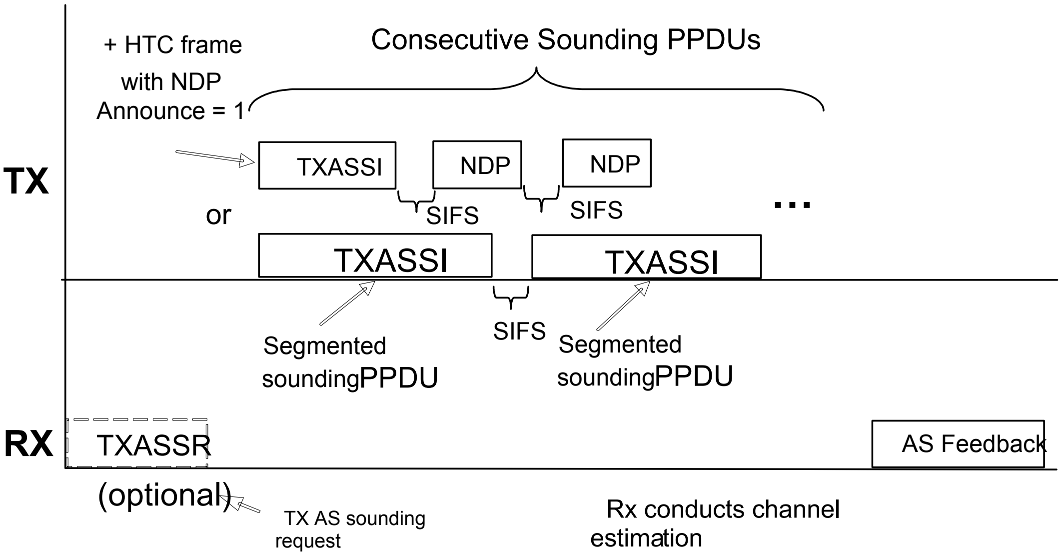

Figure n59—Frame exchange sequence of transmit antenna selection

The frame exchange sequence for a receiver conducting antenna selection is shown in Figure n60 (Frame exchange sequence of receive antenna selection).

a) The receiver sends out a frame + HTC setting RX ASEL sounding request in the command part of ASELC subfield in HT Control Field, and the data part in ASELC to indicate the number of total sounding PPDUs required.

   NOTE— For example, in case of sounding over all disjointed antenna sets, the number of total consecutive sounding PPDUs or NDPs equals the smallest integer that is greater than or equal to the number of antennas divided by the number of RF chains.

b) The transmitter responds with the corresponding number of sounding PPDUs or NDPs in its subsequent TXOP, using burst transmission with no ACK, with setting RX ASEL sounding indication, and sounding frame format.

The receiver uses different antenna sets to receive these sounding PPDUs or NDPs, estimates channel state information after receiving all these sounding PPDUs or NDPs, and conducts the antenna selection.

During the frame exchange processes of explicit beamforming, implicit beamforming and calibration, neither the receiving nor the transmitting STA should switch its antennas.When both transmitter and receiver have antenna selection capabilities, the peer station shall use fixed antenna subset to receive or transmit the consecutive sounding PPDUs in the training processes defined in Figure n59 (Frame exchange sequence of transmit antenna selection) and Figure n60 (Frame exchange sequence of receive antenna selection); and TX and RX antenna selection training shall be done alternately.

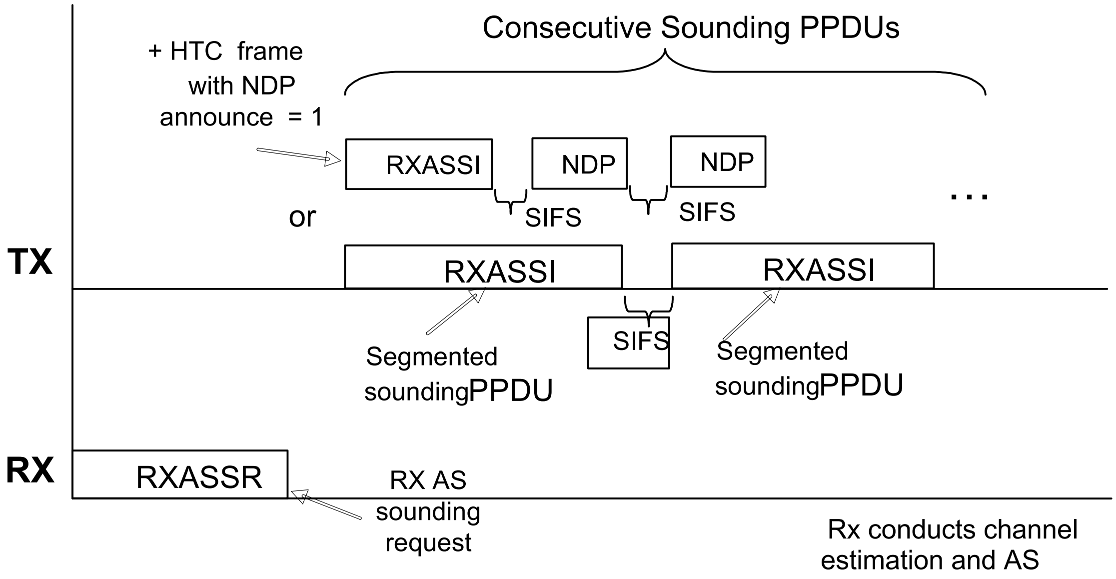

Figure n60—Frame exchange sequence of receive antenna selection

Insert the following subclause heading:

9.19 Null Data Packet (NDP) as sounding PPDU

Insert the following new subclause:

9.19.1 NDP Rules

If an HT STA has indicated receive capability for Null Data Packet (NDP) sounding in the HT Capabilities element during association, the STA shall process an NDP as a sounding packet if the destination of the sounding packet is determined to match itself as described in 9.19.2 (Determination of NDP destination), and if the source of the sounding packet can be ascertained as described in 9.19.3 (Determination of NDP source).

An RXVECTOR LENGTH parameter set to 0 indicates that the frame is an NDP.

A STA shall set the NOT_SOUNDING parameter of the TXVECTOR to zero in the PHY-TXSTART.request primitive corresponding to an NDP transmission to indicate that this frame is a sounding frame.

Only the current TXOP holder or a calibration responder or an RD responder may transmit an NDP. A TxOP holder shall not set to 1 the NDP Announcement and RDG/More PPDU fields simultaneously.

The value of the Duration field of the NDP announcement frame shall be no less than the combined duration of the expected response frame (if any), the SIFS interval preceding the expected response frame, the NDP transmissions and the additional SIFS(s) that precede each NDP transmission.

From a MAC perspective a +HTC frame with NDP announcement set and No-ACK policy followed by an NDP within a SIFS is not a burst (i.e. the NDP is not processed by the MAC).

A STA that transmits an NDP shall start the transmission of the NDP as follows:

- a SIFS interval after sending a +HTC frame that does not require an immediate response with the NDP Announcement field set to 1 or,
- a SIFS interval after successfully receiving a correctly formed and addressed immediate response to a +HTC frame that requires an immediate response with the NDP Announcement field set to 1.

This rule enables the NDP receiver to know that it will receive an NDP and can determine the source and destination of the NDP. It enables the receiver and transmitter to know when the immediate response and NDP will be transmitted relative to the frame containing the NDP announcement indication.

A STA shall transmit only one NDP per NDP announcement, unless the frame with the NDP Announcement field set to 1 includes a value in the ASEL Data subfield of the ASELC subfield of the HTC Control field that is greater than one, in which case, the STA shall transmit the number of NDPs indicated in the ASEL Data subfield.

A STA shall use the Control Wrapper frame (7.2.1.9 (Control Wrapper frame)) to announce NDP in non-HT PPDU control frames.

Feedback information generated from the reception of a NDP shall be transmitted using any of the feedback rules and signaling as appropriate, e.g. immediate or delayed.

If the reception immediately preceding (the frame ending at SIFS from the start of the NDP) the NDP has an FCS error, the NDP shall be dropped by the receiver.

If the HT Control field of a frame with the NDP Announcement field set to 1 announces a number of NDP sounding frames that is greater than one as indicated by the value provided in the ASEL Data portion of the ASELC subfield of the Link Adaptation control field of the HT Control field, then the transmitter shall transmit an additional NDP a SIFS after the end of each transmitted NDP until the total number of NDP transmissions is equal to the announced number of NDPs.

The number of sounded spatial streams in an NDP transmission is determined by the MCS. The MCS of an NDP transmission determines only the number of spatial streams. The MCS of an NDP transmission shall not be limited by the receiving station’s supported MCSs. A STA shall set the NUM_EXTEN_SS parameter of the TXVECTOR to zero in the PHY TXSTART.request primitive corresponding to an NDP transmission.

A STA shall not transmit an NDP with a destination address corresponding to a STA that does not support TXBF.

Insert the following new subclause:

9.19.2 Determination of NDP destination

The destination of an NDP is determined at the NDP receiver by examining the frame immediately previous (within SIFS) to the NDP as follows:

- If the immediately previous frame at the NDP receiver was a transmission by the TXOP holder or by an RD responder, the destination of the NDP is equal to the RA of that immediately previous frame.
- If the immediately previous frame at the NDP receiver was a transmission by a STA that is not the TXOP holder or RD responder, the destination of the NDP is equal to the TA of that immediately previous frame.

If the PPDU a SIFS before the reception of an NDP is also an NDP, the destination of the NDP is equal to the destination of the previous NDP.

Insert the following new subclause:

9.19.3 Determination of NDP source

The source of an NDP is determined at the NDP receiver by examining the frame immediately previous (within SIFS) to the NDP as follows:

- If the immediately previous frame at the NDP receiver was a transmission by the TXOP holder or the calibration responder or RD responder, the source of the NDP is equal to the TA of that immediately previous frame.
- If the immediately previous frame at the NDP receiver was a transmission by a STA that is not the TXOP holder, the source of the NDP is equal to the RA of that immediately previous frame.

If the PPDU a SIFS before the reception of an NDP is also an NDP, the source of the NDP is equal to the destination of the previous NDP.

Insert the following subclause heading

9.20 20/40 Functional description

Insert the following new subclause:

9.20.1 Rules for operation in 20/40 MHz BSS

A 20/40 capable STA operating in 20 MHz mode follows the rules for a 20 MHz capable STA.

A 20/40 capable STA operating under PCO operates as defined in 11.16 (Phased Coexistence Operation).

A 20/40 capable STA operating under L-SIG TXOP protection operates as defined in 9.13.5 (L-SIG TXOP protection).

Otherwise, a 20/40 capable STA shall operate as defined in 9.20.2 (STA CCA sensing 20/40 MHz BSS) to 9.20.4 (Switching between 40 MHz and 20 MHz).

Insert the following new subclause:

9.20.2 STA CCA sensing 20/40 MHz BSS

A station may transmit a 20 MHz mask PPDU in the primary channel following the rules in 9.9.1.

A STA transmitting a 40 MHz mask PPDU that begins a TXOP as described in 9.9.1.3, shall sense CCA on both the 20 MHz primary channel and the 20 MHz secondary channel before the 40 MHz mask PPDU transmission shall commence. Secondary channel CCA shall be deemed BUSY during transmission or reception of a 20 MHz PPDU in the primary channel. Secondary channel CCA shall be deemed BUSY during transmission of a 20 MHz PPDU in the secondary channel. Secondary and primary channel CCA shall be deemed BUSY during transmission of a 40 MHz PPDU.

At the specific slot boundaries, determined by the STA based on the 20 MHz primary channel CCA, when the transmission begins a TXOP (as described in 9.9.1.3), the STA shall be permitted to transmit a 40 MHz mask PPDU only if the secondary channel has been idle for a duration of at least PIFS immediately preceding the expiration of the backoff counter and may not transmit a PPDU if the secondary channel has not been idle for a duration of at least PIFS (using short timeslot for 5GHz band and long timeslot for 2.4GHz band) immediately preceding the expiration of the backoff counter. The next earliest 40 MHz mask PPDU transmission for the STA shall be when an additional backoff (determined using the same contention window value as the previous backoff) on the primary channel has expired and the secondary channel has been idle for at least the PIFS (using short timeslot for 5GHz band and long timeslot for 2.4GHz band) immediately preceding the expiration of the backoff counter.

When a TXOP is obtained for a 40 MHz PPDU, the station may transmit 40 MHz PPDUs and/or 20 MHz PPDUs during the TXOP. When the TXOP is obtained by the exchange of 20 MHz PPDUs only in the primary channel, the station shall not transmit 40 MHz PPDUs during the TXOP.

Insert the following new subclause:

9.20.3 NAV assertion in 20/40 MHz BSS

An HT STA shall update its NAV using the Duration/ID field value in any frame received in a 20 MHz PPDU in the primary channel or received in a 40 MHz PPDU and that does not have an RA matching the STA MAC address.

NOTE—A STA need not set its NAV in response to 20 MHz frames received on the secondary channel, even if it is capable of receiving those frames.

Insert the following new subclause:

9.20.4 Switching between 40 MHz and 20 MHz

Once associated, a non-AP STA shall support the same channel width capabilities it declared in its Association Request. This capability is asserted in the Supported Channel Width Set in the HT capabilities element.

When a STA is associated with an AP that declares a Supported Channel Width of 20/40 MHz, the STA may transmit frames in the 20 MHz wide primary channel as well as the 40 MHz wide channel. A non-AP STA that is a member of a 40 MHz BSS shall not transmit 20 MHz frames in the secondary channel.

An HT-AP-19 that set the Supported Channel Width Set field of its most recently transmitted HT Capability element to 0 may set the Forty MHz Intolerant field to 1 in transmitted HT Capabilities elements.

An HT-AP-19 that set the Supported Channel Width Set field of its most recently transmitted HT Capability element to a non-zero value may set the Forty MHz Intolerant field to 1 in transmitted HT Capabilities elements.

The following events are defined to be BSS width trigger events:

a) detection on any 40 MHz affected channel of at least one unicast data frame that is not a Null subtype frame originating from a BSSID that is not the BSSID of the AP or non-AP STA detecting the frame and is not a BSSID that matches the BSSID of a beacon that was detected on the primary channel in the previous 500 milliseconds

b) reception on any 40 MHz sensitive channel, of a frame that contains an HT Capabilities element with the value of 1 in the Forty MHz Intolerant field

c) reception of an HT Information Exchange management action frame with the Forty MHz Intolerant field set to 1 from a STA with which the receiver has an active association

An HT-AP-19 that detects any of the BSS width trigger events a), b) or c) shall set the STA Channel Width field to 0 in transmitted HT Information elements beginning at the next DTIM or next TBTT if no DTIMs are transmitted and shall set the Secondary Channel Offset field to 0 in transmitted HT Information elements beginning at the next DTIM or next TBTT if no DTIMs are transmitted to indicate that no secondary channel is present (i.e., that the BSS operating width is 20 MHz) and shall subsequently operate in accordance with the following restrictions:

The HT-AP-19 shall not set the STA Channel Width field to 1 in transmitted HT Information elements until thirty minutes have elapsed during which there are no BSS width trigger events.

The HT-AP-19 shall not set the Secondary Channel Offset field to a non-zero value in transmitted HT Information elements until thirty minutes have elapsed during which there are no BSS width trigger events.

An HT-AP-19 that has an active association with at least one non-HT STA may set the Forty MHz Intolerant bit in transmitted HT Capability elements to 1, and may set the Forty MHz Intolerant bit to 1 at other times.

An HT-AP-19 that has an active association with at least one HT STA whose last successfully indicated value of the Forty_MHz_Intolerance bit is 1 in any frame transmitted to the HT-AP-19 shall set the STA Channel Width field to 0 in transmitted HT Information elements beginning at the next DTIM or next TBTT if no DTIMs are transmitted and shall set the Secondary Channel Offset field to 0 in transmitted HT Information elements beginning at the next DTIM or next TBTT if no DTIMs are transmitted to indicate that no secondary channel is present.

An HT-AP-19 may transmit an HT Information Exchange management frame with a value of 1 in the Request Information bit to a STA including an Information element in order to request an update of the status of the Forty MHz Intolerant field of the HT Capabilities element.

Before transmitting a frame containing an HT Information element with the Secondary Channel Offset field set to non-zero value, an HT-AP-19 may complete an overlapping BSS scan (defined below) at a time no earlier than one beacon interval preceeding the transmission.

An overlapping BSS scan operation is defined as a passive or active scan of all of the 40 MHz affected channel excluding the primary channels contained in the AP Channel Report set wherein, the per-channel scan duration is a minimum of 10 TU and where each channel in the set is scanned at two times per thirty minutes and the minimum total scan time per channel per thirty minutes is 200 msec.

The AP may communicate its STA Channel Width either by transmitting the HT Information Element (in beacons and probe response frames) or by transmitting the Notify Channel Width management action frame.

A 20/40 MHz capable non-AP STA in a 20/40 MHz capable BSS may request that frames sent to it be of 20 or 40 MHz width. The STA shall use the Notify Channel Width management action frame to achieve this.

The reaction of both STA and AP to switch the channel width may be not immediate after receiving these frames. The STA that has transmitted one of these frames shall decide that the related request has been adopted after having received an HT frame of requested specified channel width.

Recommending a transmission width of 20 MHz has no effect on the BSS requirements regarding protection of 40 MHz transmissions or on the STA Channel Width advertised by the associated AP. A STA should reassociate with its Supported Channel Width Set field set to 0 (indicating only 20 MHz operation) to obtain this protection.

An HT STA that is associated with an HT-AP-19 and that detects either of the BSS width trigger events a) or b) shall perform either of the following operations:

- disassociate from the HT-AP-19 and reassociate with the HT-AP-19 with its Supported Channel Width Set field set to 0, indicating support only for 20 MHz operation, and the Forty MHz Intolerant field set to 1 in the HT Capability element
- successfully transmit to its associated HT-AP-19 an HT Information Exchange management action frame with the Forty MHz Intolerant field set to 1 if the last successfully transmitted indication to the HT-AP-19 of the Forty MHz Intolerant field was 0.

A STA that has met the above conditions and performed at least one of the above operations shall subsequently operate in accordance with the following three restrictions:

- The HT STA shall not transmit any frame using a 40 MHz mask PPDU
- The STA shall not transmit to its associated AP an HT Information Exchange management action frame with the Forty MHz Intolerant field set to 0 before for a period of thirty minutes has elapsed during which there are no BSS width trigger events a) or b).
- The STA shall not reassociate with the HT-AP-19 with a Capability element containing a value of 0 for the Forty MHz Intolerant field before a period of thirty minutes has elapsed during which there are no BSS width trigger events a) or b).

A STA may set the Forty MHz Intolerant bit to 1 in an association or reassociation frame or in an HT Information Exchange management action frame sent to the AP, for reasons other than the detection of an intolerant BSS.

Before transmitting a frame containing an HT Capability element with the Forty MHz Intolerant bit set to 0, an HT STA that is associated with an HT-AP-19 shall complete an overlapping BSS scan at a time no earlier than one beacon interval preceeding the transmission.

An HT STA that indicates in the Supported Channel Width Set field of its most recently transmitted HT Capability element a value of 1 shall accept all Beacon Measurement Requests from its associated HT-AP-19 that have a value of 254 for the reporting condition, except when the total number of octets in the transmitted MSDUs and received unicast MSDUs during the past 30 minutes did not exceed 10000 octets.

An HT-AP-19 that indicates in the Secondary Channel Offset field of its most recently transmitted HT Information element a non-zero value shall assume a value of 1 for the STA Channel Width of a STA that has associated with a value of 1 in the Supported Channel Width Set field of its HT Capability element until it receives an HT Information Exchange management action frame from that STA.

An HT-AP-19 that indicates in the Secondary Channel Offset field of its most recently transmitted HT Information element a value of 0 shall assume a value of 0 for the STA Channel Width of a STA that has associated with a value of 1 in the Supported Channel Width Set field of its HT Capability element until it receives an HT Information Exchange management action frame from that STA.

An HT STA shall assume that its associated HT-AP-19 has assumed a value of 1 for the STA Channel Width value for corresponding to its association until the HT STA successfully transmits an HT Information Exchange management action frame to the HT-AP-19.

An HT-AP-19 that indicates in the Secondary Channel Offset field of its most recently transmitted HT Information element a non-zero value shall transmit a Beacon Request Measurement request to an HT STA that set the Supported Channel Width Set field of its most recently transmitted HT Capability element to a value of 1 within 2 minutes of the successful completion of the association by that HT STA. The request shall include the following specifics:

- the mode shall be either passive mode or active mode,
- the measurement duration shall be a minimum of 10 TU, representing the time required to scan per channel,
- the channel number shall be 255, indicating that iterative measurements shall be performed on all channels in the AP Channel Report,
- the BSSID shall be the broadcast BSSID,
- the reporting condition shall be 254 (report not necessary), and
- the threshold value may be non-zero, in which case, it indicates the minimum RCPI for a frame to be examined as per the procedures in “9.20.7 STA switching from 40 MHz to 20 MHz in 20/40 MHz BSS. Received beacons that do not meet this minimum RCPI threshold do not need to be processed.

During each successive thirty minute period of continued association by an HT STA, the associated HT-AP-19 shall transmit additional Beacon Request Measurement requests to that HT STA such that all of the channels in the AP Channel Report shall have been scanned at least twice by the HT STA for a minimum duration of 10 TU per scanned channel during the thirty minutes.

An HT-AP-19 that set the Supported Channel Width Set field of its most recently transmitted HT Capability element to a non-zero value shall transmit an AP Channel Report containing at least all of the 40 MHz affected channels excluding the primary channel.

An HT STA whose most recently successfully acknowledged transmission of the STA Channel Width field in any frame was set to 0 shall not transmit a 40 MHz mask PPDU.

10. Layer management

10.3 MLME SAP interface

10.3.2 Scan

10.3.2.2 MLME-SCAN.confirm

10.3.2.2.2 Semantics of the service primitive

Insert the following entries into the table defining BSSDescription in 10.3.2.2.2 as follows:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	The values from the HT Capabilities element if such an element was present in the probe response or beacon, else null. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.
HT Information	As defined in frame format	As defined in frame format	The values from the HT Information element if such an element was present in the probe response or beacon, else null. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.
BSSBasicMembershipSelectorSet	set of integers	1-127 for each member of the set	The BSS membership selectors that represent the set of features that shall be supported by all STAs to join this BSS. The STA that is creating the BSS shall be able to support each of the features represented by the set.

10.3.6 Associate

10.3.6.1 MLME-ASSOCIATE.request

10.3.6.1.2 Semantics of the service primitive

Change the primitive parameters in 10.3.6.1.2 as follows:

MLME-ASSOCIATE.request(
PeerSTAAddress,
AssociateFailureTimeout,
CapabilityInformation,
ListenInterval,
Supported Channels,
RSN,
QoSCapability,
HT Capabilities,
SupportedRegulatoryClasses,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.6.1.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are supported by the MAC entity. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.
Supported Regulatory Classes	As defined in the Supported Regulatory Classes element	As defined in the Supported Regulatory Classes element	Specifies the Supported Regulatory Classes capabilities of the non-AP STA. This parameter shall only be present if the MIB attribute dot11ExtendedChannelSwitchImplemented is true.

10.3.6.2 MLME-ASSOCIATE.confirm

10.3.6.2.2 Semantics of the service primitive

Change the primitive parameters of 10.3.6.2.2 as shown:

MLME-ASSOCIATE.confirm(
ResultCode,
CapabilityInformation,
AssociationID,
SupportedRates,
EDCAParameterSet,
<u>HT Capabilities,</u>
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.6.2.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are to be used by the peer MAC entity (AP). The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

10.3.6.3 MLME-ASSOCIATE.indication

10.3.6.3.2 Semantics of the service primitive

Change the primitive parameters of 10.3.6.3.2 as shown:

MLME-ASSOCIATE.indication(
PeerSTAAddress,
CapabilityInformation,
ListenInterval,
SSID,
SupportedRates,
RSN,

QoSCapability,
RCPI,
RSNI,
HT Capabilities,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.6.3.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are supported by the peer MAC entity. The parameter may be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

10.3.6.4 MLME-ASSOCIATE.response

10.3.6.4.2 Semantics of the service primitive

Change the primitive parameters in 10.3.6.4.2 as shown:

MLME-ASSOCIATE.response(
PeerSTAAddress,
ResultCode,
CapabilityInformation,
AssociationID,
EDCAParameterSet,
SupportedRegulatoryClasses,
VendorSpecificInfo
)

Insert the following row at the end of the parameter table:

Name	Type	Valid Range	Description
Supported Regulatory Classes	As defined in the Supported Regulatory Classes element	As defined in the Supported Regulatory Classes element	Indicates the Supported Regulatory Classes capabilities of the AP. This parameter shall only be present if the MIB attribute dot11ExtendedChannelSwitchImplemented is true.

10.3.7 Reassociate

10.3.7.1 MLME-REASSOCIATE.request

10.3.7.1.2 Semantics of the service primitive

Change the primitive parameters in 10.3.7.1.2 as follows:

MLME-REASSOCIATE.request(
NewAPAddress,
ReassociateFailureTimeout,
CapabilityInformation,

ListenInterval,
Supported Channels,
RSN,
QoSCapability,
Content of FT Authentication Information Elements,
HT Capabilities,
Supported Regulatory Classes,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.7.1.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are supported by the MAC entity. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.
Supported Regulatory Classes	As defined in the Supported Regulatory Classes element	As defined in the Supported Regulatory Classes element	Specifies the Supported Regulatory Classes of the non-AP STA. This parameter shall only be present if the MIB attribute dot11ExtendedChannelSwitchImplemented is true.

10.3.7.2 MLME-REASSOCIATE.confirm

10.3.7.2.2 Semantics of the service primitive

Change the primitive parameters in 10.3.7.2.2 as follows:

MLME-REASSOCIATE.confirm(
ResultCode,
CapabilityInformation,
AssociationID,
SupportedRates,
EDCAParameterSet,
Content of FT Authentication Information Elements,
HT Capabilities,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.7.2.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are to be used by the peer MAC entity (AP). The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

10.3.7.3 MLME-REASSOCIATE.indication

10.3.7.3.2 Semantics of the service primitive

Change the primitive parameters in 10.3.7.3.2 as follows:

MLME-REASSOCIATE.indication(
PeerSTAAddress,
CurrentAPAddress,
CapabilityInformation,
ListenInterval,
SSID,
SupportedRates,
RSN,
QoSCapability,
RCPI,
RSNI,
Content of FT Authentication Information Elements,
HT Capabilities,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.7.3.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are supported by the peer MAC entity. The parameter may be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

10.3.7.4 MLME-REASSOCIATE.response

10.3.7.4.2 Semantics of the service primitive

Change the primitive parameter list of 10.3.7.4.2 as shown:

MLME-REASSOCIATE.response(
PeerSTAAddress,
ResultCode,
CapabilityInformation,
AssociationID,
EDCAParameterSet,

Content of FT Authentication Information Elements,
Supported Regulatory Classes,
VendorSpecificInfo
)

Insert the following row at the end of the parameter table:

Name	Type	Valid Range	Description
Supported Regulatory Classes	As defined in the Supported Regulatory Classes element	As defined in the Supported Regulatory Classes element	Specifies the Supported Regulatory Classes of the non-AP STA. This parameter shall only be present if the MIB attribute dot11ExtendedChannelSwitchImplemented is true.

10.3.10 Start

10.3.10.2 MLME-START.request

10.3.10.2.2 Semantics of the service primitive

Change the primitive parameters in 10.3.10.1.2 as follows:

MLME-START.request(
SSID,
BSSType,
BeaconPeriod,
DTIMPeriod,
CF parameter set,
PHY parameter set,
IBSS parameter set,
ProbeDelay,
CapabilityInformation,
BSSBasicRateSet,
OperationalRateSet,
Country,
IBSS DFS Recovery Interval,
EDCAParameterSet,
HT Capabilities,
HT Information,
BSSBasicMembershipSelectorSet,
VendorSpecificInfo
)

Insert the following three entries in the table in 10.3.10.1.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format HT Capabilities Element	As defined in frame format	The HT capabilities to be advertised for the BSS. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.
HT Information	As defined in frame format HT Information Element	As defined in frame format	Present only if BSSType = INFRASTRUCTURE and if the MIB attribute dot11HighThroughputOptionImplemented is true. The additional HT capabilities to be advertised for the BSS.
BSSBasicMembershipSelectorSet	set of integers	1-127 for each member of the set	The BSS membership selectors that represent the set of features that shall be supported by all STAs to join this BSS. The STA that is creating the BSS shall be able to support each of the features represented by the set.

10.3.15 Channel switch

10.3.15.1 MLME-CHANNELSWITCH.request

10.3.15.1.2 Semantics of the service primitive

Change the parameter list in 10.3.15.1.2 follows:

The primitive parameters are as follows:

MLME-CHANNELSWITCH.request(
Mode,
Channel Number,
<u>Secondary Channel Offset,</u>
Channel Switch Count,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.15.1.2 immediately before the row for VendorSpecificInfo:

Name	Type	Valid range	Description
Secondary Channel Offset	Integer	0, 1, 3	Specifies the position of secondary channel in relation to the primary channel. Present only when the BSS is operating in 20/40 mode. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

Insert the following new paragraph at the end of 10.3.15.1.2:

The Secondary Channel Offset parameter may be present for the HT Stations.

10.3.15.3 MLME-CHANNELSWITCH.indication

10.3.15.3.2 Semantics of the service primitive

Change the parameter list in 10.3.15.3.2 as follows:

MLME-CHANNELSWITCH.indication(
Peer MAC Address,
Mode,
Channel Number,
Secondary Channel Offset,
Channel Switch Count,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.15.3.2 immediately before the row for Channel Switch Count:

Name	Type	Valid range	Description
Secondary Channel Offset	Integer	0, 1, 3	Specifies the position of secondary channel in relation to the primary channel. Present only when the BSS is operating in 20/40 mode. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

10.3.15.4 MLME-CHANNELSWITCH.response

10.3.15.4.2 Semantics of the service primitive

Change the parameter list in 10.3.15.4.2 as follows:

MLME-CHANNELSWITCH.response(
Mode,
Channel Number,
Secondary Channel Offset,
Channel Switch Count,
VendorSpecificInfo
)

Insert the following entry in the table in 10.3.15.4.2 immediately before the row for Channel Switch Count:

Name	Type	Valid range	Description
Secondary Channel Offset	Integer	0, 1, 3	Specifies the position of secondary channel in relation to the primary channel. Present only when the BSS is operating in 20/40 mode. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

10.3.25.2 MLME-DLS.confirm

10.3.25.2.2 Semantics of the service primitive

Change the parameter list in 10.3.25.2.2 as follows:

The primitive parameters are as follows:

MLME-DLS.confirm (
PeerMACAddress,
ResultCode,
CapabilityInformation,
DLSTimeoutValue,
SupportedRates,
HT Capabilities
)

Insert the following entry in the table in 10.3.25.2.2 after the row for SupportedRates:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are supported by the MAC entity. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

10.3.25.3 MLME-DLS.indication

10.3.25.3.2 Semantics of the service primitive

Change the parameter list in 10.3.25.3.2 as follows:

The primitive parameters are as follows:

MLME-DLS.indication (
PeerMACAddress,
CapabilityInformation,
DLSTimeoutValue,
DLSResponseTimeout,

HT Capabilities
)

Insert the following entry in the table in 10.3.25.3.2 after the row for SupportedRates:

Name	Type	Valid range	Description
HT Capabilities	As defined in frame format	As defined in frame format	Specifies the parameters within the HT Capabilities element that are supported by the MAC entity. The parameter shall be present only if the MIB attribute dot11HighThroughputOptionImplemented is true.

Insert the following new subclause:

10.3.38 Extended channel switch

The following MLME primitives support the signaling of Extended Channel Switch Announcement.

Insert the following new subclause header:

10.3.38.1 MLME-EXTCHANNELSWITCH.request

Insert the following new subclause:

10.3.38.1.1 Function

This primitive requests that an Extended Channel Switch Announcement frame be sent by an AP.

Insert the following new subclause:

10.3.38.1.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-EXTCHANNELSWITCH.request(
Mode,
Regulatory Class,
Channel Number,
Channel Switch Count,
VendorSpecificInfo
)

Name	Type	Valid Range	Description
Mode	Integer	0,1	Channel switch mode, as defined for the Extended Channel Switch Announcement element. 7.4.1.6 (Extended Channel Switch Announcement frame format)
Regulatory Class	Integer	As defined in-Annex J	Specifies the new regulatory class.
Channel Number	Integer	As defined in-Annex J	Specifies the new channel number.
Channel Switch Count	Integer	0 – 255	Specifies the number of TBTTs until the channel switch event, as described for the Extended Channel Switch Announcement element.
VendorSpecificInfo	A set of information elements	As defined in 7.3.2.26	Zero or more information elements.

Insert the following new subclause:

10.3.38.1.3 When generated

This primitive is generated by the SME to request that an Extended Channel Switch Announcement frame be sent to a non-AP STA that is associated to the AP.

Insert the following new subclause:

10.3.38.1.4 Effect of receipt

On receipt of this primitive, the MLME constructs an Extended Channel Switch Announcement frame. The AP then attempts to transmit this frame to STAs that are associated.

Insert the following new subclause header:

10.3.38.2 MLME-EXTCHANNELSWITCH.confirm

Insert the following new subclause:

10.3.38.2.1 Function

This primitive reports the result of a request to switch channel.

Insert the following new subclause:

10.3.38.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-EXTCHANNELSWITCH.confirm(
        ResultCode,
        VendorSpecificInfo
)
```

Name	Type	Valid Range	Description
ResultCode	Enumeration	SUCCESS, INVALID PARAMETERS or UNSPECIFIED FAILURE	Reports the result of an extended channel switch request.
VendorSpecificInfo	A set of information elements	As defined in 7.3.2.26	Zero or more information elements.

Insert the following new subclause:

10.3.38.2.3 When generated

This primitive is generated by the MLME when an extended channel switch request completes. Possible unspecified failure causes include an inability to schedule an extended channel announcement.

Insert the following new subclause:

10.3.38.2.4 Effect of receipt

The SME is notified of the results of the extended channel switch procedure.

Insert the following new subclause heading:

10.3.38.3 MLME-EXTCHANNELSWITCH.indication

Insert the following new subclause:

10.3.38.3.1 Function

This primitive indicates that an Extended Channel Switch Announcement frame was received from an AP.

Insert the following new subclause:

10.3.38.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-EXTCHANNELSWITCH.indication(
        Peer MAC Address,
        Mode,
        Regulatory Class,
        Channel Number,
```

Channel Switch Count,
VendorSpecificInfo
)

Name	**Type**	**Valid Range**	**Description**
Peer MAC Address	MACAddress	Any valid individual MAC Address	The address of the peer MAC entity from which the Measurement Report frame was received.
Mode	Integer	0,1	Channel switch mode, as defined for the Extended Channel Switch Announcement element.
Regulatory Class	Integer	As defined in Annex J	Specifies the new regulatory class.
Channel Number	Integer	As defined in-Annex J	Specifies the new channel number.
Channel Switch Count	Integer	0 – 255	Specifies the number of TBTTs until the channel switch event, as described for the Extended Channel Switch Announcement element.
VendorSpecificInfo	A set of information elements	As defined in 7.3.2.26	Zero or more information elements.

Insert the following new subclause:

10.3.38.3.3 When generated

This primitive is generated by the MLME when a valid Extended Channel Switch Announcement frame is received.

Insert the following new subclause:

10.3.38.3.4 Effect of receipt

On receipt of this primitive, the SME decides whether to accept the switch request.

Insert the following new subclause heading:

10.3.38.4 MLME-EXTCHANNELSWITCH.response

Insert the following new subclause:

10.3.38.4.1 Function

This primitive is used to schedule an accepted extended channel switch.

Insert the following new subclause:

10.3.38.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
                    MLME-EXTCHANNELSWITCH.response(
                                   Mode,
                                   Regulatory Class,
                                   Channel Number,
                                   Channel Switch Count,
                                   VendorSpecificInfo
                    )
```

Name	Type	Valid Range	Description
Mode	Integer	0,1	Channel switch mode, as defined for the Extended Channel Switch Announcement element.
Regulatory Class	Integer	As defined in Annex J	Specifies the new regulatory class.
Channel Number	Integer	As defined in- Annex J	Specifies the new channel number.
Channel Switch Count	Integer	0 – 255	Specifies the number of TBTTs until the channel switch event, as described for the Extended Channel Switch Announcement element.
VendorSpecificInfo	A set of information elements	As defined in 7.3.2.26	Zero or more information elements.

Insert the following new subclause:

10.3.38.4.3 When generated

This primitive is generated by the SME to schedule an accepted extended channel switch request.

Insert the following new subclause:

10.3.38.4.4 Effect of receipt

On receipt of this primitive, the MLME schedules the extended channel switch. The actual channel switch is made at the appropriate time through the MLME-PLME interface using the PLME-SET primitive of the dot11CurrentFrequency MIB attribute. If Mode = 0, STA shall refrain from transmitting until the time of the extended channel switch.

10.4 PLME SAP interface

10.4.3 PLME-CHARACTERISTICS.confirm

10.4.3.2 Semantics of the service primitive

Change the primitive parameters as shown:

```
                    PLME-CHARACTERISTICS.confirm(
                                   aSlotTime,
```

aSIFSTime,
aCCATime,
aPHY-RX-START-Delay,
aRxTxTurnaroundTime,
aTxPLCPDelay,
aRxPLCPDelay,
aRxTxSwitchTime,
aTxRampOnTime,
aTxRampOffTime,
aTxRFDelay,
aRxRFDelay,
aAirPropagationTime,
aMACProcessingDelay,
aPreambleLength,
aRIFSTime,
aSymbolLength,
aSTFOneLength,
aSTFTwoLength,
aLTFOneLength,
aLTFTwoLength,
aPLCPHeaderLength,
aPLCPSigTwoLength,
aMPDUDurationFactor,
aMPDUMaxLength,
aPSDUMaxLength,
aPPDUMaxTime,
aIUSTime,
aDTT2UTTTime,
aCWmin,
aCWmax,
aMaxCSIMatricesReportDelay
)

Change the last paragraph of the subclause as follows:

The values assigned to the parameters shall be as specified in the PLME SAP interface specification contained within each PHY subclass of this standard. The parameters aRIFSTime, aSymbolLength, aSTFOneLength, aSTFTwoLength, aLTFOneLength, aLTFTwoLength, aPLCPSigTwoLength, aMPDUDurationFactor, aMPDUMaxLength, aPSDUMaxLength, aPPDUMaxTime, aIUSTime and aDTT2UTTTime are not used by all PHYs defined within this standard.

Change the following entries after aPreambleLength in the table as shown by the following non-header rows:

Name	Type	Description
aRIFSTime	integer	Value of the reduced interframe spacing (in μs), which is the time by which multiple transmissions from a single transmitter may be separated, when no SIFS-separated response transmission is expected. See 9.2.3.6 (RIFS).
aSymbolLength	integer	The current PHY's Symbol length (in μs). If the actual value of the length is not an integral number of μs, the value is rounded up to the next higher value.
aSTFOneLength	integer	The Short Training Field One Length (in μs)
aSTFTwoLength	integer	The Short Training Field Two Length (in μs)
aLTFOneLength	integer	The Long Training Field One Length (in μs)

Name	**Type**	**Description** ***(continued)***
aLTFTwoLength	integer	The Long Training Field Two Length (in µs)
aPLCPHeader-Length	integer	The current PHY's PLCP header length (in µs), excluding aPLCPSigTwoLength if present . If the actual value of the length of the modulated header is not an integral number of µs, the value is rounded up to the next higher value.
aPLCPSigTwo-Length	integer	The HT-SIG length (in µs)
aMPDUDuration-Factor	integer	The overhead added by the PHY to the MPDU as it is transmitted through the WM expressed as a scaling factor applied to the number of bits in the MPDU. The value of aMPDUDurationFactor is generated by the following equation: Truncate[((PPDUbits/PSDUbits)–1) × 10^9)]. The total time to transmit a PPDU over the air is generated by the following equation rounded up to the next integer µs: aPreambleLength + aPLCPHeaderLength + (((aMPDUDurationFactor × 8 × PSDUoctets) / 10^9) + (8 × PSDUoctets)) / data rate where data rate is in Mb/s. The total time (in µs) to the beginning of any octet in a PPDU from the first symbol of the preamble can be calculated using the duration factor in the following equation: Truncate[aPreambleLength + aPLCPHeaderLength + (((aMPDUDurationFactor × 8 × N) / 10^9) + (8 × N)) / data rate] + 1, where data rate is in Mb/s and where *N* counts the number of octets in the PPDU prior to the desired octet, but does not count the number of octets in the preamble PLCP header.
aMPDUMax-Length	integer	The maximum number of octets in an MPDU that can be conveyed by a PLCP protocol data unit (PPDU).
aPSDUMax-Length	integer	The maximum number of octets in a PSDU that can be conveyed by a PLCP protocol data unit (PPDU).
aPPDUMaxTime	integer	The maximum duration of a PPDU in units of milliseconds
aIUSTime	integer	The minimum time between the end of a PSMP-UTT and the start of the following PSMP-UTT in the same PSMP sequence
aDTT2UTTTime	integer	The minimum time between the end of a PSMP-DTT and the start of the PSMP-UTT addressed to the same STA

10.4.6 PLME-TXTIME.request

10.4.6.1 Function

Change 10.4.6.1 as follows:

This primitive is a request for the PHY to calculate the time that will be required to transmit onto the WM a PPDU containing a specified length ~~MPDU~~PSDU, and using a specified format, data rate, and signalling.

10.4.6.2 Semantics of the service primitive

Change 10.4.6.2 as follows:

This primitive provides the following parameters:

PLME-TXTIME.request(TXVECTOR)

The TXVECTOR represents a list of parameters that the MAC sublayer provides to the local PHY entity in order to transmit a~~n MPDU~~ PSDU, as further described in 12.3.4.4 and 17.4 or 20.4 (HT PLME)(which defines the local PHY entity).

10.4.6.3 When generated

Change 10.4.6.3 as follows:

This primitive is issued by the MAC sublayer to the PHY entity when the MAC sublayer needs to determine the time required to transmit a particular ~~MPDU~~PSDU.

11. MLME

11.1 Synchronization

11.1.2 Maintaining synchronization

11.1.2.1 Beacon generation in infrastructure networks

Insert the following 2 paragraphs at the end of 11.1.2.1:

The AP may transmit a secondary beacon and broadcast/multicast traffic using the basic STBC MCS, as defined in 9.6.5 (HT Basic STBC MCS) . The Secondary Beacon field shall be set to 1 to identify a secondary beacon. The TBTT for the secondary beacon is offset by half a beacon period from the TBTT of the beacon with the Secondary Beacon field set to 0 . Except for the setting of the Secondary Beacon field, TIM field and TSF field, all other fields inside the secondary beacon shall be identical to the beacon with the Secondary Beacon field set to 0. After transmission of a secondary beacon, the AP shall repeat the transmission using the basic STBC MCS of all broadcast or multicast MPDUs that were transmitted since the previous beacon transmission.An STBC-capable STA shall discard either all received broadcast/multicast Data frames that are STBC frames, or all received broadcast/multicast Data frames that are non-STBC frames. How it makes this decision is a matter of local policy

11.1.3 Acquiring synchronization, scanning

11.1.3.4 Synchronizing with a BSS

Change the third paragraph of 11.1.3.4 as follows:

In addition to these synchronization parameters, a STA joining an infrastructure BSS will adopt each of the parameters found in the BssDescription of the MLME-JOIN.request except Local time, Capability Information, ~~and~~ BSSBasicRateSet parameters, and HT Capabilities element. Local time is not adopted but is used as a local variable in adopting the TSF as described in 11.1.2.4. The Capability Information reflects the capabilities of the sender and is not adopted but may be used to determine local configuration or behavior. The BSSBasicRateSet parameter is not adopted but may determine if the STA can join the BSS. A STA joining an IBSS will adopt the same parameters except the CF parameter set (since contention free period is not permitted in an IBSS).

11.1.4 Adjusting STA timers

Change the third paragraph of 11.1.4 as follows:

All Beacon and Probe Response frames carry a Timestamp field. A STA receiving such a frame from another

STA in an IBSS with the same SSID shall compare the Timestamp field with its own TSF time. If the Timestamp field of the received frame is later than its own TSF timer, the STA in the IBSS shall adopt all parameters contained in the Beacon frame, except the Capability bits, Supported Rates information element, ~~and~~ Extended Supported Rates information element, and HT Capabilities element.

11.2 Power management

11.2.1 Power management in an infrastructure network

Change 11.2.1 as follows:

STAs changing Power Management mode shall inform the AP of this fact using the Power Management bits within the Frame Control field of transmitted frames. The AP shall not arbitrarily transmit MSDUs or A-MSDUs to STAs operating in a PS mode, but shall buffer MSDUs and A-MSDUs and only transmit them at designated times.

The STAs that currently have buffered MSDUs or A-MSDUs within the AP are identified in a TIM, which shall be included as an element within all beacons generated by the AP. A STA shall determine that an MSDU or A-MSDU is buffered for it by receiving and interpreting a TIM.

STAs operating in PS modes shall periodically listen for beacons, as determined by the STA's ListenInterval and the ReceiveDTIMs parameter in the MLME-POWERMGT.request primitive.

In a BSS operating under the DCF, or during the CP of a BSS using the PCF, upon determining that an MSDU or A-MSDU is currently buffered in the AP, a STA operating in the *PS mode* shall transmit a short PS-Poll frame to the AP, which shall respond with the corresponding buffered MSDU or A-MSDU immediately, or acknowledge the PS-Poll and respond with the corresponding MSDU or A-MSDU at a later time. If the TIM indicating the buffered MSDU or A-MSDU is sent during a CFP, a CF-Pollable STA operating in the PS mode does not send a PS-Poll frame, but remains active until the buffered MSDU or A-MSDU is received (or the CFP ends). If any STA in its BSS is in PS mode, the AP shall buffer all broadcast and multicast MSDUs and deliver them to all STAs immediately following the next Beacon frame containing a DTIM transmission.

A STA shall remain in its current Power Management mode until it informs the AP of a Power Management mode change via a frame exchange that includes an acknowledgement from the AP. Power Management mode shall not change during any single frame exchange sequence, as described in 9.12.

A non-AP QoS STA may be in PS mode before the setup of DLS or Block Ack. Once DLS is set up with another non-AP QSTA, the non-AP QSTA suspends the PS mode and shall always be awake. When a STA enters normal (non-APSD) PS mode, any downlink Block Ack agreement without an associated schedule is suspended for the duration of this PS mode. MSDUs and A-MSDUs for TID without a schedule are sent using Normal Ack following a PS-poll as described in rest of this subclause. Uplink Block Ack, Block Acks for any TID with a schedule, and any Block Acks to APSD STA continue to operate normally.

11.2.1.1 STA Power Management modes

Change the second row of Table 78 as follows:

Table 72—Power Management modes

PS	STA listens to selected beacons (based upon the ListenInterval parameter of the MLMEASSOCIATE.request primitive) and sends PS-Poll frames to the AP if the TIM element in the most recent beacon indicates a directed MSDU or A-MSDU buffered for that STA. The AP shall transmit buffered directed MSDUs or A-MSDUs to a PS STA only in response to a PS-Poll from that STA, or during the CFP in the case of a CF-Pollable PS STA. In PS mode, a STA shall be in the Doze state and shall enter the Awake state to receive selected beacons, to receive broadcast and multicast transmissions following certain received beacons, to transmit, and to await responses to transmitted PS-Poll frames or (for CF-Pollable STAs) to receive CF transmissions of buffered MSDUs or A-MSDUs.

11.2.1.2 AP TIM transmissions

Change 11.2.1.2 as follows:

The TIM shall identify the STAs for which traffic is pending and buffered in the AP. This information is coded in a *partial virtual bitmap*, as described in 7.3.2.6. In addition, the TIM contains an indication whether broadcast/multicast traffic is pending. Every STA is assigned an AID by the AP as part of the association process. AID 0 (zero) is reserved to indicate the presence of buffered broadcast/multicast MSDUs. The AP shall identify those STAs for which it is prepared to deliver buffered MSDUs or A-MSDUs by setting bits in the TIM's partial virtual bitmap that correspond to the appropriate AIDs.

11.2.1.3 TIM types

Change the first paragraph of 11.2.1.3 as follows:

Two different TIM types are distinguished: TIM and DTIM. After a DTIM, the AP shall send out the buffered broadcast/multicast MSDUs using normal frame transmission rules, before transmitting any unicast frames. When the AP transmits secondary beacons, all buffered broadcast/multicast MSDUs that were sent following the immediately-preceding non-secondary DTIM shall be sent again, using the basic STBC MCS, following the transmission of the secondary DTIM beacon.

Change paragraph 4 of 11.2.1.3 as follows:

The third and fourth lines in Figure 199 depict the activity of two STAs operating with different power management requirements. Both STAs power-on their receivers when they need to listen for a TIM. This is indicated as a ramp-up of the receiver power prior to the TBTT. The first STA, for example, powers up its receiver and receives a TIM in the first beacon; that TIM indicates the presence of a buffered MSDU or A-MSDU for the receiving STA. The receiving STA then generates a PS-Poll frame, which elicits the transmission of the buffered ~~data~~ MSDU or A-MSDU from the AP. Broadcast and multicast MSDUs are sent by the AP subsequent to the transmission of a beacon containing a DTIM. The DTIM is indicated by the DTIM count field of the TIM element having a value of 0.

11.2.1.4 Power management with APSD

Change paragraph 4 of 11.2.1.4 as follows:

If there is no unscheduled SP in progress, the unscheduled SP begins when the AP receives a trigger frame from a non-AP STA, which is a QoS data or QoS Null frame associated with an AC the STA has configured to be trigger-enabled. An unscheduled SP ends after the AP has attempted to transmit at least one MSDU, A-MSDU or MMPDU associated with a delivery-enabled AC and destined for the non-AP STA, but no more than the number indicated in the Max SP Length field if the field has a nonzero value.

11.2.1.5 AP operation during the CP

Change paragraph 1 of 11.2.1.5 as follows:

APs shall maintain a Power Management status for each currently associated STA that indicates in which Power Management mode the STA is currently operating. APs that implement and signal their support of APSD shall maintain an APSD and an access policy status for each currently associated non-AP STA that indicates whether the non-AP STA is presently using APSD and shall maintain the schedule (if any) for the non-AP STA. An AP shall, depending on the Power Management mode of the STA, temporarily buffer the MSDU, A-MSDU or management frame destined to the STA. An AP implementing APSD shall, if a non-AP STA is using APSD and is in PS mode, temporarily buffer the MSDU, A-MSDU or management frames destined to that non-AP STA. No MSDUs, A-MSDUs or management frames addressed directly to STAs operating in the Active mode shall be buffered for power management reasons.

Change list items a) and b) of 11.2.1.5 as follows:

a) MSDUs, A-MSDUs or management frames destined for PS STAs, shall be temporarily buffered in the AP. MSDUs, A-MSDUs or management frames, destined for PS STAs using APSD shall be temporarily buffered in the APSD-capable QAP. The algorithm to manage this buffering is beyond the scope of this standard, with the exception that if the AP is QoS-enabled, it shall preserve the order of arrival of frames on a per-TID, per-STA basis.

b) MSDUs, A-MSDUs or management frames destined for STAs in the Active mode, shall be directly transmitted to those STAs.

Change numbered item f) in 11.2.1.5 as follows:

f) Immediately after every DTIM, the AP shall transmit all buffered broadcast/multicast MSDUs. The More Data field of each broadcast/multicast frame shall be set to indicate the presence of further buffered broadcast/multicast MSDUs. If the AP is unable to transmit all of the buffered broadcast/multicast MSDUs before the primary or secondary TBTT following the DTIM, the AP shall indicate that it will continue to deliver the broadcast/multicast MSDUs by setting the bit for AID 0 (zero) in the bit map control field of the TIM element of every Beacon frame, until all buffered broadcast/multicast frames have been transmitted. When the AP transmits secondary beacons, the AP shall ensure that all buffered broadcast/multicast frames that are transmitted following primary DTIM or TIM beacons shall be transmitted again following a secondary DTIM or TIM in a manner similar to that prescribed for the primary transmissions, except that they are transmitted using the basic STBC MCS. It may be the case that a complete set of buffered broadcast/multicast frames is sent over a period of time during which primary and secondary transmissions are interleaved, but the transition from primary broadcast/multicast transmissions to secondary broadcast/multicast transmissions shall be preceded by the transmission of a secondary DTIM beacon or secondary TIM beacon and the transition from secondary broadcast/multicast transmissions to primary broadcast/multicast transmissions shall be preceded by the transmission of a primary DTIM beacon or primary TIM beacon.

Change list item g) of 11.2.1.5 as follows:

g) A single buffered MSDU, A-MSDU or management frame for a STA in the PS mode shall be forwarded to the STA after a PS-Poll has been received from that STA. For a non-AP QSTAs using U-APSD, the AP transmits one frame destined for the non-AP STA from any AC that is not delivery-enabled in response to PS-Poll from the non-AP STA. When all ACs associated with the non-AP STA are delivery-enabled, AP transmits one frame from the highest priority AC. The AP can respond with either an immediate Data frame or with an ACK, while delaying the responding Data frame.

For a STA in PS mode and not using U-APSD, the More Data field of the response Data frame shall be set to indicate the presence of further buffered MSDUs, A-MSDUs or management frames for the polling STA. For a non-AP STA using U-APSD, the More Data field shall be set to indicate the presence of further buffered MSDUs, A-MSDUs or management frames that do not belong to delivery-enabled ACs. When all ACs associated with the non-AP STA are delivery-enabled, the More Data field shall be set to indicate the presence of further buffered MSDUs, A-MSDUs or management frames belonging to delivery-enabled ACs. If there are buffered frames to transmit to the STA, the AP may set the More Data bit in a QoS +CF-Ack frame to 1, in response to a QoS data frame to indicate that it has one or more pending frames buffered for the PS STA identified by the RA address in the QoS +CF-Ack frame. An AP may also set the More Data bit in an ACK frame in response to a QoS data frame to indicate that it has one or more pending frames buffered for the PS STA identified by the RA address in the ACK frame, if that PS STA has set the More Data Ack subfield in the QoS Capability information element to 1.

Further PS-Poll frames from the same STA shall be acknowledged and ignored until the MSDU, A-MSDU or management frame has either been successfully delivered or presumed failed due to maximum retries being exceeded. This prevents a retried PS-Poll from being treated as a new request to deliver a buffered frame.

Change list item h) of 11.2.1.5 as follows:

h) At each scheduled APSD SP for a non-AP STA, the APSD-capable AP shall attempt to transmit at least one MSDU, A-MSDU or MMPDU, associated with admitted TSPECs with the APSD and Schedule subfields both set to 1, that are destined for the non-AP STA. At each unscheduled SP for a non-AP STA, the AP shall attempt to transmit at least one MSDU, A-MSDU or MMPDU, but no more than the value specified in the Max SP Length field in the QoS Capability element from delivery-enabled ACs, that are destined for the non-AP STA.

The More Data bit of the directed data or management frame associated with delivery-enabled ACs and destined for that non-AP STA indicates that more frames are buffered for the delivery-enabled ACs. The More Data bit set in MSDUs, A-MSDUs or management frames associated with nondelivery-enabled ACs and destined for that non-AP STA indicates that more frames are buffered for the nondelivery-enabled ACs. For all frames except for the final frame of the SP, the EOSP subfield of the QoS Control field of the QoS data frame shall be set to 0 to indicate the continuation of the SP. An AP may also set the More Data bit to 1 in a QoS +CF-Ack frame in response to a QoS data frame to indicate that it has one or more pending frames buffered for the target STA identified by the RA address in the QoS +CF-Ack frame. If the QoS data frame is associated with a delivery-enabled AC, the More Data bit in the QoS +CF-Ack frame indicates more frames for all delivery-enabled ACs. If the QoS data frame is not associated with a delivery-enabled AC, the More Data bit in the QoS +CF-Ack frame indicates more frames for all ACs that are not delivery-enabled.

The AP considers APSD STA to be in awake state after it has sent a QoS +CF-Ack frame, with the EOSP subfield in the QoS Control field set to 0, to the APSD STA. If necessary, the AP may generate an extra QoS Null frame, with the EOSP set to 1. When the AP has transmitted a directed frame to the non-AP STA with the EOSP subfield set to 1 during the SP except for retransmissions of that frame, the AP shall not transmit any more frames to that STA using this mechanism until the next SP. The AP shall set the EOSP subfield to 1 to indicate the end of the SP in APSD.

Change list items i) to l) of 11.2.1.5 as follows:

i) If the AP does not receive an acknowledgment to a directed MSDU, A-MSDU or management frame sent to a non-AP STA in PS mode following receipt of a PS-Poll from that non-AP STA, it may retransmit the frame for at most the lesser of the maximum retry limit and the MIB attribute dot11QAPMissingAckRetryLimit times before the next beacon, but it shall retransmit that frame at least once before the next beacon, time permitting and subject to its appropriate lifetime limit. If an acknowledgment to the retransmission is not received, it may wait until after the next Beacon frame to further retransmit that frame subject to its appropriate lifetime limit.

j) If the AP does not receive an acknowledgment to a directed frame containing all or part of an MSDU or A-MSDU sent with the EOSP subfield set to 1, it shall retransmit that frame at least once within the same SP, subject to applicable retry or lifetime limit. The maximum number of retransmissions within the same SP is the lesser of the maximum retry limit and the MIB attribute dot11QAPMissingAckRetryLimit. If an acknowledgment to the retransmission of this last frame in the same SP is not received, it may wait until the next SP to further retransmit that frame, subject to its applicable retry or lifetime limit.

k) An AP can delete buffered frames for implementation dependent reasons, including the use of an aging function and availability of buffers. The AP may base the aging function on the listen interval specified by the non-AP QSTA in the association or reassociation request frame.

l) When an AP is informed that a STA changes to the Active mode, then the AP shall send buffered MSDUs, A-MSDUs and management frames (if any exist) to that STA without waiting for a PS-Poll. When an AP is informed that an APSD-capable non-AP STA is not using APSD, then the AP shall send buffered MSDUs, A-MSDUs and management frames (if any exist) to that non-AP STA according to the rules corresponding to the current PS mode of the non-AP STA.

11.2.1.6 AP operation during the CFP

Change 11.2.1.6 as follows:

APs shall maintain a Power Management status for each currently associated CF-Pollable STA that indicates in which Power Management mode the STA is currently operating. An AP shall, for STAs in PS mode, temporarily buffer ~~the~~any MSDU or A-MSDU destined to the STA.

a) MSDUs or A-MSDUs destined for PS STAs shall be temporarily buffered in the AP. The algorithm to manage this buffering is beyond the scope of this standard.

b) MSDUs or A-MSDUs destined to STAs in the Active mode shall be transmitted as defined in Clause 9.

c) Prior to every CFP, and at each beacon interval within the CFP, the AP shall assemble the partial virtual bitmap containing the buffer status per destination for STAs in the PS mode, set the bits in the partial virtual bitmap for STAs the PC is intending to poll during this CFP, and shall send this out in the TIM field of the DTIM. The bit for AID 0 (zero) in the bit map control field of the TIM IE shall be set when broadcast or multicast traffic is buffered, according to 7.3.2.6.

d) All broadcast and multicast MSDUs, with the Order bit in the Frame Control field clear, shall be buffered if any associated STAs are in the PS mode, whether or not those STAs are CF-Pollable.

e) Immediately after every DTIM (Beacon frame with DTIM Count field of the TIM element equal to zero), the AP shall transmit all buffered broadcast and multicast frames. The More Data field shall be set to indicate the presence of further buffered broadcast/multicast MSDUs. If the AP is unable to transmit all of the buffered broadcast/multicast MSDUs before the primary or secondary TBTT following the DTIM, the AP shall indicate that it will continue to deliver the broadcast/multicast MSDUs by setting the bit for AID 0 (zero) in the bit map control field of the TIM element of every Beacon frame, until all buffered broadcast/multicast frames have been transmitted. When the AP transmits secondary beacons, the AP shall ensure that all buffered broadcast/multicast frames that are transmitted following primary DTIM or TIM beacons shall be transmitted again following a secondary DTIM or TIM in a manner similar to that prescribed for the primary transmissions, except that they are transmitted using the basic STBC MCS. It may be the case that a complete set of buffered broadcast/multicast frames is sent over a period of time during which primary and secondary transmissions are interleaved, but the transition from primary broadcast/multicast transmissions to secondary broadcast/multicast transmissions shall be preceded by the transmission of a secondary DTIM beacon or secondary TIM beacon and the transition from secondary broadcast/multicast transmissions to primary broadcast/multicast transmissions shall be preceded by the transmission of a primary DTIM beacon or primary TIM beacon.

f) Buffered MSDUs, A-MSDUs or MMPDUs for STAs in the PS mode shall be forwarded to the CF-Pollable STAs under control of the PC. Transmission of these buffered MSDUs or management frames as well as CF-Polls to STAs in the PS mode that were indicated in the DTIM in accordance with paragraph c) of this subclause shall begin immediately after transmission of buffered broadcast and multicast frames (if any), and shall occur in order by increasing AID of F-Pollable STAs. A CF-Pollable STA for which the TIM element of the most recent beacon indicated buffered MSDUs or management frames shall be in the Awake state at least until the receipt of a directed frame from the AP in which the Frame Control field does not indicate the existence of more buffered MSDUs, A-MSDUs or management frames. After acknowledging the last of the buffered MSDUs, A-MSDUs or management frames, the CF-Pollable STA operating in the PS mode may enter the Doze state until the next DTIM is expected.

g) An AP shall have an aging function to delete pending traffic buffered for an excessive time period. The exact specification of the aging function is beyond the scope of this standard.

h) When an AP detects that a CF-Pollable STA has changed from the PS mode to the Active mode, then the AP shall queue any buffered frames addressed to that STA for transmission to that CF-Pollable STA as directed by the AP's PC.

11.2.1.7 Receive operation for STAs in PS mode during the CP

Change 11.2.1.7 as follows:

STAs in PS mode shall operate as follows to receive an MSDU, A-MSDU or management frame from the AP when no PC is operating and during the CP when a PC is operating.

a) STAs shall wake up early enough to be able to receive the first beacon scheduled for transmission after the time corresponding to the last TBTT plus the STA's current ListenInterval.

b) When a STA detects that the bit corresponding to its AID is set in the TIM, the STA shall issue a PS-Poll to retrieve the buffered MSDU, A-MSDU or management frame. The PS-Poll shall be transmitted after random delay uniformly distributed between zero and aCWmin slots following a DIFS.

c) The STA shall remain in the Awake state until it receives the Data or Management frame in response to its poll or it receives another beacon whose TIM indicates that the AP does not have any MSDUs, A-MSDUs or management frames buffered for this STA. If the bit corresponding to the STA's AID is set in the subsequent TIM, the STA shall issue another PS-Poll to retrieve the buffered MSDU, A-MSDU or management frame(s). When a non-AP STA that is using U-APSD and has all ACs delivery enabled detects that the bit corresponding to its AID is set in the TIM, the non-AP STA shall issue a trigger frame or a PS-Poll frame to retrieve the buffered MSDU, A-MSDU or management frames.

d) If the More Data field in the received MSDU, A-MSDU or management frame indicates that more traffic for that STA is buffered, the STA, at its convenience, shall Poll until no more MSDUs, A-MSDUs or management frames are buffered for that STA.

e) When ReceiveDTIMs is true, the STA shall wake up early enough to be able to receive at least every primary (DTIM that is a non-STBC frame) DTIM or at least every secondary DTIM sent by the AP of the BSS. A STA that stays awake to receive broadcast/multicast MSDUs shall elect to receive at least all primary (non-STBC frame) broadcast/multicast transmissions or at least all secondary broadcast/multicast transmissions, and shall remain awake until the More Data field of the appropriate type (primary or secondary) of broadcast/multicast MSDUs indicates there are no further buffered broadcast/multicast MSDUs of that type, or until a TIM is received indicating there are no more buffered broadcast/multicast MSDUs of that type. If a non-AP STA receives a QoS +CF-Ack frame from its AP with the More Data bit set to 1, then the STA shall operate exactly as if it received a TIM with its AID bit set. If a non-AP STA has set the More Data Ack subfield in QoS Capability information element to 1, then if it receives an ACK frame from its AP with the More Data bit set to 1, the STA shall operate exactly as if it received a TIM with its AID bit set. For example, a STA that is using the PS-Poll delivery method shall issue a PS-Poll frame to retrieve a buffered frame.

11.2.1.8 Receive operation for STAs in PS mode during the CFP

Change 11.2.1.8 as follows:

STAs in PS mode that are associated as CF-Pollable shall operate as follows in a BSS with an active PC to receive MSDUs or management frames from the AP during the CFP:

a) STAs shall enter the Awake state so as to receive the Beacon frame (which contains a DTIM) at the start of each CFP.

b) To receive broadcast/multicast MSDUs, the STA shall wake up early enough to be able to receive at least every primary DTIM or at least every secondary DTIM that may be sent during the CFP. A STA receiving broadcast/multicast MSDUs shall elect to receive at least all primary (non-STBC frame) broadcast/multicast transmissions or at least all secondary broadcast/multicast transmissions, and shall remain awake until the More Data field of the appropriate type (primary or secondary) of broadcast /multicast MSDUs indicates there are no further buffered broadcast/multicast MSDUs of that type, or until a TIM is received indicating there are no more broadcast/multicast MSDUs of that type buffered.

c) When a STA detects that the bit corresponding to its AID is set in the DTIM at the start of the CFP (or in a subsequent TIM during the CFP), the STA shall remain in the Awake state for at least that portion of the CFP through the time that the STA receives a directed MSDU, A-MSDU or management frame from the AP with the More Data field in the Frame Control field indicating that no further traffic is buffered.

d) If the More Data field in the Frame Control field of the last MSDU, A-MSDU or management frame received from the AP indicates that more traffic for the STA is buffered, then, when the CFP ends, the STA may remain in the Awake state and transmit PS-Poll frames during the CP to request the delivery of additional buffered MSDU, A-MSDU or management frames, or may enter the Doze state during the CP (except at TBTTs for DTIMs expected during the CP), awaiting the start of the next CFP.

11.2.1.9 Receive operation for non-AP STAs using APSD

Change the first paragraph of 11.2.1.9 as follows:

A non-AP STA using APSD shall operate as follows to receive an MSDU, A-MSDU or management frame from the AP:

Change list item b) of 11.2.1.9 as follows:

b) If the non-AP STA is initiating an unscheduled SP, the non-AP STA wakes up and transmits a trigger frame to the AP. When one or more ACs are not delivery-enabled, the non-AP STA may retrieve MSDUs, A-MSDUs and MMPDUs belonging to those ACs by sending PS-Poll frames to the AP.

11.2.1.12 PSMP Power management

A STA can manage its power usage per Service Interval. A STA with an established SP is awake at the beginning of its SP (as defined in 11.2.1.9). Once the STA is awake at the beginning of a SP, the STA shall stay awake at least until a PSMP frame is received or the agreed upon maximum SP interval has elapsed, whichever comes first.

The AP shall signal the end of the Service Period for all STA by setting the More PSMP field to 0, or by sending CF-End instead of the next PSMP frame.

NOTE1—The AP can also signal the end of a service period on a per-STA basis using the EOSP field set to 1 in the QoS Control field, as defined in 7.1.3.5.2 and 11.2.1.5. This field remains set to 1 for any retransmissions of the same frame and no more new frames are sent to this particular STA in the current SP.

NOTE2—The operation of the More Data field in the Frame Control field and the TIM element are defined by the S-APSD rules in 11.2.1.4, 11.2.1.5 and 11.2.1.9.

A STA shall wake up at start of the next PSMP frame if the More PSMP field is set to 1 in the current PSMP frame, unless the STA has been permitted to return to sleep through the reception of a frame addressed to it with the EOSP field set to 1 or the maximum SP interval has elapsed.

A PPDU containing MPDUs addressed to a STA shall not start after expiry of the STA's PSMP-DTT. A STA completes the reception of any PPDU that starts before the end of the PSMP-DTT. If no frames addressed to a STA begin within a PSMP-DTT, it can assume that no frame addressed to it will arrive during this PSMP sequence.

The STA shall be awake to receive at the start of the PSMP-DTT determined from a STA_INFO that has the STA_INFO Type field set to 2 and the AID field matching the STA’s AID where the PSMP-DTT Duration is not set to 0.

11.2.2 Power management in an IBSS

11.2.2.1 Basic approach

Change paragraphs 1 to 6 of 11.2.2.1 as follows:

The basic approach is similar to the infrastructure case in that the STAs are synchronized, and multicast MSDUs and those MSDUs or A-MSDUs that are to be transmitted to a power-conserving STA are first announced during a period when all STAs are awake. The announcement is done via an ad hoc ATIM sent in an ATIM Window. A STA in the PS mode shall listen for these announcements to determine if it needs to remain in the awake state. The presence of the ATIM window in the IBSS indicates if the STA may use PS Mode. To maintain correct information on the power save state of other stations in an IBSS, a station needs to remain awake during the ATIM window. At other times the STA may enter the Doze state except as indicated in the following procedures.

The basic approach is similar to the infrastructure case in that the STAs are synchronized, and multicast MSDUs and those MSDUs or A-MSDUs that are to be transmitted to a power-conserving STA are first announced during a period when all STAs are awake. The announcement is done via an ad hoc ATIM sent in an ATIM Window. A STA in the PS mode shall listen for these announcements to determine if it needs to remain in the awake state. The presence of the ATIM window in the IBSS indicates if the STA may use PS Mode. To maintain correct information on the power save state of other stations in an IBSS, a station needs to remain awake during the ATIM window. At other times the STA may enter the Doze state except as indicated in the following procedures.

When an MSDU or A-MSDU is to be transmitted to a destination STA that is in a PS mode, the transmitting STA first transmits an ATIM frame during the ATIM Window, in which all the STAs including those operating in a PS mode are awake. The ATIM Window is defined as a specific period of time, defined by the value of the ATIM Window parameter in the IBSS Parameter Set supplied to the MLME-START.request primitive, following a TBTT, during which only Beacon or ATIM frames shall be transmitted. ATIM transmission times are randomized, after a Beacon frame is either transmitted or received by the STA, using the backoff procedure with the CW equal to aCWmin. Directed ATIMs shall be acknowledged. If a STA transmitting a directed ATIM does not receive an acknowledgment, the STA shall execute the backoff procedure for retransmission of the ATIM. Multicast ATIMs shall not be acknowledged.

If a STA receives a directed ATIM frame during the ATIM Window, it shall acknowledge the directed ATIM and stay awake for the entire beacon interval waiting for the announced MSDU(s) or A-MSDU(s) to be received. If a STA does not receive an ATIM, it may enter the Doze state at the end of the ATIM Window. Transmissions of MSDUs announced by ATIMs are randomized after the ATIM Window, using the backoff procedure described in Clause 9.

It is possible that an ATIM may be received from more than one STA, and that a STA that receives an ATIM may receive more than a single MSDU or A-MSDU from the transmitting STA. ATIM frames are only addressed to the destination STA of the MSDU or A-MSDU.

An ATIM for a broadcast or multicast MSDU shall have a destination address identical to that of the MSDU. After the ATIM interval, only those directed MSDUs or A-MSDUs that have been successfully announced with an acknowledged ATIM, and broadcast/multicast MSDUs that have been announced with an ATIM, shall be transmitted to STAs in the PS mode. Transmission of these frames shall be done using the normal DCF access procedure.

11.2.2.3 STA power state transitions

Change paragraph 1 of 11.2.2.3 as follows:

A STA may enter PS mode if and only if the value of the ATIM Window in use within the IBSS is greater than zero. A STA shall set the Power Management subfield in the Frame Control field of Data MPDUs containing all or part of MSDUs or A-MSDUs that it transmits using the rules in 7.1.3.1.7.

11.2.2.4 ATIM and frame transmission

Change 11.2.2.4 as follows:

If power management is in use within an IBSS, all STAs shall buffer MSDUs and A-MSDUs for STAs that are known to be in PS mode. The algorithm used for the estimation of the power management state of STAs within the IBSS is outside the scope of this standard. MSDUs and A-MSDUs may be sent to STAs in Active mode at any valid time.

a) Following the reception or transmission of the beacon, during the ATIM Window, the STA shall transmit a directed ATIM management frame to each STA for which it has one or more buffered unicast MSDUs and A-MSDUs. If the STA has one or more buffered multicast MSDUs, with the Strictly Ordered bit clear, it shall transmit an appropriately addressed multicast ATIM frame. A STA transmitting an ATIM management frame shall remain awake for the entire current beacon interval.

b) All STAs shall use the backoff procedure defined in 9.2.5.2 for transmission of the first ATIM following the beacon. All remaining ATIMs shall be transmitted using the conventional DCF access procedure.

c) ATIM management frames shall only be transmitted during the ATIM Window.

d) A STA shall transmit no frame types other than RTS, CTS, and ACK Control frames and Beacon and ATIM management frames during the ATIM Window.

e) Directed ATIM management frames shall be acknowledged. If no acknowledgment is received, the ATIM shall be retransmitted using the conventional DCF access procedure. Multicast ATIM management frames shall not be acknowledged.

f) If a STA is unable to transmit an ATIM during the ATIM Window, for example due to contention with other STAs, the STA shall retain the buffered MSDU(s) and A-MSDU(s) and attempt to transmit the ATIM during the next ATIM Window.

g) Immediately following the ATIM Window, a STA shall begin transmission of buffered broadcast/multicast frames for which an ATIM was previously transmitted. Following the transmission of any broadcast/multicast frames, any MSDUs and management frames addressed to STAs for which an acknowledgment for a previously transmitted ATIM frame was received shall be transmitted. All STAs shall use the backoff procedure defined in 9.2.5.2 for transmission of the first frame following the ATIM Window. All remaining frames shall be transmitted using the conventional DCF access procedure.

h) A buffered MSDU may be transmitted using fragmentation. If an MSDU or A-MSDU has been partially transmitted when the next beacon frame is sent, the STA shall retain the buffered MSDU or A-MSDU and announce the remaining fragments by transmitting an ATIM during the next ATIM Window.

i) If a STA is unable to transmit a buffered MSDU during the beacon interval in which it was announced, for example due to contention with other STAs, the STA shall retain the buffered MSDU or A-MSDU and announce the MSDU or A-MSDU again by transmitting an ATIM during the next ATIM Window.

j) Following the transmission of all buffered MSDUs or A-MSDUs, a STA may transmit MSDUs or A-MSDUs without announcement to STAs that are known to be in the Awake state for the current beacon interval due to an appropriate ATIM management or Beacon frame having been transmitted or received.

k) A STA may discard frames buffered for later transmission to power-saving STAs if the STA determines that the frame has been buffered for an excessive amount of time or if other conditions internal to the STA implementation make it desirable to discard buffered frames (e.g., buffer starvation). In no case shall a frame be discarded that has been buffered for less than dot11BeaconPeriod. The algorithm to manage this buffering is beyond the scope of this standard.

Insert the following new subclause:

11.2.3 SM Power Save

A MIMO STA consumes power on all active Rx chains, even though they are not necessarily required for the actual frame exchange. The SM Power Save feature allows a STA to operate with only active RX chain for a significant portion of time.

In the case of Dynamic SM Power Save mode, a STA enables its multiple Rx chains when it receives the start of a frame sequence addressed to it. Such a frame sequence shall start with a single-spatial stream unicast frame addressed to a STA in Dynamic SM Power Save mode. An RTS/CTS sequence may be used for this purpose. The receiver switches to the multiple Rx chain mode when it receives the RTS addressed to it and switches back immediately when the TXOP ends.

In the case of static MIMO power save mode, the STA maintains only a single active Rx chain active while in this mode.

A STA operating Dynamic SM Power Save mode that receives any frame with the RA field matching its address shall enable all of its RX chains for the duration of the current TXOP.

NOTE 1—A STA operating Dynamic SM Power Save mode cannot distinguish between an RTS/CTS sequence that precedes a MIMO transmission and any other RTS/CTS and therefore always enables its multiple Rx chains when it receives an RTS addressed to itself.

An HT STA may use the SM Power Save management action frame to communicate its SM Power Save state. A non-AP HT STA may also use SM Power Save bits in the HT capabilities element of its Association Request to achieve the same purpose. The latter allows the STA to use only a single Rx chain immediately after association.

A STA that has one or more DLS links shall notify all STA with which it has a DLS link of any change in SM power save mode before operating in that mode.
Any changes to local operated SM Power Save mode takes effect when SM Power Save Mode indication is delivered by the HT Capabilities element and the associatation succeeds and/or when the SM Power Save Mode indication delivered by SM Power Save frame is acknowledged. The SM Power Save Mode indication shall be sent in unicast frame.NOTE 2—The SM Power Save field establishes the initial SM Power Save mode of a peer on association. This SM Power Save mode may be subsequently updated by receiving a SM Power Save management action frame from that peer.

11.3 STA Authentication and Association

Change numbered item c.2) as follows:

c) Class 3 frames (if and only if associated; allowed only from within State 3):
  2) Management frames
    i) QoS, DLS and Block Ack Action
    ii) Radio Measurement Action
    iii) HT action frames

11.4 TS operation

Insert the following new subclause heading:

11.4.4b PSMP Management

Insert the following new subclause:

11.4.4b.1Resource reservation using TSPEC

The main purpose of the TSPEC is to reserve resources within the AP and modify the AP's scheduling behavior. The parameters in the TSPEC can be grouped into two categories: PSMP scheduling and PSMP reservation . The scheduling parameters are used by the AP to schedule a suitable Service Interval. The reservation parameters are used by the AP to reserve time in the PSMP-UTT and PSMP-DTT.

The Service Start time and Service Interval specifies the PSMP schedule in the response’s Scheduling Element. All other parameters result in a reservation for the PSMP-UTT and PSMP-DTT within the scheduled PSMP sequence.

It is always the responsibility of the non-AP STA to initiate the creation of a PSMP session regardless of the TSPEC direction.

An AP shall terminate the PSMP session only when the last TS associated with the particular PSMP session is terminated.

Once created, the PSMP session can be extended by another TSPEC setup. The same or another STA can issue an additional TSPEC request to an already existing PSMP session. The parameters of a TS already associated with the PSMP session can be changed, however the Service Interval shall not be changed. The

Start Time of existing STAs in the PSMP schedule shall not be changed by the addition of TSPEC from a new STA. ***Insert the following new subclause:***

11.4.4b.2PSMP-UTT estimation within a PSMP burst

Insert the following new subclause:

The PSMP-UTT Duration delivered in a PSMP frame can be estimated by the AP, based on the TSPEC associated with each STA.

NOTE—for effective resource allocation, the AP should precisely estimate the PSMP-UTT Duration for each STA using the information indicated in TSPEC, such as Minimum Data Rate, Mean Data Rate, Peak Data Rate, Burst Size, and Delay Bound fields. However, in the case where the traffic characteristic is quite bursty (*e.g.,* a real-time video application), precise estimation of PSMP-UTT Duration is difficult without timely and frequent feedback of the current traffic statistics. In order to avoid wasting the available bandwidth by overestimating the PSMP-UTT Duration, the AP can allocate the minimum amount of time to each STA using the PSMP-UTT Duration field in the PSMP frame, based on Minimum Data Rate in TSPEC. When the STA receives the PSMP frame, it decides if the allocated resource indicated by the PSMP-UTT Duration is sufficient for its queued data. If the allocated resource is sufficient, the STA can transmit all the queued data at the allocated time.

11.4.4b.3Management of scheduled PSMP

A TSPEC that reserves resources for a STA under scheduled PSMP shall have the APSD field set to 0 and the Scheduled field set to 1 (representing Scheduled PSMP).

An HT STA joins a PSMP session outside the PSMP mechanism using any appropriate channel access mechanism. The non-AP STA SME decides that a PSMP session needs to be joined. How it does this, and how it selects the related TSPEC parameters, is beyond the scope of this specification. The SME generates an MLME-ADDTS.request containing a TSPEC. A TSPEC may also be generated autonomously by the MAC without any initiation by the SME. The non-AP STA MAC transmits the TSPEC in an ADDTS request frame to the AP and waits for a response.

The encoding of the Status Code field is defined in Table 23.

The STA may resubmit a TSPEC request with suggested changes if the ResultCode is “Rejected with suggested changes”. The suggested changes are included in the response’s Schedule element. The suggestion may be related to scheduling as well to reservation parameters.

The STA may add another TS as necessary. In this case the AP shall use the Service Interval of an already established service. The requested Service Intervals of different TSPECs shall be multiples of the Service Interval Granularity.

11.4.4cManagement of unscheduled PSMP

Under unscheduled PSMP operation, a STA does not need to use a TSPEC for resources reservation. A PSMP capable STA can request resources from the AP by transmitting a TSPEC request with APSD field set to 0, and Schedule field set to 0. Either of the two methods of setting up a TS as U-APSD may be used to make a particular AC trigger-enabled and/or delivery-enabled. An AP may choose not to send data in an unscheduled PSMP sequence PSMP-DTT even though both AP and STA are PSMP capable. An AP may choose sometimes to use PSMP and sometimes not to use PSMP to transmit data of a particular AC.

11.5 Block Ack operation

11.5.1 Setup and modification of the Block Ack parameters

11.5.1.1 Procedure at the originator

Insert the following new paragraph at the end of 11.5.1.1:

The successful establishment of a block ack agreement with the Block Ack Policy subfield set to 1 between HT peers is defined to be an HT-immediate Block Ack agreement. The successful establishment of a Block Ack agreement with the Block Ack Policy subfield set to 0 between HT peers is defined to be an HT-delayed Block Ack agreement.

11.5.1.2 Procedure at the recipient

Insert the following new paragraph at the end of 11.5.1.2:

The successful establishment of a block ack agreement with the Block Ack Policy subfield set to 1 between HT peers is defined to be an HT-immediate Block Ack agreement. The successful establishment of a Block Ack agreement with the Block Ack Policy subfield set to 0 between HT peers is defined to be an HT-delayed Block Ack agreement.

11.16 Higher layer timer synchronization

11.16.2 Procedure at the STA

Change paragraph 2 of 11.6.2 as follows:

In order to determine whether to provide an MLME-HL-SYNC.indication primitive for a particular data frame, a MAC that supports MLME-HL-SYNC primitives compares the Address 1 field in a data frame's MAC header against a list of group addresses previously registered by an MLME-HL-SYNC.request primitive. If the MAC and the transmitter of the Sync frame are collocated within the same STA, the MLME-HL-SYNC.indication primitive shall occur when the last symbol of the PPDU carrying a matching data frame is transmitted. Otherwise, the indication shall occur when the last symbol of the PPDU carrying the matching data frame is received. In both cases, the MLME-HL-SYNC.indication primitive provided is simultaneous (within implementation dependent delay bounds) with the indication provided to other STAs within the BSS for the same data frame.

11.9 DFS procedures

11.9.2 Quieting channels for testing

Change paragraph 4 of 11.9.2 as follows:

Control of the channel is lost at the start of a quiet interval, and the NAV is set by all the STAs in the BSS or IBSS for the length of the quiet interval. Transmission of any MPDU and any associated acknowledgment shall be complete before the start of the quiet interval. If, before starting transmission of an MPDU, there is not enough time remaining to allow the transmission to complete before the quiet interval starts, the STA shall defer the transmission by selecting a random backoff time, using the present CW (without advancing to the next value in the series). The short retry counter and long retry counter for the MSDU or A-MSDU are not affected.

11.9.6 Requesting and reporting of measurements

Change paragraph 4 of 11.9.6 as follows:

A STA that successfully requests another STA to perform a measurement on another channel should not transmit MSDUs, A-MSDUs or MMPDUs to that STA during the interval defined for the measurement plus any required channel switch intervals. In determining this period, a STA shall assume that any required channel switches take less than dot11ChannelSwitchTime per switch.

11.9.7 Selecting and advertising a new channel

11.9.7.1 Selecting and advertising a new channel in an infrastructure BSS

Change the first paragraph of 11.9.7.1 as follows:

The decision to switch to a new operating channel in an infrastructure BSS shall be made only by the AP. An AP may make use of the information in Supported Channel and Supported Regulatory Classes elements and the results of measurements undertaken by the AP and other STAs in the BSS to assist the selection of the new channel. The algorithm to choose a new channel is beyond the scope of this standard, but shall satisfy applicable regulatory requirements, including uniform spreading rules and channel testing rules. The AP shall attempt to select a new channel that is supported by all associated STAs, although it should be noted that this might not always be possible.

Insert the following after the first paragraph of 11.9.7.1:

In the following text wherever Channel Switch Announcement is referred to, the following rules apply:

- If an AP is switching to a new channel in a different regulatory class then the AP shall use either the Extended Channel Switch Announcement element and Extended Channel Switch Announcement-frame instead of the Channel Switch Announcement element and Channel Switch Announcement frame or both the Extended Channel Switch Announcement and the Channel Switch Announcement element and Channel Switch Announcement frame.
- If an AP is switching to a channel within the same regulatory class, and dot11ExtendedChannelSwitchImplemented is true, then the AP shall send the Extended Channel Switch Announcement element and Extended Channel Switch Announcement frame, else the AP shall send the Channel Switch Announcement element and Channel Switch Announcement frame. Optionally the Extended Channel Switch Announcement element and Extended Channel Switch Announcement element frame may be used.

11.9.7.2 Selecting and advertising a new channel in an IBSS

Insert a new first paragraph in 11.9.7.2 as follows:

In the following text wherever Channel Switch Announcement is referred to, the following rules apply:

- If a DFS owner is switching to a new channel in a different regulatory class then the DFS owner shall use either the Extended Channel Switch Announcement element and Extended Channel Switch Announcement frame instead of the Channel Switch Announcement element and Channel Switch Announcement frame or both the Extended Channel Switch Announcement and the Channel Switch Announcement element and Channel Switch Announcement frame.
- If a DFS owner is switching to a channel within the same regulatory class, and dot11ExtendedChannelSwitchImplemented is true, then the DFS owner shall send the Extended Channel Switch Announcement element and Extended Channel Switch Announcement frame, else the DFS owner shall send the Channel Switch Announcement element and Channel Switch

Announcement frame. Optionally the Extended Channel Switch Announcement element and Extended Channel Switch Announcement frame may be used.

Insert the following new subclause heading:

11.9.8 Channel selection methods for 20/40 MHz Operation

Insert the following new subclause:

11.9.8.1 General

For an HT STA, the following MIB attributes shall be set to true: dot11RegulatoryClassesImplemented, dot11RegulatoryClassesRequired, and dot11ExtendedChannelSwitchImplemented.

Insert the following new subclause:

11.9.8.2 Introduction

On detecting an overlapping BSS operating on the secondary channel, the AP operating a 20/40 MHz BSS may choose to move to a different pair of channels or switch to 20 MHz BSS operation.

Insert the following new subclause:

11.9.8.3 Scanning prior to starting a BSS

Before an AP starts a 20/40 MHz BSS it shall scan the environment for existing BSSs. It may use passive scan for at least MinChannelTime or active scan. If the scanning AP chooses to start a 20/40 MHz BSS that occupies the same two channels as an existing 20/40 MHz BSS, then the scanning AP shall ensure that the primary channel of the new BSS is identical to the primary channel of the existing 20/40 MHz BSS and that the secondary channel of the new 20/40 MHz BSS is identical to the secondary channel of the existing 20/40 MHz BSS. The AP may also use passive or active scan after the BSS has been started, with the same PPDU format restrictions as given above.

The AP shall scan the channels (either itself or through the STAs) before making a transition from a 20 MHz BSS to a 20/40 MHz BSS.

Insert the following new subclause:

11.9.8.4 Channel management at the AP

An AP operating a 20/40 MHz BSS may decide to move the BSS and/or adjust its channel width if, for example, another BSS starts to operate in either or both of the primary or secondary channels, or radar is detected in either or both of the primary or secondary channels. Specifically, the AP may move its BSS to a different pair of channels, or change from a 20/40 MHz BSS to a 20 MHz BSS using either the primary channel of the previous channel pair or any other available 20 MHz channel. The AP may also change from a 20 MHz BSS to a 20/40 MHz BSS.

An AP may switch the BSS capability between 20/40 MHz and 20 MHz by changing the value of the Supported Channel Width Set field of the HT capabilities element in the Beacon. The STAs may disassociate and associate or reassociate to accommodate the new capability. In order to maintain existing associations while making a channel width change or while performing a channel pair relocation, an AP may inform associated HT STAs that it is making the change by including an Extended Channel Switch Announcement element in Beacon, Probe Response, and Extended Channel Switch Announcement frame transmissions until the intended channel switch time. The New Channel Number of the Extended Channel Switch Announcement element represents the new channel in the case that the BSS after relocation/width change will be a 20 MHz BSS, or the primary channel of the new pair of channels in the case that the BSS after relocation/width change will be a 20/40 MHz BSS. When changing to a new pair of channels, the New Regulatory Class field specifies the position of the secondary channel relative to the new primary channel, i.e., either above or below.

When changing from a single channel to a new channel, or from a pair of channels to a new pair of channels, the Supported Channel Width Set field of the HT capabilities element in the Beacon remains unchanged.

When the Extended Channel Switch Announcement is used to switch the BSS from 20/40 MHz operation to 20 MHz operation on the primary channel, the Supported Channel Width Set field of the HT Capabilities element in the Beacon remains unchanged.

When an AP uses the Extended Channel Switch Announcement element to announce a channel switch or channel width adjustment, the values for New Channel Number and New Regulatory Class shall comply with the values given in Table n52 (Channel switching and channel width adjustment combinations). The values for Supported Channel Width Set are also given in the table.

Table n52—Channel switching and channel width adjustment combinations

Original channel	**Destination channel**			
	Same 20 MHz channel	**Different 20 MHz channel**	**Pair of 20 MHz channels with same primary channel as original**	**Pair of 20 MHz channels with different primary channel than original**
20 MHz channel	N/A	New Channel Number: any number different from the current number, satisfying channel allocation rules specified in 20.3.14.3 (40 MHz channelization) and Annexes I and J. Supported Channel Width Set: 0 (unchanged).	New Channel Number: same as the current number, satisfying channel allocation rules specified in definitions in 20.3.14.3 (40 MHz channelization) and Annexes I and J. Supported Channel Width Set: 1.	New Channel Number: any number different from the current number, satisfying channel allocation rules specified in 20.3.14.3 (40 MHz channelization) and Annexes I and J. Supported Channel Width Set: 1.
Pair of 20 MHz channels	New Channel Number: same as the current primary channel, satisfying channel allocation rules specified in 20.3.14.3 (40 MHz channelization) and Annexes I and J. Supported Channel Width Set: 1 (unchanged).	New Channel Number: any number different from the current primary channel, satisfying channel allocation rules specified in 20.3.14.3 (40 MHz channelization) and Annexes I and J. Supported Channel Width Set: 0.	N/A	New Channel Number: any number different from the current number, satisfying channel allocation rules specified in 20.3.14.3 (40 MHz channelization) and Annexes I and J. Supported Channel Width Set: 1 (unchanged).

Movements of a 20/40 MHz BSS from one channel pair to a different channel pair and changes between 20 MHz and 20/40 MHz operation should be scheduled so that all STAs in the BSS, including STAs in power save mode, have the opportunity to receive at least one Extended Channel Switch Announcement element before the switch. The AP may send the Extended Channel Switch Announcement element in a Beacon without performing a backoff, after determining the WM is idle for one PIFS period.

A STA shall support the Extended Channel Switch Announcement if dot11ExtendedChannelSwitchImplemented is true.

When the Extended Channel Switch Announcement element and Extended Channel Switch Announcement frame are transmitted in bands where dot11SpectrumManagementRequired is true, the Channel Switch Announcement element and Channel Switch Announcement frame may also be transmitted. If both the Extended Channel Switch Announcement element and the Channel Switch Announcement element are transmitted, the New Channel Number of both elements shall be identical. An HT STA associated to an HT AP shall ignore the Channel Switch Announcement element.

For 20 MHz operation when the New Regulatory Class signifies 40 MHz channel spacing, the 20 MHz channel is the primary channel of the 40 MHz channel.

11.10 Radio Measurement Procedures

11.10.8 Specific measurement usage

11.10.8.1 Beacon Report

Change the second sentence of the second from last paragraph as follows:

When the requested Reporting Condition value is non-zero and not 254, the STA shall create and transmit a Beacon Report element for that measured frame only if the condition indicated in Table 29b is true.

Insert a new paragraph to become the last paragraph of 11.10.8.1 as follows:

When the requested Reporting Condition value is 254, then the STA is not required to create and transmit a Beacon Report element in response to the received Beacon Report measurement request.

Insert the following subclause heading:

11.15 20/40 MHz Operation

Insert the following new subclause:

11.15.1 Basic functionality in BSS 20/40 MHz mode

The following terms are used in this subclause to describe transmitted PPDU formats:

- 40 MHz HT is a Clause 20 transmission using FORMAT=HT_MF or HT_GF and CH_BANDWIDTH= HT_CBW40
- 20 MHz HT is a Clause 20 transmission using FORMAT=HT_MF or HT_GF and CH_BANDWIDTH=HT_CBW20
- DSSS/CCK is a Clause 15 or Clause 18 transmission

An HT AP declares its channel width capability (20 MHz only or 20/40 MHz) in the Supported Channel Width Set subfield of the HT Capabilities element. An HT AP declares the BSS channel width in the BSS Channel Width subfield in the HT Information element.

A non-AP HT STA declares its channel width capability (20 MHz capable or 20/40 MHz capable) in the Supported Channel Width Set in the HT Capabilities element.

A 20/40 MHz capable HT STA, 20 MHz capable HT STA or non-HT STA may be associated in a BSS with

BSS Channel Width equal to 20/40 MHz.

A non-AP HT STA may switch between 20/40 MHz capable and 20 MHz capable operation by disassociation and association or reassociation.

A 20/40 MHz capable HT STA shall use the 20 MHz primary channel to transmit and receive 20 MHz HT frames. The Notify Channel Width action frame may be used by a non-AP STA to notify another STA that the STA wishes to receive frames in the indicated channel width.

A 20 MHz capable HT STA shall use the 20 MHz primary channel to transmit and receive HT frames.

The PPDU Formats for Beacon transmission are defined in Table n53 (PPDU Formats for Beacon transmission).

Table n53—PPDU Formats for Beacon transmission

Band and BSS channel width	PPDU Format for Beacon transmission
5 GHz band BSS 20/40 MHz	Non-HT OFDM
5 GHz band BSS 20 MHz	Non-HT OFDM
2.4 GHz band BSS 20/40 MHz	DSSS/CCK or non-HT OFDM. See NOTE.
2.4 GHz band BSS 20 MHz	DSSS/CCK or non-HT OFDM. See NOTE.
NOTE — As determined by the BSSBasicRateSet	

The HT AP indicates protection requirements in the BSS through the Operating Mode field and Non-greenfield STAs Present field of the HT information element as well as the Use Protection field of the ERP information element. Protection requirements for different settings of these fields are defined in 9.13.

Phased Coexistence Operation (PCO) is an optional BSS mode with alternating 20 MHz and 40 MHz phases controlled by a PCO capable AP (defined in 11.16 (Phased Coexistence Operation)). A PCO capable AP advertises its BSS as 20/40 MHz BSS Channel Width and PCO Capable. A non-PCO capable STA regards the BSS as a 20/40 MHz BSS and may associate with the BSS without regard to this field.

A STA may associate with a PCO BSS as a PCO capable STA by setting the PCO field in the HT Extended Capabilities element to 1. If the PCO transition time of the STA does not meet the time indicated by the PCO AP in the PCO Transition Time field, then the PCO capable STA regards the BSS as a 20/40 MHz BSS and may associate with the BSS as a 20/40 MHz STA.

Insert the following new subclause

11.15.2 Support of DSSS/CCK in 40 MHz

Transmission and reception of PPDUs using DSSS/CCK by 20/40 MHz capable HT STA is managed using the DSSS/CCK Mode in 40 MHz subfield of the HT Capabilities Info field (see 7.3.2.49.2 (HT Capabilities Info field)).

If the DSSS/CCK Mode in 40 MHz subfield is set to 1 in Beacon and Probe Response frames, an associated HT STA in a 20/40 MHz BSS may generate DSSS/CCK transmissions. If the subfield is set to 0:

— associated HT STAs shall not generate DSSS/CCK transmissions;

— the AP shall not include an ERP information element in its Beacon and Probe Response transmissions;

— the AP shall not include DSSS/CCK rates in the Supported Rates information element;

- the AP shall refuse association requests from any STA that includes DSSS/CCK rates in its Supported Rates information element;
- the AP shall refuse association requests from an HT STA that has the DSSS/CCK Mode in 40 MHz subfield set to 1;
- the Beacon shall be transmitted using a non-HT OFDM PPDU.

An HT STA declares its capability to use DSSS/CCK rates through the DSSS/CCK Mode in 40 MHz subfield of its Association and Reassociation Request transmissions. If this subfield is set to 0, the STA shall not use DSSS/CCK rates. If it is set to 1, the STA may use DSSS/CCK rates.

Insert the following new subclause

11.16 Phased Coexistence Operation

The following definitions apply in this subclause:

- A PCO-capable AP is an HT AP that sets the PCO field in the HT Extended Capabilities field to the value 1.
- A PCO AP is an HT AP that is operating PCO.
- A PCO BSS is an HT BSS that is operated by a PCO AP.
- A PCO-capable non-AP STA is an HT non-AP STA that sets the PCO field in the HT Extended Capabilities field to the value 1.
- A PCO non-AP STA is an HT non-AP STA that is associated with a PCO BSS and following PCO.
- A PCO-capable STA is either a PCO-capable AP or a PCO-capable non-AP STA.
- A PCO STA is either a PCO AP or a PCO non-AP STA.
- A non-PCO-capable 20/40 STA is a 20/40 capable STA that sets the PCO field in the HT Extended Capabilities field to the value 0.

Phased Coexistence Operation (PCO) is an optional coexistence mechanism in which a PCO AP divides time into alternating 20 MHz and 40 MHz phases (see Figure n61 (Phased Coexistence Operation)). The PCO AP reserves the 20 MHz primary channel and the 20 MHz secondary channel in turn to start the 40 MHz phase and resets the NAV in the 20 MHz channels in the opposite order to start the 20 MHz phase. Due to the protection of the 40 MHz period in both channels, it is tolerant of overlapping BSSs on both 20 MHz halves of a 40 MHz channel.

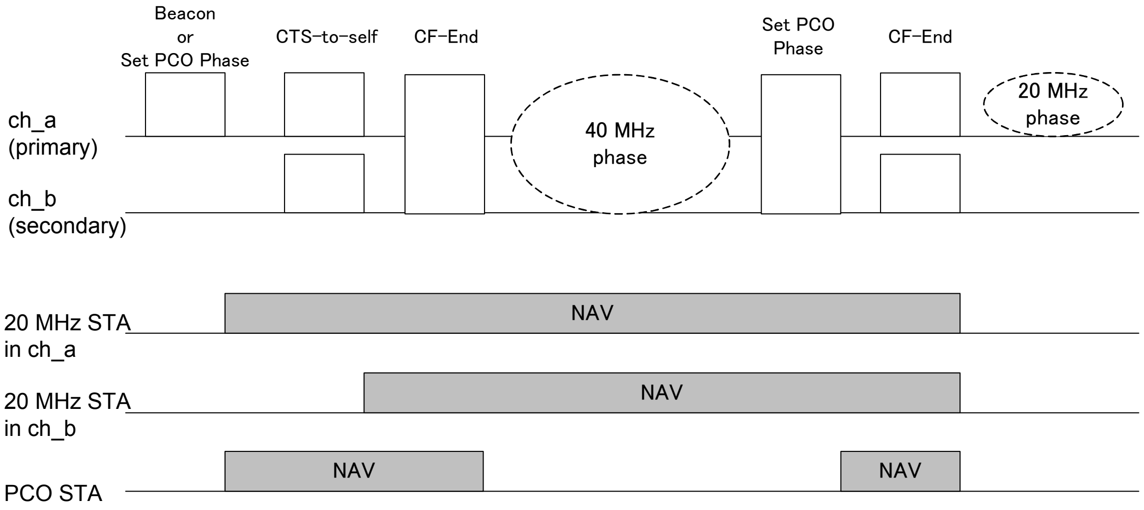

Figure n61—Phased Coexistence Operation

A PCO STA that does not know the current PCO phase shall transmit in a 20 MHz PPDU.

During the 40 MHz phase, a PCO STA shall transmit data frames using a 40 MHz HT PPDU and control frames using a non-HT duplicate or a 40 MHz HT PPDU, except that any CF-End frame shall be sent using a 40 MHz HT PPDU only. During the 40 MHz phase, protection is not required as in a 40 MHz BSS with Supported Channel Width Set field in the HT Capabilities Info field set to 1 and Operating Mode field in the HT Information element set to the value 0. A PCO STA shall update its NAV using Duration/ID field information from any frame received in the primary channel or 40 MHz channel.

During the 20 MHz phase, a PCO STA shall only transmit frames using a 20 MHz (HT or non-HT) PPDU. The protection of a PCO STA during the 20 MHz phase is the same as protection in a 20 MHz BSS.

A non-PCO-capable 20/40 STA regards the PCO BSS as 20/40 MHz BSS. The protection of a non-PCO-capable 20/40 STA that associates with the PCO BSS is the same as protection in a 20/40 MHz BSS.

The PCO Transition Time field in the HT Extended Capabilities field is measured from the end of the PPDU carrying the Set PCO Phase frame. The PCO STA shall be able to receive a PPDU using the new channel width no later than the value specified in the PCO Transition Time field after the end of the PPDU carrying the Set PCO Phase frame.

Insert the following new subclause:

11.16.1 Operation at a PCO AP

A PCO-capable AP activates PCO if it decides that PCO is more appropriate than either 20/40 MHz mode or 20 MHz mode in the current circumstances. The algorithm for making this decision is beyond the scope of this standard.[1]

The PCO-capable AP shall set the Supported Channel Width Set subfield in the HT Capabilities Info field to 1 to indicate that the BSS is 20/40 MHz capable. A PCO AP shall set the PCO Active field in the HT Information element to 1.

When a PCO AP detects that the PCO is not providing a performance benefit, the PCO AP may deactivate PCO and switch to either 20/40 MHz mode or 20 MHz mode. When switching to 20 MHz mode, the PCO AP first switches to 20/40 MHz mode and then to 20 MHz mode[2]. The algorithm for making this decision is beyond the scope of this standard. A PCO-capable AP shall set the PCO Active field in the HT Information element to 0 when PCO operation is disabled. Since the AP advertises the current mode in its Beacon and Probe Response frames, its associated STAs are informed of the mode change.

Values of the PCO Transition Time field in the HT Extended Capabilities field from 1 to 3 indicate the maximum time the PCO STA takes to switch between a 20 MHz channel width and a 40 MHz channel width. A PCO AP may set the PCO Transition Time field to 0 when it requires the associated PCO STAs to be able to receive 40 MHz frames and respond with 40 MHz frames during the 20 MHz phase. The PCO AP shall interpret the receipt of an Association Request frame with the PCO field set to 1 in the HT Extended Capabilities field in the HT Capabilities element as an indication that the STA transmitting the Association Request frame is PCO-capable. The AP may choose to continue PCO when a non-PCO-capable 20/40 STA requests association, and in such case, the PCO AP shall be able to receive 40 MHz frames and respond using 40 MHz frames

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[1] A PCO capable AP may consider the capabilities of associated STAs as well as the interference between the BSS and overlapping BSSs to determine the BSS operation mode.

[2] The mechanism used to switch from 20/40 MHz mode to 20 MHz mode is the same regardless of PCO support at the AP, because PCO is not enabled at this time.

during the 20 MHz phase. The PCO Transition Time field value announced by the PCO AP is independent of the current state of the PCO AP but it shall satisfy the required transition time indicated by the associated PCO STAs.

The PCO AP may increase the transition time if a PCO-capable STA associates whose transition time exceeds the one currently used by the PCO AP. If the PCO AP decides not to extend its transition time to meet the value of the requesting STA, the PCO AP shall deny the association.

A PCO AP that transmits a Set PCO Phase frame indicating a switch to the 40 MHz phase in a Beacon or a Set PCO Phase frame shall wait for at least the transition time before sending a CF-End in the 40 MHz channel to start the 40 MHz operating phase. To start the 20 MHz phase, a PCO AP shall send a Set PCO Phase frame. It may also send a CF-End in both primary and secondary channels following the Set PCO Phase frame. If the PCO Transition Time field is set to a value other than 0 by the PCO AP, the PCO AP shall wait for at least the duration specified by the PCO Transition Time field before sending out a CF-End in the primary channel.

The value of the CFP DurRemaining field in the CF Parameter Set element of a Beacon frame or the value of the Duration/ID field of a Set PCO Phase frame that are sent by the PCO AP on the primary channel in order to start the 40 MHz phase shall include the transition times from 20 MHz channel width to 40 MHz channel width and from 40 MHz channel width to 20 MHz channel width and an intended duration of 40 MHz phase. The transition time is specified by the PCO Transition Time field in the HT Extended Capabilities field when it contains a value from 1 to 3. The value of the Duration/ID field in a CTS-to-self frame shall include the intended duration of the 40 MHz phase. A PCO AP may continue the CFP after the 40 MHz phase by setting a longer duration for the CFP. The CTS-to-self shall be sent in non-HT duplicate mode. In order to issue this frame, the AP shall sense the secondary channel clear at least PIFS period. It need not sense the primary channel since it is already reserved by a Beacon frame or a Set PCO Phase action frame. The CCA sensing rule in PCO is the same as described in 9.20 (20/40 Functional description).

To avoid an unexpectedly long delay for the secondary channel access before the 40 MHz phase, the PCO AP starts a timer with a time-out value equal to transition time after transmitting the Beacon or a Set PCO Phase action frame. If the timer expires while attempting to reserve the secondary channel, the AP abandons switching to the 40 MHz phase by transmitting a Set PCO Phase action frame indicating switch-back to 20 MHz phase and a CF-End frame on the primary channel.

A PCO AP may transmit a Set PCO Phase frame in a non-HT duplicate PPDU followed by a CF-End frame in a 40 MHz PPDU to reserve both the primary channel and the secondary channel again for the 40 MHz phase or to extend the 40 MHz phase. The value of the Duration/ID field in a Set PCO Phase frame contained in a non-HT duplicate PPDU for this intent shall include the intended duration of the 40 MHz phase and the transition time specified by the PCO Transition Time field.)

When a Set PCO Phase frame indicates a switch from 40 MHz phase to 20 MHz phase, the Duration/ID field of this frame shall be set so that it covers the time specified by the PCO Transition Time field.

A PCO AP may broadcast a Set PCO Phase frame to advertise the current PCO phase to PCO STAs.

Although PCO improves throughput in some circumstances, PCO might also introduce jitter. To minimize the jitter, the maximum duration of 40 MHz phase and 20 MHz phase is dot11PCO40MaxDuration and dot11PCO20MaxDuration, respectively. Also in order for the PCO AP to give opportunities for each STA to send frames, the minimum duration of 40 MHz phase and 20 MHz phase is dot11PCO40MinDuration and dot11PCO20MinDuration, respectively.

Insert the following new subclause:

11.16.2 Operation at a PCO non-AP STA

A PCO-capable non-AP STA declares its capabilities using the HT Extended Capabilities field in the HT Capabilities element of an Association Request. If the PCO field in the Association Request to a PCO AP is set to 1 and the association succeeds, the STA shall operate in PCO mode. When requesting association, a PCO-capable STA shall set the PCO Transition Time field to 0 if the PCO AP has set the PCO Transition Time field to 0. A PCO-capable STA may attempt to associate with a transition time that is larger than one currently advertised by the PCO AP. If such an association fails, the PCO-capable non-AP STA may regard the BSS as a 20/40 MHz BSS and may attempt an association as a non-PCO-capable 20/40 STA.

A PCO non-AP STA may transmit a Probe Request frame to the associated PCO AP to determine the current PCO phase. A PCO STA associated with a PCO AP shall switch its operating phase from 20 MHz channel width to 40 MHz channel width when it receives a Beacon frame or a Probe Response frame that contains the PCO Phase field set to 1 or a Set PCO Phase frame with the PCO Phase field set to 1 from the associated AP. The CFP DurRemaining field in the CF Parameter Set element of a Beacon frame or the value of the Duration/ID field of a Set PCO Phase frame shall be interpreted as the duration of the PCO 40 MHz phase.

A PCO STA associated with a PCO AP shall switch its operating phase from 40 MHz channel width to 20 MHz channel width when it receives a Beacon frame or a Probe Response frame that contains the PCO Phase field set to 0 or a Set PCO Phase frame with the PCO Phase field set to 0 and when it has frames to transmit during the 20 MHz phase. It also may switch from 40 MHz channel width to 20 MHz channel width when the expected 40 MHz phase duration ends.

A PCO-capable STA shall follow the BSS Operating Mode by receiving the AP's Beacons and Probe Response frames. A PCO STA shall halt PCO operation if PCO mode is deactivated by the AP. An HT STA may disassociate and associate or reassociate with an AP to change its PCO capabilities.

11.17 STA-STA HT Information Exchange

A STA that supports the HT Information Exchange management action frame type shall set the HT Information Exchange Support bit to 1 in transmitted Extended Capabilities information elements.

An AP that supports the HT Information Exchange management action frame type shall set the HT Information Exchange Support bit to 1 in transmitted Extended Capabilities information elements.

A STA that supports the transmission of and reception of the HT Information Exchange management action frame may transmit any information that is indicated in the HT Information Exchange management action frame format to any other STA that also supports the transmission of and reception of the HT Information Exchange management action frame, including to the AP with which it is associated.

Additionally, a STA that supports the transmission of and reception of the HT Information Exchange management action frame may transmit any information that is indicated in the HT Information Exchange management action frame format to any APs with which it is not associated using either an individual or group addressed frame.

A STA shall not transmit an HT Information Exchange management action frame to a STA that does not support the transmission of and reception of the HT Information Exchange management action frame with the exception of when it transmits an HT Information frame with a broadcast address in the address1 field.

Any changes to information that are indicated through an HT Information Exchange management action frame take effect when the HT Information Exchange management action frame is successfully transmitted.

The most recently received information from within an HT Information Exchange management action frame shall supersede any earlier received information, regardless of the frame type and subtype that was used to communicate that information. For example, information may be provided within HT Information Exchange management action frames, within Management Action frames, and within other management frames.

The most recently successfully transmitted information from within an HT Information Exchange management action frame shall supersede any earlier transmitted information, regardless of the frame type and subtype that was used to communicate that information. For example, information may be provided within HT Information Exchange management action frames, within Management Action frames, and within other management frames.

A STA may transmit an HT Information Exchange management action frame that contains a value of 1 for the Request Information bit to another STA that supports the transmission of and reception of HT Information Exchange management action frame. A STA that receives an HT Information Exchange management action frame that contains a value of 1 for the Request Information bit shall transmit an HT Information Exchange management action frame that has the value of its RA corresponding to the address of the STA from which it received the HT Information Exchange management action frame that contained a value of 1 for the Request Information bit.

12. PHY service specification

12.3.4.2 PHY-SAP sublayer-to-sublayer service primitives

Insert the following entries into the Table 81:

Table 81— PHY-SAP sublayer-to-sublayer service primitives

Primitive	Request	Indicate	Confirm
PHY-RXCONFIG	X		X

12.3.4.3 PHY-SAP service primitives parameters

Insert the following entries into the table defining PHY-SAP service primitive parameters

Table 82—PHY-SAP service primitive parameters

Parameter	Associated primitive	Value
PHYCONFIG_VECTOR	PHY-RXCONFIG	A set of parameters

12.3.4.4 Vector descriptions

Add the following paragraph to the end of 12.3.4.4:

The Clause 20 PHY TXVECTOR and RXVECTOR contain additional parameters related to the operation of the Clause 20 PHY modes of operation as described in 20.2 (HT PHY service interface). In certain modes of operation, the DATARATE parameter is replaced by a modulation and coding scheme (MCS) value. The mapping from Clause 20 MCS to data rate is defined in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)).

Insert the following entries into the table defining Vector descriptions

Table 83—Vector descriptions

Parameter	Associated vector	Value
ACTIVE_RXCHAIN_SET	PHYCONFIG_VECTOR	PHY dependent. The ACTIVE_RXCHAIN_SET parameter indicates which RX chains of the available RX chains are active. The length of the field is 8 bits. A 1 in bit potion *n* indicates that the RX chain numbered *n* is used. At most 4 bits out of 8 may be set to 1.

12.3.5.4 PHY-TXSTART.request

12.3.5.4.1 Function

Change 12.3.5.4.1 as follows:

This primitive is a request by the MAC sublayer to the local PHY entity to start the transmission of a~~n MPDU~~ PSDU.

12.3.5.4.2 Semantics of the service primitive

Change 12.3.5.4.2 as follows:

The primitive provides the following parameters:

PHY-TXSTART.request(TXVECTOR)

The TXVECTOR represents a list of parameters that the MAC sublayer provides to the local PHY entity in order to transmit a~~n MPDU~~ PSDU. This vector contains both PLCP and PHY management parameters. The required PHY parameters are listed in 12.3.4.4.

12.3.5.4.3 When generated

Change 12.3.5.4.3 as follows:

This primitive will be issued by the MAC sublayer to the PHY entity when the MAC sublayer needs to begin the transmission of a~~n MPDU~~ PSDU.

12.3.5.6 PHY-TXEND.request

12.3.5.6.1 Function

Change 12.3.5.6.1 as follows:

This primitive is a request by the MAC sublayer to the local PHY entity that the current transmission of the ~~MPDU~~ PSDU be completed.

12.3.5.6.3 When generated

Change 12.3.5.6.3 as follows:

This primitive will be generated when the MAC sublayer has received the last PHY-DATA.confirm from the local PHY entity for the ~~MPDU~~PSDU currently being transferred.

12.3.5.12 PHY-RXEND.indication

12.3.5.12.1 Function

Change 12.3.5.12.1 as follows:

This primitive is an indication by the PHY to the local MAC entity that the ~~MPDU~~PSDU currently being received is complete.

12.3.5.12.2 Semantics of the service primitive

Change 12.3.5.12.2 as follows:

The primitive provides the following parameter:

PHY-RXEND.indication (RXERROR)

The RXERROR parameter can convey one or more of the following values: NoError, FormatViolation, CarrierLost, or UnsupportedRate. A number of error conditions may occur after the PLCP's receive state machine has detected what appears to be a valid preamble and SFD. The following describes the parameter returned for each of those error conditions.

- *NoError.* This value is used to indicate that no error occurred during the receive process in the PLCP.
- *FormatViolation.* This value is used to indicate that the format of the received PPDU was in error.
- *CarrierLost.* This value is used to indicate that during the reception of the incoming ~~MPDU~~PSDU, the carrier was lost and no further processing of the ~~MPDU~~PSDU can be accomplished.
- *UnsupportedRate.* This value is used to indicate that during the reception of the incoming PPDU, an unsupported date rate was detected.

Insert the following new subclause after 12.3.5.12 - PHY-RXEND.indication

12.3.5.13 PHY-RXCONFIG.request

12.3.5.13.1 Function

This primitive is a request by the MAC sublayer to the local PHY entity to configure the PHY receiver.

12.3.5.13.2 Semantics of the service primitive

The semantics of the primitives are as follows:

PHY-RXCONFIG.request (PHYCONFIG_VECTOR)

12.3.5.13.3 When generated

This primitive is generated by the MAC sublayer for the local PHY entity when it desires to change the configuration of the PHY.

12.3.5.13.4 Effect of receipt

The effect of receipt of this primitive by the PHY is to apply the parameters provided and configure the PHY for future operation.

Insert the following new subclause

12.3.5.14 PHY-RXCONFIG.confirm

12.3.5.14.1 Function

This primitive is issued by the PHY to the local MAC entity to confirm that the PHY has applied the parameters provided in the PHY-RXCONFIG.request.

12.3.5.14.2 Semantics of the service primitive

The semantics of the primitives are as follows:

PHY-RXCONFIG.confirm

This primitive has no parameters.

12.3.5.14.3 When generated

This primitive is issued by the PHY to the MAC entity when the PHY has received and successfully applied the parameters in the PHY-RXCONFIG.request.

12.3.5.14.4 Effect of receipt

The effect of the receipt of this primitive by the MAC is unspecified.

Insert the following new subclause heading:

20. High Throughput (HT) PHY specification

Insert the following new subclause:

20.1 Introduction

Clause 20 (High Throughput (HT) PHY specification) specifies the PHY Entity for a high throughput (HT) orthogonal frequency division multiplexing (OFDM) system. The HT STA shall be compliant with PHY specifications as defined in Clause 17 for operation in the 5 GHz bands, and Clauses 18 and 19 for operation in the 2.4 GHz bands . The HT features are applicable to operation in either the 2.4 GHz band or the 5 GHz bands, or both, as specified in 20.3.14 (Channel numbering and channelization). The HT OFDM PHY is based on the OFDM PHY defined in Clause 17, with extensibility up to 4 spatial streams, operating in 20 MHz bandwidth. Additionally, transmission using 1 to 4 spatial streams is also defined for operation in 40 MHz bandwidth. These features are capable of supporting data rates up to 600 Mb/s (4 spatial streams, 40 MHz bandwidth). The HT OFDM PHY data subcarriers are modulated using binary phase shift keying (BPSK), quadrature phase shift keying (QPSK), 16-quadrature amplitude modulation (16-QAM), or 64-QAM. Forward error correction coding (convolutional coding) is used with a coding rate of 1/2, 2/3, 3/4, or 5/6. Low-density parity-check (LDPC) codes are added . Other features at both transmit and receive sides are 400 ns short guard interval (GI), transmit beamforming, HT greenfield format , space-time block codes (STBC), and 40 MHz operation. The HT OFDM PHY defined in Clause 20 is mandatory for all equal modulation rates specified for 1 and 2 spatial streams (MCSs 0 through 15) at an AP and for 1 spatial stream (MCSs 0 through 7) at a STA using 20 MHz channel width. Support for all other MCSs in 2 to 4 spatial streams in 20 MHz, and for all MCSs in 1-4 spatial streams using 40 MHz channel width is optional. The maximum MPDU length is extended to 65535 octets.

The HT PHY supports non-HT operation in the 2.4 GHz band as defined by Clause 19. It supports non-HT operation in the 5 GHz bands in as defined by Clause 17.

Insert the following new subclause:

20.1.1 Scope

The services provided to the MAC by the HT 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 PHY sublayer service data units (PSDU) into a framing format suitable for sending and receiving user data and management information between two or more stations 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 stations, each using the HT OFDM PHY.

Insert the following new subclause:

20.1.2 HT PHY functions

The HT PHY contains three functional entities: the PHY convergence function (PLCP), the layer management function (PLME) and the PMD function. Each of these functions is described in detail in 20.3 (HT PLCP sublayer) to 20.5 (HT PMD sublayer).

The HT PHY service is provided to the MAC through the PHY service primitives defined in Clause 12.

Insert the following new subclause:

20.1.2.1 HT PLCP sublayer

In order to allow the MAC to operate with minimum dependence on the PMD sublayer, a PHY convergence sublayer is defined (PLCP). The PLCP sublayer simplifies the PHY service interface to the MAC services.

Insert the following new subclause:

20.1.2.2 HT PMD sublayer

The HT PMD sublayer provides a means to send and receive data between two or more stations. This Clause is concerned with the 2.4 GHz and 5 GHz frequency bands using HT OFDM modulation.

Insert the following new subclause:

20.1.2.3 PHY management entity (PLME)

The PLME performs management of the local PHY functions in conjunction with the MLME.

Insert the following new subclause:

20.1.2.4 Service specification method

The models represented by figures and state diagrams are intended to be illustrations of the functions provided. It is important to distinguish between a model and a real implementation. The models are optimized for simplicity and clarity of presentation; the actual method of implementation is left to the discretion of the HT PHY compliant developer. The service of a layer or sublayer is the set of capabilities that it offers to a user in the next higher layer (or sublayer). Abstract services are specified here by describing the service primitives and parameters that characterize each service. This definition is independent of any particular implementation.

Insert the following new subclause:

20.1.3 PPDU Formats

The PPDU format transmitted by an HT STA is determined by the TXVECTOR FORMAT, CH_BANDWIDTH , CH_OFFSET and MCS parameters as defined in this subclause.

The FORMAT parameter determines the overall structure of the PPDU as follows:

- *Non-HT format***:** packets of this format are structured according to the Clause 17 (OFDM) or 19 (ERP) specification. Support for Non-HT Format is mandatory.
- *HT mixed format***:** packets of this format contain a preamble compatible with the non-HT receivers. The non-HT Short Training Field (L-STF), the non-HT Long Training Field (L-LTF) and the non-HT SIGNAL field are defined so they can be decoded by non-HT Clause 17 and 19 STAs. The rest of the packet cannot be decoded by Clause 17 or Clause 19 STAs. Support for HT mixed format is mandatory.
- *HT greenfield format***:** HT packets of this format do not contain a non-HT compatible part. Support for HT greenfield format is optional. An HT STA that does not support the reception of an HT greenfield format packet shall be able to detect that an HT greenfield format packet is an HT transmission (as opposed to a non-HT transmission). In this case the receiver shall decode the HT-SIG and determine if the HT-SIG cyclic redundancy check (CRC) passes.

The operation of the PHY in the frequency domain is determined by the CH_BANDWIDTH and

CH_OFFSET parameters. Table n55 (PPDU format as a function of CH_BANDWIDTH and CH_OFFSET parameters) shows the combination of CH_BANDWIDTH and CH_OFFSET parameters that are supported.

Support of 20 MHz Non-HT Format and 20 MHz HT Format with one and two spatial streams is mandatory at APs. Support of 20 Mhz Non-HT Format and 20 MHz HT Format with one spatial stream is mandatory the non-AP STAs.

Insert the following new subclause heading:

20.2 HT PHY service interface

Insert the following new subclause:

20.2.1 Introduction

The PHY interfaces to the MAC through the TX_VECTOR, RX_VECTOR, and the PHYCONFIG_VECTOR. The TX_VECTOR supplies the PHY with per packet TX parameters. Using the RX_VECTOR, the PHY informs the MAC of the received packet parameters. Using the PHYCONFIG_VECTOR, the MAC configures the PHY for operation, independent of frame transmission or reception.

This interface is an extension of the generic PHY service interface defined in 12.3.4.

Insert the following new subclause:

20.2.2 TXVECTOR and RXVECTOR parameters

The parameters in Table n56 (TXVECTOR and RXVECTOR parameters) are defined as part of the TXVECTOR parameter list in the PHY-TXSTART.request service primitive and/or as part of the RXVECTOR parameter list in the PHY-RXSTART.indication service primitive.

Insert the following new subclause:

20.2.3 Support for NON_HT formats

When the FORMAT parameter is set to NON_HT, the behavior of the HT PHY is defined in other Clauses as shown in Table n57 (Mapping of HT PHY parameters for NON_HT operation), dependent on the operational band. In this case, the PHY-TXSTART.request is handled by mapping the TXVECTOR parameters as defined in Table n57 (Mapping of HT PHY parameters for NON_HT operation) and following operation as defined in the referenced Clause. Likewise the PHY-RXSTART.indication emitted when a NON_HT PPDU is received is defined in the referenced Clauses, with mapping of TXVECTOR parameters as defined in Table n57 (Mapping of HT PHY parameters for NON_HT operation).

Insert the following new subclause heading:

20.3 HT PLCP sublayer

Insert the following new subclause:

20.3.1 Introduction

20.3 (HT PLCP sublayer) provides a convergence procedure for the HT PHY in which PSDUs are converted to and from PPDUs. During transmission, the PSDU shall be appended to the PLCP preamble to create the PPDU. At the receiver, the PLCP preamble is processed to aid in demodulation and delivery of the PSDU.

Two preamble formats are defined. For HT mixed format operation, the preamble has a non-HT portion and an HT portion. The non-HT portion of the HT mixed format preamble enables detection of the PPDU and acquisition of carrier frequency and timing by both HT STAs and STAs that are compliant with Clause 17 and/or Clause 19. The non-HT portion of the HT mixed format preamble also consists of the SIGNAL field defined in Clause 17 and is thus decodable by STAs compliant with Clause 17 and Clause 19, as well as HT STAs.

The HT portion of the HT mixed format preamble enables estimation of the MIMO channel to support demodulation of the HT data by HT STAs. The HT portion of the HT mixed format preamble also consists of the HT-SIG field that supports HT operation, and the SERVICE field.

For greenfield operation, compatibility with Clause 17 and Clause 19 STAs is not required. Therefore, the non-HT portions of the preamble are not included in the greenfield format preamble .

Insert the following new subclause:

20.3.2 PLCP frame format

Two formats are defined for the PLCP (PHY Layer Convergence Protocol): HT mixed format and greenfield format. These two formats are called HT formats. Figure n62 (PPDU frame format) shows the non-HT format[1] and the HT formats. There is also an HT duplicate format (specified in 20.3.10.10.4) used for MCS 32 that provides the lowest rate in a 40 MHz channel. In addition to the HT formats, there is a non-HT duplicate format (specified in 20.3.10.11 (Non-HT duplicate transmission)) that duplicates the 20 MHz non-HT packet in two 20 MHz halves of a 40 MHz channel.

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[1] The Non-HT format is shown related to the terminology of this subclause. The Non-HT PPDU format is defined in 17.3.3 and 17.3.2.

Table n55—PPDU format as a function of CH_BANDWIDTH and CH_OFFSET parameters

CH_BANDWIDTH	**CH_OFFSET**			
	Not present	**CH_OFF_40**	**CH_OFF_20U**	**CH_OFF_20L**
HT_CBW20	*20 MHz HT Format*: a PPDU of this format is transmitted by a STA that has a 20 MHz operating channel width to transmit an HT Mixed or greenfield format packet of 20 MHz bandwidth. The PPDU contains one to four spatial streams.	X	*40 MHz HT upper format*: the STA transmits an HT Mixed or greenfield format packet of 20 MHz bandwidth with one to four spatial streams in the upper 20 MHz of a 40 MHz channel	*40 MHz HT lower format*: the STA transmits an HT Mixed or greenfield format packet of 20 MHz bandwidth with one to four spatial streams in the lower 20 MHz of a 40 MHz channel

Table n55—PPDU format as a function of CH_BANDWIDTH and CH_OFFSET parameters

CH_BANDWIDTH	**CH_OFFSET**			
	Not present	**CH_OFF_40**	**CH_OFF_20U**	**CH_OFF_20L**
HT_CBW40	X	When MCS is not set to 32: *40 MHz HT format*: a PPDU of this format occupies a 40 MHz channel to transmit an HT Mixed or greenfield format packet of 40 MHz bandwidth with one to four spatial streams.	X	X
		When MCS is set to 32: *HT duplicate format*: a PPDU of this format occupies a 40 MHz channel composed of two adjacent 20 MHz channels and transmits an HT Mixed or greenfield format packet on a single spatial stream This provides the lowest HT transmission rate in 40 MHz.		
NON_HT_CBW20	*20 MHz non-HT format*: The STA has a 20 MHz operating channel width to transmit a Non-HT Format packet according to Clause 17 or Clause 19 operation	X	X	X

Table n55—PPDU format as a function of CH_BANDWIDTH and CH_OFFSET parameters

CH_BANDWIDTH	CH_OFFSET			
	Not present	CH_OFF_40	CH_OFF_20U	CH_OFF_20L
NON_HT_CBW40	X	*Non-HT duplicate format*: The STA operates in a 40 MHz channel composed of two adjacent 20 MHz channels. The packets to be sent are in the Clause 17 format (Ed: CID 3432) in each of the 20 MHz channels. The upper channel (higher frequency) is rotated by +90º relative to the lower channel.	*40 MHz Non-HT upper format:* The STA transmits a non-HT packet of 20 MHz bandwidth in the upper 20 MHz of a 40 MHz channel	*40 MHz Non-HT lower format*: The STA transmits a non-HT packet of 20 MHz bandwidth with in the lower 20 MHz of a 40 MHz channel
X = Not defined				

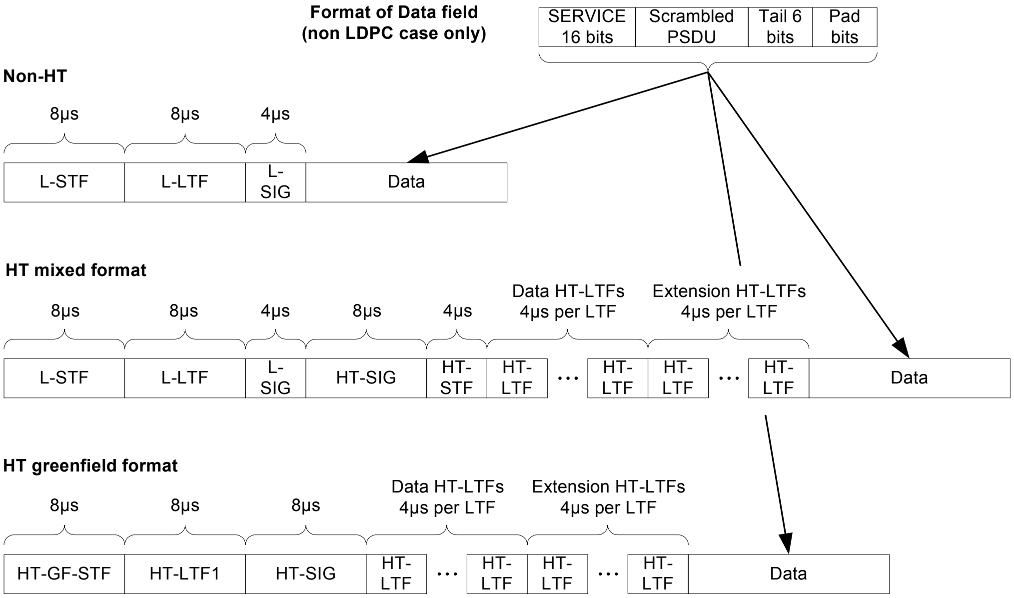


Figure n62—PPDU frame format

The elements of the PLCP packet are:

- L-STF: Non-HT Short Training Field
- L-LTF: Non-HT Long Training Field

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
FORMAT		Determines the format of the PPDU. Enumerated Type: NON_HT indicates Clause 15, 17, 18 or 19 PPDU formats, or non-HT duplicated PPDU format. In this case the modulation is determined by the NON-HT MODULATION parameter. HT_MF indicates HT mixed format HT_GF indicates HT greenfield format	Y	Y
NON_HT_ MODULATION		When FORMAT is NON_HT: Enumerated Type: ERP-DSSS ERP-CCK ERP-OFDM ERP-PBCC DSSS-OFDM OFDM Otherwise this parameter is not present.	Y	Y

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
L_LENGTH	FORMAT is NON_HT	Indicates the length of the PSDU in octets in the range 1-4095. 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 HT_MF	Indicates the value in the Length field of the Non-HT SIGNAL Field in the range 1-4095. This use is defined in 9.13.4 (Setting the L-LENGTH and L-RATE parameters for HT_MF PPDUs). This parameter may be used for the protection of more than one PPDU as described in 9.13.5 (L-SIG TXOP protection).	Y	Y
	FORMAT is HT_GF	Not present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
L_DATARATE	FORMAT is NON_HT	Indicates the rate used to transmit the PSDU in Mb/s. Allowed values depend on the value of the NON-HT MODULATION parameter thus: DSSS: 1 and 2 CCK: 5.5 and 11 PBCC: 5.5, 11, 22 and 33 DSSS-OFDM: 6, 9, 12, 18, 24, 36, 48 and 54 OFDM (depends on channel spacing): 20 MHz channel spacing: 6, 9, 12, 18, 24, 36, 48, and 54 10 MHz channel spacing: 3, 4.5, 6, 9, 12, 18, 24, and 27 (See Note 1) 5 MHz channel spacing: 1.5, 2.25, 3, 4.5, 6, 9, 12, and 13.5 (See Note 1)	Y	Y
	FORMAT is HT_MF	Indicates the data rate value that is in the Non-HT SIGNAL Field. This use is defined in 9.13.4 (Setting the L-LENGTH and L-RATE parameters for HT_MF PPDUs). This parameter shall be set to 6 Mb/s when FORMAT is HT_MF.	Y	Y
	FORMAT is HT_GF	Not Present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
SERVICE	FORMAT is NON_HT and NON-HT MODULATION is either OFDM or DSSS-OFDM	Scrambler initialization, 7 null bits + 9 reserved null bit	Y	N
	FORMAT is HT_MF or HT_GF	Scrambler initialization, 7 null bits + 9 reserved null bit	Y	N
	Otherwise	Not present	N	N
TXPWR_LEVEL		The allowed values for the TXPWR_LEVEL parameter are in the range from 1 to 8. This parameter is used to indicate which of the available TxPowerLevel attributes defined in the MIB shall be used for the current transmission	Y	N
RSSI		The allowed values for the RSSI parameter are in the range from 0 through RSSI maximum. This parameter is a measure by the PHY of the power observed at the antennas used to receive the current PPDU. RSSI shall be measured during the reception of the PLCP preamble. In HT mixed format the reported RSSI shall be measured during the reception of the HT LTFs. RSSI is intended to be used in a relative manner, and it shall be a monotonically increasing function of the received power.	N	Y

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	**RXVECTOR Y/N/O**
PREAMBLE_TYPE	FORMAT is NON_HT and HT MODULATION is one of (ERP-DSSS, ERP-CCK, ERP-PBCC, DSSS-OFDM)	Enumerated type: SHORTPREAMBLE, LONGPREAMBLE	Y	Y
	Otherwise	Not present	N	N
MCS	FORMAT is HT_MF or HT_GF	The MCS field selects the modulation and coding scheme used in the transmission of the packet. The value used in each modulation and coding scheme is the index defined in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)). Integer: range 0 to 76. Values of 77 to 127 are reserved. The interpretation of the MCS index is defined in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	Y	Y
	Otherwise	Not present	N	N
REC_MCS	FORMAT is HT_MF or HT_GF	The MCS that the STA's receiver recommends.	N	O
	Otherwise	Not Present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
CH_BANDWIDTH	FORMAT is HT_MF or HT_GF	The CH_BANDWIDTH parameter indicates whether the packet is transmitted using 40 MHz or 20 MHz channel width. Enumerated type: HT_CBW20, for 20 MHz, and 40 MHz Upper and Lower modes HT_CBW40, for 40 MHz	Y	Y
	FORMAT is NON_HT	Enumerated type: NON_HT_CBW40 for non-HT duplicate NON_HT_CBW20 for all other non-HT	Y	N
CH_OFFSET	FORMAT is HT_MF or HT_GF	The CH_OFFSET parameter indicates which portion of the channel is used for transmission. Enumerated type: CH_OFF_20 indicates the use of a 20 MHz channel (that is not part of a 40 MHz channel) CH_OFF_40 indicates the entire 40 MHz channel CH_OFF_20U indicates the upper 20 MHz of the 40 MHz channel CH_OFF_20L indicates the lower 20 MHz of the 40 MHz channel	Y	N
	Otherwise	Not present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
LENGTH	FORMAT is HT_MF or HT_GF	Indicates the length of an HT PSDU in the range 0-65535 octets. A value of zero indicates a Null Data Packet that contains no data symbols after the preamble.	Y	Y
	Otherwise	Not present	N	N
SMOOTHING	FORMAT is HT_MF or HT_GF	Indicates whether frequency-domain smoothing is recommended as part of channel estimation. Enumerated type: SMOOTHING_REC indicates that smoothing is recommended SMOOTHING_NOT_REC indicates that smoothing is not recommended	Y	Y
	Otherwise	Not present	N	N
SOUNDING	FORMAT is HT_MF or HT_GF	Indicates whether this packet is a sounding packet. Enumerated type: SOUNDING indicates this is a sounding packet NOT_SOUNDING indicates this is not a sounding packet	Y	Y
	Otherwise	Not present	N	N
AGGREGATION	FORMAT is HT_MF or HT_GF	Indicates whether the PSDU contains an A-MPDU. Enumerated type: AGGREGATED indicates this is a packet with A-MPDU aggregation NOT_AGGREGATED indicates this is a packet without A-MPDU aggregation	Y	Y
	Otherwise	Not present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
STBC	FORMAT is HT_MF or HT_GF	Indicates the difference between the number of space time streams (N_{STS}) and the number of spatial streams (N_{SS}) indicated by the MCS. Set to 0 indicates no STBC ($N_{STS} = N_{SS}$) Set to 1 indicates $N_{STS} - N_{SS} = 1$ Set to 2 indicates $N_{STS} - N_{SS} = 2$ Value of 3 is reserved	Y	Y
	Otherwise	Not present	N	N
LDPC_CODING	FORMAT is HT_MF or HT_GF	Indicates whether Binary Convolutional Code (BCC) or Low Density Parity Check (LDPC) encoding is used. Enumerated type: BCC_CODING for Binary Convolutional Code LDPC_CODING for Low Density Parity Check code	Y	Y
	Otherwise	Not present	N	N
SHORT_GI	FORMAT is HT_MF or HT_GF	Indicates whether a short Guard Interval (GI) is used in the transmission of the packet. Enumerated type: LONG_GI indicates short GI is not used in the packet SHORT_GI indicates Short GI is used in the packet	Y	Y
	Otherwise	Not present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
NUM_EXTEN_SS	FORMAT is HT_MF or HT_GF	Indicates the number of extension spatial streams that are sounded during the extension part of the HT training in the range 0-3	Y	Y
	Otherwise	Not present	N	N
ANTENNA_SET	FORMAT is HT_MF or HT_GF	The ANTENNA_SET parameter indicates which antennas of the available antennas are used in the transmission. The length of the field is 8 bits. A 1 in the nth bit from LSB indicates that the nth antenna is used. At most 4 bits out of 8 may be set to 1. This field is only present if antenna selection is applied.	O	N
	Otherwise	Not present	N	N
ANTENNA_SET_ON	FORMAT is HT_MF or HT_GF	The ANTENNA_SET_ON parameter indicates whether the ANTENNA_SET parameter contains valid values. Enumerated type: ANTENNA_SET_ON indicates that ANTENNA_SET is valid NO_ANTENNA_SET_ON indicates that ANTENNA_SET is not valid	Y	N
	Otherwise	Not present	N	N
N_TX	FORMAT is HT_MF or HT_GF	The N_TX parameter indicates the number of transmit chains.	Y	N
	Otherwise	Not present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
EXPANSION_MAT	EXPANSION_MAT_TYPE is COMPRESSED_SV	Contains a set of compressed beamforming matrices as defined in 20.3.11.2.3 (Compressed beamforming matrix feedback). The number of elements depends on the number of spatial streams and the number of transmit chains.	Y	N
	EXPANSION_MAT_TYPE is NON_COMPRESSED_SV	Contains a set of non-compressed beamforming matrices as defined in 20.3.11.2.2 (Non-compressed beamforming matrix feedback). The number of complex elements is $N_{ST} \times N_r \times N_c$ where N_{ST} is the total number of subcarriers, N_c is the number of columns and N_r is the number of rows in each matrix.	Y	N
	EXPANSION_MAT_TYPE is CSI_MATRICES	Contains a set of CSI matrices as defined in 20.3.11.2.1 (CSI Matrices feedback). The number of complex elements is $N_{ST} \times N_r \times N_c$ where N_{ST} is the total number of subcarriers, N_c is the number of columns and N_r is the number of rows in each matrix.	Y	N
	(FORMAT is not HT_MF or HT_GF) or EXPANSION_MAT_TYPE is NO_EXPANSION_MAT	Not present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
EXPANSION_ MAT_TYPE	FORMAT is HT_MF or HT_GF	Enumerated type: NO_EXPANSION_MAT indicates that EXPANSION_MAT is not valid COMPRESSED_SV indicates that EXPANSION_MAT is a set of compressed beamforming matrices NON_COMPRESSED_SV indicates that EXPANSION_MAT is a set of non-compressed beamforming matrices. CSI_MATRICES indicates that EXAPNSION_MAT is a set of channel state matrices.	Y	N
	Otherwise	Not present	N	N

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	RXVECTOR Y/N/O
CHAN_MAT	CHAN_MAT_TYPE is COMPRESSED_SV	CHAN_MAT contains a set of compressed beamforming matrices as defined in 20.3.11.2.3 (Compressed beamforming matrix feedback) based on the channel measured during the training symbols of the received PPDU. The number of elements depends on the number of spatial streams and the number of transmit chains.	N	Y
	CHAN_MAT_TYPE is NON_COMPRESSED_SV	CHAN_MAT contains a set of non-compressed beamforming matrices as defined in 20.3.11.2.2 (Non-compressed beamforming matrix feedback) based on the channel measured during the training symbols of the received PPDU. The number of complex elements is $N_{ST} \times N_r \times N_c$ where N_{ST} is the total number of subcarriers, N_c is the number of columns and N_r is the number of rows in each matrix.	N	Y
	CHAN_MAT_TYPE is CSI_MATRICES	CHAN_MAT contains a set of CSI matrices as defined in 20.3.11.2.1 (CSI Matrices feedback) based on the channel measured during the training symbols of the received PPDU. The number of complex elements is $N_{ST} \times N_r \times N_c$ where N_{ST} is the total number of subcarriers, N_c is the number of columns and N_r is the number of rows in each matrix	N	Y

Table n56—TXVECTOR and RXVECTOR parameters

Parameter	Condition	Value	Parameter is Present in which? (See NOTE)	
			TXVECTOR Y/N/O	**RXVECTOR Y/N/O**
CHAN_MAT_TYPE	FORMAT is HT_MF or HT_GF	Enumerated type: COMPRESSED_SV indicates that CHAN_MAT is a set of compressed beamforming vector matrices NON_COMPRESSED_SV indicates that CHAN_MAT is a set of non-compressed beamforming vector matrices. CSI_MATRICES indicates that CHAN_MAT is a set of channel state matrices.	N	Y
	Otherwise	Not present	N	N
RCPI		This parameter is a measure of the received RF Power in the selected channel. RCPI indications of 8 bits are supported. RCPI shall be measured over the data portion of the received frame. RCPI shall be the average of the power in all receive chains.	N	Y
NOTE-In the TXVECTOR and RXVECTOR columns, the following apply: Y = Present N = Not present O = Optional NOTE 1-- Channel spacings of 5 or 10 MHz indicated for L_DATARATE do not apply to HT devices.				

— L-SIG: Non-HT SIGNAL Field

— HT-SIG: HT SIGNAL Field

— HT-STF: HT Short Training Field

— HT-GF-STF: HT greenfield Short Training Field

— HT-LTF1: First HT Long Training Field (Data HT-LTF)

— HT-LTFs: Additional HT Long Training Fields (Data HT-LTFs and Extension HT-LTFs)

— Data: The data field includes the PSDU (PHY Service Data Unit)

The HT-SIG, HT-STF and HT-LTFs exist only in HT packets. In non-HT and non-HT duplicate formats only the L-STF, L-LTF, L-SIG and Data fields exist.

In both HT mixed format and HT greenfield format frames, there are two types of HT-LTFs: Data HT-LTFs (DLTFs) and Extension HT-LTFs (ELTFs). DLTFs are always included in HT frames to provide the necessary reference for the receiver to form a channel estimate that allows it to demodulate the data portion of the

Table n57—Mapping of HT PHY parameters for NON_HT operation

HT PHY Parameter	2.4 GHz operation Operation defined by Clause 19	5.0 GHz operation Operation defined by Clause 17
L_LENGTH	LENGTH	LENGTH
L_DATARATE	DATARATE	DATARATE
TXPWR_LEVEL	TXPWR_LEVEL	TXPWR_LEVEL
RSSI	RSSI	RSSI
FORMAT	-	-
PREAMBLE_TYPE	PREAMBLE_TYPE	-
NON-HT MODULATION	MODULATION	-
SERVICE	SERVICE	SERVICE
MCS	-	-
CH_BANDWIDTH	-	-
CH_OFFSET	-	-
LENGTH	-	-
SMOOTHING	-	-
SOUNDING	-	-
AGGREGATION	-	-
STBC	-	-
LDPC_CODING	-	-
SHORT_GI	-	-
NUM_EXTEN_SS	-	-
ANTENNA_SET	-	-
EXPANSION_MAT	-	-
CHAN_MAT	-	-

frame. The number of DLTFs, N_{DLTF}, may be either 1, 2, or 4, and is determined by the number of space time streams being transmitted in the frame (see Table n65 (Number of DLTFs required for data space-time streams)). ELTFs provide additional reference in sounding PPDUs so that the receiver can form an estimate of additional dimensions of the channel beyond those that are used by the data portion of the frame. The number of ELTFs, N_{ELTF}, may be either 0, 1, 2, or 4 (see Table n66 (Number of ELTFs required for extension spatial streams)). PLCP preambles in which DLTFs are followed by ELTFs are referred to as staggered preambles. The HT mixed format and HT greenfield format frames shown in Figure n62 (PPDU frame format) both contain staggered preambles for illustrative purposes.

Insert the following new subclause:

20.3.3 Transmitter block diagram

The transmitter is composed of the following blocks:

a) *Scrambler*: scrambles the data to prevent long sequences of zeros or ones, see 20.3.10.2 (Scrambler).

b) *Encoder parser:* de-multiplexes the scrambled bits among N_{ES} (number of FEC encoders) FEC encoders, in a round robin manner.

c) *FEC encoders*: encodes the data to enable error correction—an FEC encoder may include a binary convolutional encoder followed by a puncturing device, or an LDPC encoder.

d) *Stream parser*: divides the outputs of the encoders into blocks that are sent to different interleaver and mapping devices. The sequences of the bits sent to the interleavers are called spatial streams.

e) *Interleaver*: if BCC encoding is to be used, interleaves the bits of each spatial stream (changes order of bits) to prevent long sequences of adjacent noisy bits from entering the BCC decoder.

f) *Constellation mapper*: maps the sequence of bits in each spatial stream to constellation points (complex numbers).

g) *Space time block encoder*: constellation points from N_{SS} spatial streams are spread into N_{STS} space time streams using a space time block code, whereby $N_{SS} < N_{STS}$ – see 20.3.10.8.1 (Space-Time Block Coding (STBC)).

h) *Spatial mapper*: maps space time streams to transmit chains. This may include one of the following:

   1) *Direct mapping*: constellation points from each space time stream are mapped directly onto the transmit chains (one-to-one mapping).

   2) *Spatial expansion*: vectors of constellation points from all the space time streams are expanded via matrix multiplication to produce the input to all the transmit chains.

   3) *Beamforming*: similar to spatial expansion: each vector of constellation points from all the space time streams is multiplied by a matrix of steering vectors to produce the input to the transmit chains.

i) *Inverse discrete Fourier transform (IDFT)*: converts a block of constellation points to a time domain block.

j) *Cyclic shift (CSD) insertion*: insertion of the cyclic shifts prevents unintentional beamforming. There are three cyclic shift types as follows:

   1) A cyclic shift specified per transmitter chain with the values defined in Table n61 (Cyclic shift for non-HT portion of the packet) (possible implementation is shown in Figure n63 (Transmitter block diagram for the non-HT portion and the HT signal field of the HT mixed format packet)).

   2) A cyclic shift specified per space time stream with the values defined in Table n62 (Cyclic shift values of HT portion of the packet) (possible implementation is shown in Figure n64 (Transmitter block diagram for the greenfield format packet and HT portion of the mixed format packet except HT signal field)).

   3) A cyclic shift $M_{CSD}(k)$ may be applied as a part of the spatial mapper, see 20.3.10.10.1 (Spatial mapping). When beamforming is not used it is sometimes possible to implement the cyclic shifts in the time domain.

k) *Guard interval (GI) insertion*: inserts the guard interval.

l) *Windowing:* optionally smoothing the edges of each symbol to increase spectral decay.

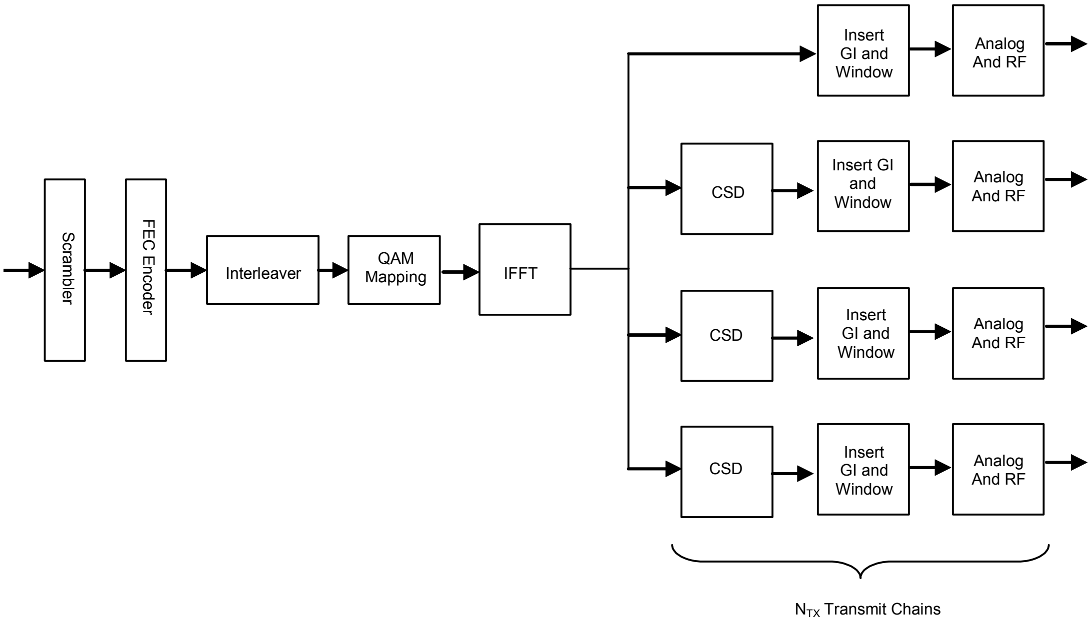
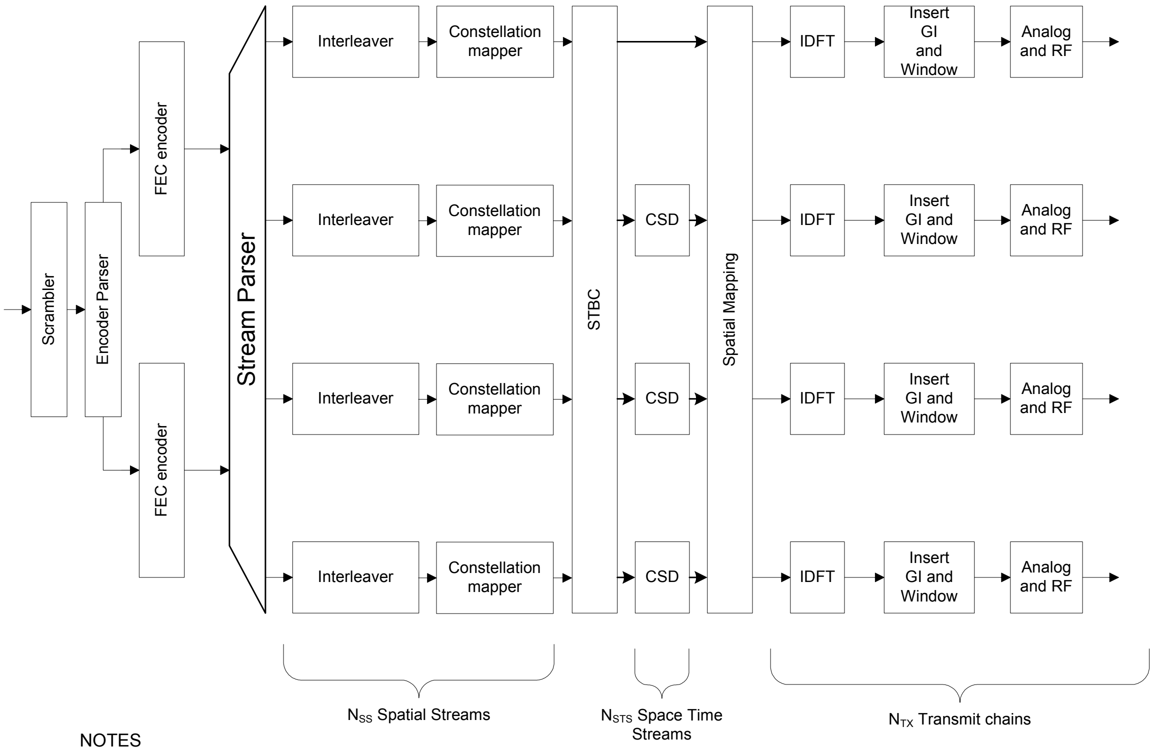


Figure n63—Transmitter block diagram for the non-HT portion and the HT signal field of the HT mixed format packet



NOTES
—there may be 1 or 2 BCC FEC encoders
—the stream parser may have 1, 2, 3 or 4 outputs
—when STBC is used, the STBC block has more outputs than inputs
—when spatial multiplexing is used, there may be more outputs than inputs
—the number of RF outputs may be 1, 2, 3, or 4

Figure n64—Transmitter block diagram for the greenfield format packet and HT portion of the mixed format packet except HT signal field

Figure n63 (Transmitter block diagram for the non-HT portion and the HT signal field of the HT mixed format packet) and Figure n64 (Transmitter block diagram for the greenfield format packet and HT portion of the mixed format packet except HT signal field) show block diagrams of the transmitter. Different implementations are possible as long as they are equivalent within the EVM requirements.

Insert the following new subclause:

20.3.4 Overview of the PPDU encoding process

The encoding process is composed of the steps described below. The following overview is intended to facilitate understanding of the details of the convergence procedure:

a) Determine the number of transmit chains, N_{TX}, from the N_TX field of the TXVECTOR. Produce the PLCP Preamble training fields for each of the N_{TX} transmit chains based on the FORMAT, NUM_EXTEN_SS, and MCS fields of the TXVECTOR. The format and relative placement of the PLCP Preamble training fields vary depending on the frame format being used, as indicated by the FORMAT, NUM_EXTEN_SS, MCS and STBC fields of the TXVECTOR. Apply cyclic shifts. Determine spatial mapping to be used for HT-STF and HT-LTFs in HT mixed format frame and HT-GF-STF and HT-LTFs in greenfield format frame from EXPANSION_MAT field of the TXVECTOR. Refer to 20.3.9 (HT preamble) for details.

b) Construct the PLCP preamble signal fields from the appropriate fields of the TXVECTOR, adding tail bits, applying convolutional coding, formatting into one or more OFDM symbols, applying cyclic shifts, applying spatial processing, calculating an inverse Fourier transform for each OFDM symbol and transmit chain, and prepending a cyclic prefix, or guard interval (GI) to each OFDM symbol in each transmit chain. The number and placement of the PLCP preamble signal fields depends on the frame format being used. Refer to, 20.3.9.3.5 (The Non-HT SIGNAL field), 20.3.9.4.3 (The HT SIGNAL field), and 20.3.9.5.3 (HT SIGNAL field).

c) Concatenate the PLCP Preamble training and signal fields for each transmit chain one field after another, in the appropriate order, as described in 20.3.2 (PLCP frame format) and 20.3.7 (Mathematical description of signals).

d) Use the MCS and CH_BANDWIDTH fields from TXVECTOR to determine the number of data bits per OFDM symbol (N_{DBPS}), the coding rate (R), the number of coded bits in each OFDM subcarrier (N_{BPSC}), and the number of coded bits per OFDM symbol (N_{CBPS}). Determine the number of encoding streams (N_{ES}) from the MCS, CH_BANDWIDTH, and LDPC_CODING fields of the TXVECTOR. Refer to 20.3.10.3 (Coding) for details.

e) Append the PSDU to the SERVICE field (see 20.3.10.1 (The SERVICE field)). If BCC encoding is to be used, as indicated by the LDPC_CODING field of the TXVECTOR, tail bits are appended to the PSDU. If a single BCC encoder is used (the value of N_{ES} is 1), the bit string is be extended by 6 zero bits. If two BCC encoders are used (the value of N_{ES} is 2), the bit string is be extended by 12 zero bits. If necessary, the bit string is further extended with zero bits so that the resulting length is a multiple of N_{DBPS}, as described in 20.3.10. If LDPC encoding is to be used, as indicated by the LDPC_CODING field of the TXVECTOR, the resulting bit string is padded, if needed, by repeating coded bits rather than using zero bits, as given in the encoding procedure of 20.3.10.6.5 (LDPC PPDU encoding process). The number of resulting symbols is given by Equation (20-41), and the number of repeated coded bits used for padding is given by Equation (20-42). The resulting bit string constitutes the DATA part of the packet.

f) Initiate the scrambler with a pseudo-random nonzero seed, generate a scrambling sequence, and XOR (Boolean exclusive OR operation) it with the string of data bits, as described in 17.3.5.4.

g) If BCC encoding is to be used, replace the scrambled zero bits that served as tail bits (six bits if the value of N_{ES} is 1, twelve bits if the value of N_{ES} is 2) following the data with the same number of nonscrambled zero bits, as described in 17.3.5.2. (These bits return the convolutional encoder to the zero state and are denoted as tail bits.)

h) If BCC encoding is to be used, and the value of N_{ES} is 2, then the scrambled data bits are divided between two BCC encoders by sending alternating bits to the two different encoders, as described in 20.3.10.4 (Encoder parsing operation).

i) If BCC encoding is to be used, encode the extended, scrambled data string with a rate ½ convolutional encoder (see 17.3.5.5 Convolutional encoder.) Omit (puncture) some of the encoder output string (chosen according to puncturing pattern) to reach the desired coding rate, R. Refer to 20.3.10.5 (Binary convolutional coding and puncturing) for details. If LDPC encoding is to be used, encode the scrambled data stream according to 20.3.10.6.5 (LDPC PPDU encoding process).

j) Parse the coded bit stream that results from the BCC encoding or LDPC encoding into N_{SS} spatial streams, where the value of N_{SS} is determined from the MCS field of the TXVECTOR. See 20.3.10.7.2 (Stream parser) for details.

k) Divide each of the N_{SS} encoded and parsed spatial streams of bits into groups of $N_{CBPSS}(i)$ bits. If BCC encoding is to be used, within each spatial stream and group, perform an "interleaving" (reordering) of the bits according to a rule corresponding to $N_{BPSCS}(i)$, where i is the index of the spatial stream. Refer to 20.3.6 (Timing related parameters) for details.

l) For each of the N_{SS} encoded, parsed and interleaved spatial streams, divide the resulting coded and interleaved data string into groups of $N_{BPSCS}(i)$ bits, where i is the index of the spatial stream. For each of the bit groups, convert the bit group into a complex number according to the modulation encoding tables. Refer to 17.3.5.7 for details.

m) Divide the complex number string for each of the resulting N_{SS} spatial streams into groups of N_{SD} complex numbers, where the value of N_{SD} is determined from the CH_OFFSET field of TXVECTOR and the CH_BANDWIDTH field of TXVECTOR. Each such group is associated with one OFDM symbol in one spatial stream. In each group, the complex numbers are indexed 0 to $N_{SD}-1$ and mapped hereafter onto OFDM subcarriers as described in 20.3.10.10.2 (Transmission in 20 MHz HT format), 20.3.10.10.3 (Transmission in 40 MHz HT Format), 20.3.10.10.4 (Transmission in HT duplicate format), and 20.3.10.11 (Non-HT duplicate transmission).

n) If space time block coding (STBC) or hybrid space time block coding/spatial multiplexing (STBC/SM) is to be applied, as indicated by the STBC field in the TXVECTOR, operate on the complex number in each data subcarrier in sequential pairs of OFDM symbols as described in 20.3.10.8.1 (Space-Time Block Coding (STBC)) to generate N_{STS} OFDM symbols for every N_{SS} OFDM symbols associated with the N_{SS} spatial streams. If STBC or hybrid STBC/SM is not to be used, the number of space time streams is the same as the number of spatial streams, and the sequences of OFDM symbols in each space time stream are composed of the sequences of OFDM symbols in the corresponding spatial stream.

o) Determine whether 20 MHz or 40 MHz operation is to be used from the CH_BANDWIDTH, CH_OFFSET field in the TXVECTOR. For 20 MHz operation, insert four subcarriers as pilots into positions –21, –7, 7, and 21. The total number of the subcarriers, N_{ST}, is 56. For 40 MHz operation (with the exception of MCS 32 and non-HT duplicate format), insert six subcarriers as pilots into positions -53, -25, -11, 11, 25, and 53, resulting in a total of $N_{ST}=114$ subcarriers. See 20.3.10.10.4 (Transmission in HT duplicate format) for pilot locations when using MCS 32, and 20.3.10.11 (Non-HT duplicate transmission) for pilot locations when using non-HT duplicate format . The pilots are modulated using a pseudo-random cover sequence. Refer to 20.3.10.9 (Pilot subcarriers) for details.

p) Map each of the complex numbers in each of the N_{ST} subcarriers in each of the OFDM symbols in each of the N_{STS} space time streams to the N_{TX} transmit chain inputs. For direct-mapped operation, $N_{TX}=N_{STS}$ and there is a one-to-one correspondence between space time streams and transmit chains. In this case, the OFDM symbols associated with each space time stream are also associated with the corresponding transmit chain. Otherwise, a spatial mapping matrix associated with each OFDM subcarrier, as indicated by the EXPANSION_MAT field of the TXVECTOR, is used to perform a linear transformation on the vector of N_{STS} complex numbers associated with each subcarrier in each OFDM symbol. This spatial mapping matrix maps the vector of N_{STS} complex numbers in each subcarrier into a vector of N_{TX} complex numbers in each subcarrier. The sequence of N_{ST} complex numbers associated with each transmit chain (where each of the N_{ST} complex numbers is taken from the same position in the N_{TX} vector of complex numbers across the N_{ST} subcarriers associated with an OFDM symbol) constitutes an OFDM symbol associated with the corresponding transmit chain. For details, see 20.3.10.10 (OFDM modulation). Spatial mapping matrices may include cyclic shifts, as described in subclause 20.3.10.10.1 (Spatial mapping).

q) If the CH_BANDWIDTH and CH_OFFSET fields of TXVECTOR indicate that upper or lower 20 MHz are to be used in 40 MHz, move the complex numbers associated with subcarriers -28 to 28 in each transmit chain to carriers 4 to 60 in the upper channel or -60 to -4 in the lower channel. Note that this shifts the signal in frequency from the center of the 40 MHz channel to +10 MHz or -10 MHz offset from the center of the 40 MHz channel. The complex numbers in the other subcarriers shall be set to zero.

r) For each group of N_{ST} subcarriers and each of the N_{TX} transmit chains, convert the subcarriers to time domain using inverse Fourier transform. Prepend to the Fourier-transformed waveform a circular extension of itself thus forming a GI, and truncate the resulting periodic waveform to a single OFDM symbol length by applying time domain windowing. Determine the length of the guard interval according to the SHORT_GI field in the TXVECTOR. Refer to 20.3.10.10 (OFDM modulation) and 20.3.10.11 (Non-HT duplicate transmission) for details.

s) Append the OFDM symbols associated with each transmit chain one after another, starting after the final field of the PLCP preamble. Refer to 20.3.2 (PLCP frame format) and 20.3.7 (Mathematical description of signals) for details.

t) 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 20.3.7 (Mathematical description of signals) for details. The transmit chains are connected to antenna elements according to ANTENNA_SET of the TXVECTOR if antenna selection is applied.

Insert the following new subclause:

20.3.5 Modulation and Coding Scheme (MCS)

The Modulation and Coding Scheme (MCS) is a value that determines the modulation, coding and number of spatial channels. It is a compact representation that is carried in the HT SIGNAL field. Rate dependent parameters for the full set of modulation and coding schemes (MCS) are shown in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)) in Table n82 (Rate dependent parameters for mandatory 20 MHz, NSS =1 MCSs, NES = 1) to Table n96 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs). These tables give rate dependent parameters for MCSs with indices 0 through 76. MCS indices 77-127 are reserved.

MCS Table n82 (Rate dependent parameters for mandatory 20 MHz, NSS =1 MCSs, NES = 1) to Table n85 (Rate-dependent parameters for optional 20 MHz, NSS = 4 MCSs, N_{ES} = 1) show rate-dependent parameters for equal-modulation MCSs for one, two, three, and four streams for 20 MHz operation. Table n86 (Rate-dependent parameters for optional 40 MHz, NSS = 1 MCSs, N_{ES} = 1) to Table n89 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs) show rate-dependent parameters for equal-modulation MCSs in one, two, three, and four streams for 40 MHz operation. The same equal modulation MCSs are used for 20 MHz and 40 MHz operation. Table n90 (Rate-dependent parameters for optional 40 MHz HT duplicate format, NSS = 1, NES = 1) shows rate-dependent parameters for the 40 MHz, 6 Mb/s HT duplicate format.

The remaining tables, Table n91 (Rate-dependent parameters for optional 20 MHz, NSS = 2 MCSs, NES = 1) to Table n96 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs), show rate-dependent parameters for the MCSs with unequal modulation on the spatial streams for use with

- transmit beamforming and
- STBC modes for which two spatial streams (N_{SS}=2) are encoded into three space time streams (N_{STS}=3) and three spatial streams (N_{SS}=3) are encoded into four space time streams (N_{STS}=4). These STBC mode cases are specified in Table n70 (Constellation mapper output to spatial mapper input for STBC).

Unequal modulation MCSs are detailed in the following tables: Table n91 (Rate-dependent parameters for optional 20 MHz, NSS = 2 MCSs, NES = 1) to Table n93 (Rate-dependent parameters for optional 20 MHz, NSS = 4 MCSs, N_{ES} = 1) are for 20 MHz operation. Table n94 (Rate-dependent parameters for optional 40 MHz, NSS = 2 MCSs, NES = 1) to Table n96 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs) are for 40 MHz operation.

MCS 0 through 15 are mandatory in 20 MHz with 800 ns guard interval at an access point (AP). MCS 0 through 7 are mandatory in 20 MHz with 800 ns guard interval at all STAs. All other MCSs and modes are optional, specifically including Tx (transmit) and Rx (receive) support of 400 ns guard interval, operation in 40 MHz, and support of MCSs with indices 16 through 76.

Insert the following new subclause:

20.3.6 Timing related parameters

Table n58 (Timing related constants) defines the timing related parameters.

Table n58—Timing related constants

Parameter	Value in non-HT 20 MHz channel	Value in 20 MHz HT channel	Value in 40 MHz channel	
			HT format	HT and Non-HT duplicate
N_{SD}: Number of data subcarriers	48	52	108	48
N_{SP}: Number of pilot subcarriers	4	4	6	4
N_{ST}: Total Number of subcarriers	52	56	114	104 See NOTE 1
N_{SR}: The highest data subcarrier index	26	28	58	58
Δ_F : subcarrier frequency spacing	312.5kHz (20 MHz/64)	312.5kHz	312.5kHz (40 MHz/128)	
T_{DFT}: IDFT/DFT period	3.2 µs	3.2 µs	3.2 µs	
T_{GI}: Guard Interval duration	0.8 µs= T_{DFT}/4	0.8 µs	0.8 µs	
T_{GI2}: Double GI	1.6 µs	1.6 µs	1.6 µs	
T_{GIS}: Short Guard Interval duration	N/A	0.4 µs = $T_{DFT/}$8	0.4 µs See NOTE 2	
$T_{L\text{-}STF}$: Non-HT Short training sequence duration	8 µs=10× T_{DFT}/4	8 µs	8 µs	

Table n58—Timing related constants *(continued)*

$T_{HT-GF-STF}$: HT GF Short training sequence duration	N/A	8 μs=10× T_{DFT}/4	8 μs
T_{L-LTF}: Non-HT Long training sequence duration	8 μs=2× T_{DFT}+T_{GI2}	8 μs	8 μs
T_{SYM}: Symbol Interval	4 μs= T_{DFT}+T_{GI}	4 μs	4 μs
T_{SYMS}: Short GI Symbol Interval	N/A	3.6 μs = T_{DFT}+T_{GIS}	3.6 μs See NOTE 2
T_{L-SIG}	4 μs= T_{SYM}	4 μs	4 μs
T_{HT-SIG}		8 μs= 2T_{SYM}	8 μs
T_{HT-STF}: HT-STF duration	N/A	4 μs	4 μs
$T_{HT-LTF1:}$ HT first long training field duration	N/A	4 μs in HT mixed format, 8 μs in greenfield format	4 μs in HT mixed format, 8 μs in greenfield format
$T_{HT-LTFs:}$ HT second, and subsequent, long training fields duration	N/A	4 μs	4 μs
NOTE 1—Data and pilot tones are replicated in upper and lower 20 MHz portions of 40 MHz signal to make a total of 104 tones used in HT duplicate and non-HT duplicate formats NOTE 2—Not applicable in Non-HT formats NOTE 3—N/A = Not applicable			

Table n59 (Frequently used parameters) defines parameters used frequently in Clause 20**.**

Table n59—Frequently used parameters

Symbol	Explanation
N_{CBPS}	Number of coded bits per symbol
$N_{CBPSS}(i)$	Number of coded bits per symbol per the *i*-th spatial stream
N_{DBPS}	Number of data bits per symbol
N_{BPSC}	Number of coded bits per single carrier

Table n59—Frequently used parameters *(continued)*

$N_{BPSCS}(i)$	Number of coded bits per single carrier per the *i*-th spatial stream
N_{STS}	Number of space time streams
N_{SS}	Number of spatial streams
N_{ESS}	Number of extension spatial streams
N_{TX}	Number of transmit chains
N_{ES}	Number of FEC encoders
N_{LTF}	Number of HT long training fields (see 20.3.9.4.6 (The HT-LTF long training field))
N_{DLTF}	Number of Data HT long training fields
N_{ELTF}	Number of Extension HT long training fields
R	Code rate

Insert the following new subclause:

20.3.7 Mathematical description of signals

For the description of the convention on mathematical description of signals see 17.3.2.4

In the case of either a 20 MHz Non-HT Format transmission or a 20 MHz HT Format transmission, the channel is divided into 64 sub-carriers. In the 20 MHz Non-HT Format, the signal is transmitted on sub-carriers -26 to -1 and 1 to 26, with 0 being the center (DC) carrier. In the 20 MHz HT Format, the signal is transmitted on sub-carriers -28 to -1 and 1 to 28.

In the case of the 40 MHz HT Format, two adjacent 20 MHz channels are used. The channel is divided into 128 sub-carriers. The signal is transmitted on sub-carriers -58 to -2 and 2 to 58.

In the case of 40 MHz HT Upper Format or 40 MHz HT Lower Format, the upper or lower 20 MHz channel is divided into 64 sub-carriers. The signal is transmitted on sub-carriers -60 to -4 in the case of a 40 MHz HT Lower Format transmission and on sub-carriers 4 to 60 in the case of a 40 MHz HT Upper Format transmission.

In the case of the HT duplicate and Non-HT duplicate formats, the same data are transmitted over two adjacent 20 MHz channels. In this case, the 40 MHz channel is divided into 128 sub-carriers and the data are transmitted on carriers -58 to -6 and 6 to 58.

The transmitted signal is described in complex base-band signal notation. The actual transmitted signal is related to the complex baseband signal by the following relation:

$$r_{RF}(t) = \mathrm{Re}\left\{ r(t)\exp\left(j2\pi f_c t\right)\right\} \tag{20-1}$$

where

$\mathrm{Re}\{\cdot\}$ represents the real part of a complex variable;

f_c is the center frequency of the carrier.

The transmitted RF signal is derived by modulating the complex baseband signal, which consists of several fields. The timing boundaries for the various fields are shown in Figure n65 (Timing boundaries for PPDU fields).

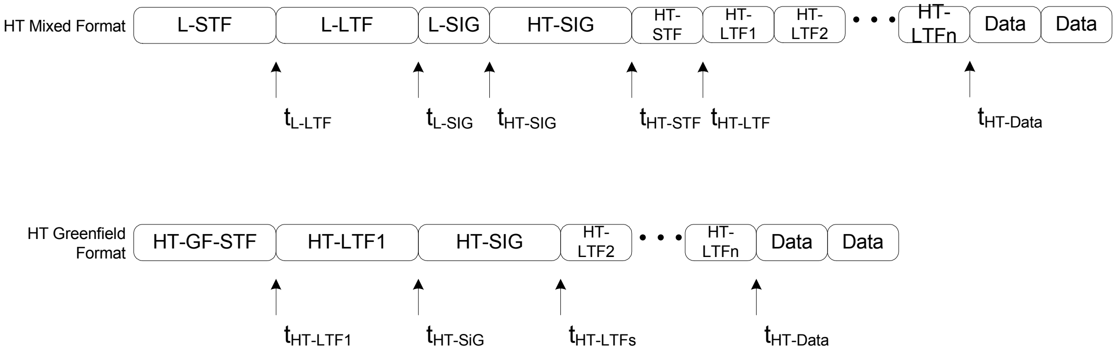


Figure n65—Timing boundaries for PPDU fields

The time offset, t_{Field}, determines the starting time of the corresponding field.

In HT mixed format, the signal transmitted on transmit chain i_{TX} is

$$\begin{aligned} r_{PPDU}^{(i_{TX})}(t) \; = \; & r_{L-STF}^{(i_{TX})}(t) + r_{L-LTF}^{(i_{TX})}\left(t - t_{L-LTF}\right) \\ & + r_{L-SIG}^{(i_{TX})}\left(t - t_{L-SIG}\right) \\ & + r_{HT-SIG}^{(i_{TX})}\left(t - t_{HT-SIG}\right) \\ & + r_{HT-STF}^{(i_{TX})}\left(t - t_{HT-STF}\right) \\ & + \sum_{i_{LTF}=1}^{N_{LTF}} r_{HT-LTF}^{(i_{TX},i_{LTF})}\left(t - t_{HT-LTF} - \left(i_{LTF} - 1\right)T_{HT-LTFs}\right) \\ & + r_{HT-DATA}^{(i_{TX})}(t - t_{HT-DATA}) \end{aligned} \quad (20\text{-}2)$$

where

$$t_{L-LTF} = T_{L-STF}$$

$$t_{L-SIG} = t_{L-LTF} + T_{L-LTF}$$

$$t_{HT-SIG} = t_{L-SIG} + T_{L-SIG}$$

$$t_{HT-STF} = t_{HT-SIG} + T_{HT-SIG}$$

$$t_{HT-LTF} = t_{HT-STF} + T_{HT-STF}$$

$$t_{HT-Data} = t_{HT-LTF} + N_{LTF} \cdot T_{HT-LTFs}$$

In the case of greenfield format, the transmitted signal on transmit chain i_{TX} is:

$$\begin{aligned} r_{PPDU}^{(i_{TX})}(t) = {} & r_{HT-GF-STF}^{(i_{TX})}(t) + r_{HT-LTF1}^{(i_{TX})}(t - t_{HT-LTF1}) \\ & + r_{HT-SIG}^{(i_{TX})}(t - t_{HT-SIG}) \\ & + \sum_{i_{LTF}=1}^{N_{LTF}} r_{HT-LTF}^{(i_{TX}, i_{LTF})}(t - t_{HT-LTFs} - (i_{LTF} - 2)T_{HT-LTFs}) \\ & + r_{HT-DATA}^{(i_{TX})}(t - t_{HT-DATA}) \end{aligned} \tag{20-3}$$

where

$$t_{HT-LTF1} = T_{HT-GF-STF}$$

$$t_{HT-SIG} = t_{HT-LTF1} + T_{HT-LTF1}$$

$$t_{HT-LTFs} = t_{HT-SIG} + T_{HT-SIG}$$

$$t_{HT-Data} = t_{HT-LTFs} + (N_{LTF} - 1) \cdot T_{HT-LTFs}$$

Each baseband waveform, $r_{\text{Field}}^{(i_{TX})}(t)$, is defined via the discrete Fourier transform as

$$r_{\text{Field}}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{\text{Field}}^{\text{Tone}} \cdot N_{TX}}} w_{\text{T}_{\text{Field}}}(t) \sum_{k} \Upsilon_k X_k^{(i_{TX})} \exp(j2\pi k \Delta_F t) \tag{20-4}$$

This general representation holds for all fields. A suggested definition of the windowing function , $w_{\text{T}_{\text{Field}}}(t)$, is given in 17.3.2.4. The frequency-domain symbols $X_k^{(i_{TX})}$ represent the output of any spatial processing in subcarrier k for Tx chain i_{TX} required for the field.

The function Υ_k is used to represent a rotation of the upper tones in a 40 MHz channel:

$$\Upsilon_k = \begin{cases} 1, k \le 0, \text{ in a 40 MHz channel} \\ j, k > 0, \text{ in a 40 MHz channel} \end{cases} \tag{20-5}$$

$$\Upsilon_k = 1, \text{ in a 20 MHz channel} \tag{20-6}$$

The $1 / \sqrt{N_{\mathrm{Field}}^{\mathrm{Tone}} \cdot N_{TX}}$ scale factor in Equation (20-4) ensures that the total power of the time domain signal as summed over all transmit chains is either 1 or lower than 1 when required. Table n60 (Value of tone scaling factor) summarizes the various values of $N_{\mathrm{Field}}^{\mathrm{Tone}}$.

Table n60—Value of tone scaling factor N_{Field}^{Tone}

Field	N_{Field}^{Tone}	
	20 MHz	**40 MHz**
L-STF	12	24
HT-GF-STF	12	24
L-LTF	52	104
L-SIG	52	104
HT-SIG	52/56, see NOTE 2	104/114, see NOTE 2
HT-STF	12	24
HT-LTF	56	114
HT-Data	56	114
HT-Data- HT duplicate format	-	104

NOTE 1—The numbers in the table refer only to the value of N_{Field}^{Tone} as it appears in Equation (20-4) and in subsequent specification of various fields. It may be different from the actual number of tones being transmitted.

NOTE 2— 56 and 114 are for greenfield format, 52 and 104 are for HT mixed format.

Insert the following new subclause:

20.3.8 Transmission in the upper/lower 20 MHz of a 40 MHz channel

When transmitting in the upper/lower 20 MHz portion of a 40 MHz channel, the mathematical definition of transmission shall follow that of a 20 MHz channel with f_c in Equation (20-1) replaced by $f_c \pm 10MHz$.

Insert the following new subclause heading:

20.3.9 HT preamble

Insert the following new subclause:

20.3.9.1 Introduction

The HT preambles are defined in HT mixed format and in greenfield format to carry the required information to operate in a system with multiple transmit and multiple receive antennas.

In the HT mixed format, to ensure compatibility with non-HT STAs, specific non-HT fields are defined so that they can be received by Non-HT STAs compliant with Clause 17 or Clause 19 followed by the fields specific to HT STAs.

In the greenfield format, all of the non-HT fields are omitted. The specific HT fields used are:

- HT SIGNAL Field (HT-SIG): provides all the information required to interpret the HT packet format,
- One HT GF Short Training Field (HT-GF-STF) for AGC convergence, timing acquisition, and coarse frequency acquisition,
- One or several HT Long Training Fields (HT-LTF): provided as a way for the receiver to estimate the channel between each spatial mapper input and receive chain. The first HT-LTFs (Data HT-LTFs) are necessary for demodulation of the HT-Data portion of the PPDU, and are followed, for sounding packets only, by optional HT-LTFs (Extension HT-LTFs) to sound extra spatial dimensions of the MIMO channel.

In the case of multiple transmit chains, the HT preambles use cyclic shift techniques to prevent unintentional beamforming.

Insert the following new subclause:

20.3.9.2 HT mixed format preamble

In HT mixed format frames, the preamble has fields that support compatibility with Clause 17 and Clause 19 STAs, and fields that support HT operation. The non-HT portion of the HT mixed format preamble enables detection of the PPDU and acquisition of carrier frequency and timing by both HT STAs and STAs that are compliant with Clause 17 or Clause 19. The non-HT portion of the HT mixed format preamble consists of the SIGNAL (L-SIG) field defined in Clause 17 and is thus decodable by STAs compliant with Clause 17 and Clause 19, as well as HT STAs.

The HT portion of the HT mixed format preamble enables estimation of the MIMO channel to support demodulation of the data portion of the frame by HT STAs. The HT portion of the HT mixed format preamble also consists of the HT-SIG field that supports HT operation.

Insert the following new heading:

20.3.9.3 Non-HT portion of HT mixed format preamble

Insert the following new subclause:

20.3.9.3.1 Introduction

Subclauses 20.3.9.3.2 (Cyclic shift definition for the non-HT fields) to 20.3.9.3.5 (The Non-HT SIGNAL field) describe the transmission of the non-HT training fields and the non-HT SIGNAL field as part of an HT mixed format packet.

Insert the following new subclause:

20.3.9.3.2 Cyclic shift definition for the non-HT fields

Cyclic shifts are used to prevent unintentional beamforming when the same signal or scalar multiples of one signal are transmitted through different spatial streams or transmit chains. A cyclic shift of duration T_{CS} on a signal $s(t)$ on interval $0 \le t \le T$ is defined as follows, where T is defined as T_{DFT} as referenced in Table n58 (Timing related constants).

With $T_{CS} \le 0$, replace $s(t)$ with $s(t - T_{CS})$ when $0 \le t < T + T_{CS}$, and with $s(t - T_{CS} - T)$ when $T + T_{CS} \le t \le T$. In this case the cyclic shifted signal is defined as

$$s_{CS}(t;T_{CS})\big|_{T_{CS}<0} = \begin{cases} s(t-T_{CS}) & 0 \le t < T+T_{CS} \\ s(t-T_{CS}-T) & T+T_{CS} \le t \le T \end{cases} \tag{20-7}$$

The cyclic shift is applied to each OFDM symbol in the packet separately. Table n61 (Cyclic shift for non-HT portion of the packet) specifies the values for the cyclic shifts that are applied in the non-HT short training field (in an HT mixed format packet), the non-HT long training field, and non-HT SIGNAL field. It also applies to the HT SIGNAL field in an HT mixed format packet.

Table n61—Cyclic shift for non-HT portion of the packet

$T_{CS}^{i_{TX}}$ values for the non-HT portion of the packet				
Number of Tx Chains	**Cyclic shift for Tx chain 1**	**Cyclic shift for Tx chain 2**	**Cyclic shift for Tx chain 3**	**Cyclic shift for Tx chain 4**
1	0ns	-	-	-
2	0ns	-200 ns	-	-
3	0ns	-100 ns	-200 ns	-
4	0ns	-50ns	-100 ns	-150ns
NOTE: With more than four TX chains, each cyclic shift on the additional TX chains shall not be less than -200 ns nor greater than 0 ns.				

When an HT device transmits a Clause 17 or Clause 19 packet (rates 3, 4.5, 6, 9, 12, 24 ,27, 36, 48, 54Mb/s) using more than one transmit chain, it shall apply the cyclic shifts defined in Table n61 (Cyclic shift for non-HT portion of the packet) to the transmission in each chain.

Insert the following new subclause:

20.3.9.3.3 Non-HT Short Training field (L-STF)

The L-STF is identical to the Clause 17 short training symbol. The non-HT short training OFDM symbol in the 20 MHz channel width is:

$$\begin{aligned} S_{-26,26} = \sqrt{1/2}\ \{&0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,\\ &0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0\} \end{aligned} \tag{20-8}$$

The normalization factor $\sqrt{1/2}$ is the QPSK normalization.

The non-HT short training OFDM symbol in a 40 MHz channel width is based on:

$$S_{-58,58} = \sqrt{1/2}\{0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,$$
$$0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,0,0,$$
$$0,0,0,0,0,0,0,0,0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,$$
$$0,0,0,0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0\}$$

(20-9)

The tones in the upper sub-channel (sub-carriers 6-58) are phase rotated by +90º (see Equation (20-10)).

In HT mixed format, the L-STF on transmit chain i_{TX} is

$$r^{(i_{TX})}_{L-STF}(t) = \frac{1}{\sqrt{N_{TX} \cdot N^{Tone}_{L-STF}}} w_{T_{L-STF}}(t) \sum_{k=-N_{SR}}^{N_{SR}} \Upsilon_k S_k \exp(j2\pi k\Delta_F(t - T^{i_{TX}}_{CS})) \quad (20\text{-}10)$$

where

$T^{i_{TX}}_{CS}$ represents the cyclic shift for transmit chain i_{TX} and takes values from Table n61 (Cyclic shift for non-HT portion of the packet).

The L-STF has a period of 0.8 µs. The entire short training field includes ten such periods, with a total duration of T_{L-STF} = 8 µs.

Insert the following new subclause:

20.3.9.3.4 Non-HT Long Training field

The non-HT long training OFDM symbol is identical to the Clause 17 long training OFDM symbol. In the 20 MHz channel width, the long training OFDM symbol is given by

$$L_{-26,26} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,$$
$$1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1\}. \quad (20\text{-}11)$$

The non-HT long training OFDM signal in a 40 MHz channel width is based on:

$$L_{-58,58} = \{1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,$$
$$1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1,0,0,0,0,0$$
$$0,0,0,0,0,0,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,$$
$$1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1\} \quad (20\text{-}12)$$

The tones in the upper sub-channel (sub-carriers 6-58) are transmitted phase rotated by +90º (see Equation (20-13)).

The sub-carriers at ±32 in 40 MHz, which are the DC sub-carriers for the non-HT 20 MHz transmission, are both nulled in the L-LTF. Such an arrangement allows proper synchronization of the 20 MHz non-HT STA.

The L-LTF waveform is:

$$r_{L-LTF}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{L-LTF}^{Tone}}} w_{T_{L-LTF}}(t) \sum_{k=-N_{SR}}^{N_{SR}} \Upsilon_k L_k \exp(j2\pi k\Delta_F(t - T_{GI2} - T_{CS}^{i_{TX}})) \tag{20-13}$$

where

T_{GI2} is 1.6 μs

$T_{CS}^{i_{TX}}$ represents the cyclic shift for transmit chain i_{TX} and takes values specified in Table n61 (Cyclic shift for non-HT portion of the packet).

The entire long training field include two 3.2 μs periods of the long training symbol and an additional 1.6 μs of guard interval.

Insert the following new subclause:

20.3.9.3.5 The Non-HT SIGNAL field

The SIGNAL field is used to communicate rate and length information. When used in an HT mixed format transmission, this information has a different meaning than when used in a Clause 17 transmission. This subclause defines the meaning when used for an HT mixed format transmission. The structure of the Non-HT SIGNAL field is shown in Figure n66 (Non-HT SIGNAL field).

Rate (4 bits)				R	Length (12 bits)												P	Tail 6bits					
R1	R2	R3	R4															“0”	“0”	“0”	“0”	“0”	“0”
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Figure n66—Non-HT SIGNAL field

The value in the Rate field is obtained from the L_DATARATE field of the TXVECTOR. The value in the Length field is obtained from the L_LENGTH field of the TXVECTOR. The length field is transmitted least significant bit (LSB) first.

The reserved bit shall be set to 0.

The parity field has the even parity of bits 0-16.

The SIGNAL field shall be encoded, interleaved and mapped, and have pilots inserted following the steps described in 17.3.5.5, 17.3.5.6, 17.3.5.8. The stream of 48, complex numbers generated by these steps is denoted by $d_k, k = 0\ldots47$. The time domain waveform of the Non-HT Signal field in 20 MHz transmission is given by

$$r_{L-SIG}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tone}}} w_{\mathrm{T}_{SYM}}(t) \sum_{k=-26}^{26} (D_k + p_0 P_k) \exp(j2\pi k \Delta_F (t - T_{GI} - T_{CS}^{i_{TX}})) \tag{20-14}$$

In a 40 MHz transmission the time domain waveform of the Non-HT Signal filed is given by

$$\begin{aligned} r_{L-SIG}^{(i_{TX})}(t) &= \frac{1}{\sqrt{N_{TX} \cdot N_{L-SIG}^{Tone}}} w_{\mathrm{T}_{SYM}}(t) \sum_{k=-26}^{26} (D_k + p_0 P_k) \\ &\cdot (\exp(j2\pi(k-32)\Delta_F(t - T_{GI} - T_{CS}^{i_{TX}})) + j\exp(j2\pi(k+32)\Delta_F(t - T_{GI} - T_{CS}^{i_{TX}}))) \end{aligned} \tag{20-15}$$

where:

$$D_k = \begin{cases} 0, k = 0, \pm 7, \pm 21 \\ d_{M^r(k)}, \text{otherwise} \end{cases}$$

$$M^r(k) = \begin{cases} k + 26, -26 \le k \le -22 \\ k + 25, -20 \le k \le -8 \\ k + 24, -6 \le k \le -1 \\ k + 23, 1 \le k \le 6 \\ k + 22, 8 \le k \le 20 \\ k + 21, 22 \le k \le 26 \end{cases}$$

P_k is defined in 17.3.5.9

p_0 is the first pilot value in the sequence defined in 17.3.5.9. N_{L-SIG}^{Tone} has the value given in Table n60 (Value of tone scaling factor)

$T_{CS}^{i_{TX}}$ represents the cyclic shift for transmit chain i_{TX} and is defined by Table n61 (Cyclic shift for non-HT portion of the packet) for HT mixed format PPDUs

NOTE— D_k exists for $-N_{SR} \le k \le N_{SR}$ and takes the values from d_k which exists for $0 \le k \le N_{SD} - 1$. $M^r(k)$ is a "reverse" function of the function $M(k)$ defined in 17.3.5.9.

Insert the following new heading:

20.3.9.4 The HT portion of HT mixed format preamble

Insert the following new subclause:

20.3.9.4.1 Introduction

When an HT mixed format preamble is transmitted, the high throughput preamble consists of the HT short training field, the HT long training fields and the HT SIGNAL field.

Insert the following new subclause:

20.3.9.4.2 Cyclic shift definition for the HT portion of the HT mixed format preamble

Throughout the HT portion of an HT mixed format preamble, cyclic shift is applied to prevent beamforming when similar signals are transmitted in different space time streams. The same cyclic shift is applied to these streams during the transmission of the data portion of the frame. The values of the cyclic shifts to be used during the HT portion of the HT mixed format preamble and the data portion of the frame are specified in Table n62 (Cyclic shift values of HT portion of the packet).

NOTE—These cyclic shift values do not apply to the HT-SIG in an HT mixed format PPDU.

Table n62—Cyclic shift values of HT portion of the packet

$T_{CS}^{i_{STS}}$ **values for HT portion of the packet**				
Number of space time streams	**Cyclic shift for space time stream 1**	**Cyclic shift for space time stream 2**	**Cyclic shift for space time stream 3**	**Cyclic shift for space time stream 4**
1	0ns	-	-	-
2	0ns	-400 ns	-	-
3	0ns	-400 ns	-200 ns	-
4	0ns	-400 ns	-200 ns	-600 ns

Insert the following new subclause:

20.3.9.4.3 The HT SIGNAL field

The HT SIGNAL field is used to carry information required to interpret the HT packet formats. The fields of the HT SIGNAL field are described in Table n63 (Fields of HT SIGNAL field).

The structure of the HT-SIG1 and HT-SIG2 fields is defined in Figure n67 (Format of HT-SIG1 and HT-SIG2).

Table n63—Fields of HT SIGNAL field

Field Name	Number of bits	Explanation and coding
Modulation and Coding Scheme	7	Index into the MCS table, See NOTE 1.
CBW 20/40	1	Set to 0 for 20 MHz or 40 MHz upper/lower Set to 1 for 40 MHz
Length	16	The number of octets of data in the PSDU in the range 0-65535 See NOTE 1 and NOTE 2.
Smoothing	1	Set to 1 indicates that channel estimate smoothing is allowed Set to 0 indicates that only per-carrier independent (unsmoothed) channel estimate is recommended
Not Sounding	1	Set to 0 indicates that PPDU is a Sounding PPDU Set to 1 indicates that the PPDU is not a sounding PPDU
Reserved	1	Set to 1
Aggregation	1	Set to 1 to indicate that the PPDU in the data portion of the packet contains an A-MPDU; otherwise, set to 0.
STBC	2	Set to a non-zero number, to indicate the difference between the number of space time streams (N_{STS}) and the number of spatial streams (N_{SS}) indicated by the MCS. Set to 00 to indicate no STBC ($N_{STS} = N_{SS}$)
LDPC coding	1	Set to 1 for LDPC Set to 0 for BCC
Short GI	1	Set to 1 to indicate that the short GI is used after the HT training. Set to 0 otherwise
Number of extension spatial streams	2	Indicates the Number of extension spatial streams (N_{ESS}). Set to 0 for no extension spatial stream Set to 1 for 1 extension spatial stream Set to 2 for 2 extension spatial streams Set to 3 for 3 extension spatial streams See NOTE 1
CRC	8	CRC of bits 0-23 in HT-SIG1 and bits 0-9 in HT-SIG2—see 20.3.9.4.4 (CRC calculation for the HT SIGNAL field). The first bit to be transmitted is bit C7 as explained in 20.3.9.4.4 (CRC calculation for the HT SIGNAL field).
Tail Bits	6	Used to terminate the trellis of the convolution coder. Set to 0.

NOTE 1—Integer fields are transmitted in unsigned binary format, least significant bit first.
NOTE 2—A value of 0 in the Length field indicates a PPDU that does not include a data field. The packets ends after the last HT-LTF or the HT-SIG.

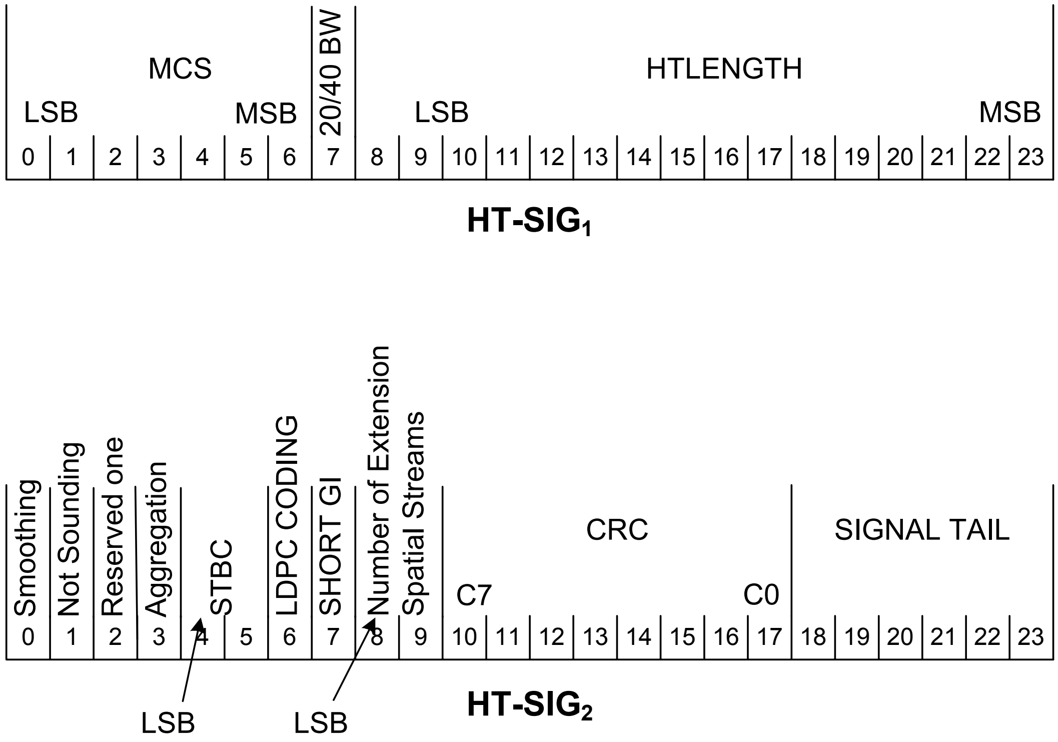


Figure n67—Format of HT-SIG$_1$ and HT-SIG$_2$

The HT-SIG is composed of two parts, HT-SIG$_1$ and HT-SIG$_2$, each containing 24 bits, as shown in Figure n67 (Format of HT-SIG1 and HT-SIG2). All the fields in the HT-SIG are transmitted LSB first, and HT-SIG1 is transmitted before HT-SIG2.

The HT-SIG parts are encoded, interleaved, mapped, and have pilots inserted following the steps described in 17.3.5.5, 17.3.5.6, and 17.3.5.8. The stream of 96 complex numbers generated by these steps is divided into two groups of 48 complex numbers: $d_{k,n}, 0 \le k \le 47, n = 0, 1$. The time domain waveform for the HT SIGNAL field in an HT mixed format packet in a 20 MHz transmission is:

$$r_{HT-SIG}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{TX} \cdot N_{HT-SIG}^{Tone}}} \sum_{n=0}^{1} w_{\mathrm{T}_{SYM}}(t - nT_{SYM}) \cdot \sum_{k=-26}^{26} (jD_{k,n} + p_{n+1}P_k)\exp(j2\pi k\Delta_F(t - nT_{SYM} - T_{GI} - T_{CS}^{i_{TX}})) \qquad (20\text{-}16)$$

For a 40 MHz transmission the time domain waveform is:

$$r^{i_{TX}}_{HT-SIG}(t) = \frac{1}{\sqrt{N_{TX} \cdot N^{Tone}_{HT-SIG}}} \sum_{n=0}^{1} w_{T_{SYM}}(t - nT_{SYM}) \cdot \sum_{k=-26}^{26} (jD_{k,n} + p_{n+1}P_k)(\exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI} - T^{i_{TX}}_{CS})) + j\exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI} - T^{i_{TX}}_{CS}))) \quad (20\text{-}17)$$

where:

$$D_{k,n} = \begin{cases} 0, k = 0, \pm 7, \pm 21 \\ d_{M^r(k),n}, \text{ otherwise} \end{cases}$$

$M^r(k)$ is defined in 20.3.9.3 (Non-HT portion of HT mixed format preamble)

P_k and p_n are defined in 17.3.5.9

N^{Tone}_{HT-SIG} has the value given in Table n60 (Value of tone scaling factor)

$T^{i_{TX}}_{CS}$ represents the cyclic shift for transmit chain i_{TX} and is defined by Table n61 (Cyclic shift for non-HT portion of the packet) for HT mixed format PPDUsNOTE—this definition results in a BPSK modulation in which the constellation of the data tones is rotated by 90º relative to the non-HT SIGNAL field in HT mixed format frames, and relative to the first HT-LTF in greenfield format frames (see Figure n68 (Data tone constellations in the non-HT SIGNAL field (L-SIG) and the HT SIGNAL field (HT-SIG) in an HT mixed format PPDU)).

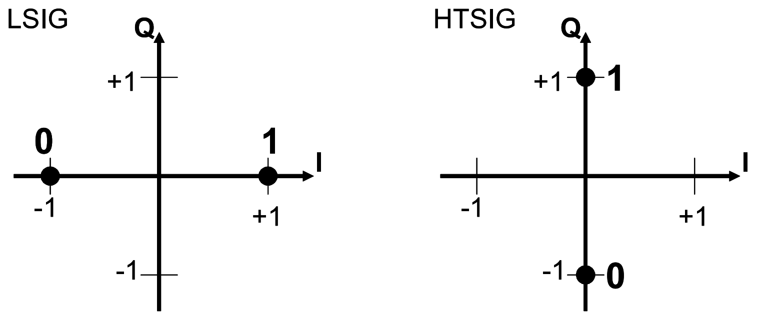


Figure n68—Data tone constellations in the non-HT SIGNAL field (L-SIG) and the HT SIGNAL field (HT-SIG) in an HT mixed format PPDU

Insert the following new subclause:

20.3.9.4.4 CRC calculation for the HT SIGNAL field

The CRC protects bits 0-33 of the HT-SIG (bits 0-23 of HT-SIG$_1$ and bits 0-9 of HT-SIG$_2$). The value of the CRC field is the ones complement of

$$crc(D) = (M(D) \oplus I(D))D^8 modulo G(D) \tag{20-18}$$

where

$M(D) = m_0 D^{33} + m_1 D^{32} + \ldots + m_{32} D + m_{33}$ is the HT-SIG represented as polynomial where m_0 is bit 0 of HT-SIG$_1$ and m_{33} is bit 9 of HT-SIG$_2$

$I(D) = \sum_{i=26}^{33} D^i$ are initialization values that are added modulo 2 to the first 8 bits of HT-SIG1

$G(D) = D^8 + D^2 + D + 1$ is the CRC generating polynomial

$crc(D) = c_0 D^7 + c_1 D^6 + \ldots + c_6 D + c_7$

The CRC field is transmitted with c$_7$ first.

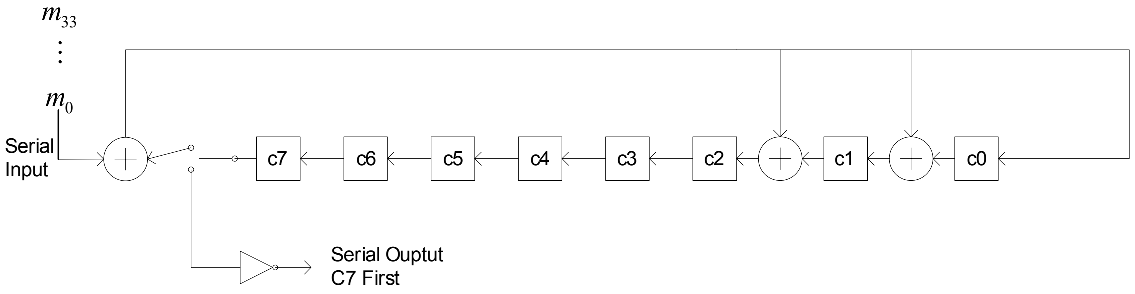


Figure n69—HT-SIG CRC calculation

Figure n69 (HT-SIG CRC calculation) shows the operation of the CRC. First, the shift register is reset to all ones. The bits are then passed through the exclusive-or operation (XOR) at the input. When the last bit has entered, the output is generated by shifting the bits out of the shift register, C7 first, through an inverter.

As an example, if bits $\{m_0 \ldots m_{33}\}$ are given by

{1 1 1 1 0 0 0 1 0 0 1 0 0 1 1 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0}

Then the CRC bits $\{c_7 \ldots c_0\}$ are

{1 0 1 0 1 0 0 0}

Insert the following new subclause:

20.3.9.4.5 The HT-STF training symbol

The purpose of the HT-STF training field is to improve AGC training in a MIMO system. The duration of the HT-STF is 4 μs; the frequency sequence used to construct the HT-STF in 20 MHz transmission is identical to L-STF; in 40 MHz transmission, the HT-STF is constructed from the 20 MHz version by duplicating and frequency shifting, and rotating the upper sub-carriers by 90°. The frequency sequences are shown in Equation (20-19) and Equation (20-20).

For 20 MHz:

$$\begin{aligned} HTS_{-28,28} = \sqrt{1/2}\ \{&0,0,0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,\\ &0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,0\} \end{aligned} \tag{20-19}$$

The HT-STF in 40 MHz is based on:

$$\begin{aligned} HTS_{-58,58} = \sqrt{1/2}\,\{&0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,\\ &0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,0,0,\\ &0,0,0,0,0,0,0,0,0,0,1+j,0,0,0,-1-j,0,0,0,1+j,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,\\ &0,0,0,0,0,0,0,-1-j,0,0,0,-1-j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0,0,1+j,0,0\} \end{aligned} \tag{20-20}$$

The time domain representation of the transmission in transmit chain i_{TX} is:

$$r_{HT-STF}^{i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{HT-STF}^{Tone}}} w_{T_{HT-STF}}(t) \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX},\, i_{STS}} \Upsilon_k HTS(k) \exp(j2\pi k\Delta_F(t - T_{CS}^{i_{STS}})) \tag{20-21}$$

where

$T_{CS}^{i_{STS}}$ represents the cyclic shift for the space time stream i_{STS} and takes the values given in Table n62 (Cyclic shift values of HT portion of the packet).

Q_k is defined in 20.3.10.10.1 (Spatial mapping).

Insert the following new subclause:

20.3.9.4.6 The HT-LTF long training field

The HT long training field provides a means for the receiver to estimate the MIMO channel between the set of QAM mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains. If the transmitter is providing training for exactly the space time streams (spatial mapper inputs) used for the transmission of the PSDU, the number of training symbols, N_{LTF}, is equal to the number of space time streams, N_{STS}, except that for three space time streams, four training symbols are required. If the transmitter is providing training for more space time streams (spatial mapper inputs) than the number used for the transmission of the PSDU, the number of training symbols is greater than the number of space time streams. This latter case happens in a sounding PPDU.

The HT long training field portion has one or two parts. The first part consists of from one to four HT long training fields (HT-LTFs) that are necessary for demodulation of the HT-Data portion of the PPDU. These HT-LTFs are referred to as Data HT-LTFs. The optional second part consists of from zero to four HT-LTFs that may be used to sound extra spatial dimensions of the multiple-input multiple-output (MIMO) channel that are not utilized by the HT-Data portion of the PPDU. These HT-LTFs are referred to as Extension HT-LTFs. If a receiver has not advertised its ability to receive Extension HT-LTFs, it may discard a frame including Extension HT-LTFs as an unknown frame type. The number of Data HT-LTFs is denoted N_{DLTF}. The number of extension HT-LTFs is denoted N_{ELTF}. The total number of HT-LTFs is:

$$N_{LTF} = N_{DLTF} + N_{ELTF} \tag{20-22}$$

N_{LTF} shall not exceed 5. Table n64 (Determining the number of space time streams) shows the determination of the number of space time streams from the MCS and STBC fields in the HT-SIG. Table n65 (Number of DLTFs required for data space-time streams) shows the number of Data HT-LTFs as a function of the number of space time streams (N_{STS}). Table n66 (Number of ELTFs required for extension spatial streams) shows the number of extension HT-LTFs as a function of the number of extension spatial streams (N_{ESS}). N_{STS} plus N_{ESS} is less than or equal to 4. In the case where N_{STS} equals 3, N_{ESS} cannot exceed one; if N_{ESS} equals one in this case then N_{LTF} equals 5. When an HT packet includes one or more extension HT-LTFs, it is optional for a receiver to decode the data portion of the PPDU.

Table n64—Determining the number of space time streams

Number of Spatial Streams (from MCS) N_{SS}	**STBC field**	**Number of space time streams** N_{STS}
1	0	1
1	1	2
2	0	2
2	1	3
2	2	4
3	0	3
3	1	4
4	0	4

The following HT-LTF sequence is transmitted in the case of 20 MHz operation:

Table n65—Number of DLTFs required for data space-time streams

N_{STS}	N_{DLTF}
1	1
2	2
3	4
4	4

Table n66—Number of ELTFs required for extension spatial streams

N_{ESS}	N_{ELTFs}
0	0
1	1
2	2
3	4

$$\begin{aligned} HTLTF_{-28:28} = \{&1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,0,\\ &1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1,-1,-1\} \end{aligned} \tag{20-23}$$

NOTE—This sequence is an extension of the non-HT LTF where the 4 extra sub-carriers are filled with +1 for negative frequencies and -1 for positive frequencies.

In a 40 MHz transmission the sequence to be transmitted is based on:

$$\begin{aligned} HTLTF_{-58,58} = \{&1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,\\ &1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1,-1,-1,-1,1,0\\ &0,0,-1,1,1,-1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,1,-1,-1,1,1,-1,1,-1,1,1,1,1,1,\\ &1,-1,-1,1,1,-1,1,-1,1,-1,-1,-1,-1,-1,1,1,-1,-1,1,-1,1,-1,1,1,1,1\} \end{aligned} \tag{20-24}$$

NOTE—This sequence is also constructed by extending the non-HT LTF in the following way: first, the non-HT LTF is duplicated and shifted as explained in 20.3.9.3.4 (Non-HT Long Training field) for the non-HT duplicate format; then the missing sub-carriers, [-32, -5, -4, -3, -2, 2, 3, 4, 5, 32], are filled with the values [1, -1, -1, -1, 1, -1, 1, 1, -1, 1] respectively.

This sequence, which uses 114 tones, is used even if the HT-duplicate format (MCS 32), which uses 104 tones, is used in the data.

In an HT mixed format preamble, each HT-LTF consists of a single occurrence of the sequence plus a GI insertion, and has a duration of 4 μs. In case of multiple space time streams, cyclic shift is invoked as specified in Table n62 (Cyclic shift values of HT portion of the packet).

The generation of Data HT-LTFs is shown in Figure n70 (Generation of Data HT-LTFs). The generation of Extension HT-LTFs is shown in Figure n71 (Generation of the Extension HT-LTFs). In these figures, and in the following text, the following notational conventions are used:

— $\left[X\right]_{m,n}$ indicates the element in row m and column n of matrix X

— $\left[X\right]_{N}$ indicates a matrix consisting of the first N columns of matrix X

— $\left[X\right]_{M:N}$ indicates a matrix consisting of columns M through N of matrix X

where

$M \le N$

X is either Q_k or P_{HTLTF}

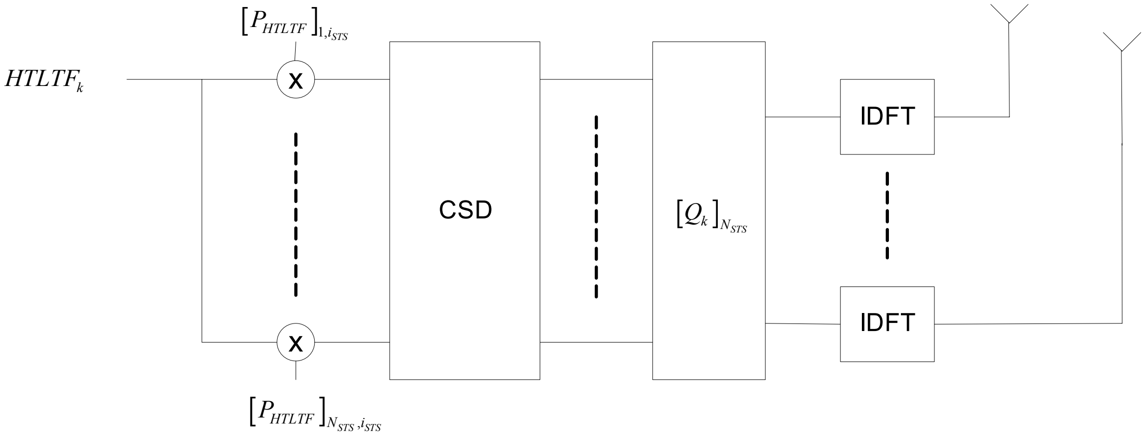


Figure n70—Generation of Data HT-LTFs

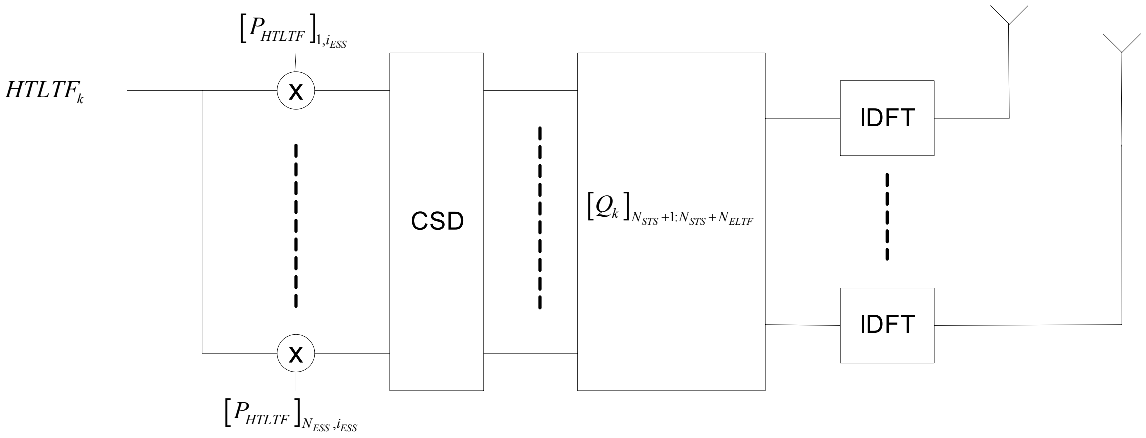


Figure n71—Generation of the Extension HT-LTFs

The mapping between space time streams and transmit chains is defined by the columns of an antenna map matrix Q_k for subcarrier k. The first N_{STS} columns define the space time streams used for data transmission, and the next N_{ESS} columns (up to $N_{TX} - N_{STS}$ columns) define the extension spatial streams. Thus, for the purpose of defining HT-LTFs, Q_k is an $N_{TX} \times \left(N_{STS} + N_{ESS}\right)$ dimension matrix. Columns $1 \cdots N_{STS}$ of Q_k are excited by the Data HT-LTFs, and columns $N_{STS} + 1 \cdots N_{STS} + N_{ESS}$ are excited by the Extension HT-LTFs, where $N_{STS} + N_{ESS} \le N_{TX}$ is the total number of spatial streams being probed by the HT-LTFs. Q_k may be an identity matrix, in the case of direct-mapped MIMO. Other limitations on Q_k are specified in 20.3.10.10.1 (Spatial mapping). P_{HTLTF} is defined in Equation (20-27)).

The time domain representation of the waveform transmitted on transmit chain i_{TX} during Data HT-LTF $n,\ 1 \le n \le N_{DLTF}$ is:

$$r_{HT-LTF}^{n,\, i_{TX}}(t) = \frac{1}{\sqrt{N_{STS} \cdot N_{HT-LTF}^{Tone}}} w_{\mathrm{T}_{HT-LTFs}}(t)$$
$$\cdot \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX},\, i_{STS}} [P_{HTLTF}]_{i_{STS},\, n} \Upsilon_k HTLTF(k) \exp(j2\pi k\Delta_F(t - T_{GI} - T_{CS}^{i_{STS}}))$$

(20-25)

and for the extension HT-LTFs $(N_{DLTF} < n \le N_{LTF})$, it is:

$$r_{HT-LTF}^{n,\, i_{TX}}(t) = \frac{1}{\sqrt{N_{HT-LTF}^{Tone} \cdot N_{ESS}}} w_{\mathrm{T}_{HT-LTFs}}(t) \cdot$$
$$\sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{ESS}=1}^{N_{ESS}} [Q_k]_{i_{TX},\, N_{STS}+i_{ESS}} [P_{HTLTF}]_{i_{ESS},\, n-N_{DLTF}} \Upsilon_k HTLTF(k) \exp(j2\pi k\Delta_F(t - T_{GI} - T_{CS}^{i_{ESS}}))$$

(20-26)

where

the values for the cyclic shift $T_{CS}^{i_{STS}}$ are given in Table n62 (Cyclic shift values of HT portion of the packet)

the values for the cyclic shift $T_{CS}^{i_{ESS}}$ are given in Table n62 (Cyclic shift values of HT portion of the packet) with $i_{ESS} = i_{STS}$

Q_k is defined in 20.3.10.10.1 (Spatial mapping) the HT-LTF mapping matrix P_{HTLTF} is:

$$P_{HTLTF} = \begin{bmatrix} 1 & -1 & 1 & 1 \\ 1 & 1 & -1 & 1 \\ 1 & 1 & 1 & -1 \\ -1 & 1 & 1 & 1 \end{bmatrix} \qquad (20\text{-}27)$$

Insert the following new subclause:

20.3.9.5 Greenfield format preamble

For greenfield operation, compatibility with Clause 17 and Clause 19 STAs is not required. Therefore, the portions of the preamble that are compatible with Clause 17 and Clause 19 STAs are not included. The result is a shorter and more efficient PLCP frame format that includes a short training field, long training fields, and an HT SIGNAL field.

Insert the following new subclause:

20.3.9.5.1 Cyclic shift definition for the greenfield format preamble

Throughout the greenfield format preamble, cyclic shift is applied to prevent beamforming when similar signals are transmitted on different spatial streams. The same cyclic shift is applied to these streams during the transmission of the data portion of the frame. The values of the cyclic shift to be used during the greenfield format preamble, as well as the data portion of the greenfield format frame, are specified in Table n62 (Cyclic shift values of HT portion of the packet).

Insert the following new subclause:

20.3.9.5.2 HT greenfield format Short Training field (HT-GF-STF)

The HT greenfield format short training field (HT-GF-STF) is placed at the beginning of a greenfield format frame. The time domain waveform for the HT-GF-STF on transmit chain i_{TX} is:

$$r^{(i_{TX})}_{HT-GF-STF}(t) = \frac{1}{\sqrt{N_{STS} \cdot N^{Tone}_{HT-GF-STF}}} w_{T_{HT-GF-STF}}(t) \cdot \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX}, i_{STS}} [P_{HTLTF}]_{i_{STS}, 1} \Upsilon_k S_k \exp(j2\pi k\Delta_F(t - T_{CS}^{i_{STS}})) \qquad (20\text{-}28)$$

where

$T_{CS}^{i_{STS}}$ represents the cyclic shift for the space time stream i_{STS} and takes values from Table n62 (Cyclic shift values of HT portion of the packet)

Q_k is defined in 20.3.10.10.1 (Spatial mapping)

P_{HTLTF} is defined in Equation (20-27)

S_k is defined in Non-HT Short Training field (L-STF), Equation (20-8) for 20 MHz operation and Equation (20-9) for 40 MHz operation.

The waveform defined by Equation (20-28) has a period of 0.8 μs, and the HT-GF-STF includes ten such periods, with a total duration of $\mathrm{T}_{HT-GF-STF}$ = 8 μs.

Insert the following new subclause:

20.3.9.5.3 HT SIGNAL field

The content and format of the HT SIGNAL field of a greenfield format frame is identical to the HT SIGNAL field in an HT mixed format frame, as described in 20.3.9.4.3 (The HT SIGNAL field). The placement of the HT SIGNAL field in a greenfield format frame is shown in Figure n62 (PPDU frame format). The time-domain waveform is generated according Equation (20-29) and Equation (20-30).

The following equation gives the time domain waveform for the signal field on transmit chain i_{TX} with 20 MHz operation.

$$\begin{aligned} r^{i_{TX}}_{HT-SIG}(t) &= \frac{1}{\sqrt{N_{STS}\cdot N^{Tone}_{HT-SIG}}} \sum_{n=0}^{1} w_{\mathrm{T}_{SYM}}(t-nT_{SYM}) \\ &\cdot \sum_{k=-26}^{26} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX},\, i_{STS}} [P_{HTLTF}]_{i_{STS},\, 1} (jD_{k,\,n}+p_nP_k) \\ &\cdot \exp(j2\pi k\Delta_F(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}})) \end{aligned} \tag{20-29}$$

where

P_k and p_n are defined in 17.3.5.9

$D_{k,\,n}$ is defined in 20.3.9.4.3 (The HT SIGNAL field)

$T_{CS}^{i_{STS}}$ represents the cyclic shift for space time stream i_{STS} and takes values from Table n62 (Cyclic shift values of HT portion of the packet)

Q_k is defined in 20.3.10.10.1 (Spatial mapping)

P_{HTLTF} is defined in Equation (20-27).

The following equation gives the time domain waveform for the signal field on transmit chain i_{TX} with 40 MHz operation.

$$\begin{aligned} r_{HT-SIG}^{i_{TX}}(t) &= \frac{1}{\sqrt{N_{STS}\cdot N_{HT-SIG}^{Tone}}}\sum_{n=0}^{1} w_{T_{SYM}}(t-nT_{SYM}) \\ &\cdot \sum_{k=-26}^{26}\sum_{i_{STS}=1}^{N_{STS}} [P_{HTLTF}]_{i_{STS},1}(jD_{k,n}+p_nP_k) \\ &\cdot ([Q_{k-32}]_{i_{TX},i_{STS}}\exp(j2\pi(k-32)\Delta_F(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}})) \\ &+j[Q_{k+32}]_{i_{TX},i_{STS}}\exp(j2\pi(k+32)\Delta_F(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{STS}}))) \end{aligned} \qquad (20\text{-}30)$$

where

p_n and P_k are defined in 17.3.5.9

$D_{k,n}$ is defined in 20.3.9.4.3 (The HT SIGNAL field)

$T_{CS}^{i_{STS}}$ represents the cyclic shift for space time stream i_{STS} and takes values from Table n62 (Cyclic shift values of HT portion of the packet)

Q_k is defined in 20.3.10.10.1 (Spatial mapping)

P_{HTLTF} is defined in Equation (20-27)

Insert the following new subclause:

20.3.9.5.4 HT Long Training field

The format of the long training field portion of the preamble in a greenfield format frame is identical to that of the HT long training field in an HT mixed format frame, as described in 20.3.9.4.6 (The HT-LTF long training field), with the exception of the first HT-LTF (HT-LTF1), which is twice as long (8 μs) as the other HT-LTFs. The time domain waveform for the long training symbol on transmit chain i_{TX} for the first HT-LTF in a greenfield format frame is

$$\begin{aligned} r_{HT-LTF}^{1,i_{TX}}(t) &= \frac{1}{\sqrt{N_{STS}\cdot N_{HT-LTF}^{Tone}}} w_{T_{HT-LTF1}}(t) \\ &\cdot \sum_{k=-N_{SR}}^{N_{SR}}\sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX},i_{STS}}[P_{HTLTF}]_{i_{STS},1}\Upsilon_k HTLTF(k)\exp(j2\pi k\Delta_F(t-T_{GI2}-T_{CS}^{i_{STS}})) \end{aligned} \qquad (20\text{-}31)$$

where

$T_{CS}^{i_{STS}}$ represents the cyclic shift for space time stream i_{STS} and takes values from Table n62 (Cyclic shift values of HT portion of the packet)

Q_k is defined in 20.3.10.10.1 (Spatial mapping)

P_{HTLTF} is defined in Equation (20-27)

The first HT-LTF (HT-LTF1) consists of two periods of the long training symbol, preceded by a double-length (1.6 µs) cyclic prefix. The placement of the first and subsequent HT-LTFs in a greenfield format frame is shown in Figure n62 (PPDU frame format).

Insert the following new subclause:

20.3.10 The Data field

The Data field consists of the 16-bit SERVICE field, the PSDU, either six or twelve tail bits, depending on whether there are one or two encoding streams, and pad bits.

The number of OFDM symbols in the data field when BCC encoding is used is computed using the formula:

$$N_{SYM} = m_{STBC} \left\lceil \frac{8 \cdot length + 16 + 6 \cdot N_{ES}}{m_{STBC} \cdot N_{DBPS}} \right\rceil \tag{20-32}$$

where

m_{STBC} is 2 if STBC is used and 1 otherwise (making sure that the number of symbols is even when STBC is used)

length is the value of the Length field in the HT-SIG field defined in Table n63 (Fields of HT SIGNAL field)

N_{DBPS} can take the values defined in Table n82 (Rate dependent parameters for mandatory 20 MHz, NSS =1 MCSs, NES = 1) through Table n96 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs)

The symbol $\lceil x \rceil$ denotes the smallest integer greater than or equal to *x*

The number of “zero” pad bits is thus $N_{SYM} \cdot N_{DBPS}$ - 8 · *length* - 16 - 6 · N_{ES}. The number of symbols in the data field when LDPC encoding is used is described in 20.3.10.6 (Low density parity check (LDPC) codes).

For LDPCC encoding, the number of encoded data bits, N_{avbits}, is given by Equation (20-39), the number of OFDM symbols, N_{SYM}, is given by Equation (20-41), and the number of repeated encoded bits for padding, N_{rep}, is given by Equation (20-42), in 20.3.10.6.5 (LDPC PPDU encoding process).

Insert the following new subclause:

20.3.10.1 The SERVICE field

The SERVICE field is used for scrambler initialization. The service field is composed of 16 bits, all set to zero before scrambling. In non-HT and non-HT duplicate transmissions the service field is the same as in 17.3.5.1. In HT frames, the service field is composed of 16 zero bits, scrambled by the scrambler, as defined in 20.3.10.2 (Scrambler).

Insert the following new subclause:

20.3.10.2 Scrambler

The data field is scrambled by the scrambler defined in 17.3.5.4.

Insert the following new subclause:

20.3.10.3 Coding

The data are encoded using either the binary convolutional code (BCC) defined in 17.3.5.5, or the low density parity check (LDPC) code defined in 20.3.10.6 (Low density parity check (LDPC) codes). The encoder is selected by the LDPC coding field in the High Throughput Signal Field, as described in 20.3.9.4.3 (The HT SIGNAL field). A single FEC encoder is always used when LDPC coding is used. When the BCC FEC encoder is used, a single encoder is used, except that two encoders shall be used when the selected MCS has a PHY rate greater than 300 Mb/s calculated based on 800 ns GI. The operation of the BCC FEC is described in 20.3.10.5 (Binary convolutional coding and puncturing). The operation of the LDPC coder is described in 20.3.10.6 (Low density parity check (LDPC) codes).

20.3.10.4 Encoder parsing operation

If two encoders are used, the scrambled data bits are divided between the encoders by sending alternating bits to different encoders. The i^{th} bit to the j^{th} encoder, denoted $x_i^{(j)}$, is:

$$x_i^{(j)} = b_{N_{ES} \cdot i + j} \quad ; \quad 0 \le j \le N_{ES} - 1 \tag{20-33}$$

Following the parsing operation, 6 scrambled “zero” bits following the end of the message bits in each FEC input sequence are replaced by unscrambled “zero” bits, as described in 17.3.5.2.

The replaced bits are:

$$x_i^{(j)} \quad : \qquad 0 \le j \le N_{ES} - 1 \quad ; \quad \frac{length \cdot 8 + 16}{N_{ES}} \le i \le \frac{length \cdot 8 + 16}{N_{ES}} + 5 \tag{20-34}$$

Insert the following new subclause:

20.3.10.5 Binary convolutional coding and puncturing

When BCC encoding is used, the encoder parser output sequences $\{x_i^0\}$, and $\{x_i^1\}$ where applicable, are each encoded by the rate-½ convolutional encoder defined in 17.3.5.5. After encoding, the encoded data is punctured by the method defined in 17.3.5.6 to achieve the rate selected by the modulation and coding scheme.

In the case that rate 5/6 coding is selected, the puncturing scheme is defined in Figure n72 (Puncturing at rate 5/6).

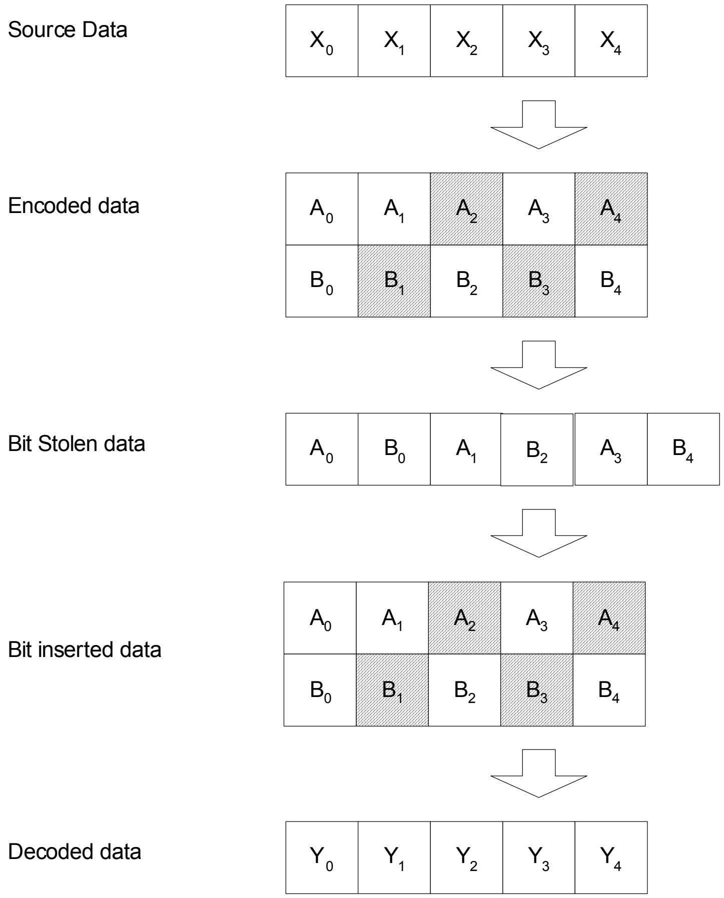


Figure n72—Puncturing at rate 5/6

Insert the following new heading:

20.3.10.6 Low density parity check (LDPC) codes

Insert the following new subclause:

20.3.10.6.1 Introduction

Subclauses 20.3.10.6.2 (LDPC code rates and codeword block lengths) to 20.3.10.6.6 (LDPC parser) describe the LDPC codes to be optionally used in the HT system as a high-performance ECC technique, instead of the convolutional code (20.3.10.5 (Binary convolutional coding and puncturing)). The rate-dependent parameters in Table n82 (Rate dependent parameters for mandatory 20 MHz, NSS =1 MCSs, NES = 1) to Table n96 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs) shall still apply.

Support for LDPC codes is optional.

Insert the following new subclause:

20.3.10.6.2 LDPC code rates and codeword block lengths

The supported code rates, information block lengths, and codeword block lengths are described in Table n67 (LDPC parameters).

Table n67—LDPC parameters

Code rate (R)	LDPC information block length (bits)	LDPC codeword block length (bits)
1/2	972	1944
1/2	648	1296
1/2	324	648
2/3	1296	1944
2/3	864	1296
2/3	432	648
3/4	1458	1944
3/4	972	1296
3/4	486	648
5/6	1620	1944
5/6	1080	1296
5/6	540	648

Insert the following new subclause:

20.3.10.6.3 LDPC encoder

For each of the three available codeword block lengths, the LDPC encoder supports rate-1/2, rate-2/3, rate-3/4 and rate-5/6 encoding. The LDPC encoder is systematic, i.e., it encodes an information block, c=(i_0,i_1,..., $i_{(k-1)}$), of size *k,* into a codeword, **c,** of size *n,* **c**=(i_0,i_1,... $i_{(k-1)}$, p_0, p_1,..., $p_{(n-k-1)}$), by adding *n*-*k* parity bits obtained so that $\mathbf{H}\cdot\mathbf{c}^T = \mathbf{0}$, where **H** is an ($n$-$k$)×$n$ parity-check matrix. The selection of the codeword block length (n) is achieved via the LDPC PPDU encoding process described in 20.3.10.6.5 (LDPC PPDU encoding process).

Insert the following new subclause:

20.3.10.6.4 Parity check matrices

Each of the parity-check matrices can be partitioned into square subblocks (submatrices) of size $Z \times Z$. These submatrices are either cyclic-permutations of the identity matrix or null submatrices.

The cyclic-permutation matrix P_i is obtained from the $Z \times Z$ identity matrix by cyclically shifting the columns to the right by i elements. The matrix P_0 is the $Z \times Z$ identity matrix. Figure n73 (Examples of cyclic-permutation matrices with Z=8. The matrix Pi is produced by cyclically shifting the columns of the identity matrix to the right by i places.) illustrates examples (for a subblock size of 8 × 8) of cyclic-permutation matrices P_i.

$$P_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}, P_1 = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}, P_5 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

Figure n73—Examples of cyclic-permutation matrices with Z=8. The matrix P_i is produced by cyclically shifting the columns of the identity matrix to the right by *i* places.

Table R.1 of Annex R displays the "matrix prototypes" of parity-check matrices for all four code rates at block length n=648 bits. The integer i denotes the cyclic-permutation matrix P_i, as illustrated in Figure n73 (Examples of cyclic-permutation matrices with Z=8. The matrix Pi is produced by cyclically shifting the columns of the identity matrix to the right by i places.). Vacant entries of the table denote null (zero) submatrices.

Table R.2 of Annex R displays the matrix prototypes of parity-check matrices for block length n=1296 bits, in the same fashion.

Table R.3 of Annex R displays the matrix prototypes of parity-check matrices for block length n=1944 bits, in the same fashion.

Insert the following new subclause:

20.3.10.6.5 LDPC PPDU encoding process

To encode an LDPC PPDU, steps a) to g) defined below are performed in sequence.

a) Compute the number of available bits, N_{avbits}, in the minimum number of OFDM symbols in which the Data field of the packet may fit.

$$N_{\text{pld}} = length \times 8 + 16 \tag{20-35}$$

$$N_{\text{avbits}} = N_{\text{CBPS}} \times m_{STBC} \times \left\lceil \frac{N_{\text{pld}}}{N_{\text{CBPS}} \times \mathrm{R} \times m_{STBC}} \right\rceil , \tag{20-36}$$

where

m_{STBC} is 2 if STBC is used and 1 otherwise

length is the value of the Length field in the HT-SIG field defined in Table n63 (Fields of HT SIGNAL field)

$\lceil x \rceil$ denotes the smallest integer greater than or equal to x

N_{pld} is the number of bits in the PSDU and SERVICE field

b) Compute the integer number of LDPC codewords to be transmitted, N_{CW}, and the length of the codewords to be used, L_{LDPC} from Table n68 (PPDU encoding parameters).

Table n68—PPDU encoding parameters

Range of N_{avbits} (bits)	**Number of LDPC codewords (N_{CW})**	**LDPC codeword length L_{LDPC} (bits)**
$N_{avbits} \le 648$	1	1296, if $N_{avbits} \ge N_{pld} + 912 \times (1\text{-}R)$ 648, otherwise
$648 < N_{avbits} \le 1296$	1	1944, if $N_{avbits} \ge N_{pld} + 1464 \times (1\text{-}R)$ 1296, otherwise
$1296 < N_{avbits} \le 1944$	1	1944
$1944 < N_{avbits} \le 2592$	2	1944, if $N_{avbits} \ge N_{pld} + 2916 \times (1\text{-}R)$ 1296, otherwise
$2592 < N_{avbits}$	$\left\lceil \frac{N_{pld}}{1944 \cdot R} \right\rceil$	1944

c) Compute the number of shortening bits, N_{shrt}, to be padded to the N_{pld} data bits before encoding, as follows.

$$N_{shrt} = (N_{CW} \times L_{LDPC} \times R) - N_{pld} \quad (20\text{-}37)$$

When $N_{shrt} \le 0$, shortening is not performed. When $N_{shrt} > 0$, shortening bits shall be equally distributed over all N_{CW} codewords with the first $\mathrm{rem}(N_{shrt}, N_{CW})$ codewords being shortened one bit more than the remaining codewords. Define $N_{spcw} = \lfloor N_{shrt}/N_{CW} \rfloor$. Then, when $N_{shrt} > 0$, the shortening is performed by setting information bits $(i(k - N_{spcw} - 1), \ldots, i(k-1))$ to 0 in the first $\mathrm{rem}(N_{shrt}, N_{CW})$ codewords and, provided $N_{shrt} > 0$, setting information bits $(i(k - N_{spcw}), \ldots, i(k-1))$ to 0 in the remaining codewords. For all values of N_{shrt}, encode each of the N_{CW} codewords using the LDPC encoding technique described in 20.3.10.6.2 (LDPC code rates and codeword block lengths) through 20.3.10.6.4 (Parity check matrices). When $N_{shrt} > 0$, the shortened bits shall be discarded after encoding.

d) Compute the number of bits to be punctured, N_{punc}, from the codewords after encoding, as follows.

$$N_{punc} = \max(0, (N_{CW} \times L_{LDPC}) - N_{avbits} - N_{shrt}) \quad (20\text{-}38)$$

If $((N_{punc} > 0.1 \times N_{CW} \times L_{LDPC} \times (1-R))$ AND $(N_{shrt} < 1.2 \times N_{punc} \times R/(1-R)))$ is true OR if $(N_{punc} > 0.3 \times N_{CW} \times L_{LDPC} \times (1-R))$ is true, then increment N_{avbits} and recompute N_{punc} by the following:

$$N_{avbits} = N_{avbits} + N_{CBPS} \times m_{STBC} \quad (20\text{-}39)$$

$$N_{\text{punc}} = \max(0, (N_{\text{CW}} \times L_{\text{LDPC}}) - N_{\text{avbits}} - N_{\text{shrt}}) \quad (20\text{-}40)$$

The punctured bits shall be equally distributed over all N_{CW} codewords with the first $\text{rem}(N_{\text{punc}}, N_{\text{CW}})$ codewords being punctured one bit more than the remaining codewords. Define $N_{\text{ppcw}} = \lfloor N_{\text{punc}} / N_{\text{CW}} \rfloor$. When $N_{\text{ppcw}} > 0$, the puncturing is performed by discarding parity bits $(p(n-k-N_{\text{ppcw}}-1), \ldots, p(n-k-1))$ of the first $\text{rem}(N_{\text{punc}}, N_{\text{CW}})$ codewords and discarding parity bits $(p(n-k-N_{\text{ppcw}}), \ldots, p(n-k-1))$ of the remaining codewords after encoding. The number of OFDM symbols to be transmitted in the PPDU can be computed per:

$$N_{\text{SYM}} = N_{\text{avbits}} / N_{\text{CBPS}} \quad (20\text{-}41)$$

e) Compute the number of coded bits to be repeated, N_{rep}, as follows.

$$N_{\text{rep}} = \max(0, N_{\text{avbits}} - N_{\text{CW}} \times L_{\text{LDPC}} \times (1-R) - N_{\text{pld}}) \quad (20\text{-}42)$$

The number of coded bits to be repeated shall be equally distributed over all N_{CW} codewords with one more bit repeated for the first $\text{rem}(N_{\text{rep}}, N_{\text{CW}})$ codewords than for the remaining codewords.

NOTE—When puncturing occurs, the coded bits are not repeated, and vice versa.

The coded bits to be repeated for any codeword shall be copied only from that codeword itself, starting from information bit i(0) and continuing sequentially through the information bits and, when necessary, into the parity bits, until the required number of repeated bits are obtained for that codeword. Note that these repeated bits are copied from the codeword after the shortening bits have been removed. If for a codeword the required number of repeated bits cannot be obtained in this manner (i.e. repeating the codeword once), the procedure is repeated until the required number is achieved. These repeated bits are then concatenated to the codeword after the parity bits in their same order. The is process is illustrated in Figure n74 (LDPC PPDU encoding padding and puncturing of a single codeword). In this figure, the outlined arrows indicate the encoding procedure steps, while the solid arrows indicate the direction of puncturing and padding with repeated bits.

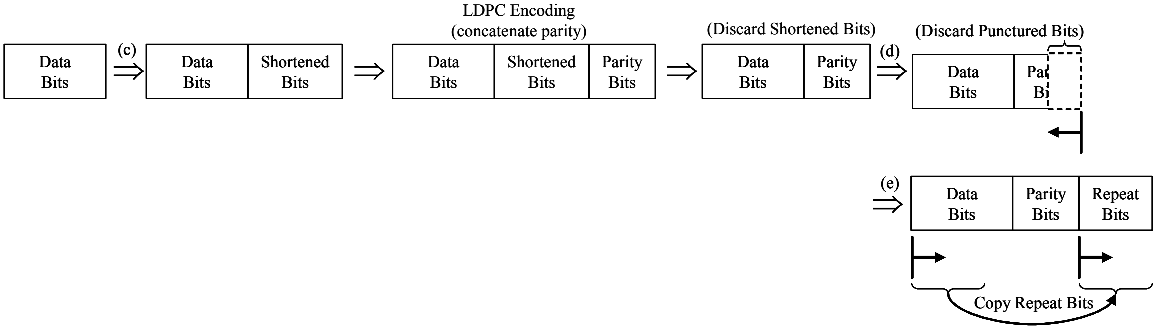


Figure n74—LDPC PPDU encoding padding and puncturing of a single codeword

f) Encode the data per, 20.3.10.6.3 (LDPC encoder), 20.3.10.6 (Low density parity check (LDPC) codes), and 20.3.10.6.4 (Parity check matrices) using the number of shortening bits per codeword as computed in step c), and puncture or repeat bits per codeword as computed per step d) and e), as illustrated in Figure n74 (LDPC PPDU encoding padding and puncturing of a single codeword).

g) Aggregate all codewords and parse per 20.3.10.6.6 (LDPC parser).

Insert the following new subclause:

20.3.10.6.6 LDPC parser

The LDPC shortened and punctured codewords that result from the encoding process shall be sent in sequential fashion. Within each codeword, bit i_0 is sent first. The parsing of this encoded data stream into spatial streams shall follow exactly the parsing rules defined for the BCC encoder, as defined in 20.3.10.7.1 (Overview). However, the frequency interleaver is bypassed in 20.3.10.7.3 (Frequency interleaver).

Insert the following new subclause heading:

20.3.10.7 Data interleaver

Insert the following new subclause:

20.3.10.7.1 Overview

After coding and puncturing, the data bit streams at the output of the FEC encoders are re-arranged into blocks of $N_{CBPSS}(i_{SS})$ bits, where $i_{SS} = 1, 2, \ldots N_{SS}$ is the spatial stream index. This operation is referred to as "stream parsing" and is described in 20.3.10.7.2 (Stream parser). If BCC encoding was used, each of these blocks is then interleaved by an interleaver that is a modification of the Clause 17 interleaver.

Insert the following new subclause:

20.3.10.7.2 Stream parser

The number of bits assigned to a single axis (real or imaginary) in a constellation point in spatial stream i_{SS} is denoted by

$$s(i_{SS}) = \max\left\{1, \frac{N_{BPSCS}(i_{SS})}{2}\right\} \tag{20-43}$$

The sum of these over all streams is: $S = \sum_{i_{SS}=1}^{N_{SS}} s\left(i_{SS}\right)$.

NOTE—if equal MCS is used for all spatial streams this becomes $N_{SS} \cdot s$, where s is the number of bits for an axis common to all streams.

Consecutive blocks of $s\left(i_{SS}\right)$ bits are assigned to different spatial streams in a round robin fashion.

If two encoders are present, the output of each encoder is used alternately for each round robin cycle, i.e., at the beginning S bits from the output of first encoder are fed into all spatial streams, and then S bits from the output of second encoder are used and so on.

Input k to spatial stream i_{SS} is $y_i^{(j)}$, which is output bit i of the encoder j,

where:

$$j = \left\lfloor \frac{k}{s(i_{SS})} \right\rfloor \bmod N_{ES} \qquad (20\text{-}44)$$

$$i = \sum_{i'=1}^{i_{SS}-1} s(i') + S \cdot \left\lfloor \frac{k}{N_{ES} \cdot s(i_{SS})} \right\rfloor + k \bmod s(i_{SS}) \qquad (20\text{-}45)$$

$$1 \le i_{SS} \le N_{SS}$$

$\lfloor x \rfloor$ is the largest integer less than or equal to x

$s \bmod t$ is the remainder resulting from the division of integer s by integer t

For $i_{SS} = 1$, the first term in Equation (20-45) has a value of 0.

Insert the following new subclause:

20.3.10.7.3 Frequency interleaver

The bits at the output of the stream parser are divided into blocks of $N_{CBPSS}(i_{SS})$, $i_{SS} = 1, 2, \ldots N_{SS}$ bits, and if BCC encoding was used, each block is interleaved by an interleaver based on the Clause 17 interleaver. This interleaver, which is based on entering the data in rows and reading it out in columns, has a different number of columns and rows depending on whether a 20 MHz channel or a 40 MHz channel is used. Table n69 (Number of rows and columns in the interleaver) defines the interleaver parameters. If LDPC encoding was used, no interleaving is performed, hence skip to 20.3.10.8 (QAM mapping) in order to map the parsed streams.

Table n69—Number of rows and columns in the interleaver

Parameter	20 MHz	40 MHz
N_{COL}	13	18
N_{ROW}	$4 \times N_{BPSCS}(i_{SS})$	$6 \times N_{BPSCS}(i_{SS})$
$\mathrm{N_{ROT}}$	11	29

After the Clause 17 like operations have been applied, if more than one spatial stream exists, a third operation called frequency rotation is applied to the additional spatial streams. The parameter for the frequency rotation is N_{ROT}.

The interleaving is defined using three permutations. The first permutation is defined by the rule:

$$i = N_{ROW}\left(k \bmod N_{\mathrm{COL}}\right) + \mathrm{floor}\left(k / N_{\mathrm{COL}}\right) \qquad k = 0,1,\ldots,N_{\mathrm{CBPSS}}(i_{SS}) - 1 \qquad (20\text{-}46)$$

The second permutation is defined by the rule

$$\begin{aligned} j &= s(i_{SS}) \times \operatorname{floor}\left(i / s(i_{SS})\right) \\ &\quad + \left(i + N_{\text{CBPSS}}(i_{SS}) - \operatorname{floor}\left(N_{\text{COL}} \times i / N_{\text{CBPSS}}(i_{SS})\right)\right) \operatorname{mod} s(i_{SS}); \\ &\qquad i = 0, 1, \ldots, N_{\text{CBPSS}}(i_{SS}) - 1 \end{aligned} \tag{20-47}$$

The value of $s(i_{SS})$ is determined by the number of coded bits per sub carrier:

$$s(i_{SS}) = \max(N_{BPSCS}(i_{SS})/2, 1) \tag{20-48}$$

If more that one spatial stream exists, a frequency rotation is applied to the output of the second permutation

$$\begin{aligned} r &= \left(j - \left(\left((i_{ss} - 1) \times 2 \right) \operatorname{mod} 3 + 3 \times \operatorname{floor}\left({(i_{ss} - 1)} \big/ {3} \right) \right) \times N_{ROT} \times N_{BPSCS}(i_{SS}) \right) \operatorname{mod} N_{CBPSS}(i_{SS}); \\ &\qquad j = 0, 1, \ldots, N_{\text{CBPSS}}(i_{SS}) - 1 \end{aligned} \tag{20-49}$$

where

$i_{SS} = 1, 2, \ldots, N_{SS}$ is the index of the spatial stream on which this interleaver is operating.

The deinterleaver uses the following operations to perform the inverse rotation. The index of the bit in the received block (per spatial stream) is denoted by *r*. The first permutation reverses the third (frequency rotation) permutation of the interleaver

$$\begin{aligned} j &= \left(r + \left(\left((i_{ss} - 1) \times 2 \right) \operatorname{mod} 3 + 3 \times \operatorname{floor}\left({(i_{ss} - 1)} \big/ {3} \right) \right) \times N_{ROT} \times N_{BPSCS}(i_{SS}) \right) \operatorname{mod} N_{CBPSS}(i_{SS}); \\ &\qquad r = 0, 1, \ldots, N_{\text{CBPSS}}(i_{SS}) - 1 \end{aligned} \tag{20-50}$$

The second permutation reverses the second permutation in the interleaver.

$$\begin{aligned} i &= s(i_{SS}) \times \operatorname{floor}\left(j / s(i_{SS})\right) + \left(j + \operatorname{floor}\left(N_{COL} \times j / N_{\text{CBPSS}}(i_{SS})\right)\right) \operatorname{mod} s(i_{SS}); \\ &\qquad j = 0, 1, \ldots, N_{\text{CBPSS}}(i_{SS}) - 1 \end{aligned} \tag{20-51}$$

where $s(i_{SS})$ is defined in Equation (20-48).

The third permutation reverses the first permutation of the interleaver:

$$k = N_{COL} \times i - \left(N_{CBPSS}(i_{SS}) - 1\right) \times \operatorname{floor}\left(i / N_{ROW}\right) \qquad i = 0, 1, \ldots, N_{CBPSS}(i_{SS}) - 1 \tag{20-52}$$

Insert the following new subclause:

20.3.10.8 QAM mapping

The mapping between bits at the output of the interleaver and complex constellation points for BPSK, QPSK, 16-QAM and 64-QAM follows exactly the rules defined in 17.3.5.7.

The streams of complex numbers are denoted:

$$d_{k,l,n},\ k = 0,1,\ldots,N_{\mathrm{SD}} - 1,\ l = 1,\ldots,N_{\mathrm{SS}},\ n = 0,1,\ldots,N_{\mathrm{SYM}} - 1 \qquad (20\text{-}53)$$

Insert the following new subclause:

20.3.10.8.1 Space-Time Block Coding (STBC)

This subclause defines a set of optional robust transmission rates that are applicable only when N_{STS} is greater than N_{SS} spatial streams are mapped to N_{STS} space time streams, which are mapped to N_{TX} transmit chains. These rates are based either on Space-Time Block Coding (STBC) or hybrid STBC /SM schemes. When the use of STBC is indicated in the STBC field of the HT-SIG, a symbol operation shall occur between the constellation mapper and the spatial mapper (see Figure n64 (Transmitter block diagram for the greenfield format packet and HT portion of the mixed format packet except HT signal field)) as defined in this Clause.

Denote the complex modulator symbol transmitted on data subcarrier *k* of OFDM symbols 2*m* and 2*m*+1 in spatial stream *i* as $d_{k,\,i,\,2m}$ and $d_{k,\,i,\,2m+1}$, respectively, where *m* = 0, 1, ...

Table n70 (Constellation mapper output to spatial mapper input for STBC) indicates, for each combination of N_{STS} and N_{SS}, which modulator symbol shall be transmitted during OFDM symbol period (2*m*) and (2*m*+1) from space time stream $i_{STS} = 1,\ldots,N_{STS}$.

In the following description, the complex-valued modulation symbol at the output of the STBC encoder, as given in Table n70 (Constellation mapper output to spatial mapper input for STBC), in data subcarrier *k* of OFDM symbol *m* of space time stream *i* is denoted $\tilde{d}_{k,\,i,\,m}$. If space time block coding is not applied, then $\tilde{d}_{k,\,i,\,m} = d_{k,\,i,\,m}$ and $N_{SS} = N_{STS}$.

NOTE—The specific STBC schemes for single spatial streams ($N_{SS} = 1$) with $N_{TX} \geq 3$ are not detailed in this subclause since they can be covered through the use of spatial expansion as detailed in 20.3.10.10.1 (Spatial mapping).

Insert the following new subclause:

20.3.10.9 Pilot subcarriers

In the case of 20 MHz, 4 pilot tones are inserted in the same sub-carriers used in Clause 17, i.e., in sub-carriers -21, -7, 7 and 21. The pilot sequence for the n^{th} symbols and $i_{STS}{}^{th}$ space time stream is defined as follows:

$$\begin{aligned} P_{(i_{STS},n)}^{-28,28} = \{&0,0,0,0,0,0,0,\Psi_{i_{STS},n\oplus 4}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi_{i_{STS},(n+1)\oplus 4}^{(N_{STS})},0,0,0,0,0,0,0,\\ &0,0,0,0,0,0,\Psi_{i_{STS},(n+2)\oplus 4}^{(N_{STS})},0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi_{i_{STS},(n+3)\oplus 4}^{(N_{STS})},0,0,0,0,0,0,0\} \end{aligned} \qquad (20\text{-}54)$$

In the case of 40 MHz transmission (excluding MCS 32, see 20.3.10.10.4 (Transmission in HT duplicate format)), pilot signals are inserted in sub-carriers -53, -25, -11, 11, 25, 53. The pilot sequence for the n^{th} symbols and $i_{STS}{}^{\mathrm{th}}$ space time stream is defined as follows

Table n70—Constellation mapper output to spatial mapper input for STBC

N_{STS}	HT-SIG MCS field (bits 0-6 in HT-SIG1)	N_{SS}	HT-SIG STBC field (bits 4–5 in HT-SIG2)	i_{STS}	Space time stream in OFDM symbol (2*m*)	Space time stream in OFDM symbol (2*m*+1)
2	0-7	1	1	1	$d_{k,1,2m}$	$d_{k,1,2m+1}$
				2	$-d^{*}_{k,1,2m+1}$	$d^{*}_{k,1,2m}$
3	8-15, 33-38	2	1	1	$d_{k,1,2m}$	$d_{k,1,2m+1}$
				2	$-d^{*}_{k,1,2m+1}$	$d^{*}_{k,1,2m}$
				3	$d_{k,2,2m}$	$d_{k,2,2m+1}$
4	8-15	2	2	1	$d_{k,1,2m}$	$d_{k,1,2m+1}$
				2	$-d^{*}_{k,1,2m+1}$	$d^{*}_{k,1,2m}$
				3	$d_{k,2,2m}$	$d_{k,2,2m+1}$
				4	$-d^{*}_{k,2,2m+1}$	$d^{*}_{k,2,2m}$
4	16-23, 39, 41, 43, 46, 48, 50	3	1	1	$d_{k,1,2m}$	$d_{k,1,2m+1}$
				2	$-d^{*}_{k,1,2m+1}$	$d^{*}_{k,1,2m}$
				3	$d_{k,2,2m}$	$d_{k,2,2m+1}$
				4	$d_{k,3,2m}$	$d_{k,3,2m+1}$

$$\begin{aligned}
P^{-58..58}_{(i_{STS},n)} = \{&0,0,0,0,0,\Psi^{(N_{STS})}_{i_{STS},n\oplus 6},0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,\\
&0,0,\Psi^{(N_{STS})}_{i_{STS},(n+1)\oplus 6},0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi^{(N_{STS})}_{i_{STS},(n+2)\oplus 6},0,0,0,0,0,0,0,0,0,\\
&0,0,0,0,0,0,0,0,0,0,0,0,\Psi^{(N_{STS})}_{i_{STS},(n+3)\oplus 6},0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi^{(N_{STS})}_{i_{STS},(n+4)\oplus 6},\\
&0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,\Psi^{(N_{STS})}_{i_{STS},(n+5)\oplus 6},0,0,0,0,0\}
\end{aligned} \qquad (20\text{-}55)$$

where $n \oplus a$ indicates symbol number modulo integer a and the patterns $\Psi^{(N_{STS})}_{i_{STS},n}$ are defined in Table n71 (pilot values for 20 MHz transmission) and Table n72 (Pilots values for 40 MHz transmission (excluding MCS 32)).

NOTE—For each space time stream there is a different pilot pattern and the pilot patterns are cyclically rotated over symbols.

The basic patterns are also different according to the total number of space time streams for the packet.

The patterns $\Psi_{i_{STS},n}^{(N_{STS})}$ are defined in Table n71 (pilot values for 20 MHz transmission) and Table n72 (Pilots values for 40 MHz transmission (excluding MCS 32)). The first table (Table n71 (pilot values for 20 MHz transmission)) defines the values for 20 MHz transmission and the second table (Table n72 (Pilots values for 40 MHz transmission (excluding MCS 32))) defines the values for 40 MHz transmission.

Table n71—pilot values for 20 MHz transmission

N_{STS}	i_{STS}	$\Psi_{i_{STS},0}^{(N_{STS})}$	$\Psi_{i_{STS},1}^{(N_{STS})}$	$\Psi_{i_{STS},2}^{(N_{STS})}$	$\Psi_{i_{STS},3}^{(N_{STS})}$
1	1	1	1	1	-1
2	1	1	1	-1	-1
2	2	1	-1	-1	1
3	1	1	1	-1	-1
3	2	1	-1	1	-1
3	3	-1	1	1	-1
4	1	1	1	1	-1
4	2	1	1	-1	1
4	3	1	-1	1	1
4	4	-1	1	1	1

Table n72—Pilots values for 40 MHz transmission (excluding MCS 32)

N_{STS}	i_{STS}	$\Psi_{i_{STS},0}^{(N_{STS})}$	$\Psi_{i_{STS},1}^{(N_{STS})}$	$\Psi_{i_{STS},2}^{(N_{STS})}$	$\Psi_{i_{STS},3}^{(N_{STS})}$	$\Psi_{i_{STS},4}^{(N_{STS})}$	$\Psi_{i_{STS},5}^{(N_{STS})}$
1	1	1	1	1	-1	-1	1
2	1	1	1	-1	-1	-1	-1
2	2	1	1	1	-1	1	1
3	1	1	1	-1	-1	-1	-1
3	2	1	1	1	-1	1	1
3	3	1	-1	1	-1	-1	1
4	1	1	1	-1	-1	-1	-1
4	2	1	1	1	-1	1	1
4	3	1	-1	1	-1	-1	1
4	4	-1	1	1	1	-1	1

Insert the following new subclause:

20.3.10.10 OFDM modulation

The time domain signal is composed from the stream of complex numbers

$$\tilde{d}_{k,l,n},\ k = 0,1,\ldots,N_{\mathrm{SD}}-1,\ l = 1,\ldots,N_{\mathrm{STS}},\ n = 0,1,\ldots,N_{\mathrm{SYM}}-1 \quad (20\text{-}56)$$

and from the pilot signals. In the case of 40 MHz transmission, the upper sub-carriers are rotated 90° relative to the lower sub-carriers.

Insert the following new subclause:

20.3.10.10.1 Spatial mapping

The transmitter may choose to rotate and/or scale the constellation mapper output vector (or the space time block coder output, if applicable). This is useful in the following cases:

- there are more transmit chains than space time streams, $N_{STS} < N_{TX}$,
- as part of (an optional) sounding packet,
- as part of (an optional) calibration procedure,
- when the packet is in (an optional) beamforming mode.

If the data to be transmitted on sub-carrier k on space time stream i_{STS} is $X_k^{(i_{STS})}$, then the transmitted data on the transmit chain i_{TX} shall be:

$$r_{Field}^{(i_{TX})}(t) = \frac{1}{\sqrt{N_{STS}\cdot N_{Field}^{Tone}}} w_{\mathrm{T}_{Field}}(t) \sum_{k} \sum_{i_{STS}=1}^{N_{STS}} \left[Q_k\right]_{i_{TX},i_{STS}} X_k^{(i_{STS})} \exp\left(j2\pi k\Delta_F \left(t-T_{CS}^{i_{STS}}\right)\right) \quad (20\text{-}57)$$

where

$\left[Q_k\right]_{i_{TX},i_{STS}}$ is the element in the i_{TX}'th row and i_{STS}'th column in a matrix Q_k with N_{TX} rows and N_{STS} columns. Q_k may be frequency dependent.

Below are some examples of spatial mapping matrices that can be used. There exist many other alternatives, implementation is not restricted to the spatial mapping matrices shown.

a) *Direct Mapping*: in this case Q_k is a diagonal matrix of unit magnitude complex values that can take two forms:
   1) $Q_k = \mathbf{I}$, the identity matrix
   2) A CSD matrix in which the diagonal elements represent cyclic shifts in the time domain: $\left[Q_k\right]_{i,i} = \exp(-j2\pi k\Delta_F \tau_{CS}^{i})$, where tau τ_{CS}^{i} represents the CSD applied.

b) *Spatial Expansion:* in this case Q_k is the product of a CSD matrix and a square matrix formed of orthogonal columns. As an illustration:
   1) Q_k may be the product of a CSD matrix and a square unitary matrix such as the Hadamard matrix or the Fourier matrix.

2) the spatial expansion may be performed by duplicating some of the N_{STS} streams to form the N_{TX} streams, with each stream being scaled by the normalization factor $\sqrt{\frac{N_{STS}}{N_{TX}}}$. The spatial expansion may be performed by using for instance one of the following matrices, denoted D, left multiplied by a CSD matrix, denoted $M_{CSD}(k)$, and/or possibly multiplied by any square unitary matrix. The resulting spatial mapping matrix is then $Q_k = M_{CSD}(k) \cdot D$, where D may take on one of the following values:

i) N_{TX}=2, N_{STS}=1, $D = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \end{bmatrix}^T$

ii) N_{TX}=3, N_{STS}=1, $D = \frac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1 & 1 \end{bmatrix}^T$

iii) N_{TX}=4, N_{STS}=1, $D = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \end{bmatrix}^T$

iv) N_{TX}=3, N_{STS}=2, $D = \sqrt{\frac{2}{3}}\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 0 \end{bmatrix}$

v) N_{TX}=4, N_{STS}=2, $D = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$

vi) N_{TX}=4, N_{STS}=3, $D = \frac{\sqrt{3}}{2}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$

3) Different Spatial Expansion over sub-carriers—this should be used in HT mixed format only and with the smoothing bit set to 0:

i) N_{TX}=2, N_{STS}=1, $\left[Q_k\right]_{N_{STS}} = \begin{bmatrix} 1 & 0 \end{bmatrix}^T \; or \; \left[Q_k\right]_{N_{STS}} = \begin{bmatrix} 0 & 1 \end{bmatrix}^T$

ii) N_{TX}=3, N_{STS}=2, $\left[Q_k\right]_{N_{STS}} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} or \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$

$$\text{iii) } N_{TX}\text{=4, } N_{STS}\text{=2, } \left[Q_k\right]_{N_{STS}} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} or \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$$

$$\text{iv) } N_{TX}\text{=4, } N_{STS}\text{=3, } \left[Q_k\right]_{N_{STS}} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} or \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

c) *Beamforming Steering Matrix:* In this case, Q_k is any matrix that improves the reception in the receiver based on some knowledge of the channel between the transmitter and the receiver. With transmit beamforming with explicit feedback, the steering matrix Q_k is determined using either H_{eff} for CSI feedback or V_k for Non-Compressed and Compressed Matrices feedback from the STA to which the beamformed packet is addressed.

In the case where there are fewer space time streams than transmit chains, the first N_{STS} columns of the matrices above that are square can be used.

The same matrix Q_k shall be applied to subcarrier k during all parts of the packet in greenfield format and all parts of the packet following and including the HT-STF field in an HT mixed format packet. This operation is transparent to the receiver.

If 95 percent of the sum of the energy from all impulse responses of the time domain channels between all space time streams and all transmit chain inputs, induced by the CSD added according to Table n62 (Cyclic shift values of HT portion of the packet) and the frequency-dependence in the matrix Q_k, is contained within 800 ns, the smoothing bit should be set to 1, otherwise it shall be set to 0.

The CSD of Table n62 (Cyclic shift values of HT portion of the packet) shall be applied at the input of the spatial mapper.

If no spatial mapping is applied, the matrix Q_k is equal to the identity matrix and $N_{STS} = N_{TX}$.

Sounding PPDUs using spatial expansion shall use unitary Q_k.

Insert the following new subclause:

20.3.10.10.2 Transmission in 20 MHz HT format

The signal from transmit chain i_{TX}, $1 \le i_{TX} \le N_{TX}$ is:

$$r^{i_{TX}}_{HT-DATA}(t) = \frac{1}{\sqrt{N_{STS} \cdot N^{Tone}_{HT-DATA}}} \sum_{n=0}^{N_{SYM}-1} w_{\mathrm{T}_{SYM}}(t - nT_{SYM}) \tag{20-58}$$

$$\cdot \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX}, i_{STS}} (\tilde{D}_{k,n} + p_{n+z} P^{k}_{(i_{STS}, n)}) \exp(j2\pi k\Delta_F(t - nT_{SYM} - T_{GI} - T^{i_{STS}}_{CS}))$$

where:

z is 3 in an HT mixed format packet and 2 in a greenfield format packet,

p_n is defined in 17.3.5.9,

$$\tilde{D}_{k,n} = \begin{cases} 0, k = 0, \pm 7, \pm 21 \\ \tilde{d}_{M^r(k), n}, \text{otherwise} \end{cases}$$

$$M^r(k) = \begin{cases} k + 28, -28 \le k \le -22 \\ k + 27, -20 \le k \le -8 \\ k + 26, -6 \le k \le -1 \\ k + 25, 1 \le k \le 6 \\ k + 24, 8 \le k \le 20 \\ k + 23, 22 \le k \le 28 \end{cases}$$

$P^{k}_{(i_{STS}, n)}$ is defined in Equation (20-54).

Insert the following new subclause:

20.3.10.10.3 Transmission in 40 MHz HT Format

In the case of 40 MHz, the signal from transmit chain i_{TX} is:

$$r^{i_{TX}}_{HT-DATA}(t) = \frac{1}{\sqrt{N_{STS} \cdot N^{Tone}_{HT-DATA}}} \sum_{n=0}^{N_{SYM}-1} w_{\mathrm{T}_{SYM}}(t - nT_{SYM}) \tag{20-59}$$

$$\cdot \sum_{k=-N_{SR}}^{N_{SR}} \sum_{i_{STS}=1}^{N_{STS}} [Q_k]_{i_{TX}, i_{STS}} (\tilde{D}_k + p_{n+z} P^{k}_{(i_{STS}, n)}) \Upsilon_k \exp(j2\pi k\Delta_F(t - nT_{SYM} - T_{GI} - T^{i_{STS}}_{CS}))$$

where

z is 3 in an HT mixed format packet and 2 in a greenfield format packet,

p_n is defined in 17.3.5.9, $\tilde{D}_k = \begin{cases} 0, k = 0, \pm1, \pm11, \pm25, \pm53 \\ \tilde{d}_{M^r(k)}, \text{ otherwise} \end{cases}$

$$M^r(k) = \begin{cases} k + 58, -58 \le k \le -54 \\ k + 57, -52 \le k \le -26 \\ k + 56, -24 \le k \le -12 \\ k + 55, -10 \le k \le -2 \\ k + 52, 2 \le k \le 10 \\ k + 51, 12 \le k \le 24 \\ k + 50, 26 \le k \le 52 \\ k + 49, 54 \le k \le 58 \end{cases}$$

$P^k_{(i_{STS}, n)}$ is defined in Equation (20-55).

NOTE—the 90º rotation that is applied to the upper part of the 40 MHz channel is applied in the same way to the HT-STF, HT-LTF, and HT-SIG. The rotation applies to both pilots and the data in the upper part of the 40 MHz channel.

Insert the following new subclause:

20.3.10.10.4 Transmission in HT duplicate format

HT duplicate format provides the lowest transmission rate in 40 MHz. It shall only be used for one spatial stream and only with BPSK modulation and rate-½ coding.

In the HT duplicate format, the following equation defines the signal:

$$r^{i_{TX}}_{HT-DATA}(t) = \frac{1}{\sqrt{N^{Tone}_{Duplicate}}} \sum_{n=0}^{N_{SYM}-1} w_{T_{SYM}}(t - nT_{SYM})$$

$$\cdot \sum_{k=-N_{SR}}^{N_{SR}} (D_{k,n} + p_{n+z}P_k)([Q_{k-32}]_{i_{TX},1} \exp(j2\pi(k-32)\Delta_F(t - nT_{SYM} - T_{GI}))$$

$$+ j[Q_{k+32}]_{i_{TX},1} \exp(j2\pi(k+32)\Delta_F(t - nT_{SYM} - T_{GI})))$$

(20-60)

where:

z is defined in 20.3.10.10.2 (Transmission in 20 MHz HT format),

P_k and p_n are defined in 17.3.5.9,

$D_{k,n}$ is defined in 20.3.9.4.3 (The HT SIGNAL field)

N_{SR} has the value defined for non-HT 20 MHz transmission, and

$[Q_k]_{i_{TX},\,1}$ is an element from a vector of length N_{TX}, which may be frequency dependent.

The rules of spatial expansion CSD limitation, as specified in 20.3.10.10.1 (Spatial mapping), shall apply to $[Q_k]_{i_{TX},\,1}$.

Insert the following new subclause:

20.3.10.10.5 Transmission with a short guard interval

Short guard interval is used in the data field of the packet when the Short GI field in the HT-SIG is set to 1. When it is used, the same formula for the formation of the signal is used as in 20.3.10.10.2 (Transmission in 20 MHz HT format), 20.3.10.10.3 (Transmission in 40 MHz HT Format), and 20.3.10.10.4 (Transmission in HT duplicate format), with T_{GI} replaced by T_{GIS} and T_{SYM} replaced by T_{SYMS}. Short GI shall not be used in greenfield format when the MCS indicates a single spatial stream. Note that in greenfield format with one spatial stream, the HT-SIG is immediately followed by data. It is very difficult to parse the HT-SIG in time to demodulate this data with the correct GI length if the GI length is not known in advance.

Insert the following new subclause:

20.3.10.11 Non-HT duplicate transmission

Non-HT duplicate transmission is used to transmit to Clause 17 STAs that may be present in either the upper or lower halves of the 40 MHz channel. The L-STF, L-LTF, and L-SIG are transmitted in the same way as in the HT 40 MHz transmission. The HT-SIG, HT-STF, and HT-LTF are not transmitted. Data transmission is defined in Equation (20-61).

$$\begin{aligned} r_{LEG-DUP}^{i_{TX}}(t-nT_{SYM}) &= \frac{1}{\sqrt{N_{Duplicate}^{Tone}}}\sum_{n=0}^{N_{SYM}-1} w_{\mathrm{T}_{SYM}}(t-nT_{SYM}) \\ &\cdot \sum_{k=-26}^{26}(jD_{k,n}+p_nP_k)(\exp(j2\pi(k-32)\Delta_F(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}})) \\ &+j\exp(j2\pi(k+32)\Delta_F(t-nT_{SYM}-T_{GI}-T_{CS}^{i_{TX}}))) \end{aligned} \quad (20\text{-}61)$$

where:

P_k, and p_n and are defined in 17.3.5.9

$D_{k,n}$ is defined in 20.3.9.4.3 (The HT SIGNAL field)

$T_{CS}^{i_{TX}}$ represents the cyclic shift of the transmit chain i_{TX} and is defined in Table n61 (Cyclic shift for non-HT portion of the packet).

Insert the following new subclause:

20.3.11 Beamforming

Beamforming is a technique in which the transmitter utilizes the knowledge of the MIMO channel to generate a steering matrix Q_k that improves reception in the receiver.

The equivalent complex baseband MIMO channel model is one in which when a vector $\mathbf{x}_k = \left[x_1, x_2, \ldots, x_{N_{TX}}\right]^T$ is transmitted in subcarrier k the received vector $\mathbf{y}_k = \left[y_1, y_2, \ldots, y_{N_{RX}}\right]^T$ is modeled as:

$$\mathbf{y}_k = H_k \mathbf{x}_k + \mathbf{n} \tag{20-62}$$

where

H_k is channel matrix of dimensions $N_{RX} \times N_{TX}$

$\mathbf{n}$ is white (spatially and temporally) Gaussian noise. This is illustrated in Figure n75 (The beamforming MIMO channel model).

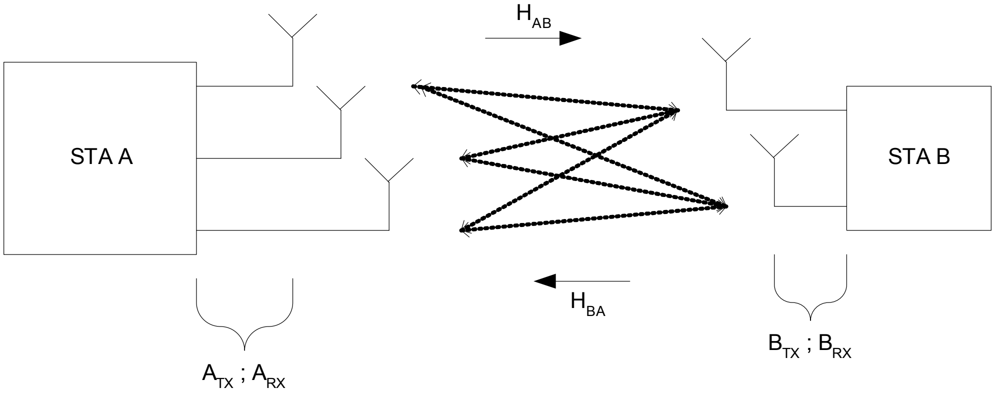


Figure n75—The beamforming MIMO channel model

When beamforming is used, the transmitter replaces $\mathbf{x}_k$, which in this case has $N_{STS} \le N_{TX}$ elements, with $Q_k \mathbf{x}_k$, where Q_k has N_{TX} rows and N_{STS} columns, so that the received vector is

$$\mathbf{y}_k = H_k Q_k \mathbf{x}_k + \mathbf{n} \tag{20-63}$$

The beamforming steering matrix that is computed (or updated) from a new channel measurement replaces the existing Q_k for the next beamformed data transmission. There are several methods of beamforming, differing in the way the transmitter acquires the knowledge of the channel matrices H_k and on whether the transmitter or the receiver generates Q_k.

Insert the following new subclause:

20.3.11.1 Implicit feedback beamforming

Implicit beamforming is a technique that relies on reciprocity in the time division duplex channel to estimate the channel that a device is transmitting over based on MIMO reference received from the device to which it plans to transmit. This allows the transmitting device to calculate a set of transmit steering matrices, Q_k, one for each subcarrier, which are intended to optimize the performance of the link.

Referring to Figure n75 (The beamforming MIMO channel model) beamforming transmissions from a STA A to a STA B using implicit techniques are enabled when STA B sends STA A a sounding PPDU, allowing STA A to form an estimate of the MIMO channel from STA B to STA A, for all subcarriers. For a TDD channel in which the forward and reverse channels are reciprocal, the channel from STA A to STA B in subcarrier k is the matrix transpose of the channel from STA B to STA A in subcarrier k, to within a complex scaling factor, i.e., $H_{\mathrm{AB},\,k} = \rho H_{\mathrm{BA},\,k}$. Here $H_{\mathrm{AB},\,k}$ is the MIMO channel matrix from STA A to STA B at subcarrier k, and $H_{\mathrm{BA},\,k}$ is the channel matrix from STA B to STA A at subcarrier k. STA A uses this relationship to compute transmit steering matrices that are suitable for transmitting to STA B over $H_{\mathrm{AB},\,k}$.

When the over-the-air channel between the antenna(s) at one STA and the antenna(s) at a second STA is reciprocal, the observed baseband-to-baseband channel used for communication may not be, as it includes the transmit and receive chains of the STAs. Differences in the amplitude and phase characteristics of the transmit and receive chains associated with individual antennas degrade the reciprocity of the over-the-air channel, and cause degradation of performance of implicit beamforming techniques. The over-the-air calibration procedure described in subclause 9.17.2.4 (Calibration) may be used to restore reciprocity. The procedure provides the means for calculating a set of correction matrices that can be applied at the transmit side of a STA to correct the amplitude and phase differences between the transmit and receive chains in the STA. If this is done in both the STAs that are communicating with each other, reciprocity is restored in the baseband-to-baseband response of the forward and reverse channels.

Figure n76 (The baseband-to-baseband channel) illustrates the observed baseband-to-baseband channel, including reciprocity correction. The amplitude and phase responses of the transmit and receive chains can be expressed as diagonal matrices with complex valued diagonal entries, of the form $A_{\mathrm{TX(RX)},\,k}$. The relationship between the baseband-to-baseband channel, $\tilde{H}_{\mathrm{AB},\,k}$, and the over-the-air channel, $H_{\mathrm{AB},\,k}$, is

$$\tilde{H}_{\mathrm{AB},\,k} = B_{\mathrm{RX},\,k} H_{\mathrm{AB},\,k} A_{\mathrm{TX},\,k} \tag{20-64}$$

and, similarly, the relationship between $\tilde{H}_{\mathrm{BA},\,k}$ and $H_{\mathrm{BA},\,k}$ is

$$\tilde{H}_{\mathrm{BA},\,k} = A_{\mathrm{RX},\,k} H_{\mathrm{BA},\,k} B_{\mathrm{TX},\,k} \tag{20-65}$$

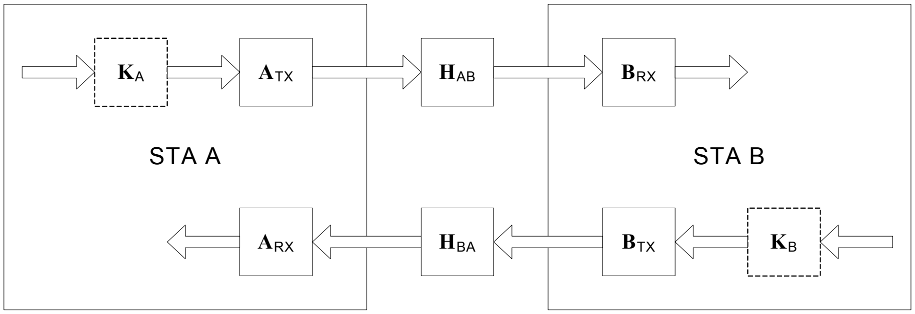


Figure n76—The baseband-to-baseband channel

As an example, consider the case where calibration is performed at both STA A and STA B. The objective is to compute correction matrices, $K_{\mathrm{A},\,k}$ and $K_{\mathrm{B},\,k}$, that restore reciprocity such that

$$\tilde{H}_{\mathrm{AB},\,k}K_{\mathrm{A},\,k} = \rho[\tilde{H}_{\mathrm{BA},\,k}K_{\mathrm{B},\,k}]^{\mathrm{T}} \tag{20-66}$$

The correction matrices are diagonal matrices with complex valued diagonal entries. The reciprocity condition above is enforced when

$$K_{\mathrm{A},\,k} = \alpha_{\mathrm{A},\,k}[A_{\mathrm{TX},\,k}]^{-1}A_{\mathrm{RX},\,k} \tag{20-67}$$

and

$$K_{\mathrm{B},\,k} = \alpha_{\mathrm{B},\,k}[B_{\mathrm{TX},\,k}]^{-1}B_{\mathrm{RX},\,k} \tag{20-68}$$

where $\alpha_{\mathrm{A},\,k}$ and $\alpha_{\mathrm{B},\,k}$ are complex valued scaling factors.

Using these expressions for the correction matrices, the calibrated baseband-to-baseband channel between STA A and STA B is expressed as

$$\hat{H}_{\mathrm{AB},\,k} = \tilde{H}_{\mathrm{AB},\,k}K_{\mathrm{A},\,k} = \alpha_{\mathrm{A},\,k}B_{\mathrm{RX},\,k}H_{\mathrm{AB},\,k}A_{\mathrm{RX},\,k} \tag{20-69}$$

and if both sides apply the correction matrices, then we have that

$$\hat{H}_{\mathrm{BA},\,k} = \alpha_{\mathrm{B},\,k}A_{\mathrm{RX},\,k}H_{\mathrm{BA},\,k}B_{\mathrm{RX},\,k} = \frac{\alpha_{\mathrm{B},\,k}}{\alpha_{\mathrm{A},\,k}}[\hat{H}_{\mathrm{AB},\,k}]^{\mathrm{T}} \tag{20-70}$$

Focusing on STA A, the procedure for estimating $K_{\mathrm{A},\,k}$ is as follows:

a)STA A sends STA B a sounding PPDU, allowing STA B to estimate the channel matrices $\tilde{H}_{\mathrm{AB},\,k}$.

b)STA B sends STA A a sounding PPDU, allowing STA A to estimate the channel matrices $\tilde{H}_{\mathrm{BA},\,k}$.

c)STA B sends the quantized estimates of $\tilde{H}_{\mathrm{AB},\,k}$ to STA A.

d)STA A uses its local estimates of $\tilde{H}_{\mathrm{BA},\,k}$ and the quantized estimates $\tilde{H}_{\mathrm{AB},\,k}$ received from STA B to compute the correction matrices $K_{\mathrm{A},\,k}$.

Steps a) and b) occur over a short time interval to ensure that the channel changes as little as possible between measurements. A similar procedure is used to estimate $K_{\mathrm{B},\,k}$ at STA B. The details of the computation of the correction matrices is implementation specific, and beyond the scope of this document.

Insert the following new subclause:

20.3.11.2 Explicit feedback beamforming

In explicit beamforming, in order for STA A to transmit a beamformed packet to STA B, STA B measures the channel matrices and sends STA A, either the effective channel, $H_{\mathrm{eff},k}$, or the beamforming feedback matrix, V_k for STA A to determine a steering matrix, $Q_{\mathrm{steer},k} = Q_k V_k$, with V_k found from $H_k Q_k$, where Q_k is the orthonormal spatial mapping matrix which was used to transmit the sounding packet that elicited the V_k feedback. When new steering matrix $Q_{\mathrm{steer},\,k}$ is found, $Q_{\mathrm{steer},\,k}$ may replace Q_k for the next beamformed data transmission.

Note - $Q_{\mathrm{steer},\,k}$ is a mathematical term to update a new steering matrix for Q_k in the next beamformed data transmission.

Insert the following new subclause:

20.3.11.2.1 CSI Matrices feedback

In CSI Matrices feedback the transmitting STA receives the quantized MIMO channel matrix, H_{eff}, from the receiving STA. The transmitting STA then may use this matrix to compute a set of transmit steering matrices, Q_k. The CSI matrix, H_{eff}, shall be determined from the transmitter spatial mapper input to the receiver FFT outputs (the beamformee removes the CSD in table n67 from the measured channel matrix).

The matrices $H_{eff}(k)$, where k is the subcarrier index, are encoded so that applying the procedure below will optimally reconstruct the matrix.

The received, quantized, matrix $H^{q}_{eff}(k)$ (of a specific subcarrier, k) shall be decoded as follows:

d) The real and imaginary parts of each element of the matrix $H^{q(R)}_{eff(m,\,l)}(k)$ and $H^{q(I)}_{eff(m,\,l)}(k)$ shall be decoded as a pair of two's complement numbers to create the complex element. Each element in the matrix of subcarrier k is then scaled using the value in the carrier matrix amplitude field (3 bits), $M_H(k)$, interpreted as a positive integer in dB, as follows:

1) Calculate the linear value as defined in Equation (20-71), and
2) Calculate decoded values of the real and imaginary parts of the matrix element as defined in Equation (20-72) and Equation (20-73).

$$r(k) = 10^{M_H(k)/20}. \tag{20-71}$$

$$\mathrm{Re}\{\tilde{H}_{eff(m,\,l)}(k)\} = \frac{H^{q(R)}_{eff(m,\,l)}(k)}{r(k)} \tag{20-72}$$

$$\mathrm{Im}\{\tilde{H}_{eff(m,\,l)}(k)\} = \frac{H^{q(I)}_{eff(m,\,l)}(k)}{r(k)} \tag{20-73}$$

The following is an example of an encoding process:

a) The maximum of the real part and the imaginary part of each element of the matrix in each subcarrier are found, as defined by Equation (20-74).

$$m_H(k) = \max\left\{\max\left\{\left|\mathrm{Re}(H_{eff(m,\,l)}(k))\right|_{m\,=\,1,\,l\,=\,1}^{m\,=\,N_r,\,l\,=\,N_c}\right\}, \max\left\{\left|\mathrm{Im}(H_{eff(m,\,l)}(k))\right|_{m\,=\,1,\,l\,=\,1}^{m\,=\,N_r,\,l\,=\,N_c}\right\}\right\} \tag{20-74}$$

b) The scaling ratio is calculated and quantized to 3 bits as defined by Equation (20-75) and its linear counterpart is given by Equation (20-76).

$$M_H(k) = \min\left\{7, \left\lfloor 20\log_{10}\left(\frac{\max\{m_H(k)\}_{k\,=\,-N_{SR}}^{k\,=\,N_{SR}}}{m_H(k)}\right)\right\rfloor\right\}, \tag{20-75}$$

where

$\lfloor x \rfloor$ is the largest integer smaller than or equal to x.

$$:M_H^{\mathrm{lin}}(k) = \frac{\max\{m_H(k)\}_{k\,=\,-N_{SR}}^{k\,=\,N_{SR}}}{10^{M_H(k)/20}} \tag{20-76}$$

c) The real and imaginary parts of each element in the matrix $H_{eff(m,\,l)}(k)$ are quantized to N_b bits in two's complement encoding as defined by Equation (20-77) and Equation (20-78).

$$H^{q(R)}_{eff(m,\,l)}(k) = \mathrm{round}\left(\frac{\mathrm{Re}\{H_{eff(m,\,l)}(k)\}}{M_H^{\mathrm{lin}}(k)}(2^{N_b-1}-1)\right) \tag{20-77}$$

$$H^{q(I)}_{eff(m,\,l)}(k) = \mathrm{round}\left(\frac{\mathrm{Im}\{H_{eff(m,\,l)}(k)\}}{M_H^{\mathrm{lin}}(k)}(2^{N_b-1}-1)\right) \tag{20-78}$$

Each matrix is encoded using $3 + 2 \times N_b \times N_r \times N_c$ bits, where N_r and N_c are the number of rows and columns, respectively, in the channel matrix estimate computed by the receiving station, and N_b may have the value of 4, 5, 6, 8 bits.

Insert the following new subclause:

20.3.11.2.2 Non-compressed beamforming matrix feedback

In non compressed beamforming matrix feedback, the receiving STA removes the space-time stream CSD in 62 (Cyclic shift values of HT portion of the packet) from the measured channel before computing a set of matrices for feedback to the transmitter. These matrices are sent to the transmitter. The transmitter can use these matrices to determine the steering matrices Q_k.

The beamformee shall encode the matrices $V(k)$ so a beamformer applying the procedure below will optimally reconstruct the matrix.

The received matrix $V^q(k)$ (of a specific subcarrier k) shall be decoded as follows:

d) The real and imaginary parts of each element of the matrix, $V^{q,R}_{m,l}$ and $V^{q,I}_{m,l}$, shall be decoded as a pair of two's complement numbers to create the complex element.

The dimensions of the beamforming matrices is $N_r \times N_c$, where N_r and N_c are the number of rows and columns, respectively, in the beamforming matrix computed by the receiving station. Each matrix is encoded using $2 \times N_b \times N_r \times N_c$ bits. N_b may have the value of 4, 5, 6, 8 bits.

Columns $1 \dots Nc$ of the beamforming feedback matrix correspond to spatial streams $1 \dots Nc$, respectively. Spatial stream to modulation mapping is defined in the MCS Tables in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)). A transmitter shall not re-order the columns of the beamforming feedback matrices.

Insert the following new subclause:

20.3.11.2.3 Compressed beamforming matrix feedback

In compressed beamforming matrix feedback, the receiving STA removes the space-time stream CSD in Table n62 (Cyclic shift values of HT portion of the packet) from the measured channel before computing a set of matrices for feedback to the transmitter. These matrices are compressed in the form of angles, which are sent to the transmitter. The transmitter can use these angles to de-compress the matrices and determine the steering matrices Q_k.

The matrix compression is defined as follows. The unitary beamforming $N_r \times N_c$ matrix V found by the beamformee shall be represented as:

$$V = \left[\prod_{i=1}^{\min(N_c, N_r-1)} \left[D_i \begin{pmatrix} 1_{i-1} & e^{j\phi_{i,i}} & \dots & e^{j\phi_{N_r-1,i}} & 1 \end{pmatrix} \prod_{l=i+1}^{N_r} G_{li}^T \left(\psi_{li} \right) \right] \right] \tilde{I}_{N_r \times N_c} \tag{20-79}$$

The matrix $D_i \begin{pmatrix} 1_{i-1} & e^{j\phi_{i,i}} & \dots & e^{j\phi_{N_r-1,i}} & 1 \end{pmatrix}$ is an $N_r \times N_r$ diagonal matrix, where 1_{i-1} represents a sequence of ones with length of *i*-1, as follows:

$$D_i\left(1_{i-1} \quad e^{j\phi_{i,i}} \quad \ldots \quad e^{j\phi_{N_r-1,i}} \quad 1\right) = \begin{bmatrix} I_{i-1} & 0 & \cdots & \cdots & 0 \\ 0 & e^{j\phi_{i,i}} & 0 & \cdots & 0 \\ \vdots & 0 & \ddots & 0 & 0 \\ \vdots & \vdots & 0 & e^{j\phi_{N_r-1,i}} & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \tag{20-80}$$

The matrix $G_{li}(\psi)$ is an $N_r \times N_r$ Givens rotation matrix:

$$G_{li}(\psi) = \begin{bmatrix} I_{i-1} & 0 & 0 & 0 & 0 \\ 0 & \cos(\psi) & 0 & \sin(\psi) & 0 \\ 0 & 0 & I_{l-i-1} & 0 & 0 \\ 0 & -\sin(\psi) & 0 & \cos(\psi) & 0 \\ 0 & 0 & 0 & 0 & I_{N_r-l} \end{bmatrix} \tag{20-81}$$

where each I_m is an $m \times m$ identity matrix, and $\cos(\psi)$ and $\sin(\psi)$ are located at l^{th} and i^{th} row and column. $\tilde{I}_{N_r \times N_c}$ is an identity matrix padded with zeros to fill the additional rows or columns when $N_r \neq N_c$.

For example, a 4x2 V matrix has the following representation:

$$V = \begin{bmatrix} e^{j\phi_{11}} & 0 & 0 & 0 \\ 0 & e^{j\phi_{21}} & 0 & 0 \\ 0 & 0 & e^{j\phi_{31}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} \cos\psi_{21} & \sin\psi_{21} & 0 & 0 \\ -\sin\psi_{21} & \cos\psi_{21} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^T \begin{bmatrix} \cos\psi_{31} & 0 & \sin\psi_{31} & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\psi_{31} & 0 & \cos\psi_{31} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^T \begin{bmatrix} \cos\psi_{41} & 0 & 0 & \sin\psi_{41} \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\sin\psi_{41} & 0 & 0 & \cos\psi_{41} \end{bmatrix}^T$$

$$\times \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\phi_{22}} & 0 & 0 \\ 0 & 0 & e^{j\phi_{32}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\psi_{32} & \sin\psi_{32} & 0 \\ 0 & -\sin\psi_{32} & \cos\psi_{32} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^T \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\psi_{42} & 0 & \sin\psi_{42} \\ 0 & 0 & 1 & 0 \\ 0 & -\sin\psi_{42} & 0 & \cos\psi_{42} \end{bmatrix}^T \times \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \tag{20-82}$$

The procedure for finding a compressed V matrix is described as follows:

A unitary $N_r \times N_c$ beamforming matrix V is column-wise phase invariant because the steering matrix needs a reference in phase per each column. This means V may be equivalent to $\tilde{V}\tilde{D}$, where $\tilde{D}$ is a column-wise phase shift matrix such as $\tilde{D} = \mathrm{diag}\left(e^{j\theta_1}, e^{j\theta_2}, \ldots, e^{j\theta_{N_c}}\right)$. When the beamformee estimates the channel, it may find $\tilde{V}$ for the beamforming matrix for the beamformer, but it should send $\tilde{V}\tilde{D}$ back to the beamformer, where $V = \tilde{V}\tilde{D}$. The angle, θ_i, in $\tilde{D}$ is found to make the last row of $\tilde{V}\tilde{D}$ to be non-negative real numbers.

The angles $\phi_{1,1} \ldots \phi_{N_r-1,1}$ in the diagonal matrix $D_1\left(e^{j\phi_{11}} \quad \ldots \quad e^{j\phi_{N_r-1,1}} \quad 1\right)^*$ may be found to make the first column of $D_1^* V$ to all be non-negative real numbers. Now, the first column of $(G_{N_r1} \ldots G_{31}G_{21}D_1^*) \times V$ can be $\begin{bmatrix}1 & 0 & \ldots & 0\end{bmatrix}^T$ by Givens rotation G_{l1} 's such as.

$$\begin{bmatrix} \cos\psi_{N_r1} & 0 & 0 & \sin\psi_{N_r1} \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ -\sin\psi_{N_r1} & 0 & 0 & \cos\psi_{N_r1} \end{bmatrix} \cdots \begin{bmatrix} \cos\psi_{31} & 0 & \sin\psi_{31} & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\psi_{31} & 0 & \cos\psi_{31} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\psi_{21} & \sin\psi_{21} & 0 & 0 \\ -\sin\psi_{21} & \cos\psi_{21} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e^{j\phi_{11}} & 0 & 0 & 0 \\ 0 & \ddots & 0 & 0 \\ 0 & 0 & e^{j\phi_{N_r-1,1}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^* \times V = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & & & \\ 0 & & V_2 & \\ 0 & & & \end{bmatrix} \tag{20-83}$$

For a new $(N_r - 1) \times (N_c - 1)$ submatrix V_2, this process may be applied in the same way. Then, the angles $\phi_{2,2} \ldots \phi_{N_r-1,2}$ in the diagonal matrix $D_2\left(1 \quad e^{j\phi_{22}} \quad \ldots \quad e^{j\phi_{N_r-1,2}} \quad 1\right)^*$ may be found to make the second column of $D_2^* \times \mathrm{diag}(1, V_2)$ to be all non-negative real numbers. Now, the first two columns of$(G_{N_r2} \ldots G_{32}D_2^*)(G_{N_r1} \ldots G_{31}G_{21}D_1^*) \times V$ can be $\tilde{I}_{N_r \times 2}$ by Givens rotation G_{l2}s such as

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\psi_{N_r2} & 0 & \sin\psi_{N_r2} \\ 0 & 0 & 1 & 0 \\ 0 & -\sin\psi_{N_r2} & 0 & \cos\psi_{N_r2} \end{bmatrix} \cdots \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\psi_{32} & \sin\psi_{32} & 0 \\ 0 & -\sin\psi_{32} & \cos\psi_{32} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & e^{j\phi_{22}} & 0 & 0 \\ 0 & 0 & e^{j\phi_{N_r-1,2}} & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^* \times G_{N_r1} \ldots G_{31}G_{21}D_1^* \times V = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & & \\ 0 & 0 & V_3 & \end{bmatrix} \tag{20-84}$$

This process may continue until the first N_c columns of the right side matrix become $\tilde{I}_{N_r \times N_c}$. When $N_c < N_r$, this process does not need to continue because V_{N_c+1} will be nulled out by $\tilde{I}_{N_r \times N_c}$. Then, by multiplying the complex conjugate transpose of the products of the D_i 's and G_{li} 's on the left, V can be expressed as

$$V = D_1 G_{21}^T G_{31}^T \ldots G_{N_r1}^T \times D_2 G_{32}^T G_{42}^T \ldots G_{N_r2}^T \times \ldots \times D_p G_{p+1,p}^T G_{p+2,p}^T \ldots G_{N_rp}^T \times \tilde{I}_{N_r \times N_c}, \tag{20-85}$$

where $p = \min(N_c, N_r - 1)$, which can be written in short form as in Equation (20-79).

The angles found from the decomposition process above, e.g., ψ 's and ϕ 's, shall be quantized as described in 7.4.9.8 (MIMO Compressed Beamforming frame format).

Columns $1 \ldots N_c$ of the beamforming feedback matrix correspond to spatial streams $1 \ldots N_c$, respectively. Spatial stream to modulation mapping is defined in the MCS Tables in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS)). A transmitter shall not re-order the columns of the beamforming feedback matrices in determining steering matrices.

Insert the following new subclause:

20.3.12 HT Preamble format for sounding PPDUs

The MIMO channel measurement takes place in every PPDU as a result of transmitting the HT-LTFs as part of the PLCP preamble. At a minimum, the number of HT-LTFs transmitted shall be equal to the number of space time streams transmitted, and these are transmitted using the same spatial transformation that is used for the HT-Data. This enables the computation of the spatial equalization at the receiver.

When the number of space time streams, N_{STS}, is less than the number of transmit antennas, or less than $\min\left(N_{TX}, N_{RX}\right)$, sending only N_{STS} HT-LTFs does not allow the receiver to recover a full characterization of the MIMO channel, even though the resulting MIMO channel measurement is sufficient for receiving the HT-Data.

However, there are several cases where it is desirable to obtain as full a characterization of the channel as is possible, thus requiring the transmission of a sufficient number of HT-LTFs to sound the full dimensionality of the channel, which is in some cases N_{TX}, and in other cases $\min\left(N_{TX}, N_{RX}\right)$. These cases of MIMO channel measurement are referred to as MIMO channel sounding. A sounding packet may be used to sound available channel dimensions. A sounding PPDU is identified by setting the Not Sounding field in the HT-SIG to zero. A sounding PPDU may have any allowed number of HT-LTFs satisfying $N_{LTF} \geq N_{STS}$. In general, if the Not Sounding field in the HT-SIG is set to zero and $N_{LTF} > N_{STS}$, extension HT-LTFs are used, except for the case where $N_{SS} = 3$ and $N_{LTF} = 4$ or in an NDP.

Even if N_{ESS}=0 in a sounding packet, the Not Sounding field shall be set to zero.

20.3.12.1 Sounding with a Null Data Packet

An STA may sound the channel using a Null Data Packet (NDP) (indicated by zero in the Length field in the HT-SIG) with the Not Sounding field set to 0. The number of LTFs is the number implied by the MCS, which shall indicate two or more spatial streams. The last HT-LTF of an NDP shall not be followed by a Data field (see Figure n77 (Example of an NDP used for sounding)).

It is optional for a STA to process an NDP.

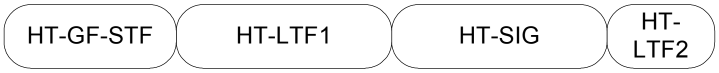


Figure n77—Example of an NDP used for sounding

Insert the following new subclause:

20.3.12.2 Sounding PPDU for calibration

In the case of a bidirectional calibration exchange, two STAs exchange sounding PPDUs, enabling the receiving STA to compute an estimate of the MIMO channel matrix H_k for each sub-carrier *k*. In general, in an exchange of calibration messages, the number of spatial streams is less than the number of transmit antennas, necessitating the use of extension HT-LTFs. In the case of sounding PPDUs for calibration, the antenna mapping matrix shall be

$$Q_k = C_{CSD}(k)P_{CAL} \tag{20-86}$$

where

$C_{CSD}(k)$ is a diagonal cyclic shift matrix in which the diagonal elements carry frequency-domain representation of the cyclic shifts given in Table n61 (Cyclic shift for non-HT portion of the packet) and

P_{CAL} is one of the following unitary matrices:For $N_{TX} = 1, P_{CAL} = 1$

For $N_{TX} = 2, P_{CAL} = \frac{\sqrt{2}}{2}\begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$

For $N_{TX} = 3, P_{CAL} = \frac{\sqrt{3}}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & e^{-j2\pi/3} & e^{-j4\pi/3} \\ 1 & e^{-j4\pi/3} & e^{-j2\pi/3} \end{bmatrix}$

For $N_{TX} = 4, P_{CAL} = \frac{1}{2}\begin{bmatrix} 1 & -1 & 1 & 1 \\ 1 & 1 & -1 & 1 \\ 1 & 1 & 1 & -1 \\ -1 & 1 & 1 & 1 \end{bmatrix}$.

Insert the following new subclause:

20.3.12.3 Sounding PPDU for channel quality assessment

In response to the reception of an MCS Request (MRQ), sent by STA A to STA B, the responding STA B returns to the initiating STA A an MCS selection that the responding STA B determines to be a suitable MCS for the initiating STA A to use in subsequent transmissions to the responding STA B. In determining the MCS, the responding STA B performs a channel quality assessment, which entails using whatever information the responding STA B has about the channel, such as an estimate of the MIMO channel derived from the sounding PPDU that carries the MRQ. To enable this calculation, the MRQ should be sent in conjunction with a sounding PPDU (either in a sounding PPDU, or in a PPDU in which the NDP announcement bit in the HT Control field is set to 1, and which is followed by an NDP.)

The STA sending the MRQ (STA A) determines how many HT-LTFs to send, and whether to use extension HT-LTFs or an NDP, based on the number of space time streams used in the PPDU carrying the MRQ, the number of transmit chains it is using (N_{TX}), whether or not the transmit and receive stations support STBC, and in some cases, the number of receive chains at the responding STA (N_{RX}).

The maximum number of available space-time streams is set by the number of transmit and receive chains, and the STBC capabilities of the transmitter and receiver, as is shown in Table n73 (Maximum available space-time streams). While the number of receive chains at a STA is not communicated in a capabilities indicator, the maximum number of space time streams supported may be inferred from the MCS capabilities and the STBC capabilities of the receiving STA. When the number of receive chains is known at the transmitter, the number of HT-LTFs sent to obtain a full channel quality assessment is determined according to the maximum number of space-time streams indicated in Table n73 (Maximum available space-time streams). The number of HT-LTFs to use in conjunction with the indicated number of space time streams is determined according to 20.3.9.4.6 (The HT-LTF long training field)

If the initiating STA A sends an MRQ in a PPDU that uses fewer space time streams in the data portion than are available on the channel, the channel quality assessment made by responder STA B may be based on the Data HT-LTFs alone, but in this case the MCS feedback will be limited to MCSs using the number of streams used in the data portion of the PPDU, or fewer. To determine whether an MCS should be chosen that uses more spatial streams than the PPDU containing the MRQ, it is necessary for the initiating STA A to either use extension HT-LTFs (send the MRQ in a staggered sounding PPDU), or use an NDP (send the MRQ in a PPDU in which the NDP announcement bit in the HT Control field is set, and which is followed by an NDP.)

Table n73—Maximum available space-time streams

N_{TX}	N_{RX}	$N_{STS,\max}$ **without STBC**	$N_{STS,\max}$ **with STBC**
1	1	1	N/A
2	1	$\min(N_{TX}, N_{RX})$	2
3	1	1	2
3	2	$\min(N_{TX}, N_{RX})$	3
4	1	1	2
4	2	$\min(N_{TX}, N_{RX})$	4

The sounding PPDU may have non-identity spatial mapping matrix Q_k. Over different RAs, Q_k may vary.

Insert the following new subclause:

20.3.13 Regulatory requirements

Wireless LANs implemented in accordance with this standard are subject to equipment certification and operating requirements established by regional and national regulatory administrations. The PMD specification establishes minimum technical requirements for interoperability, based upon established regulations at the time this standard was issued. These regulations are subject to revision, or may be superseded. Requirements that are subject to local geographic regulations are annotated within the PMD specification. Regulatory requirements that do not affect interoperability are not addressed in this standard. Implementers are referred to the regulatory sources in Annex I for further information. Operation in countries within defined regulatory domains may be subject to additional or alternative national regulations.

Insert the following new subclause:

20.3.14 Channel numbering and channelization

The STA may operate in the 5GHz band and/or 2.4GHz band. When using 20 MHz channels it uses channels defined in 17.3.8.3 (5 GHz band) or 18.4.6 (2.4 GHz band). When using 40 MHz channels, it can operate in the channels defined in 20.3.14.1 (Channel allocation in the 2.4 GHz Band) and 20.3.14.2 (Channel allocation in the 5 GHz band).

Insert the following new subclause:

20.3.14.1 Channel allocation in the 2.4 GHz Band

Channel center frequencies are defined at every integral multiple of 5 MHz in the 2.4 GHz band. The relationship between center frequency and channel number is given by the following equation:

$$\text{Channel center frequency} = 2407 + 5 \times n_{ch} (\text{MHz}) \tag{20-87}$$

where

$$n_{ch} = 1, 2, \ldots, 13$$

Insert the following new subclause:

20.3.14.2 Channel allocation in the 5 GHz band

Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz. The relationship between center frequency and channel number is given as follows:

$$\text{Channel center frequency} = \text{Channel starting frequency} + 5 \times n_{ch} (\text{MHz}) \tag{20-88}$$

where

$$n_{ch} = 0, 1, \ldots, 200$$

Channel starting frequency is defined as dot11ChannelStartingFactor × 500 kHz or is defined as 5 GHz for systems where dot11RegulatoryClassesRequired is false or not defined

Insert the following new subclause:

20.3.14.3 40 MHz channelization

The set of valid operating channel numbers by regulatory domain is defined in Annex J.

The 40 MHz channels are specified by two fields: (Nprimary_ch, Secondary). The first field represents the channel number of the primary channel, and the second one indicates whether the secondary channel is above or below the primary channel (1 -> above, -1 -> below). The secondary channel number shall be Nprimary_ch

+ Secondary*4.

For example, a 40 MHz channel consisting of 40 MHz channel number 36 and Secondary 1 specifies the primary channel is 36 and the secondary channel is 40.

Insert the following new subclause:

20.3.15 Transmit and receive in-band and out-of-band spurious transmissions

The OFDM PHY shall conform to in-band and out-of-band spurious emissions as set by regulatory bodies.

Insert the following new subclause:

20.3.16 Transmitter RF delay

The transmitter RF delay shall follow 17.3.8.5.

Insert the following new subclause:

20.3.17 Slot time

The slot time shall follow 17.3.8.6 for 5 GHz bands and 19.4.4 for 2.4 GHz bands.

Insert the following new subclause:

20.3.18 Transmit and receive port impedance

The transmit and receive antenna port impedance for each transmit and receive antenna shall follow 17.3.8.7.

Insert the following new subclause:

20.3.19 Transmit and receive operating temperature range

The transmit and receive temperature range shall follow 17.3.8.8.

Insert the following new subclause heading:

20.3.20 PMD Tx specification

Insert the following new subclause:

20.3.20.1 Transmit spectrum mask

In the absence of other regulatory restrictions, when transmitting in a 20 MHz channel, the transmitted spectrum shall have a 0 dBr (dB relative to the maximum spectral density of the signal) bandwidth not exceeding 18 MHz, –20 dBr at 11 MHz frequency offset, –28 dBr at 20 MHz frequency offset and –45 dBr at 30 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure n78 (Transmit spectral mask for 20 MHz transmission). The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

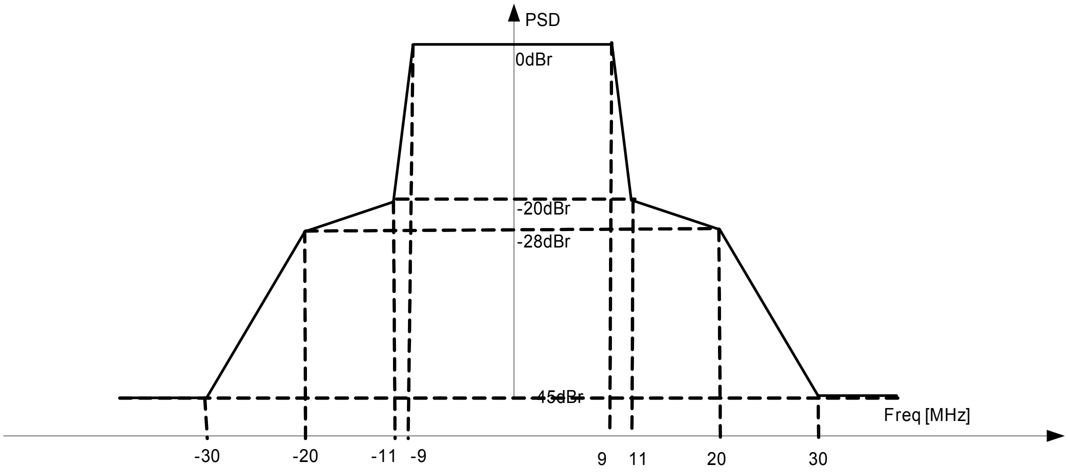


Figure n78—Transmit spectral mask for 20 MHz transmission

In the absence of other regulatory restrictions, when transmitting in a 40 MHz channel, the transmitted spectrum shall have a 0 dBr bandwidth not exceeding 38 MHz, –20 dBr at 21 MHz frequency offset, -28 dBr at 40 MHz offset and –45 dBr at 60 MHz frequency offset and above. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Figure n79 (Transmit spectral mask for a 40 MHz channel).

The transmit spectral mask for 20 MHz transmission in upper or lower 20 MHz channels of a 40 MHz is the same mask as that used for the 40 MHz channel.

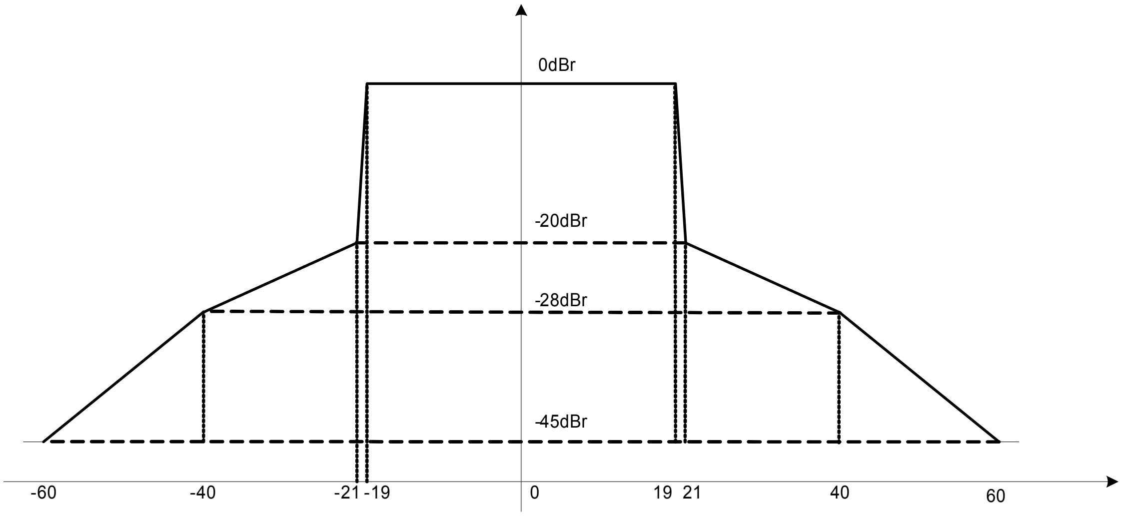


Figure n79—Transmit spectral mask for a 40 MHz channel

Insert the following new subclause:

20.3.20.2 Spectral flatness

In a 20 MHz channel and in corresponding 20 MHz transmission in a 40 MHz channel, the average energy of the constellations in each of the spectral lines –16 to –1 and +1 to +16 shall deviate no more than ± 2 dB from their average energy. The average energy of the constellations in each of the spectral lines –28 to –17 and +17 to +28 shall deviate no more than +2/–4 dB from the average energy of spectral lines –16 to –1 and +1 to +16.

In a 40 MHz transmission (excluding HT duplicate format and non-HT duplicate format) the average energy of the constellations in each of the spectral lines –42 to –2 and +2 to +42 shall deviate no more than ± 2 dB from their average energy. The average energy of the constellations in each of the spectral lines –43 to –58 and +43 to +58 shall deviate no more than +2/–4 dB from the average energy of spectral lines –42 to –2 and +2 to +42.

In HT duplicate format and non-HT duplicate format the average energy of the constellations in each of the spectral lines -42 to -33, -31 to -6, +6 to +31, and +33 to +42 shall deviate no more than ± 2 dB from their average energy. The average energy of the constellations in each of the spectral lines -43 to -58 and +43 to +58 shall deviate no more than +2/-4 dB from the average energy of spectral lines -42 to -33, -31 to -6, +6 to +31, and +33 to +42.

Insert the following new subclause:

20.3.20.3 Transmit power

The maximum allowable transmit power by regulatory domain is defined in Annex I.

Insert the following new subclause:

20.3.20.4 Transmit center frequency tolerance

The transmitter center frequency tolerance shall be ±20 ppm maximum for the 5GHz band and ±25 ppm maximum for the 2.4GHz band. The different transmit chain center frequencies (LO) and each transmit chain symbol clock frequency shall all be derived from the same reference oscillator.

Insert the following new subclause:

20.3.20.5 Packet alignment

The receiver asserts PHY-CCA.indication(idle) (see 12.3.5.10) at the 4µs boundary following the reception of the last symbol of the packet. This is illustrated for the case of a greenfield format packet using short GI in Figure n80 (Packet alignment example (greenfield format packet with short GI)).

The transmitter asserts PHY-TXEND.confirm (12.3.5.7) at the trailing boundary of the last symbol of the packet on the air as illustrated in Figure n80 (Packet alignment example (greenfield format packet with short GI)).

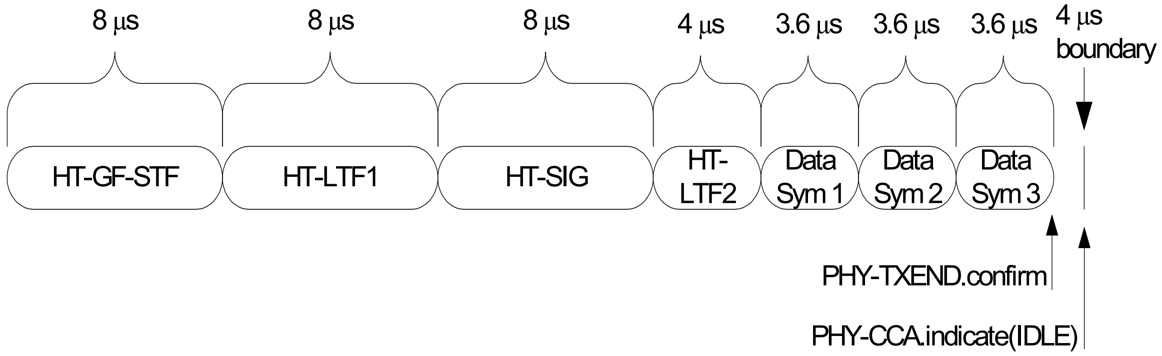


Figure n80—Packet alignment example (greenfield format packet with short GI)

Insert the following new subclause:

20.3.20.6 Symbol clock frequency tolerance

The symbol clock frequency tolerance shall be ±20 ppm maximum for 5 GHz bands and ±25 ppm for 2.4 GHz bands. The transmit center frequency and the symbol clock frequency for all transmit antennas shall be derived from the same reference oscillator.

Insert the following new subclause:

20.3.20.7 Modulation accuracy

20.3.20.7.1 Introduction to Modulation accuracy tests

Transmit modulation accuracy specifications are described in 20.3.20.7.2 (Transmit center frequency leakage) and 20.3.20.7.3 (Transmitter constellation error). The test method is described in 20.3.20.7.4 (Transmitter modulation accuracy (EVM) test).

Insert the following new subclause:

20.3.20.7.2 Transmit center frequency leakage

The transmitter center frequency leakage shall follow 17.3.9.6.1 for all transmissions in a 20 MHz channel width. For transmissions in a 40 MHz channel width, the center frequency leakage shall not exceed -20 dB relative to overall transmitted power, or, equivalently, 0 dB relative to the average energy of the rest of the subcarriers. The transmit center frequency leakage is specified per antenna.

Insert the following new subclause:

20.3.20.7.3 Transmitter constellation error

The relative constellation RMS error, averaged over subcarriers, OFDM frames, and spatial streams shall not exceed a data-rate dependent value according to Table n74 (Allowed relative constellation error versus constellation size and code rate). In this table, the number of spatial streams is equal to the number of transmit antennas. The same requirement applies both to 20 MHz channels and 40 MHz channels.

Insert the following new subclause:

20.3.20.7.4 Transmitter modulation accuracy (EVM) test

The transmit modulation accuracy test shall be performed by instrumentation capable of converting the transmitted signals into a streams of complex samples at 40 Msample/s or more, with sufficient accuracy in terms of I/Q arm amplitude and phase balance, dc offsets, phase noise, analog to digital quantization noise, etc. Each transmit chain is connected directly through a cable to the setup input port. A possible embodiment of such a setup is converting the signals to a low IF frequency with a microwave synthesizer, sampling the signal with a digital oscilloscope and decomposing it digitally into quadrature components. The sampled signal shall be processed in a manner similar to an actual receiver, according to the following steps, or an equivalent procedure:

a) Start of frame shall be detected.

b) Transition from short sequences to channel estimation sequences shall be detected, and fine timing (with one sample resolution) shall be established.

Table n74—Allowed relative constellation error versus constellation size and code rate

Modulation	Code Rate	Relative constellation error (dB)
BPSK	1/2	-5
QPSK	1/2	-10
QPSK	3/4	-13
16-QAM	1/2	-16
16-QAM	3/4	-19
64-QAM	2/3	-22
64-QAM	3/4	-25
64-QAM	5/6	-28

c) Coarse and fine frequency offsets shall be estimated.

d) The packet shall be derotated according to estimated frequency offset.

e) The complex channel response coefficients shall be estimated for each of the subcarriers and each of the transmit chains.

f) For each of the data OFDM symbols: transform the symbol into subcarrier received values, estimate the phase from the pilot subcarriers in all spatial streams, derotate the subcarrier values according to estimated phase, group the results from all the receiver chains in each subcarrier to a vector, multiply the vector by a zero-forcing equalization matrix generated from the channel estimated during the channel estimation phase.

g) For each data-carrying subcarrier in each spatial stream, find the closest constellation point and compute the Euclidean distance from it.

h) Compute the average of the RMS of all errors in a packet. It is given by:

$$Error_{RMS}=\frac{\displaystyle\sum_{i_f=1}^{N_f}\sqrt{\frac{\displaystyle\sum_{i_s=1}^{N_{SYM}}\left[\sum_{i_{ss}=1}^{N_{SS}}\left(\sum_{i_{sc}=1}^{N_{ST}}\left(\left(I\left(i_f,i_s,i_{ss},i_{sc}\right)-I_0\left(i_f,i_s,i_{ss},i_{sc}\right)\right)^2+\left(Q\left(i_f,i_s,i_{ss},i_{sc}\right)-Q_0\left(i_f,i_s,i_{ss},i_{sc}\right)\right)^2\right)\right)\right]}{N_{SYM}\times N_{SS}\times N_{ST}\times P_o}}}{N_f}$$

(20-89)

where

Nf is the number of frames for the measurement;

$I_0\left(i_f,i_s,i_{ss},i_{sc}\right),Q_0\left(i_f,i_s,i_{ss},i_{sc}\right)$ denotes the ideal symbol point of the i_f'th frame, i_s'th OFDM symbol of the frame, i_{ss}'th spatial stream, i_{sc}'th subcarrier of the OFDM symbol in the complex plane;

$I\left(i_f,i_s,i_{ss},i_{sc}\right),Q\left(i_f,i_s,i_{ss},i_{sc}\right)$ denotes the observed point of the i_f'th frame, i_s'th OFDM symbol of the frame, i_{ss}'th spatial stream, i_{sc}'th subcarrier of the OFDM symbol in the complex plane (see Figure 256;

P_0 is the average power of the constellation.

The vector error on a phase plane is shown in Figure 256.

The test shall be performed over at least 20 frames (*Nf*), and the average of the RMS shall be taken. The packets under test shall be at least 16 OFDM symbols long. Random data shall be used for the symbols.

Insert the following new subclause heading:

20.3.21 HT PMD receiver specification

Insert the following new subclause:

20.3.21.1 Receiver minimum input sensitivity

The packet error rate (PER) shall be less than 10% for a PSDU length of 4096 octets with the rate-dependent input levels listed in Table n75 (Receiver minimum input level sensitivity) or less. The minimum input levels are measured at the antenna connectors and are referenced as the average power per receive antenna. The number of spatial streams under test shall be equal to the number of utilized transmitting STA antenna (output) ports and also equal to the number of utilized Device Under Test input ports. Each output port of the transmitting STA shall be connected through a cable to one input port of the Device Under Test.

Table n75—Receiver minimum input level sensitivity

Modulation	Rate (R)	Adjacent channel rejection (dB)	Non-adjacent channel rejection (dB)	Minimum sensitivity (dBm) (20 MHz channel spacing)	Minimum sensitivity (dBm) (40 MHz channel spacing)
BPSK	1/2	16	32	-82	-79
QPSK	1/2	13	29	-79	-76
QPSK	3/4	11	27	-77	-74
16-QAM	1/2	8	24	-74	-71
16-QAM	3/4	4	20	-70	-67
64-QAM	2/3	0	16	-66	-63
64-QAM	3/4	–1	15	-65	-62
64-QAM	5/6	–2	14	-64	-61

Insert the following new subclause:

20.3.21.2 Adjacent channel rejection

The adjacent channel rejection shall follow 17.3.10.2 in the 5 GHz band or 19.5.2 in the 2.4 GHz band for all transmissions in a 20 MHz channel width with the exception that 10% PER is required for 4096 octet packets rather than 10% PER for 1000 octet packets. For all transmissions in a 40 MHz channel width, the adjacent channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate dependent sensitivity specified in Table n75 (Receiver minimum input level sensitivity) and raising the power of the interfering signal until 10% PER is caused for a PSDU length of 4096 octets. The power difference between the interfering and the desired channel is the corresponding adjacent channel rejection. The adjacent channel center frequencies shall be separated by 40 MHz. The interfering signal in the adjacent channel shall be a conformant OFDM signal, unsynchronized with the signal in the channel under test. For a conformed OFDM PHY, the corresponding rejection shall be no less than specified in Table n75 (Receiver minimum input level sensitivity). The interference signal shall have a minimum duty cycle of 50%.

Insert the following new subclause:

20.3.21.3 Non-adjacent channel rejection

The non-adjacent channel rejection shall follow 17.3.10.3 in the 5 GHz band for all transmissions in a 20 MHz channel width with the exception that 10% PER is required for 4096 octet packets rather than 10% PER for 1000 octet packet. For all transmissions in a 40 MHz channel width, the non-adjacent channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate-dependent sensitivity specified in Table n75 (Receiver minimum input level sensitivity), and raising the power of the interfering signal until a 10% PER occurs for a PSDU length of 4096 octets. The power difference between the interfering and the desired channel is the corresponding non-adjacent channel rejection. The non-adjacent channel center frequencies shall be separated by 80 MHz or more. The interfering signal in the non-adjacent channel shall be a conformant OFDM signal, unsynchronized with the signal in the channel under test. For a conformed OFDM PHY, the corresponding rejection shall be no less than specified in Table n75 (Receiver minimum input level sensitivity). The interference signal shall have a minimum duty cycle of 50%. The non-adjacent channel rejection for transmissions in a 40 MHz channel width is applicable only to 5 GHz band.

Insert the following new subclause:

20.3.21.4 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 –30 dBm in the 5 GHz band, and -20 dBm in the 2.4 GHz band, measured at each antenna for any baseband modulation.

Insert the following new subclause:

20.3.21.5 Clear Channel Assessment (CCA) sensitivity

On the start of a valid non-HT transmission on the primary channel refer to Clause 17 and 19.

20.3.21.5.1 Clear channel assessment (CCA) sensitivity in 20 MHz

The following paragraph describes the CCA sensitivity requirements for an HT-STA with the operating channel width set to 20 MHz.

The start of a valid 20 MHz HT transmission at a receive level equal to or greater than the minimum modulation and coding rate sensitivity of -82 dBm shall cause the PHY to set PHY-CCA.indicate(BUSY) with a probability > 90% within 4 µs. The receiver shall hold the CCA signal busy for any signal 20 dB or more above the minimum modulation and coding rate sensitivity (-62 dBm) in the 20 MHz channel.

20.3.21.5.2 Clear channel assessment (CCA) sensitivity in 40 MHz

The following paragraphs describe the CCA sensitivity requirements for an HT-STA with the operating channel width set to 40 MHz.

The receiver of a 20/40 MHz STA with the operating channel width set to 40 MHz shall provide CCA on both the primary and secondary channels.

When the secondary channel is idle, the start of a valid 20 MHz HT transmission in the primary channel at a receive level equal to or greater than the minimum modulation and coding rate sensitivity of -82 dBm shall cause the PHY to set PHY-CCA.indicate(BUSY) with a probability > 90% within 4 μs. The start of a valid 40 MHz HT transmission that occupies both the primary channel and the secondary channel at a receive level equal to or greater than the minimum modulation and coding rate sensitivity of -79 dBm shall cause the PHY to set PHY-CCA.indicate(BUSY) for both the primary channel and the secondary channel with a probability per channel > 90% within 4 μs.

The receiver shall hold the 20 MHz primary channel CCA signal busy for any signal 20 dB or more above the minimum modulation and coding rate sensitivity (-62 dBm) in the 20 MHz primary channel. When the primary channel is idle, the receiver shall hold the 20 MHz secondary channel CCA signal busy for any signal 20 dB or more above the minimum modulation and coding rate sensitivity (-62 dBm) in the 20 MHz secondary channel. The receiver shall hold both the 20 MHz primary channel CCA and the 20 MHz secondary channel CCA busy for any signal present in both the primary and secondary channel that is 20 dB or more above the minimum modulation and coding rate sensitivity (-59 dBm).

Insert the following new subclause:

20.3.21.6 Received channel power indicator (RCPI) measurement

The RCPI indicator is a measure of the received RF power in the selected channel. This parameter shall be a measure by the PHY sublayer of the received RF power in the channel measured over the data portion of the received frame. The received power shall be the average of the power in all receive chains. RCPI shall be a monotonically increasing, logarithmic function of the received power level defined in dBm. The allowed values for the Received Channel Power Indicator (RCPI) parameter shall be an 8 bit value in the range from 0 through 220, with indicated values rounded to the nearest 0.5 dB as follows:

- 0: Power < -110 dBm
- 1: Power = -109.5 dBm
- 2: Power = -109.0 dBm
- and so on up to
- 220: Power > 0 dBm
- 221-254: reserved
- 255: Measurement not available

where

$$RCPI = \mathrm{int}\{(\text{Power in dBm} +110)*2\} \text{ for } 0 \text{ dbm} > \text{Power} > -110 \text{ dBm} \qquad (20\text{-}90)$$

RCPI shall equal the received RF power within an accuracy of +/- 5 dB (95% confidence interval) within the specified dynamic range of the receiver. The received RF power shall be determined assuming a receiver noise equivalent bandwidth equal to the channel bandwidth multiplied by 1.1.

20.3.21.7 Reduced interframe Space (RIFS)

The receiver shall be able to decode a packet that was transmitted by a STA with a RIFS separation from the previous packet.

Insert the following new subclause:

20.3.22 PLCP transmit procedure

There are three options for transmit PLCP procedure. The first two options, for which typical transmit procedures are shown in Figure n81 (PLCP transmit procedure (HT mixed format PPDU)) and Figure n82 (PLCP transmit procedure (HT greenfield format PPDU)), are selected if the FORMAT field of PHY-TXSTART.request(TXVECTOR) is set to HT_MF or HT_GF respectively. These transmit procedures do not describe the operation of optional features, such as LDPC. The third option is to follow the transmit procedure as in Clause 17 or 19 if the FORMAT field is set to NON_HT. Additionally, if the FORMAT field is set to NON_HT, CW indicates NON_HT_CBW20, and NON_HT_MODULATION indicates OFDM, follow the transmit procedure as in Clause 17. If the FORMAT field is set to NON_HT, CH_BANDWIDTH indicates NON_HT_CBW20, and NON_HT_MODULATION indicates other than OFDM, follow the transmit procedure as in Clause 19. And furthermore, if the FORMAT field is set to NON_HT and CH_BANDWIDTH indicates NON_HT_CBW40, follow the transmit procedure as in Clause 17 duplicated on both channels. In all these options, in order to transmit data, PHY-TXSTART.request shall be enabled so that the PHY entity shall be in the transmit state. Further, the PHY shall be set to operate at the appropriate frequency through station management via the PLME. Other transmit parameters, such as MCS Coding types and TX power, are set via the PHY-SAP with the PHY-TXSTART.request(TXVECTOR), as described in 20.2.2 (TXVECTOR and RXVECTOR parameters).

A clear channel shall be indicated by PHY-CCA.indication(IDLE). The MAC considers this indication before issuing the PHY-TXSTART.request. Transmission of the PPDU shall be initiated after receiving the PHYTXSTART.request(TXVECTOR) primitive. The TXVECTOR elements for the PHY-TXSTART.request are specified in Table n56 (TXVECTOR and RXVECTOR parameters).

The PLCP shall issue the parameters in the following PMD primitives to configure the PHY:

- PMD_TXPWRLVL
- PMD_TX_PARAMETERS
- PMD_EXPANSIONS_MAT
- PMD_EXPANSIONS_MAT_ON

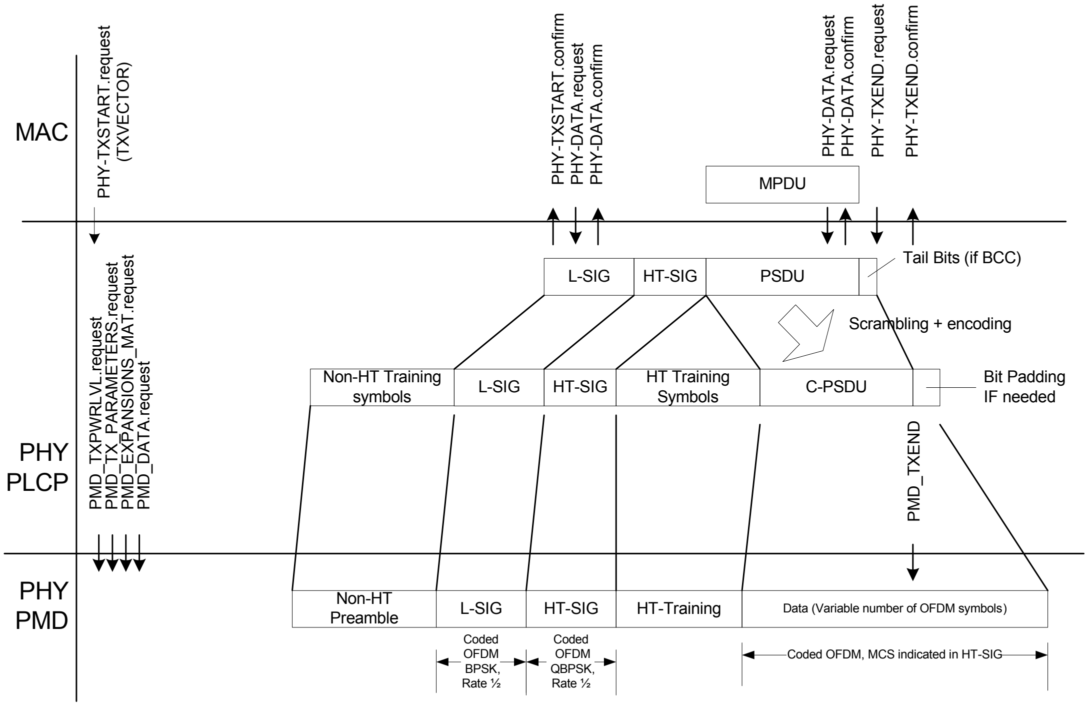
The PLCP shall then issue a PMD_TXSTART.request, and transmission of the PLCP preamble may start, based on the parameters passed in the PHY-TXSTART.request primitive. The data shall then be exchanged between the MAC and the PHY through a series of PHY-DATA.request(DATA) primitives issued by the MAC, and PHY-DATA.confirm primitives issued by the PHY. Once PLCP preamble transmission is started, the PHY entity shall immediately initiate data scrambling and data encoding. The encoding method shall be based on the LDPC_CODING, CH_BANDWIDTH, and MCS parameter of the TXVECTOR. A modulation rate change, if any, shall be initiated starting with the SERVICE field data, as described in 20.3.2 (PLCP frame format).

The PHY proceeds with PSDU transmission through a series of data octet transfers from the MAC. The SERVICE field and PSDU are encoded by the encoder selected by the LDPC_CODING, CH_BANDWIDTH, and MCS parameters of the TXVECTOR as described in 20.3.3 (Transmitter block diagram). At the PMD layer, the data octets are sent in bit 0–7 order and presented to the PHY through PMD_DATA.request primitives. Transmission can be prematurely terminated by the MAC through the primitive PHY-TXEND.request. PHY-TXSTART shall be disabled by the issuance of the PHY-TXEND.request. Normal termination occurs after the transmission of the final bit of the last PSDU octet, according to the number supplied in the LENGTH field.

The packet transmission shall be completed and the PHY entity shall enter the receive state (i.e., PHYTXSTART shall be disabled). Each PHY-TXEND.request is acknowledged with a PHY-TXEND.confirm primitive from the PHY. If the coded PSDU (C-PSDU) is not multiples of the OFDM symbol, bits shall be stuffed to make the C-PSDU length multiples of the OFDM symbol.

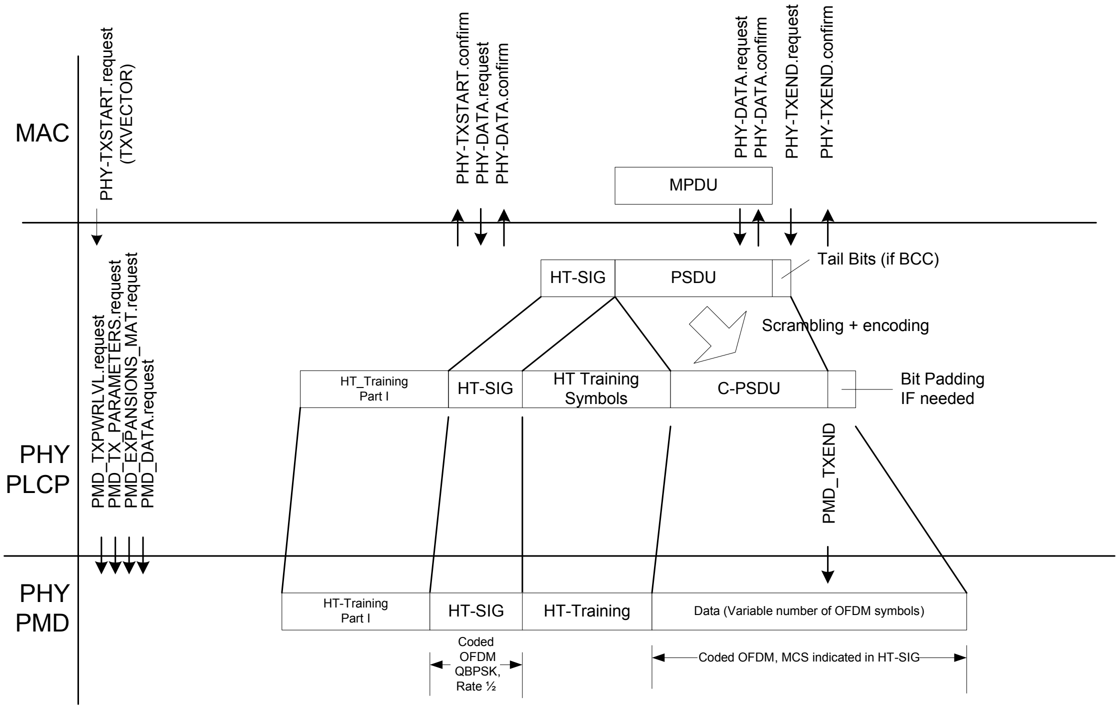
In the PMD, the GI or short GI shall be inserted in every OFDM symbol as a countermeasure against delay spread.

A typical state machine implementation of the transmit PLCP is provided in Figure n83 (PLCP transmit state machine). Requests (.req) and confirmations(.confirm) are issued once per state as shown. This state machine does not describe the operation of optional features, such as LDPC or STBC.



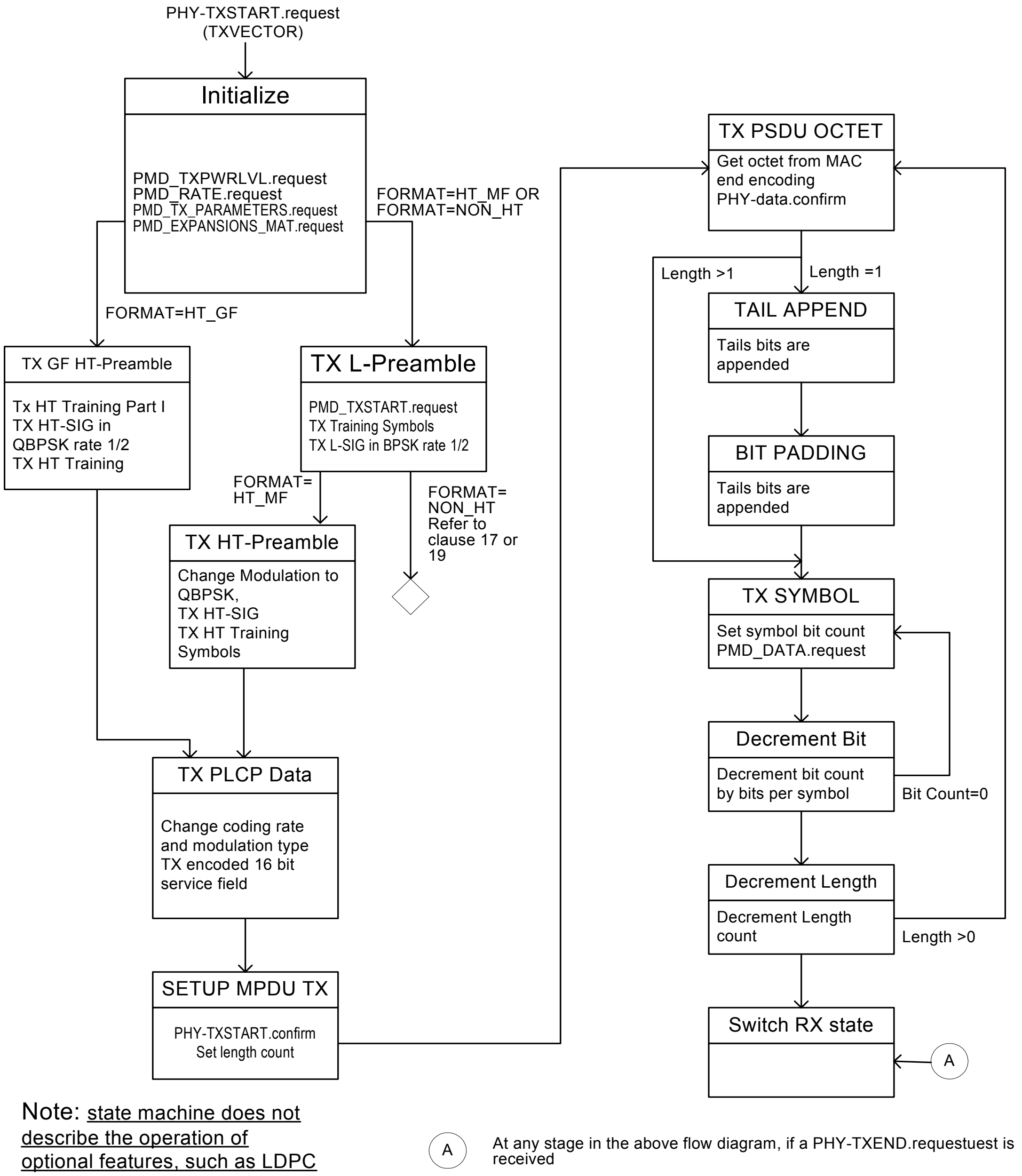
Note: procedure does not describe the operation of optional features, such as LDPC or STBC

Figure n81—PLCP transmit procedure (HT mixed format PPDU)



Note: procedure does not describe the operation of optional features, such as LDPC or STBC

Figure n82—PLCP transmit procedure (HT greenfield format PPDU)



Note: state machine does not describe the operation of optional features, such as LDPC or STBC

A At any stage in the above flow diagram, if a PHY-TXEND.requestuest is received

Figure n83—PLCP transmit state machine

Insert the following new subclause:

20.3.23 PLCP receive procedure

Typical PLCP receive procedures are shown in Figure n84 (PLCP receive procedure for HT mixed format PLCP format) and Figure n85 (PLCP receive procedure for HT greenfield format PLCP). The receive procedures correspond to HT mixed format and HT greenfield format, respectively. A typical state machine implementation of the receive PLCP is given in Figure n86 (PLCP receive state machine). These receive procedures and state machine do not describe the operation of optional features, such as LDPC or STBC. If the detected format indicates Non_HT PLCP format, refer to the receive procedure and state machine in Clause 17 or 19. In order to receive data, PHY-TXSTART.request shall be disabled so that the PHY entity is in the receive state. Further, through station management (via the PLME) the PHY is set to the appropriate frequency. Other receive parameters, such as RSSI and indicated DATARATE, may be accessed via the PHY-SAP.

Upon receiving the transmitted PLCP preamble, PMD_RSSI.indication shall report a busy channel to the PLCP. This indicates activity to the MAC via PHY-CCA.indication. PHY-CCA.indication(BUSY) shall be issued for reception of a signal prior to correct reception of the PLCP frame. The PMD primitive PMD_RSSI is issued to update the RSSI and parameter reported to the MAC.

After PHY-CCA.indication(BUSY) is issued, the PHY entity shall begin receiving the training symbols and searching for SIGNAL and HT-SIG in order to set the length of the data stream, the demodulation type, code type, and the decoding rate. If signal loss occurs before validating L-SIG and/or HT-SIG, the HT PHY shall maintain PHY-CCA.indication(BUSY) until the received level drops below the CCA sensitivity level (for a missed preamble) in 21.3.21.5. If the check of the HT-SIG CRC is not valid, a PHY-RXSTART.indication is not issued. The PHY shall issue the error condition PHY-RXEND.indication(FormatViolation). The HT PHY shall maintain PHY-CCA.indication(BUSY) until the received level drops below the CCA sensitivity level (for a missed preamble) in 21.3.21.5.

If the PLCP preamble reception is successful and a valid HT-SIG CRC is indicated:

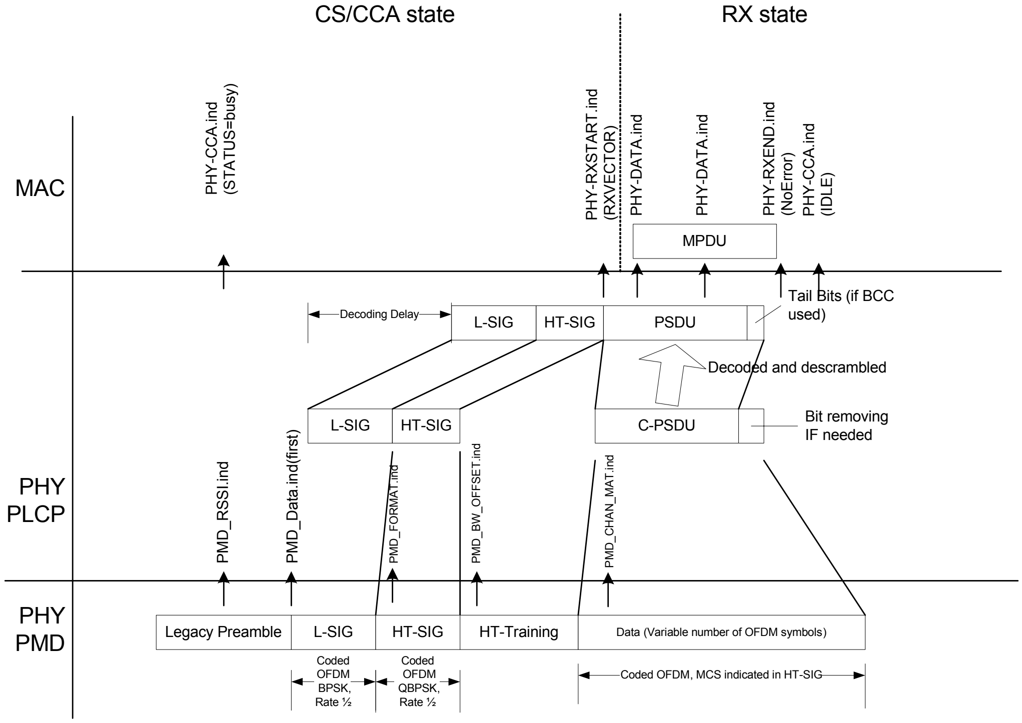
- Upon reception of an HT mixed format preamble, the HT PHY shall maintain PHY-CCA.indication(BUSY) for the predicted duration of the transmitted frame, as per TXTIME in 21.4.3, for all supported and unsupported modes except Reserved HT-SIG Indication.
- Upon reception of a GF preamble by an HT STA which does not support GF, PHY-CCA.indication(BUSY) shall be maintained until either the predicted duration of the packet from the contents of the HT-SIG field, as per TXTIME in 21.4.3, except Reserved HT-SIG Indication, or until the received level drops below the receiver minimum sensitivity level of BPSK, R=1/2 in Table n75 (Receiver minimum input level sensitivity) + 10 dB (-72 dBm for 20 MHz, -69 dBm for 40 MHz)
- Upon reception of a GF preamble by an HT STA which supports GF, the HT PHY shall maintain PHY-CCA.indication(BUSY) for the predicted duration of the transmitted frame, as per TXTIME in 21.4.3, for all supported and unsupported modes except Reserved HT-SIG Indication.
- If the HT-SIG indicates a Reserved HT-SIG Indication, the HT PHY shall maintain PHY-CCA.indication(BUSY) until the received level drops below the CCA sensitivity level (minimum modulation and coding rate sensitivity + 20 dB) in 21.3.21.5. Reserved HT-SIG Indication is defined as an HT-SIG with MCS field in the range 77-127 or Reserved field = 0 or STBC field = 3.

Subsequent to an indication of a valid HT-SIG CRC, a PHY-RXSTART.indication(RXVECTOR) shall be issued. The RXVECTOR associated with this primitive include the parameters specified in Table n63 (TXVECTOR and RXVECTOR parameters). Upon reception of a GF preamble by an HT STA which does not support GF, the FORMAT field of RXVECTOR is set to HT_GF and the remaining fields may be empty, and the PHY shall issue the error condition PHY-RXEND.indication(FormatViolation). If the HT-SIG is not completely recognizable and supported the PHY shall issue the error condition PHY-RXEND.indication(UnsupportedRate).

Following training and signal fields, the PLCP SERVICE field and PSDU shall be received. If signal loss occur during reception prior to completion of the PSDU reception, the error condition PHY-RXEND.indication(CarrierLost) shall be reported to the MAC. After waiting for the intended end of the PSDU, the PHY shall set PHY-CCA.indication(IDLE) and return to RX IDLE state.

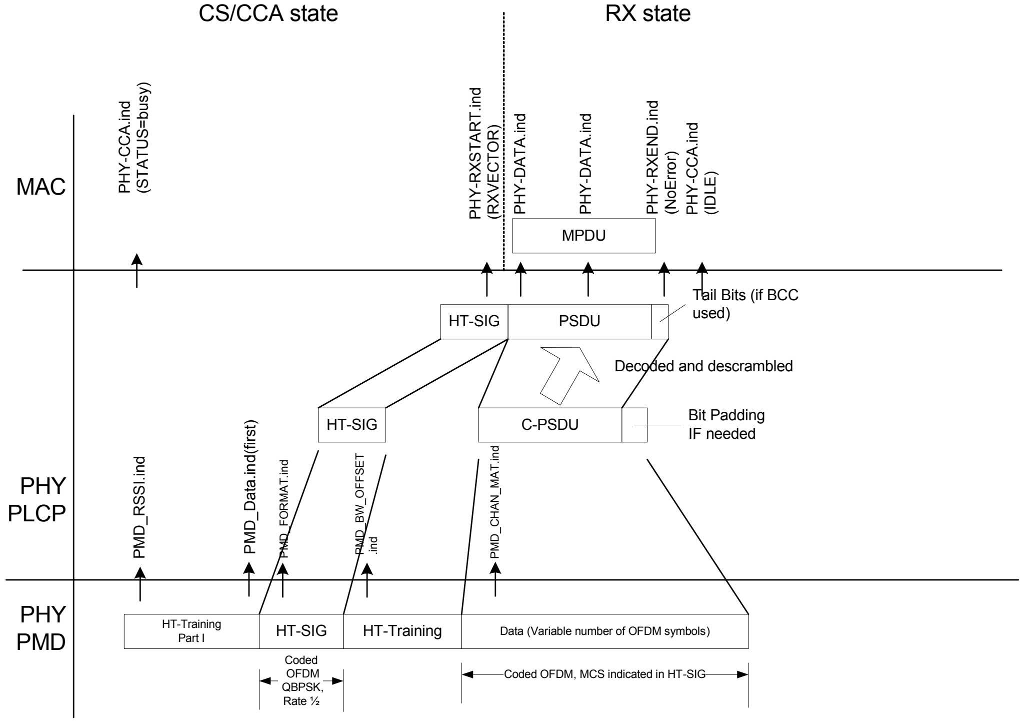
The received PSDU bits are assembled into octets, decoded, and presented to the MAC using a series of PHY-DATA.indication(DATA) primitive exchanges. The number of PSDU octets is indicted in the LENGTH field of the HT-SIG. The PHY shall proceed with PSDU reception. After the reception of the final bit of the last PSDU octet the receiver shall be returned to the RX IDLE state, as shown in Figure n86 (PLCP receive state machine). A PHY-RXEND.indication(NoError) primitive shall be issued.

If the binary convolutional code is used, any data received after the indicated data length are considered pad bits (to fill out an OFDM symbol) and should be discarded.



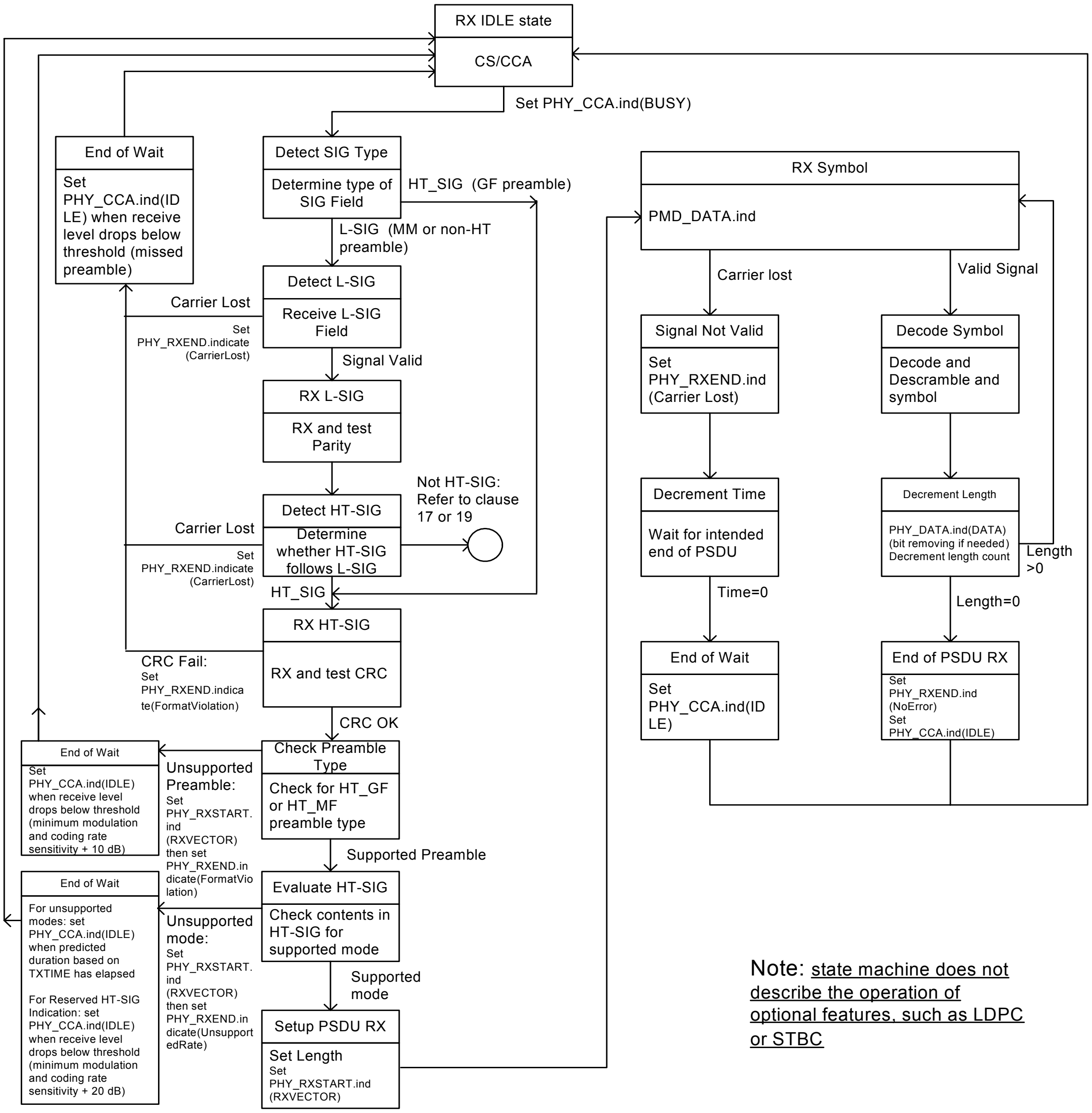
Note: procedure does not describe the operation of optional features, such as LDPC or STBC

Figure n84—PLCP receive procedure for HT mixed format PLCP format



Note: procedure does not describe the operation of optional features, such as LDPC or STBC

Figure n85—PLCP receive procedure for HT greenfield format PLCP



Note: state machine does not describe the operation of optional features, such as LDPC or STBC

Figure n86—PLCP receive state machine

Insert the following new subclause heading:

20.4 HT PLME

Insert the following new subclause:

20.4.1 PLME_SAP sublayer management primitives

Table n76 (HT PHY MIB attributes) lists the MIB attributes that may be accessed by the PHY entities and the intralayer of higher level LMEs. These attributes are accessed via the PLME-GET, PLME-SET, PLME-RESET, and PLME-CHARACTERISTICS primitives defined in 10.4.

Insert the following new subclause:

20.4.2 PHY Management Information Base

HT PHY MIB attributes are defined in Annex D with specific values defined in Table n76 (HT PHY MIB attributes).

Table n76—HT PHY MIB attributes

Managed Object	**Default value/range**	**Operational semantics**
dot11 PHY Operation Table		
dot11PHYType	HT (X'07')	Static
dot11CurrentRegDomain	Implementation dependent	Static
dot11TempType	Implementation dependent	Static
dot11 PHY Antenna Table		
dot11CurrentTxAntenna	Implementation dependent	Dynamic
dot11DiversitySupport	Implementation dependent	Static
dot11CurrentRxAntenna	Implementation dependent	Dynamic
dot11AntennaSelectionOptionImplemented	False/Boolean	Static
dot11TransmitExplicitCSIFeedbackASOptionImplemented	False/Boolean	Static
dot11TransmitIndicesFeedbackASOptionImplemented	False/Boolean	Static
dot11ExplicitCSIFeedbackASOptionImplemented	False/Boolean	Static
dot11TransmitIndicesComputationFeedbackASOptionImplemented	False/Boolean	Static
dot11ReceiveAntennaSelectionASSOptionImplemented	False/Boolean	Static
dot11TransmitSoundingPPDUOptionImplemented	False/Boolean	Static
dot11 PHY Tx Power Table		
dot11NumberSupportedPowerLevels	Implementation dependent	Static
dot11TxPowerLevel1	Implementation dependent	Static
dot11TxPowerLevel2	Implementation dependent	Static

Table n76—HT PHY MIB attributes *(continued)*

dot11TxPowerLevel3	Implementation dependent	Static
dot11TxPowerLevel4	Implementation dependent	Static
dot11TxPowerLevel5	Implementation dependent	Static
dot11TxPowerLevel6	Implementation dependent	Static
dot11TxPowerLevel7	Implementation dependent	Static
dot11TxPowerLevel8	Implementation dependent	Static
dot11CurrentTxPowerLevel	Implementation dependent	Dynamic
Dot11 Phy DSSS Table		
dot11CurrentChannel	Implementation dependent	Dynamic
dot11 Reg Domains Supported Table		
dot11RegDomainsSupported	Implementation dependent	Static
dot11FrequencyBandsSupported	Implementation dependent	Static
dot11 PHY Antennas List Table		
dot11SupportedTxAntenna	Implementation dependent	Dynamic
dot11SupportedRxAntenna	Implementation dependent	Static
dot11DiversitySelectionRx	Implementation dependent	Dynamic
dot11 Supported Data Rates Tx Table		

Table n76—HT PHY MIB attributes *(continued)*

dot11SupportedDataratesTxValue	X'02' = 1 Mb/s (2.4) X'04' = 2 Mb/s (2.4) X'0B' = 5.5 Mb/s (2.4) X'16' = 11 Mb/s (2.4) X'0C' = 6 Mb/s X'12' = 9 Mb/s X'18' = 12 Mb/s X'24' = 18 Mb/s X'2C = 22 Mb/s X'30' = 24 Mb/s X'42 = 33 Mb/s X'48' = 36 Mb/s X'60' = 48 Mb/s X'6C' = 54 Mb/s	Static
dot11 Supported Data Rates Rx Table		
`dot11SupportedDataratesRxValue`	X'02' = 1 Mb/s (2.4) X'04' = 2 Mb/s (2.4) X'0B' = 5.5 Mb/s (2.4) X'16' = 11 Mb/s (2.4) X'0C' = 6 Mb/s X'12' = 9 Mb/s X'18' = 12 Mb/s X'24' = 18 Mb/s X'2C = 22 Mb/s X'30' = 24 Mb/s X'42 = 33 Mb/s X'48' = 36 Mb/s X'60' = 48 Mb/s X'6C' = 54 Mb/s	Static
dot11 HRDSSS PHY Table		
`dot11ShortPreambleOptionImplemented`	True	Static
`dot11PBCCOptionImplemented`	Implementation dependent	Static
`dot11ChannelAgilityPresent`	Implementation dependent	Static
`dot11ChannelAgilityEnabled`	Implementation dependent	Dynamic
dot11 PHY OFDM Table		
`dot11CurrentFrequency`	Implementation dependent	Dynamic
`dot11TIThreshold`	Implementation dependent	Dynamic
`dot11 Channel starting factor`	Implementation dependent	Dynamic
dot11 PHY ERP Table		

Table n76—HT PHY MIB attributes *(continued)*

dot11ERP-PBCCOptionImplemented	Implementation dependent	Static
dot11DSSS-OFDMOptionImplemented	Implementation dependent	Static
dot11DSSS-OFDMOptionEnabled	Implementation dependent	Dynamic
dot11ShortSlotTimeOptionImplemented	Implementation dependent	Static
dot11ShortSlotTimeOptionEnabled	Implementation dependent	Dynamic
dot11 PHY HT Table		
dot11FortyMHzOperationImplemented	False/Boolean	Static
dot11FortyMHzOperationEnabled	False/Boolean	Dynamic
dot11CurrentPrimaryChannel	Implementation dependent	Dynamic
dot11CurrentSecondaryChannel	Implementation dependent	Dynamic
dot11NumberOfSpatialStreamsImplemented	Implementation dependent	Static
dot11NumberOfSpatialStreamsEnabled	Implementation dependent	Static
dot11GreenfieldOptionImplemented	False/Boolean	Static
dot11GreenfieldOptionEnabled	False/Boolean	Dynamic
dot11ShortGIOptionInTwentyImplemented	False/Boolean	Static
dot11ShortGIOptionInTwentyEnabled	False/Boolean	Dynamic
dot11ShortGIOptionInFortyImplemented	False/Boolean	Static
dot11ShortGIOptionInFortyEnabled	False/Boolean	Dynamic
dot11LDPCCodingOptionImplemented	False/Boolean	Static
dot11LDPCCodingOptionEnabled	False/Boolean	Dynamic
dot11TxSTBCOptionImplemented	False/Boolean	Static
dot11TxSTBCOptionEnabled	False/Boolean	Dynamic
dot11RxSTBCOptionImplemented	False/Boolean	Static
dot11RxSTBCOptionEnabled	False/Boolean	Dynamic
dot11BeamFormingOptionImplemented	False/Boolean	Static
dot11BeamFormingOptionEnabled	False/Boolean	Dynamic

Table n76—HT PHY MIB attributes *(continued)*

dot11 Supported MCS Tx Table		
`dot11SupportedMCSTxValue`	MCS 0-76 for 20 MHz; MCS 0-76 for 40 MHz (MCS 0-7 for 20 MHz mandatory at non-AP STA; MCS 0-15 for 20 MHz mandatory at AP)	Static
dot11 Supported MCS Rx Table		
`dot11SupportedMCSRxValue`	MCS 0-76 for 20 MHz; MCS 0-76 for 40 MHz (MCS 0-7 for 20 MHz mandatory at non-AP STA; MCS 0-15 for 20 MHz mandatory at AP)	Static
dot11 Tx BF Config Table		
`dot11ReceiveStaggerSoundingOptionImplemented`	False/Boolean	Static
`dot11TransmitStaggerSoundingOptionImplemented`	False/Boolean	Static
`dot11ReceiveNDPOptionImplemented`	False/Boolean	Static
`dot11TransmitNDPOptionImplemented`	False/Boolean	Static
`dot11ImplicitTxBFOptionImplemented`	False/Boolean	Static
`dot11CalibrationOptionImplemented`	Implementation dependent	Static
`dot11ExplicitCSITxBFOptionImplemented`	False/Boolean	Static
`dot11ExplicitNonCompressedBeamforming-MatrixOptionImplemented`	False/Boolean	Static
`dot11ExplicitBFCSIFeedbackOptionImplemented`	Implementation dependent	Static

Table n76—HT PHY MIB attributes *(continued)*

`dot11ExplicitNoncompressedBeamformingMatrix-FeedbackOptionImplemented`	Implementation dependent	Static
`dot11ExplicitCompressedBeamforming-MatrixFeedbackOptionImplemented`	Implementation dependent	Static
`dot11NumberBeamFormingCSISupportAntenna`	Implementation dependent	Static
`dot11NumberNonCompressedBeamforming-MatrixSupportAntenna`	Implementation dependent	Static
`dot11NumberCompressedBeamforming-MatrixSupportAntenna`	Implementation dependent	Static
`dot11MaxCSIFeedbackDelay`	Implementation dependent	Static
`Dot11TxMCSSetDefined`	False/Boolean	Static
`dot11TxRxMCSSetNotEqual`	False/Boolean	Static
`dot11TxMaximumNumberSpatialStreamsSupported`	False/Boolean	Static
`dot11TxUnequalModulationSupported`	False/Boolean	Static

Insert the following new subclause:

20.4.3 TXTIME calculation

The value of the TXTIME parameter returned by the PLME-TXTIME.confirm primitive shall be calculated for HT mixed format according to the Equation (20-91) and Equation (20-92) for short and regular GI, and for greenfield format according to Equation (20-93) and Equation (20-94) for short and regular GI respectively:

$$\mathrm{TXTIME} = \mathrm{T_{LEG\_PREAMBLE}} + \mathrm{T_{L\_SIG}} + \mathrm{T_{HT\_PREAMBLE}} + \mathrm{T_{HT\_SIG}} + \mathrm{T_{SYM}} \times \mathrm{Ceiling}\left(\frac{\mathrm{T_{SYMS}} \times \mathrm{N_{SYM}}}{\mathrm{T_{SYM}}}\right) \tag{20-91}$$

$$\mathrm{TXTIME} = \mathrm{T_{LEG\_PREAMBLE}} + \mathrm{T_{L\_SIG}} + \mathrm{T_{HT\_PREAMBLE}} + \mathrm{T_{HT\_SIG}} + \mathrm{T_{SYM}} \times \mathrm{N_{SYM}} \tag{20-92}$$

$$\mathrm{TXTIME} = \mathrm{T_{GF\_HT\_PREAMBLE}} + \mathrm{T_{HT\_SIG}} + \mathrm{T_{SYMS}} \times \mathrm{N_{SYM}} \tag{20-93}$$

$$\mathrm{TXTIME} = \mathrm{T_{GF\_HT\_PREAMBLE}} + \mathrm{T_{HT\_SIG}} + \mathrm{T_{SYM}} \times \mathrm{N_{SYM}} \tag{20-94}$$

where

$\mathrm{T_{LEG\_PREAMBLE}} = T_{L-STF} + T_{L-LTF}$ is the duration of the non-HT preamble,

$T_{HT\_PREAMBLE}$ is the duration of the HT preamble in HT mixed format. This duration is $T_{HT-STF} + T_{HT-LTF1} + (N_{LTF} - 1)T_{HT-LTFs}$,

$T_{HT\_PREAMBLE}$ is the duration of the preamble in HT greenfield format. This duration is $T_{HT-GF-STF} + T_{HT-LTF1} + (N_{LTF} - 1)T_{HT-LTFs}$,

T_{SYM}, T_{SYMS}, T_{HT-SIG}, T_{L-STF}, T_{HT-STF}, T_{L-LTF}, $T_{HT-LTF1}$ and $T_{HT-LTFs}$ are defined in Table n58 (Timing related constants)**,**

N_{SYM} is the total number of data symbols in the data portion, which may be calculated according to Equation (20-95).

$$\begin{aligned} N_{SYM} &= m_{STBC} \times Ceil\left(\frac{8 \cdot length + 16 + 6 \cdot N_{ES}}{m_{STBC} \cdot N_{DBPS}}\right) && \text{When BCC is used} \\ N_{SYM} &= N_{avbits} / N_{CBPS} && \text{When LDPC is used} \end{aligned} \qquad (20\text{-}95)$$

where

length is the number of octets in the data portion of the PPDU;

m_{STBC} is equal to 2 when space time block code (STBC) is used, and otherwise 1;

N_{ES} and N_{CBPS} are defined in Table n59 (Frequently used parameters);

N_{DBPS} is defined in Table n81 (Symbols used in rate dependent parameter tables)***;***

N_{avbits} is defined in Equation (20-39).

For non-HT modes of operation refer to Clause 17 and Clause 19 for TXTIME calculations.

Insert the following new subclause:

20.4.4 PHY characteristics

The static HT PHY characteristics, provided through the PLME-CHARACTERISTICS service primitive, are shown in Table n77 (MIMO PHY characteristics). The definitions for these characteristics are given in 10.4.

Table n77—MIMO PHY characteristics

Characteristics	Value
aRIFSTime	2 µs
aSlotTime	9 µs
aSIFSTime	16 µs
aCCATime	< 4 µs
aPHY-RX-START-Delay	56 µs
aRxTxTurnaroundTime	< 2 µs
aTxPLCPDelay	Implementation dependent
aRxPLCPDelay	Implementation dependent
aRxTxSwitchTime	<< 1 µs
aTxRampOnTime	Implementation dependent
aTxRampOffTime	Implementation dependent
aTxRFDelay	Implementation dependent
aRxRFDelay	Implementation dependent
aAirPropagationTime	<< 1 µs
aMACProcessingDelay	< 2 µs
aPreambleLength	16 µs
aSTFOneLength	8 µs
aSTFTwoLength	4 µs
aLTFOneLength	8 µs
aLTFTwoLength	4 µs
aPLCPHeaderLength	4 µs
aPLCPSigTwoLength	8 µs
aPSDUMaxLength	65535
aPPDUMaxTime	10 ms
aIUStime	8 µs
aDTT2UTTTime,	32 µs
aCWmin	15
aCWmax	1023
aMaxCSIMatricesReportDelay	250 ms

The HT PHY introduces these new characteristics:

- aSTFOneLength is the length of the non-HT Short Training Field
- aSTFTwoLength is the length of the HT Short Training Field
- aLTFOneLength is the length of the First Long Training Field
- aLTFTwoLength is the length of the Additional HT Long Training Fields.
- The aPLCPSigTwoLength is the length of the HT SIGNAL Field.

For non-HT modes of operation refer to Clause 17 and Clause 19 for PHY characteristics.

Insert the following new subclause heading:

20.5 HT PMD sublayer

Insert the following new subclause:

20.5.1 Scope and field of application

Subclause 20.5 (HT PMD sublayer) describes the PMD services provided to the PLCP for the High Throughput (HT) PHY. Also defined in this subclause are the functional, electrical, and RF characteristics required for interoperability of implementations conforming to this specification. The relationship of this specification to the entire HT PHY is shown in Figure n87 (PMD layer reference model).

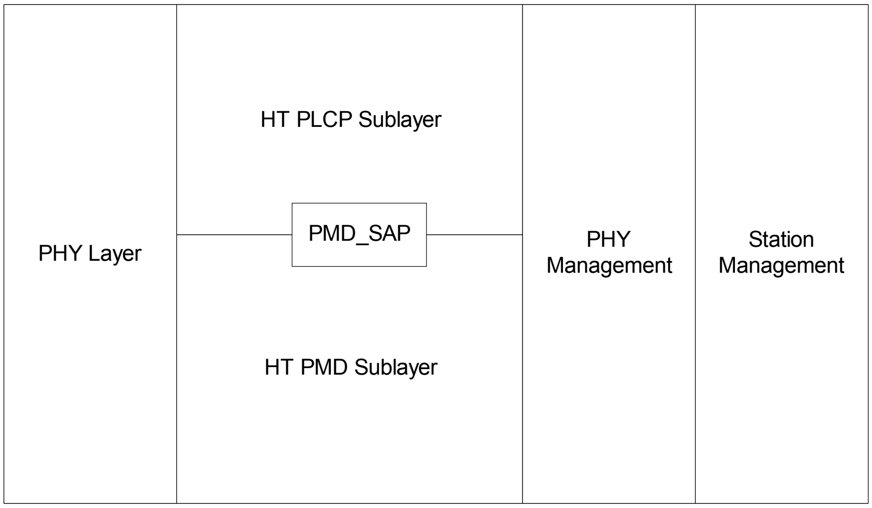


Figure n87—PMD layer reference model

Insert the following new subclause:

20.5.2 Overview of service

The HT PMD sublayer accepts PLCP sublayer service primitives and provides the actual means by which data are transmitted or received from the medium. The combined function of the HT PMD sublayer primitives and parameters for the receive function results in a data stream, timing information, and associated receive signal parameters being delivered to the PLCP sublayer. A similar functionality is provided for data transmission.

Insert the following new subclause:

20.5.3 Overview of interactions

The primitives provided by the HT PMD fall into two basic categories:

a) Service primitives that support PLCP peer-to-peer interactions;

b) Service primitives that have local significance and support sublayer-to-sublayer interactions.

Insert the following new subclause heading:

20.5.4 Basic service and options

Insert the following new subclause:

20.5.4.1 Status of service primitives

All of the service primitives described in 20.5.4 (Basic service and options) are mandatory, unless otherwise specified.

Insert the following new subclause:

20.5.4.2 PMD_SAP peer-to-peer service primitives

Table n78 (PMD_SAP peer-to-peer service primitives) indicates the primitives for peer-to-peer interactions.

Table n78—PMD_SAP peer-to-peer service primitives

Primitive	Request	Indicate	Confirm	Response
PMD_DATA	X	X	—	—

Insert the following new subclause:

20.5.4.3 PMD_SAP sublayer-to-sublayer service primitives

Table n79 (PMD_SAP sublayer-to-sublayer service primitives) indicates the primitives for sublayer-to-sublayer interactions.

Insert the following new subclause:

20.5.4.4 PMD_SAP service primitive parameters

Table n80 (List of parameters for the PMD primitives) shows the parameters used by one or more of the PMD_SAP service primitives.

Table n79—PMD_SAP sublayer-to-sublayer service primitives

Primitive	Request	Indicate	Confirm	Response
PMD_TXSTART	X	—	—	—
PMD_TXEND	X	—	—	—
PMD_TXPWRLVL	X	—	—	—
PMD_TX_PARAMETERS	X	—	—	—
PMD_EXPANSIONS_MAT	X	—	—	—
PMD_RSSI	—	X	—	—
PMD_RCPI	—	X	—	—
PMD_CHAN_MAT	—	X	—	—
PMD_FORMAT	—	X	—	—
PMD_CBW_OFFSET	—	X	—	—
PMD_EXPANSIONS_MAT_ON	X	—	—	—

Insert the following new subclause heading:

20.5.5 PMD_SAP detailed service specification

Insert the following new subclause:

20.5.5.1 Introduction to PMD_SAP service specification

20.5.5.2 (PMD_DATA.request) to 20.5.5.13 (PMD_FORMAT.indication) describe the services provided by each PMD primitive.

Insert the following new subclause:

20.5.5.2 PMD_DATA.request

Insert the following new subclause:

20.5.5.2.1 Function

This primitive defines the transfer of data from the PLCP sublayer to the PMD entity.

Insert the following new subclause:

20.5.5.2.2 Semantics of the service primitive

This primitive shall provide the following parameters: PMD_DATA.request (TXD_UNIT)

The TXD_UNIT parameter shall be the n-bit combination of 0 and 1 for one symbol of OFDM modulation. If the length of a coded PSDU (C-PSDU) is shorter than n bits, 0 bits are added to form an OFDM symbol. This parameter represents a single block of data that, in turn, shall be used by the PHY to be encoded into an OFDM transmitted symbol.

Table n80—List of parameters for the PMD primitives

Parameter	Associate primitive	Value
TXD_UNIT	PMD_DATA.request	One(1), Zero(0): one OFDM symbol value
RXD_UNIT	PMD_DATA.indication	One(1), Zero(0): one OFDM symbol value
TXPWR_LEVEL	PMD_TXPWRLVL.request	1 to 8 (max of 8 levels)
MCS	PMD_TX_PARAMETERS.request	0 to 76, MCS index defined in 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))
CH_BANDWIDTH	PMD_TX_PARAMETERS.request PMD_CBW_OFFSET.indication	Set to 0 for HT_CBW20 (20 MHz), Set to 1 for HT_CBW40 (40 MHz), Set to 2 for HT_CBW_20DN (Non-HT duplicate) Set to 3 for HT_CBW_20DH (HT duplicate)
CH_OFFSET	PMD_TX_PARAMETERS.request PMD_CBW_OFFSET.indication	Set to 0 for CH_OFF_40 (whole 40 MHz channel) Set to 1 for CH_OFF_20U (Upper 20 MHz in 40 MHz) Set to 3 for CH_OFF_20L (Lower 20 MHz in 40 MHz)
STBC	PMD_TX_PARAMETERS.request	Set to a non-zero number, indicates the difference between the number of space time streams N_{STS} and the number of spatial streams N_{SS} indicated by the MCS Set to 00 indicates no STBC (N_{STS}=N_{SS})
SHORT_GI	PMD_TX_PARAMETERS.request	Set to 0 indicates Short GI is not used in the packet Set to 1 indicates Short GI is used in the packet
ANTENNA_SET	PMD_TX_PARAMETERS.request	Bit field with 8 bits
EXPANSION_MAT	PMD_EXPANSIONS_MAT.request	$(N_{SD} + N_{SP})$ complex matrices of size $N_{TX} \times N_{STS}$
RSSI	PMD_RSSI.indication	0 to 255
RCPI	PMD_RCPI.indication	0 to 255
CHAN_MAT	PMD_CHAN_MAT.indication	$(N_{SD} + N_{SP})$ complex matrices of size $N_{RX} \times N_{STS}$
FORMAT	PMD_FORMAT.indication	Set to 0 for NON_HT Set to 1 for HT_MF Set to 2 for HT_GF

Insert the following new subclause:

20.5.5.2.3 When generated

This primitive shall be generated by the PLCP sublayer to request transmission of one OFDM symbol. The data clock for this primitive shall be supplied by the PMD layer based on the OFDM symbol clock.

Insert the following new subclause:

20.5.5.2.4 Effect of receipt

The PMD performs transmission of the data.

Insert the following new subclause header:

20.5.5.3 PMD_DATA.indication

Insert the following new subclause:

20.5.5.3.1 Function

This primitive defines the transfer of data from the PMD entity to the PLCP sublayer.

Insert the following new subclause:

20.5.5.3.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_DATA.indication(RXD_UNIT)

The RXD_UNIT parameter shall be 0 or 1, and shall represent either a SIGNAL field bit or a data field bit after the decoding of the FEC by the PMD entity.

Insert the following new subclause:

20.5.5.3.3 When generated

This primitive, generated by the PMD entity, forwards received data to the PLCP sublayer. The data clock for this primitive shall be supplied by the PMD layer based on the OFDM symbol clock.

Insert the following new subclause:

20.5.5.3.4 Effect of receipt

The PLCP sublayer interprets the bits that are recovered as part of the PLCP or passes the data to the MAC sublayer as part of the PSDU.

Insert the following new subclause heading:

20.5.5.4 PMD_TXSTART.request

Insert the following new subclause:

20.5.5.4.1 Function

This primitive, generated by the PHY PLCP sublayer, initiates PPDU transmission by the PMD layer.

Insert the following new subclause:

20.5.5.4.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_TXSTART.request

Insert the following new subclause:

20.5.5.4.3 When generated

This primitive shall be generated by the PLCP sublayer to initiate the PMD layer transmission of the PPDU. The PHY-TXSTART.request primitive shall be provided to the PLCP sublayer prior to issuing the PMD_TXSTART command.

Insert the following new subclause:

20.5.5.4.4 Effect of receipt

PMD_TXSTART initiates transmission of a PPDU by the PMD sublayer.

Insert the following new subclause heading:

20.5.5.5 PMD_TXEND.request

Insert the following new subclause:

20.5.5.5.1 Function

This primitive, generated by the PHY PLCP sublayer, ends PPDU transmission by the PMD layer.

Insert the following new subclause:

20.5.5.5.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_TXEND.request

Insert the following new subclause:

20.5.5.5.3 When generated

This primitive shall be generated by the PLCP sublayer to terminate the PMD layer transmission of the PPDU.

Insert the following new subclause:

20.5.5.5.4 Effect of receipt

PMD_TXEND terminates transmission of a PPDU by the PMD sublayer.

Insert the following new subclause heading:

20.5.5.6 PMD_TXPWRLVL.request

Insert the following new subclause:

20.5.5.6.1 Function

This primitive, generated by the PHY PLCP sublayer, selects the power level used by the PHY for transmission.

Insert the following new subclause:

20.5.5.6.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_TXPWRLVL.request (TXPWR_LEVEL)

TXPWR_LEVEL selects which of the transmit power levels should be used for the current packet transmission. The number of available power levels shall be determined by the MIB parameter aNumberSupportedPowerLevels. See 20.3.20.3 (Transmit power) for further information on the OFDM PHY power level control capabilities.

Insert the following new subclause:

20.5.5.6.3 When generated

This primitive shall be generated by the PLCP sublayer to select a specific transmit power. This primitive shall be applied prior to setting PMD_TXSTART into the transmit state.

Insert the following new subclause:

20.5.5.6.4 Effect of receipt

PMD_TXPWRLVL immediately sets the transmit power level to that given by TXPWR_LEVEL.

Insert the following new subclause heading:

20.5.5.7 PMD_RSSI.indication

Insert the following new subclause:

20.5.5.7.1 Function

This primitive, generated by the PMD sublayer, provides the receive signal strength to the PLCP and MAC entity.

Insert the following new subclause:

20.5.5.7.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_RSSI.indication (RSSI)

The RSSI shall be a measure of the RF energy received by the HT OFDM PHY. RSSI indications of up to 8 bits (256 levels) are supported.

Insert the following new subclause:

20.5.5.7.3 When generated

This primitive shall be generated by the PMD when the OFDM PHY is in the receive state. It shall be available continuously to the PLCP that, in turn, shall provide the parameter to the MAC entity.

Insert the following new subclause:

20.5.5.7.4 Effect of receipt

This parameter shall be provided to the PLCP layer for information only. The RSSI may be used as part of a CCA scheme.

Insert the following new subclause heading:

20.5.5.8 PMD_RCPI.indication

Insert the following new subclause:

20.5.5.8.1 Function

This primitive, generated by the PMD sublayer, provides the received channel power indicator to the PLCP and MAC entity.

Insert the following new subclause:

20.5.5.8.2 Semantics of the service primitive

The primitive shall provide the following parameter: PMD_RCPI.indication(RCPI).

The RCPI shall be a measure of the channel power received by the OFDM PHY. RCPI indications of 8 bits are supported.

Insert the following new subclause:

20.5.5.8.3 When generated

This primitive shall be generated by the PMD when the OFDM PHY is in the receive state. It shall be continuously available to the PLCP that, in turn, provides the parameter to the MAC entity.

Insert the following new subclause:

20.5.5.8.4 Effect of receipt

This parameter shall be provided to the PLCP layer for information only. The RCPI may be used in conjunction with RSSI to measure input signal quality.

Insert the following new subclause heading:

20.5.5.9 PMD_TX_PARAMETERS.request

Insert the following new subclause:

20.5.5.9.1 Function

This primitive, generated by the PHY PLCP sublayer, selects the related parameters used by the PHY for transmission.

Insert the following new subclause:

20.5.5.9.2 Semantics of the service primitive

This primitive shall provide the following parameter:

PMD_TX_PARAMETERS.request (MCS, CH_BANDWIDTH, CH_OFFSET, STBC, SHORT_GI, ANTENNA_SET)

Insert the following new subclause:

20.5.5.9.3 When generated

This primitive shall be generated by the PLCP sublayer to select a specific transmit parameter. This primitive shall be applied prior to setting PMD_TXSTART into the transmit state.

Insert the following new subclause:

20.5.5.9.4 Effect of receipt

PMD_TX_PARAMETERS immediately sets the transmit parameters. The receipt of these parameters selects the values that shall be used for all subsequent PPDU transmissions

Insert the following new subclause heading:

20.5.5.10 PMD_EXPANSIONS_MAT.request

Insert the following new subclause:

20.5.5.10.1 Function

This primitive, generated by the PHY PLCP sublayer, defines the steering matrices used by the PHY for transmission.

Insert the following new subclause:

20.5.5.10.2 Semantics of the service primitive

This primitive shall provide the following parameter:

PMD_EXPANSIONS_MAT.request (EXPANSION_MAT)

EXPANSION_MAT selects which steering matrices should be used for the current packet transmission.

Insert the following new subclause:

20.5.5.10.3 When generated

This primitive shall be generated by the PLCP sublayer to define specific steering matrices. This primitive shall be applied prior to setting PMD_TXSTART into the transmit state.

Insert the following new subclause:

20.5.5.10.4 Effect of receipt

PMD_EXPANSIONS_MAT immediately sets the transmission steering matrices to that given by EXPANSION_MAT. The receipt of PMD_EXPANSIONS_MAT selects the steering matrices that shall be used for all subsequent PPDU transmissions.

Insert the following new subclause:

20.5.5.11 PMD_CBW_OFFSET.indication

Insert the following new subclause:

20.5.5.11.1 Function

This primitive, generated by the PMD sublayer, provides the bandwidth and channel offset of the received frame to the PLCP and MAC entity.

Insert the following new subclause:

20.5.5.11.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_CBW_OFFSET.indication (CH_BANDWIDTH, CH_OFFSET)

CH_BANDWIDTH represents channel width (20 MHz or 40 MHz) and the transmission format (non-HT duplicate or HT duplicate). CH_OFFSET indicates a 20 MHz sub-channel of the 40 MHz channel (upper or lower).

Insert the following new subclause:

20.5.5.11.3 When generated

This primitive shall be generated by the PMD when the OFDM PHY is in the receive state. It shall be available continuously to the PLCP that, in turn, shall provide the parameter to the MAC entity.

Insert the following new subclause:

20.5.5.11.4 Effect of receipt

The PLCP sublayer passes the data to the MAC sublayer as part of the RXVECTOR.

Insert the following new subclause heading:

20.5.5.12 PMD_CHAN_MAT.indication

Insert the following new subclause:

20.5.5.12.1 Function

This primitive, generated by the PMD sublayer, provides the channel response matrices to the PLCP and MAC entity.

Insert the following new subclause:

20.5.5.12.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_CHAN_MAT.indication (CHAN_MAT)

The CHAN_MAT parameter contains the channel response matrices that were measured during the reception of the current frame.

Insert the following new subclause:

20.5.5.12.3 When generated

This primitive shall be generated by the PMD when the OFDM PHY is in the receive state. It shall be available continuously to the PLCP that, in turn, shall provide the parameter to the MAC entity.

Insert the following new subclause:

20.5.5.12.4 Effect of receipt

The PLCP sublayer passes the data to the MAC sublayer as part of the RXVECTOR.

Insert the following new subclause heading:

20.5.5.13 PMD_FORMAT.indication

Insert the following new subclause:

20.5.5.13.1 Function

This primitive, generated by the PMD sublayer, provides the format of the received frame to the PLCP and MAC entity.

Insert the following new subclause:

20.5.5.13.2 Semantics of the service primitive

This primitive shall provide the following parameter: PMD_FORMAT.indication (FORMAT).

The format indicates one of the PPDU formats: non HT, HT mixed format or greenfield format.

Insert the following new subclause:

20.5.5.13.3 When generated

This primitive shall be generated by the PMD when the OFDM PHY is in the receive state. It shall be available continuously to the PLCP that, in turn, shall provide the parameter to the MAC entity.

Insert the following new subclause:

20.5.5.13.4 Effect of receipt

The PLCP sublayer passes the data to the MAC sublayer as part of the RXVECTOR.

Insert the following new subclause:

20.6 Rate dependent parameters for HT Modulation and Coding Schemes (MCS)

Table n81 (Symbols used in rate dependent parameter tables) defines the symbols used in the rate dependent parameter tables.

Table n81—Symbols used in rate dependent parameter tables

Symbol	Explanation
N_{SS}	Number of spatial streams
R	Code rate
N_{BPSC}	Number of coded bits per single carrier (total across spatial streams)
$N_{BPSCS}(i_{SS})$	Number of coded bits per single carrier for each spatial stream, $i_{SS} = 1,...,N_{SS}$
N_{SD}	Number of data subcarriers
N_{SP}	Number of pilot subcarriers
N_{CBPS}	Number of coded bits per OFDM symbol
N_{DBPS}	Number of data bits per OFDM symbol
N_{ES}	Number of FEC encoders
N_{TBPS}	Total bits per subcarrier

Table n82 (Rate dependent parameters for mandatory 20 MHz, NSS =1 MCSs, NES = 1) defines the rate dependent parameters for mandatory 20 MHz, N_{SS} = 1 MCSs with N_{ES} = 1.

Table n82—Rate dependent parameters for mandatory 20 MHz, N_{SS} =1 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI see NOTE
0	BPSK	1/2	1	52	4	52	26	6.5	7.2
1	QPSK	1/2	2	52	4	104	52	13.0	14.4
2	QPSK	3/4	2	52	4	104	78	19.5	21.7
3	16-QAM	1/2	4	52	4	208	104	26.0	28.9
4	16-QAM	3/4	4	52	4	208	156	39.0	43.3
5	64-QAM	2/3	6	52	4	312	208	52.0	57.8
6	64-QAM	3/4	6	52	4	312	234	58.5	65.0
7	64-QAM	5/6	6	52	4	312	260	65.0	72.2
NOTE—Support of 400 ns guard interval is optional on transmit and receive									

Table n83 (Rate-dependent parameters for optional 20 MHz, NSS = 2 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 20 MHz, N_{SS} = 2 MCSs with N_{ES} = 1.

Table n83—Rate-dependent parameters for optional 20 MHz, N_{SS} = 2 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI See NOTE
8	BPSK	1/2	1	52	4	104	52	13.0	14.4
9	QPSK	1/2	2	52	4	208	104	26.0	28.9
10	QPSK	3/4	2	52	4	208	156	39.0	43.3
11	16-QAM	1/2	4	52	4	416	208	52.0	57.8
12	16-QAM	3/4	4	52	4	416	312	78.0	86.7
13	64-QAM	2/3	6	52	4	624	416	104.0	115.6
14	64-QAM	3/4	6	52	4	624	468	117.0	130.0
15	64-QAM	5/6	6	52	4	624	520	130.0	144.4
NOTE—The 400 ns GI rate values are rounded to 1 decimal place									

Table n84 (Rate-dependent parameters for optional 20 MHz, NSS = 3 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 20 MHz, N_{SS} = 3 MCSs with N_{ES} = 1.

Table n84—Rate-dependent parameters for optional 20 MHz, N_{SS} = 3 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
16	BPSK	1/2	1	52	4	156	78	19.5	21.7
17	QPSK	1/2	2	52	4	312	156	39.0	43.3
18	QPSK	3/4	2	52	4	312	234	58.5	65.0
19	16-QAM	1/2	4	52	4	624	312	78.0	86.7
20	16-QAM	3/4	4	52	4	624	468	117.0	130.0
21	64-QAM	2/3	6	52	4	936	624	156.0	173.3
22	64-QAM	3/4	6	52	4	936	702	175.5	195.0
23	64-QAM	5/6	6	52	4	936	780	195.0	216.7

Table n85 (Rate-dependent parameters for optional 20 MHz, NSS = 4 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 20 MHz, N_{SS} = 4 MCSs with N_{ES} = 1.

Table n85—Rate-dependent parameters for optional 20 MHz, N_{SS} = 4 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI[1]
24	BPSK	1/2	1	52	4	208	104	26.0	28.9
25	QPSK	1/2	2	52	4	416	208	52.0	57.8
26	QPSK	3/4	2	52	4	416	312	78.0	86.7
27	16-QAM	1/2	4	52	4	832	416	104.0	115.6
28	16-QAM	3/4	4	52	4	832	624	156.0	173.3
29	64-QAM	2/3	6	52	4	1248	832	208.0	231.1
30	64-QAM	3/4	6	52	4	1248	936	234.0	260.0
31	64-QAM	5/6	6	52	4	1248	1040	260.0	288.9

Table n86 (Rate-dependent parameters for optional 40 MHz, NSS = 1 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 1 MCSs with N_{ES} = 1.

Table n86—Rate-dependent parameters for optional 40 MHz, N_{SS} = 1 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
0	BPSK	1/2	1	108	6	108	54	13.5	15.0
1	QPSK	1/2	2	108	6	216	108	27.0	30.0
2	QPSK	3/4	2	108	6	216	162	40.5	45.0
3	16-QAM	1/2	4	108	6	432	216	54.0	60.0
4	16-QAM	3/4	4	108	6	432	324	81.0	90.0
5	64-QAM	2/3	6	108	6	648	432	108.0	120.0
6	64-QAM	3/4	6	108	6	648	486	121.5	135.0
7	64-QAM	5/6	6	108	6	648	540	135.0	150.0

Table n87 (Rate-dependent parameters for optional 40 MHz, NSS = 2 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 2 MCSs with N_{ES} = 1.

Table n87—Rate-dependent parameters for optional 40 MHz, N_{SS} = 2 MCSs, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
8	BPSK	1/2	1	108	6	216	108	27.0	30.0
9	QPSK	1/2	2	108	6	432	216	54.0	60.0
10	QPSK	3/4	2	108	6	432	324	81.0	90.0
11	16-QAM	1/2	4	108	6	864	432	108.0	120.0
12	16-QAM	3/4	4	108	6	864	648	162.0	180.0
13	64-QAM	2/3	6	108	6	1296	864	216.0	240.0
14	64-QAM	3/4	6	108	6	1296	972	243.0	270.0
15	64-QAM	5/6	6	108	6	1296	1080	270.0	300.0

Table n88 (Rate-dependent parameters for optional 40 MHz, NSS = 3 MCSs) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 3 MCSs.

Table n88—Rate-dependent parameters for optional 40 MHz, N_{SS} = 3 MCSs

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	N_{ES}	Data rate (Mb/s)	
									800 ns GI	400 ns GI
16	BPSK	1/2	1	108	6	324	162	1	40.5	45.0
17	QPSK	1/2	2	108	6	648	324	1	81.0	90.0
18	QPSK	3/4	2	108	6	648	486	1	121.5	135.0
19	16-QAM	1/2	4	108	6	1296	648	1	162.0	180.0
20	16-QAM	3/4	4	108	6	1296	972	1	243.0	270.0
21	64-QAM	2/3	6	108	6	1944	1296	2	324.0	360.0
22	64-QAM	3/4	6	108	6	1944	1458	2	364.5	405.0
23	64-QAM	5/6	6	108	6	1944	1620	2	405.0	450.0

Table n89 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 4 MCSs.

Table n89—Rate-dependent parameters for optional 40 MHz, N_{SS} = 4 MCSs

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	N_{ES}	Data rate (Mb/s)	
									800 ns GI	400 ns GI
24	BPSK	1/2	1	108	6	432	216	1	54.0	60.0
25	QPSK	1/2	2	108	6	864	432	1	108.0	120.0
26	QPSK	3/4	2	108	6	864	648	1	162.0	180.0
27	16-QAM	1/2	4	108	6	1728	864	1	216.0	240.0
28	16-QAM	3/4	4	108	6	1728	1296	2	324.0	360.0
29	64-QAM	2/3	6	108	6	2592	1728	2	432.0	480.0
30	64-QAM	3/4	6	108	6	2592	1944	2	486.0	540.0
31	64-QAM	5/6	6	108	6	2592	2160	2	540.0	600.0

Table n90 (Rate-dependent parameters for optional 40 MHz HT duplicate format, NSS = 1, NES = 1) defines the rate dependent parameters for optional 40 MHz HT duplicate format, N_{SS} = 1.

Table n90—Rate-dependent parameters for optional 40 MHz HT duplicate format, N_{SS} = 1, N_{ES} = 1

MCS Index	Modulation	R	$N_{BPSCS}(i_{SS})$	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
								800 ns GI	400 ns GI
32	BPSK	1/2	1	96	8	48	24	6.0	6.7

Table n91 (Rate-dependent parameters for optional 20 MHz, NSS = 2 MCSs, NES = 1) defines the rate dependent parameters for optional 20 MHz, N_{SS} = 2 MCSs with N_{ES} = 1.

Table n91—Rate-dependent parameters for optional 20 MHz, N_{SS} = 2 MCSs, N_{ES} = 1

MCS Index	Modulation		R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
	Stream 1	Stream 2							800 ns GI	400 ns GI
33	16-QAM	QPSK	1/2	6	52	4	312	156	39	43.3
34	64-QAM	QPSK	1/2	8	52	4	416	208	52	57.8
35	64-QAM	16-QAM	1/2	10	52	4	520	260	65	72.2
36	16-QAM	QPSK	3/4	6	52	4	312	234	58.5	65.0
37	64-QAM	QPSK	3/4	8	52	4	416	312	78	86.7
38	64-QAM	16-QAM	3/4	10	52	4	520	390	97.5	108.3

Table n92 (Rate dependent parameters for optional 20 MHz, NSS = 3 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 20 MHz, N_{SS} = 3 MCSs with N_{ES} = 1.

Table n92—Rate dependent parameters for optional 20 MHz, N_{SS} = 3 MCSs, N_{ES} = 1

MCS Index	Modulation			R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
	Stream 1	Stream 2	Stream 3							800 ns GI	400 ns GI
39	16-QAM	QPSK	QPSK	1/2	8	52	4	416	208	52	57.8
40	16-QAM	16-QAM	QPSK	1/2	10	52	4	520	260	65	72.2
41	64-QAM	QPSK	QPSK	1/2	10	52	4	520	260	65	72.2
42	64-QAM	16-QAM	QPSK	1/2	12	52	4	624	312	78	86.7
43	64-QAM	16-QAM	16-QAM	1/2	14	52	4	728	364	91	101.1
44	64-QAM	64-QAM	QPSK	1/2	14	52	4	728	364	91	101.1
45	64-QAM	64-QAM	16-QAM	1/2	16	52	4	832	416	104	115.6
46	16-QAM	QPSK	QPSK	3/4	8	52	4	416	312	78	86.7
47	16-QAM	16-QAM	QPSK	3/4	10	52	4	520	390	97.5	108.3
48	64-QAM	QPSK	QPSK	3/4	10	52	4	520	390	97.5	108.3
49	64-QAM	16-QAM	QPSK	3/4	12	52	4	624	468	117	130.0
50	64-QAM	16-QAM	16-QAM	3/4	14	52	4	728	546	136.5	151.7
51	64-QAM	64-QAM	QPSK	3/4	14	52	4	728	546	136.5	151.7
52	64-QAM	64-QAM	16-QAM	3/4	16	52	4	832	624	156	173.3

Table n93 (Rate-dependent parameters for optional 20 MHz, NSS = 4 MCSs, N_{ES} = 1) defines the rate dependent parameters for optional 20 MHz, N_{SS} = 4 MCSs with N_{ES} = 1.

Table n93—Rate-dependent parameters for optional 20 MHz, N_{SS} = 4 MCSs, N_{ES} = 1

MCS Index	Modulation				R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
	Stream 1	Stream 2	Stream 3	Stream 4							800 ns GI	400 ns GI
53	16-QAM	QPSK	QPSK	QPSK	1/2	10	52	4	520	260	65	72.2
54	16-QAM	16-QAM	QPSK	QPSK	1/2	12	52	4	624	312	78	86.7
55	16-QAM	16-QAM	16-QAM	QPSK	1/2	14	52	4	728	364	91	101.1
56	64-QAM	QPSK	QPSK	QPSK	1/2	12	52	4	624	312	78	86.7
57	64-QAM	16-QAM	QPSK	QPSK	1/2	14	52	4	728	364	91	101.1
58	64-QAM	16-QAM	16-QAM	QPSK	1/2	16	52	4	832	416	104	115.6
59	64-QAM	16-QAM	16-QAM	16-QAM	1/2	18	52	4	936	468	117	130.0
60	64-QAM	64-QAM	QPSK	QPSK	1/2	16	52	4	832	416	104	115.6
61	64-QAM	64-QAM	16-QAM	QPSK	1/2	18	52	4	936	468	117	130.0
62	64-QAM	64-QAM	16-QAM	16-QAM	1/2	20	52	4	1040	520	130	144.4
63	64-QAM	64-QAM	64-QAM	QPSK	1/2	20	52	4	1040	520	130	144.4
64	64-QAM	64-QAM	64-QAM	16-QAM	1/2	22	52	4	1144	572	143	158.9
65	16-QAM	QPSK	QPSK	QPSK	3/4	10	52	4	520	390	97.5	108.3
66	16-QAM	16-QAM	QPSK	QPSK	3/4	12	52	4	624	468	117	130.0
67	16-QAM	16-QAM	16-QAM	QPSK	3/4	14	52	4	728	546	136.5	151.7
68	64-QAM	QPSK	QPSK	QPSK	3/4	12	52	4	624	468	117	130.0
69	64-QAM	16-QAM	QPSK	QPSK	3/4	14	52	4	728	546	136.5	151.7
70	64-QAM	16-QAM	16-QAM	QPSK	3/4	16	52	4	832	624	156	173.3
71	64-QAM	16-QAM	16-QAM	16-QAM	3/4	18	52	4	936	702	175.5	195.0
72	64-QAM	64-QAM	QPSK	QPSK	3/4	16	52	4	832	624	156	173.3
73	64-QAM	64-QAM	16-QAM	QPSK	3/4	18	52	4	936	702	175.5	195.0
74	64-QAM	64-QAM	16-QAM	16-QAM	3/4	20	52	4	1040	780	195	216.7
75	64-QAM	64-QAM	64-QAM	QPSK	3/4	20	52	4	1040	780	195	216.7
76	64-QAM	64-QAM	64-QAM	16-QAM	3/4	22	52	4	1144	858	214.5	238.3

Table n94 (Rate-dependent parameters for optional 40 MHz, NSS = 2 MCSs, NES = 1) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 2 MCSs with N_{ES} = 1.

Table n94—Rate-dependent parameters for optional 40 MHz, N_{SS} = 2 MCSs, N_{ES} = 1

MCS Index	Modulation		R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	Data rate (Mb/s)	
	Stream 1	Stream 2							800 ns GI	400 ns GI
33	16-QAM	QPSK	1/2	6	108	6	648	324	81	90
34	64-QAM	QPSK	1/2	8	108	6	864	432	108	120
35	64-QAM	16-QAM	1/2	10	108	6	1080	540	135	150
36	16-QAM	QPSK	3/4	6	108	6	648	486	121.5	135
37	64-QAM	QPSK	3/4	8	108	6	864	648	162	180
38	64-QAM	16-QAM	3/4	10	108	6	1080	810	202.5	225

Table n95 (Rate-dependent parameters for optional 40 MHz, NSS = 3 MCSs) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 3 MCSs.

Table n95—Rate-dependent parameters for optional 40 MHz, N_{SS} = 3 MCSs

MCS Index	Modulation			R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	N_{ES}	Data rate (Mb/s)	
	Stream 1	Stream 2	Stream 3								800 ns GI	400 ns GI
39	16-QAM	QPSK	QPSK	1/2	8	108	6	864	432	1	108	120
40	16-QAM	16-QAM	QPSK	1/2	10	108	6	1080	540	1	135	150
41	64-QAM	QPSK	QPSK	1/2	10	108	6	1080	540	1	135	150
42	64-QAM	16-QAM	QPSK	1/2	12	108	6	1296	648	1	162	180
43	64-QAM	16-QAM	16-QAM	1/2	14	108	6	1512	756	1	189	210
44	64-QAM	64-QAM	QPSK	1/2	14	108	6	1512	756	1	189	210
45	64-QAM	64-QAM	16-QAM	1/2	16	108	6	1728	864	1	216	240
46	16-QAM	QPSK	QPSK	3/4	8	108	6	864	648	1	162	180
47	16-QAM	16-QAM	QPSK	3/4	10	108	6	1080	810	1	202.5	225
48	64-QAM	QPSK	QPSK	3/4	10	108	6	1080	810	1	202.5	225
49	64-QAM	16-QAM	QPSK	3/4	12	108	6	1296	972	1	243	270
50	64-QAM	16-QAM	16-QAM	3/4	14	108	6	1512	1134	1	283.5	315
51	64-QAM	64-QAM	QPSK	3/4	14	108	6	1512	1134	1	283.5	315
52	64-QAM	64-QAM	16-QAM	3/4	16	108	6	1728	1296	2	324	360

Table n96 (Rate-dependent parameters for optional 40 MHz, NSS = 4 MCSs) defines the rate dependent parameters for optional 40 MHz, N_{SS} = 4 MCSs.

Table n96—Rate-dependent parameters for optional 40 MHz, N_{SS} = 4 MCSs

MCS Index	Modulation				R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	N_{ES}	Data rate (Mb/s)	
	Stream 1	**Stream 2**	**Stream 3**	**Stream 4**								**800 ns GI**	**400 ns GI**
53	16-QAM	QPSK	QPSK	QPSK	1/2	10	108	6	1080	540	1	135	150
54	16-QAM	16-QAM	QPSK	QPSK	1/2	12	108	6	1296	648	1	162	180
55	16-QAM	16-QAM	16-QAM	QPSK	1/2	14	108	6	1512	756	1	189	210
56	64-QAM	QPSK	QPSK	QPSK	1/2	12	108	6	1296	648	1	162	180
57	64-QAM	16-QAM	QPSK	QPSK	1/2	14	108	6	1512	756	1	189	210
58	64-QAM	16-QAM	16-QAM	QPSK	1/2	16	108	6	1728	864	1	216	240
59	64-QAM	16-QAM	16-QAM	16-QAM	1/2	18	108	6	1944	972	1	243	270
60	64-QAM	64-QAM	QPSK	QPSK	1/2	16	108	6	1728	864	1	216	240
61	64-QAM	64-QAM	16-QAM	QPSK	1/2	18	108	6	1944	972	1	243	270
62	64-QAM	64-QAM	16-QAM	16-QAM	1/2	20	108	6	2160	1080	1	270	300
63	64-QAM	64-QAM	64-QAM	QPSK	1/2	20	108	6	2160	1080	1	270	300
64	64-QAM	64-QAM	64-QAM	16-QAM	1/2	22	108	6	2376	1188	1	297	330
65	16-QAM	QPSK	QPSK	QPSK	3/4	10	108	6	1080	810	1	202.5	225
66	16-QAM	16-QAM	QPSK	QPSK	3/4	12	108	6	1296	972	1	243	270

Table n96—Rate-dependent parameters for optional 40 MHz, N_{SS} = 4 MCSs *(continued)*

MCS Index	Modulation				R	N_{BPSC}	N_{SD}	N_{SP}	N_{CBPS}	N_{DBPS}	N_{ES}	Data rate (Mb/s)	
	Stream 1	Stream 2	Stream 3	Stream 4								800 ns GI	400 ns GI
67	16-QAM	16-QAM	16-QAM	QPSK	3/4	14	108	6	1512	1134	1	283.5	315
68	64-QAM	QPSK	QPSK	QPSK	3/4	12	108	6	1296	972	1	243	270
69	64-QAM	16-QAM	QPSK	QPSK	3/4	14	108	6	1512	1134	1	283.5	315
70	64-QAM	16-QAM	16-QAM	QPSK	3/4	16	108	6	1728	1296	2	324	360
71	64-QAM	16-QAM	16-QAM	16-QAM	3/4	18	108	6	1944	1458	2	364.5	405
72	64-QAM	64-QAM	QPSK	QPSK	3/4	16	108	6	1728	1296	2	324	360
73	64-QAM	64-QAM	16-QAM	QPSK	3/4	18	108	6	1944	1458	2	364.5	405
74	64-QAM	64-QAM	16-QAM	16-QAM	3/4	20	108	6	2160	1620	2	405	450
75	64-QAM	64-QAM	64-QAM	QPSK	3/4	20	108	6	2160	1620	2	405	450
76	64-QAM	64-QAM	64-QAM	16-QAM	3/4	22	108	6	2376	1782	2	445.5	495

Annex A (normative) **PICS**

A.4 PICS proforma–IEEE Std 802.11, 2006 Edition

A.4.3 IUT configuration

Change PICS items CF10 and CF11 as follows and insert CF15 at the end of the table:

Item	IUT configuration	References	Status	Support
*CF10	Is spectrum management operation supported?	7.3.1.4, 11.6	(CF6 OR CF15):O	Yes ☐ No ☐
*CF11	Is regulatory classes capability implemented?	7.3.2.12, 17.3.8.3.2, 17.3.8.6, 17.4.2, Annex I, Annex J	(CF6 OR CF15)& CF8&CF10:O	Yes ☐ No ☐
*CF15	Enhancements for Higher Throughput	7.3.2.49 (HT Capabilities element)	O	Yes ☐ No ☐

A.4.14 QoS base functionality

Change PICS item QB4 and insert the following two rows immediately below it as follows:

Item	Protocol capability	References	Status	Support
QB4	Block Acknowledgements (Block Acks)	~~7.2.1.7, 7.2.1.8, 7.4.4, 9.10, 11.5~~	~~CF12:O~~	~~Yes ☐ No ☐ N/A ☐~~
QB4.1	Immediate Block Ack	7.2.1.7, 7.2.1.8, 7.4.4, 9.10, 11.5	CF12:O	Yes ☐ No ☐ N/A ☐
QB4.2	Delayed Block Ack	7.2.1.7, 7.2.1.8, 7.4.4, 9.10, 11.5	CF12:O	Yes ☐ No ☐ N/A ☐

Insert the following new subclause heading:

A.4.17 Enhancements for Higher Throughput

Insert the following new subclause:

A.4.17.1 MAC enhancements for Higher Throughput

Item	Protocol capability	References	Status	Support
	Are the following MAC protocol enhancements supported?			
HTM1	HT capabilities signaling			
HTM1.1	HT capabilities element	7.3.2.49.1 (HT Capabilities element structure)	CF15:M	Yes ☐ No ☐ N/A ☐
HTM1.2	Signaling of STA capabilities in Probe Request, Association Request and Reassociation Request frames	7.3.2.49 (HT Capabilities element), 7.2.3.8 (Probe Request frame format), 7.2.3.4 (Association Request frame format), 7.2.3.6 (Reassociation Request frame format)	(CF15 AND CF2):M	Yes ☐ No ☐ N/A ☐
HTM1.3	Signaling of STA and BSS capabilities in Beacon, Probe Response, Association Response and Reassociation Response frames	7.3.2.49 (HT Capabilities element), 7.2.3.1 (Beacon frame format), 7.2.3.9 (Probe Response frame format), 7.2.3.5 (Association Response frame format), 7.2.3.7 (Reassociation Response frame format)	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTM2	Signaling of HT Information	7.3.2.50 (HT Information element)	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTM3	MPDU aggregation			

Item	Protocol capability	References	Status	Support
HTM3.1	Reception of A-MPDU	7.3.2.49.3 (A-MPDU Parameters field), 8.3 (RSNA data confidentiality protocols), 9.7c.1 (A-MPDU length limit rules), A.1.17.2	CF15:M	Yes ☐ No ☐ N/A ☐
HTM3.2	A-MPDU format	7.4a.1 (Aggregate MPDU format (A-MPDU))	CF15:M	Yes ☐ No ☐ N/A ☐
HTM3.3	A-MPDU contents	7.4a.4 (A-MPDU contents)	CF15:M	Yes ☐ No ☐ N/A ☐
HTM3.4	A-MPDU frame exchange sequences	9.9.1.4 (Multiple frame transmission in an EDCA TXOP), 9.12 (Frame exchange sequences),	CF15:M	Yes ☐ No ☐ N/A ☐
HTM3.5	Transmission of A-MPDU	7.3.2.49.3 (A-MPDU Parameters field)~~,~~ 8.3 (RSNA data confidentiality protocols)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM4	MSDU aggregation			
HTM4.1	Reception of A-MSDUs	7.1.3.5 (QoS Control field), 7.2.2.1 (Aggregate MSDU format (A-MSDU)), A1.17.2	CF15:M	Yes ☐ No ☐ N/A ☐
HTM4.2	A-MSDU format	7.2.2.1 (Aggregate MSDU format (A-MSDU))	CF15:M	Yes ☐ No ☐ N/A ☐
HTM4.3	A-MSDU content	7.2.2.1 (Aggregate MSDU format (A-MSDU))	CF15:M	Yes ☐ No ☐ N/A ☐
HTM4.4	Transmission of A-MSDUs	7.2.2.1 (Aggregate MSDU format (A-MSDU)), 7.1.3.5 (QoS Control field)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM5	Block Acknowledgement			

Item	Protocol capability	References	Status	Support
HTM5.1	Block-ACK mechanism	7.2.1.7 (Block Ack Request (BlockAck-Req) frame format), 7.2.1.8 (Block Ack (BlockAck) frame format), 7.3.1.14 (Block Ack Parameter Set field), 9.10 (Block Acknowledgment (Block Ack)), 11.5 (Block Ack operation)	CF15:M	Yes ☐ No ☐ N/A ☐
HTM5.2	Use of Compressed Bitmap between HT STAs	7.2.1.8.2 (Compressed Block-Ack variant), 9.10.6 (Use of compressed bitmap),	CF15:M	Yes ☐ No ☐ N/A ☐
HTM5.3	HT-immediate Block-ACK extensions	9.10.7 (HT-immediate BlockAck extensions)	CF15:M	Yes ☐ No ☐ N/A ☐
HTM5.4	HT-delayed Block Ack extensions	9.10.8 (HT-delayed Block-Ack extensions)	CF15 AND QB4.2:M	Yes ☐ No ☐ N/A ☐
HTM5.5	Multiple TID Block Ack	7.2.1.7.3 (Multi-TID BlockAckReq variant), 7.2.1.8.3 (Multi-TID BlockAck variant), 9.15.2.7 (PSMP Acknowledgement rules)	HTM10:M	Yes ☐ No ☐ N/A ☐
HTM6	Protection mechanisms for different HT PHY options			
HTM6.1	Protection of RIFS PPDUs in the presence of non-HT STAs	9.13.3.2 (RIFS protection)	CF15:M	Yes ☐ No ☐ N/A ☐
HTM6.2	Protection of HT greenfield PPDUs in the presence of non-HT STAs	9.13.3.3 (Greenfield protection)	HTP1.3:M	Yes ☐ No ☐ N/A ☐
*HTM7	L-SIG TXOP protection mechanism	9.13.5 (L-SIG TXOP protection)	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTM7.1	Update NAV according to L-SIG	9.13.5.4 (L-SIG TXOP protection NAV update rule)	HTM7:M	Yes ☐ No ☐ N/A ☐
HTM8	Duration/ID rules for A-MPDU and TXOP	9.13.6.1 (Duration/ID rules for A-MPDU and TXOP)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM8a	Truncation of TXOP as TXOP holder	9.13.6.2 (Truncation of TXOP)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM8b	Reception of +HTC frames	7.1.3.1.10 (Order field), 7.3.2.49.5 (HT Extended Capabilities field), 9.7a (High Throughput Control field (+HTC) operation)	CF15:O	Yes ☐ No ☐ N/A ☐
*HTM9	Reverse direction aggregation exchanges	9.14 (Reverse Direction protocol)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM9.1	Constraints regarding responses	9.14.3 (RD response constraints)	HTM9:M	Yes ☐ No ☐. N/A
HTM10	Power Save Multi-Poll (PSMP)	7.4.9.5 (PSMP frame format), 9.15 (PSMP Operation)	CF15:O	Yes ☐ No ☐ N/A ☐
*HTM10.1	Scheduled PSMP	7.3.2.30 (TSPEC element), 11.4.4b (PSMP Management)	HTM10:M	Yes ☐ No ☐ N/A ☐
HTM10.1.1	PSMP additions to TSPEC	7.3.2.30 (TSPEC element)	HTM10.1:M	Yes ☐ No ☐ N/A ☐
HTM10.1.2	AP role in scheduled PSMP sequence	9.15.2.2 (PSMP Down link transmission (PSMP-DTT)), 9.15.2.3 (PSMP Up link transmission (PSMP-UTT))	(HTM10.1 AND CF1):M	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTM10.1.3	STA role in scheduled PSMP sequence	9.15.2.2 (PSMP Down link transmission (PSMP-DTT)), 9.15.2.3 (PSMP Up link transmission (PSMP-UTT))	(HTM10.1 AND CF2):M	Yes ☐ No ☐ N/A ☐
*HTM10.2	Unscheduled PSMP	9.15.4 (Unscheduled PSMP), 11.4.4c (Management of unscheduled PSMP)	HTM10:M	Yes ☐ No ☐ N/A ☐
HTM10.2.1	PSMP additions to TSPEC	7.3.2.30 (TSPEC element)	CF1:M (CF2 AND HTM10.2):O	Yes ☐ No ☐ N/A ☐
HTM10.3	Creation, scheduling and transmission of PSMP action frame	7.4.9.5 (PSMP frame format), 9.15.2.1 (PSMP frame transmission (PSMP-DTT and PSMP-UTT))	(HTM10 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTM10.4	Reception and interpretation of PSMP action frame	7.4.9.5 (PSMP frame format)	(HTM10 AND CF2):M	Yes ☐ No ☐ N/A ☐
HTM10.5	Multi-TID Block Ack (MTBA) rules in PSMP sequence	7.2.1.7.3 (Multi-TID BlockAckReq variant), 7.2.1.8.3 (Multi-TID BlockAck variant), 9.15.2.7 (PSMP Acknowledgement rules), 11.5.2	HTM10: M	Yes ☐ No ☐ N/A ☐
HTM10.6	Multi-phase PSMP	9.15.2.5 (Resource allocation within a PSMP Burst)	HTM10:M	Yes ☐ No ☐ N/A ☐
HTM11	Link Adaptation			
HTM11.1	Use of HT Control field for Link Adaptation in immediate response exchange.	7.1.3.5a (HT Control field), 7.2.3.12a (Action No Ack frame format), 9.16.2 (Link adaptation using the HT Control field)	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTM11.2	Link adaptation using explicit feedback mechanism	7.2.3.12a (Action No Ack frame format), 9.17.3 (Explicit feedback beamforming)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM12	Transmit Beam forming			
*HTM12.1	Transmission of beam formed PPDUs	9.17 (Transmit beamforming)	CF15:O	Yes ☐ No ☐ N/A ☐
*HTM12.2	Reception of beam formed PPDUs	9.17 (Transmit beamforming)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM12.3	Initiate transmit beam forming frame exchange with implicit feedback	9.17.2 (Transmit beamforming with implicit feedback)	HTM12.1:O	Yes ☐ No ☐ N/A ☐
HTM12.3.1	Reception of sounding PPDUs	9.17.2 (Transmit beamforming with implicit feedback)	(HTM12.3 OR HTM13):M	Yes ☐ No ☐ N/A ☐
HTM12.4	Response to transmit beam forming frame exchange with implicit feedback	9.17.2 (Transmit beamforming with implicit feedback)	HTM12.2:O	Yes ☐ No ☐ N/A ☐
HTM 12.4.1	Transmission of sounding PPDUs	9.17.2 (Transmit beamforming with implicit feedback)	HTM 12.4:M	Yes ☐ No ☐ N/A ☐
HTM12.5	Initiate transmit beam forming frame exchange with explicit feedback	7.4.9.6 (MIMO CSI Matrices frame format), 9.17.3 (Explicit feedback beamforming)	HTM12.1:O	Yes ☐ No ☐ N/A ☐
HTM12.5.1	Transmission of sounding PPDUs	9.17.3 (Explicit feedback beamforming)	(HTM12.5 OR HTM13):M	Yes ☐ No ☐ N/A ☐
HTM12.6	Respond to transmit beam forming frame exchange with explicit feedback	9.17.3 (Explicit feedback beamforming)	HTM12.2:O	Yes ☐ No ☐ N/A ☐
HTM12.6.1	Transmission of Action No Ack +HTC frame including management action payload of type MIMO CSI Matrices	9.17.3 (Explicit feedback beamforming), 7.4.9.6 (MIMO CSI Matrices frame format)	HTM12.6:O.1	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTM12.6.2	Transmission of Action No Ack +HTC frame including management action payload of type “non-compressed beamforming”	9.17.3 (Explicit feedback beamforming), 7.4.9.7 (MIMO Non-compressed Beamforming frame format)	HTM12.6:O.1	Yes ☐ No ☐ N/A ☐
HTM12.6.3	Transmission of Action No Ack +HTC frame including management action payload of type “MIMO compressed beamforming”	9.17.3 (Explicit feedback beamforming), 7.4.9.8 (MIMO Compressed Beamforming frame format)	HTM12.6:O.1	Yes ☐ No ☐ N/A ☐
*HTM12.7	Calibration procedure	7.2.3.12a (Action No Ack frame format), 9.17.2.4 (Calibration)	HTM12:O	Yes ☐ No ☐ N/A ☐
HTM13	Antenna Selection	7.1.3.5a (HT Control field), 7.3.2.49.7 (Antenna Selection Capability), 7.4.9.9 (Antenna Selection Indices Feedback frame format), 9.18 (Antenna selection)	CF15:O	Yes ☐ No ☐ N/A ☐
*HTM14	Null Data Packet (NDP)	9.19 (Null Data Packet (NDP) as sounding PPDU)	CF15:O	Yes ☐ No ☐ N/A ☐
HTM15	Space-Time Block Coding (STBC) support			
HTM15.1	Secondary Beacon transmission	11.1.2.1 (Beacon generation in infrastructure networks)	HTP2.11:O	Yes ☐ No ☐ N/A ☐
HTM15.2	Dual CTS protection	9.2.5.5a (Dual CTS protection)	HTP2.11:O	Yes ☐ No ☐ N/A ☐
HTM16	SM Power Save support			
*HTM16.1	AP Support for dynamic and Static SM Power Save mode	11.2.3 (SM Power Save)	CF15 AND CF1:M	Yes ☐ No ☐ N/A ☐
HTM16.2	STA Support for dynamic and Static SM Power Save mode	11.2.3 (SM Power Save)	CF15 AND CF2:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTM16.3	Transmit SM Power Save state information using HT capabilities, or SM Power Save action frame	7.4.9.3 (SM Power Save frame format), 11.2.3 (SM Power Save)	(HTM16.1 OR HTM16.2):M	Yes ☐ No ☐ N/A ☐
HTM16.4	Receive SM Power Save state information and support frame exchanges with SM Power Save STAs	11.2.3 (SM Power Save)	CF15:M	Yes ☐ No ☐ N/A ☐
HTM17	Mechanisms for coexistence of 20 MHz and 40 MHz channels	9.20 (20/40 Functional description)	CF15:M	Yes ☐ No ☐ N/A ☐
HTM18	Channel selection methods for 20/40 MHz operation	11.9.8 (Channel selection methods for 20/40 MHz Operation)	(HTP2.3.4 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTM19	20/40 MHz Operation	11.15 (20/40 MHz Operation)	HTP2.3.4:M	Yes ☐ No ☐ N/A ☐
HTM20	Phased Coexistence Operation (PCO)			
*HTM20.1	PCO capability at AP	11.16 (Phased Coexistence Operation)	(CF15 AND CF1):O	Yes ☐ No ☐ N/A ☐
HTM20.1.1	Rules for operation at a PCO AP	7.4.9.4 (Set PCO Phase frame format), 11.16.1 (Operation at a PCO AP)	HTM20.1:M	Yes ☐ No ☐ N/A ☐
HTM20.2	STA support for PCO mode	11.16 (Phased Coexistence Operation)	(CF15 AND CF2):O	Yes ☐ No ☐ N/A ☐
HTM20.2.1	Rules for operation at PCO STA	7.4.9.4 (Set PCO Phase frame format), 11.16.2 (Operation at a PCO non-AP STA)	HTM20.2:M	Yes ☐ No ☐ N/A ☐
HTM21	Management Information Base (MIB)			
HTM21.1	dot11PhyHTComplianceGroup	Annex D	CF15:M	Yes ☐ No ☐ N/A ☐
HTM21.2	dot11PhyMCSGroup	Annex D	CF15:M	Yes ☐ No ☐ N/A ☐

Insert the following new subclause:

A.4.17.2 PHY enhancements for Higher Throughput

Item	Protocol capability	References	Status	Support
	Are the following PHY protocol enhancements supported?			
HTP1	PHY Operating Modes			
HTP1.1	Operation according to Clause 17 and Clause 19	20.1.3 (PPDU Formats)	CF15:M	Yes ☐ No ☐ N/A ☐
HTP1.2	HT mixed format	20.1.3 (PPDU Formats)	CF15:M	Yes ☐ No ☐ N/A ☐
*HTP1.3	HT greenfield format	20.1.3 (PPDU Formats)	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2	PLCP frame format			
HTP2.1	HT mixed format PLCP format	20.3.2 (PLCP frame format)	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.2	HT greenfield PLCP format	20.3.2 (PLCP frame format)	HTP1.3:M	Yes ☐ No ☐ N/A ☐
HTP2.3	Modulation and Coding Schemes (MCS)			
HTP2.3.1	MCS 0 through MCS 7 in 20 MHz with 800 ns guard interval			
HTP2.3.1.1	Support for 20 MHz with 800 ns guard interval MCS index 0	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.3.1.2	Support for 20 MHz with 800 ns guard interval MCS index 1	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.1.3	Support for 20 MHz with 800 ns guard interval MCS index 2	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.3.1.4	Support for 20 MHz with 800 ns guard interval MCS index 3	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.3.1.5	Support for 20 MHz with 800 ns guard interval MCS index 4	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.3.1.6	Support for 20 MHz with 800 ns guard interval MCS index 5	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.3.1.7	Support for 20 MHz with 800 ns guard interval MCS index 6	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.1.8	Support for 20 MHz with 800 ns guard interval MCS index 7	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.3.2	MCS 8 through MCS 15 in 20 MHz with 800 ns guard interval			
HTP2.3.2.1	Support for 20 MHz with 800 ns guard interval MCS index 8	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTP2.3.2.2	Support for 20 MHz with 800 ns guard interval MCS index 9	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTP2.3.2.3	Support for 20 MHz with 800 ns guard interval MCS index 10	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTP2.3.2.4	Support for 20 MHz with 800 ns guard interval MCS index 11	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.2.5	Support for 20 MHz with 800 ns guard interval MCS index 12	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTP2.3.2.6	Support for 20 MHz with 800 ns guard interval MCS index 13	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTP2.3.2.7	Support for 20 MHz with 800 ns guard interval MCS index 14	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTP2.3.2.8	Support for 20 MHz with 800 ns guard interval MCS index 15	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	(CF15 AND CF1):M	Yes ☐ No ☐ N/A ☐
HTP2.3.3	Transmit and receive support for 400 ns guard interval	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
*HTP2.3.4	Operation at 40 MHz	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5	Support for MCS with indices 16 through 76			
HTP2.3.5.1	Support for MCS with index 16	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.2	Support for MCS with index 17	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.3	Support for MCS with index 18	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.4	Support for MCS with index 19	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.5	Support for MCS with index 20	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.6	Support for MCS with index 21	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.7	Support for MCS with index 22	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.8	Support for MCS with index 23	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.9	Support for MCS with index 24	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.10	Support for MCS with index 25	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.11	Support for MCS with index 26	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.12	Support for MCS with index 27	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.13	Support for MCS with index 28	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.14	Support for MCS with index 29	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.15	Support for MCS with index 30	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.16	Support for MCS with index 31	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.17	Support for MCS with index 32	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.18	Support for MCS with index 33	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.19	Support for MCS with index 34	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.20	Support for MCS with index 35	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.21	Support for MCS with index 36	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.22	Support for MCS with index 37	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.23	Support for MCS with index 38	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.24	Support for MCS with index 39	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.25	Support for MCS with index 40	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.26	Support for MCS with index 41	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.27	Support for MCS with index 42	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.28	Support for MCS with index 43	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.29	Support for MCS with index 44	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.30	Support for MCS with index 45	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.31	Support for MCS with index 46	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.32	Support for MCS with index 47	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.33	Support for MCS with index 48	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.34	Support for MCS with index 49	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.35	Support for MCS with index 50	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.36	Support for MCS with index 51	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.37	Support for MCS with index 52	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.38	Support for MCS with index 53	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.39	Support for MCS with index 54	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.40	Support for MCS with index 55	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.41	Support for MCS with index 56	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.42	Support for MCS with index 57	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.43	Support for MCS with index 58	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.44	Support for MCS with index 59	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.45	Support for MCS with index 60	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.46	Support for MCS with index 61	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.47	Support for MCS with index 62	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.48	Support for MCS with index 63	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.49	Support for MCS with index 64	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.50	Support for MCS with index 65	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.51	Support for MCS with index 66	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.52	Support for MCS with index 67	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.53	Support for MCS with index 68	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.54	Support for MCS with index 69	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.55	Support for MCS with index 70	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.56	Support for MCS with index 71	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.57	Support for MCS with index 72	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.58	Support for MCS with index 73	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.59	Support for MCS with index 74	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.3.5.60	Support for MCS with index 75	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.3.5.61	Support for MCS with index 76	20.3.5 (Modulation and Coding Scheme (MCS)), 20.6 (Rate dependent parameters for HT Modulation and Coding Schemes (MCS))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.4	PHY timing parameters			
HTP2.4.1	Values in non-HT 20 MHz channel	20.3.6 (Timing related parameters)	CF15:M	Yes ☐ No ☐. N/A
HTP2.4.2	Values in 20 MHz HT channel	20.3.6 (Timing related parameters)	CF15:M	Yes ☐ No ☐. N/A
HTP2.4.3	Values in 40 MHz channel	20.3.6 (Timing related parameters)	HTP2.3.4:M	Yes ☐ No ☐. N/A
HTP2.5	HT Preamble field definition and coding			
HTP2.5.1	HT mixed format preamble	20.3.9.2 (HT mixed format preamble)_	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.5.2	HT greenfield preamble	20.3.9.5 (Greenfield format preamble)	HTP1.3:M	Yes ☐ No ☐ N/A ☐
HTP2.5.3	Extension HT-LTFs	20.3.9.4.6 (The HT-LTF long training field)	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.6	HT Data field definition and coding	20.3.10 (The Data field)_	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.6.1	Use of LDPC codes	20.3.10.6 (Low density parity check (LDPC) codes)_	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.7	Beam forming	20.3.11 (Beamforming)_	CF15:O	Yes ☐ No ☐ N/A ☐

Item	Protocol capability	References	Status	Support
HTP2.8	Sounding PPDUs			
HTP2.8.1	HT preamble format for sounding PPDUs	20.3.12 (HT Preamble format for sounding PPDUs)	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.8.2	Sounding with an NDP	20.3.12.1 (Sounding with a Null Data Packet)	HTM14:M	Yes ☐ No ☐ N/A ☐
HTP2.8.3	Sounding PPDU for calibration	20.3.12.2 (Sounding PPDU for calibration)	HTM12.7:M	Yes ☐ No ☐ N/A ☐
HTP2.9	Channel numbering and channelization			
HTP2.9.1	Channel allocation for 20 MHz channels at 5 GHz	17.3.8.3	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.9.2	Channel allocation for 20 MHz channels at 2.4 GHz	19.4.2	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.9.3	Channel allocation for 40 MHz channels at 5 GHz	20.3.14.2 (Channel allocation in the 5 GHz band)	HTP2.3.4:M	Yes ☐ No ☐ N/A ☐
HTP2.9.4	Channel allocation for 40 MHz channels at 2.4 GHz	20.3.14.1 (Channel allocation in the 2.4 GHz Band)	HTP2.3.4:M	Yes ☐ No ☐ N/A ☐
HTP2.10	PMD transmit specification			
HTP2.10.1	PMD transmit specification for 20 MHz channel	20.3.20 (PMD Tx specification)	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.10.2	PMD transmit specification for 40 MHz channel	20.3.20 (PMD Tx specification)	HTP2.3.4:M	Yes ☐ No ☐ N/A ☐
HTP2.11	Space-Time Block Coding (STBC)	20.3.10.8.1 (Space-Time Block Coding (STBC))	CF15:O	Yes ☐ No ☐ N/A ☐
HTP2.12	PMD receive specification			
HTP2.12.1	PMD receive specification for 20 MHz channel	20.3.21 (HT PMD receiver specification)	CF15:M	Yes ☐ No ☐ N/A ☐
HTP2.12.2	PMD receive specification for 40 MHz channel	20.3.21 (HT PMD receiver specification)	HTP2.3.4:M	Yes ☐ No ☐ N/A ☐

Annex C (informative) **Formal description of a subset of MAC operation**

C.3 State machines for MAC stations

Add the following paragraph after the paragraph "This Clause does not describe the behavior of a STA with QoS facility.":

This Clause does not describe the behavior of an HT STA.

Annex D(normative) ASN.1 encoding of the MAC and PHY MIB

Insert in the list of IMPORTS from SNMPv2-SMI the following:

```
Counter64
```

In Annex D, insert the following comment to the end of SMT attributes after dot11FastBSSTransitionTable:

```
-- dot11HTStationConfigTable ::= { dot11smt 16 }
```

In Annex D, insert the following comment to the end of dot11phy after dot11PhyERPTable:

```
-- dot11PhyHTTable ::= {dot11phy 15 }
-- dot11HTSupportedMCSTxTable ::= { dot11phy 16 }
-- dot11HTSupportedMCSRxTable ::= { dot11phy 17 }
-- dot11TxBFConfigTable ::= { dot11phy 18 }
```

In the dot11StationConfig table of Annex D, change the dot11StationConfigEntry sequence by inserting a comma and the new entry at the end of the existing entries (which are represented below by "…") as follows:

```
Dot11StationConfigEntry ::=
    SEQUENCE {
          … ,
          dot11HighThroughputOptionImplemented TruthValue
}
```

Change the definition of dot11OperationalRateSet as shown below:

```
dot11OperationalRateSet OBJECT-TYPE
SYNTAX OCTET STRING (SIZE(1..126))
MAX-ACCESS read-write
STATUS current
DESCRIPTION
              "This attribute shall specify the set of non-HT data rates at
which the station may transmit data. The attribute that specifies the set of
HT data rates is dot11HTOperationalMCSSet. Each octet contains a value
representing a rate. Each rate shall be within the range from 2 to 127,
corresponding to data rates in increments of 500 kbit/s from 1 Mb/s to 63.5
Mb/s, and shall be supported (as indicated in the supported rates table) for
receiving data. This value is reported in transmitted Beacon, Probe Request,
Probe Response, Association Request, Association Response, Reassociation
Request, and Reassociation Response frames, and is used to determine whether
a BSS with which the station desires to synchronize is suitable. It is also
used when starting a BSS, as specified in 10.3."
::= { dot11StationConfigEntry 11 }
```

Insert the following elements to the end of dot11StationConfigTable element definitions after dot11DLSAllowed:

```
dot11HighThroughputOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
          "This attribute indicates whether the entity is HT Capable."
::= { dot11StationConfigEntry 58 }
```

Insert the following table behind dot11RegulatoryClasses Table:

```
-- **********************************************************************
-- * dot11HTStationConfig TABLE
-- **********************************************************************
dot11HTStationConfigTable OBJECT-TYPE
          SYNTAX SEQUENCE OF Dot11StationConfigEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "Station Configuration attributes. In tabular form to allow
for multiple instances on an agent."
          ::= { dot11smt 16 }

dot11HTStationConfigEntry OBJECT-TYPE
          SYNTAX Dot11HTStationConfigEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "An entry (conceptual row) in the dot11HTStationConfig Table.

               ifIndex - Each IEEE 802.11 interface is represented by an
ifEntry. Interface tables in this MIB module are indexed by ifIndex."
          INDEX { ifIndex }
          ::= { dot11HTStationConfigTable 1 }

Dot11HTStationConfigEntry ::=
          SEQUENCE {
               dot11HTOperationalMCSSet OCTET STRING,
               dot11MIMOPowerSave INTEGER,
```

```
                dot11NDelayedBlockAckOptionImplemented TruthValue,
                dot11MaxAMSDULength INTEGER,
                dot11PSMPOPtionImplemented TruthValue,
                dot11STBCControlFrameOptionImplemented TruthValue,
                dot11LsigTxopProtectionOptionImplemented TruthValue,
                dot11MaxRxAMPDUFactor INTEGER,
                dot11MinimumMPDUStartSpacing INTEGER,
                dot11PCOOptionImplemented TruthValue,
                dot11TransitionTime INTEGER,
                dot11MCSFeedbackOptionImplemented INTEGER,
                dot11HTControlFieldSupported TruthValue,
dot11RDResponderOptionImplemented TruthValue
          }


dot11HTOperationalMCSSet OBJECT-TYPE
SYNTAX OCTET STRING (SIZE(1..127))
MAX-ACCESS read-write
STATUS current
DESCRIPTION
                "This attribute shall specify the set of MCS at which the
station may transmit data. Each octet contains a value representing a rate.
Each MCS shall be within the range from 1 to 127, and shall be supported for
receiving data. This value is reported in transmitted Beacon, Probe Request,
Probe Response, Association Request, Association Response, Reassociation
Request, and Reassociation Response frames, and is used to determine whether
a BSS with which the station desires to synchronize is suitable. It is also
used when starting a BSS, as specified in 10.3."
::= { dot11HTStationConfigEntry 1 }


dot11MIMOPowerSave OBJECT-TYPE
          SYNTAX INTEGER { static(1), dynamic(2), mimo(3) }
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
                "This is an 8-bit integer value that identifies the configured
power save state of MIMO.”
::= { dot11HTStationConfigEntry 2 }


dot11NDelayedBlockAckOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
```

```
          DESCRIPTION
               "This attribute, when TRUE, indicates that the station
implementation is capable of supporting the No ack option of the Delayed
Block Ack. The default value of this attribute is FALSE.”
::= { dot11HTStationConfigEntry 3 }

dot11MaxAMSDULength OBJECT-TYPE
          SYNTAX INTEGER { 3839, 7935 }
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               “This attribute indicates the supported maximum size of A-
MSDU. The default value of this attribute is 3839.”
::= { dot11HTStationConfigEntry 4 }

dot11PSMPOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the station
implementation is capable of supporting PSMP. The default value of this
attribute is FALSE.”
::= { dot11HTStationConfigEntry 5 }

dot11STBCControlFrameOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the station
implementation is capable of processing the received control frames that are
STBC frames. The default value of this attribute is FALSE.”
::= { dot11HTStationConfigEntry 6 }

dot11LsigTxopProtectionIOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
```

```
          "This attribute, when TRUE, indicates that the station
implementation is capable of supporting L-SIG TXOP Protection option. The
default value of this attribute is FALSE."
::= { dot11HTStationConfigEntry 7 }

dot11MaxRxAMPDUFactor OBJECT-TYPE
     SYNTAX INTEGER (0..3)
     MAX-ACCESS read-only
     STATUS current
     DESCRIPTIOM
          "This attribute indicates the maximum length of A-MPDU that
the STA can receive. The Maximum Rx A-MPDU defined by this field is equal to
$2^{13+dot11MaxRxAMPDUFactor}$ -1 octets. The default value of this attribute is 0."
::= { dot11HTStationConfigEntry 8 }

dot11MinimumMPDUStartSpacing OBJECT-TYPE
     SYNTAX INTEGER (0..7)
     MAX-ACCESS read-only
     STATUS current
     DESCRIPTIOM
          "This attribute indicates the minimum time between the start
of adjacent MPDUs within an A-MPDU. This time is measured at the PHY-SAP; the
number of octets between the start of two consecutive MPDUs in A-MPDU shall
be equal or greater than (dot11MinimumMPDUStartSpacing*PHY-bit-rate)/8. The
encoding of the minimum time to this attribute is:
          0    no restriction
          1    1/4 µsec
          2    1/2 µsec
          3    1 µsec
          4    2 µsec
          5    4 µsec
          6    8 µsec
          7    16 µsec
          The default value of this attribute is 0."

::= { dot11HTStationConfigEntry 9 }

dot11PCOOptionImplemented OBJECT-TYPE
     SYNTAX TruthValue
     MAX-ACCESS read-only
     STATUS current
     DESCRIPTION
```

```
               "This attribute, when TRUE, indicates that the station
implementation is capable of supporting Phased Coexistence Operation. The
default value of this attribute is FALSE. "
::= { dot11HTStationConfigEntry 10 }

dot11TransitionTime OBJECT-TYPE
          SYNTAX INTEGER (1..3)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates that the minimum transition time
within which the STA can switch between 20 MHz channel width and 40 MHz
channel width with a high probability. The encoding of the transition time to
this attribute is:
400 µsec
1500 µsec
5000 µsec
The default value of this attribute is 3. "
::= { dot11HTStationConfigEntry 11 }

dot11MCSFeedbackOptionImplemented OBJECT-TYPE
          SYNTAX INTEGER { none(0), unsolicited (2), both (3) }
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the MCS feed back capability
supported by the station implementation. The default value of this attribute
is 0. "
::= { dot11HTStationConfigEntry 12 }

dot11HTControlFieldSupported OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the station
implementation is capable of receiving HT Control field. The default value
of this attribute is FALSE."
::= { dot11HTStationConfigEntry 13 }
dot11RDResponderOptionImplemented OBJECT-TYPE
          MAX-ACCESS read-only
          STATUS current
```

```
          DESCRIPTION
               "This attribute, when TRUE, indicates that the station
implementation is capable operating as a RD responder. The default value of
this attribute is FALSE."
::= { dot11HTStationConfigEntry 14 }
```

Change Dot11OperationEntry in dot11OperationTable by inserting the following new entries after the existing entries in the sequence, represented below by "…":

```
Dot11OperationEntry ::=
          SEQUENCE {
               … ,
               dot11HTOperatingMode INTEGER,
               dot11RIFSMode TruthValue,
               dot11PSMPControlledAccess TruthValue,
               dot11ServiceIntervalGranularity INTEGER,
               dot11DualCTSProtection TruthValue,
               dot11LSIGTXOPFullProtectionEnabled TruthValue,
               dot11NonGFEntitiesPresent TruthValue,
               dot11PCOActivated TruthValue,
               dot11PCO40MaxDuration INTEGER,
               dot11PCO20MaxDuration INTEGER,
               dot11PCO40MinDuration INTEGER,
               dot11PCO20MinDuration INTEGER
                }
```

(Ed: CID 8119) Change the entry for dot11RTSThreshold as follows:

```
dot11RTSThreshold OBJECT-TYPE
       SYNTAX INTEGER (0..3000)
       MAX-ACCESS read-write
       STATUS current
       DESCRIPTION
             "This attribute shall indicate the number of octets in a~~n~~ ~~MPDU~~PSDU,
             below which an RTS/CTS handshake shall not be performed, except as
             RTS/CTS is used as a cross modulation protection mechanism as
             defined in 9.10. An RTS/CTS handshake shall be performed at the
             beginning of any frame exchange sequence where the ~~MPDU~~PSDU is of
             type Data or Management, the ~~MPDU~~PSDU has an individual address in
             the Address1 field, and the length of the ~~MPDU~~PSDU is greater than
             this threshold. (For additional details, refer to Table 21 in 9.7.)
             Setting this attribute to be larger than the maximum ~~MSDU~~PSDU size
             shall have the effect of turning off the RTS/CTS handshake for
             frames of Data or Management type transmitted by this STA. Setting
             this attribute to zero shall have the effect of turning on the RTS/
             CTS handshake for all frames of Data or Management type transmitted
```

by this STA. The default value of this attribute shall be ~~3000~~65535."

::= { dot11OperationEntry 2 }

Change the entry for dot11FragmentationThreshold as follows:

dot11FragmentationThreshold OBJECT-TYPE

SYNTAX INTEGER (256..~~2340~~8000)

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This attribute shall specify the current maximum size, in octets, of the ~~MPDU~~ PSDU that may be delivered to the PHY. This maximum size does not apply in the case of A-MPDU. An MSDU, A-MSDU or MMPDU shall be broken into fragments if its size exceeds the value of this attribute after adding MAC headers and trailers. An MSDU, A-MSDU or MMPDU shall be fragmented when the resulting frame has an individual address in the Address1 field, and the length of the frame is larger than this threshold. The default value for this attribute shall be the lesser of ~~3000~~ 8000 or the aMPDUMaxLength or the aPSDUMaxLength of the attached PHY and shall never exceed the lesser of ~~3000~~ 8000 or the aMPDUMaxLength or the aPSDUMaxLength of the attached PHY. The value of this attribute shall never be less than 256."

::= { dot11OperationEntry 5 }

Insert the following definitions behind the definition of dot11EDCAAveragingPeriod:

dot11HTOperatingMode OBJECT-TYPE

SYNTAX INTEGER { htPure (O), optionalProtection (1), mandatoryFortyProtection (2), mandatoryAllProtection (3) }

MAX-ACCESS read-write

STATUS current

DESCRIPTION

“This attribute indicates the level of protection that needs to be provided to the transmissions in an IEEE 802.11 network with HT STAs. The default value of this attribute is 0.”

::= { dot11OperationEntry 21 }

dot11RIFSMode OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-write

STATUS current

DESCRIPTION

```
                "This attribute, when TRUE, indicates that RIFS mode is
allowed in the BSS. The default value of this attribute is FALSE."
          ::= { dot11OperationEntry 22 }


dot11PSMPControlledAccess OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
                "This attribute, when TRUE indicates that the AP accepts
associations only from stations for which dot11PSMPOptionImplemented is
TRUE. The default value of this attribute is FALSE."
          ::= { dot11OperationEntry 23 }


dot11ServiceIntervalGranularity OBJECT-TYPE
          SYNTAX INTEGER (0..7)
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
                "This attribute indicates the Service Interval Granularity to
be used for scheduled PSMP. The value of the granularity is given by
(dot11ServiceIntervalGranularity+1)*5 milliseconds. The default value of
this attribute is 0."
          ::= { dot11OperationEntry 24 }


dot11DualCTSProtection OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
                "This attribute, when TRUE indicates that the AP uses dual CTS
protection to protect the non-STBC frame and STBC frame transmissions. The
default value of this attribute is FALSE."
          ::= { dot11OperationEntry 25 }


dot11LSigTxopFullProtectionEnabled OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
                "This attribute, when TRUE, indicates that the LSIG TXOP
Protection may be used by stations that have the attribute
```

```
dot11LSigTxopProtectionOptionImplemented set to TRUE. The default value of
this attribute is FALSE.”
          ::= { dot11OperationEntry 26 }


dot11NonGFEntitiesPresent OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               “This attribute, when TRUE, indicates that STA that are not
Greenfield Capable are present in the BSS. The default value of this
attribute is FALSE.”
          ::= { dot11OperationEntry 27 }


dot11PCOActivated OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               “This attribute, when TRUE, indicates that the PCO is
activated. The default value of this attribute is FALSE.”
          ::= { dot11OperationEntry 28 }


dot11PCO40MaxDuration OBJECT-TYPE
          SYNTAX INTEGER (1..65535)
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
"The attribute indicates the maximum duration of 40 MHz phase in TU under PCO
operation. The default value of this attribute shall be 60. The value of this
attribute shall be equal to or larger than dot11PCO40MinDuration."
          ::= { dot11OperationEntry 29 }


dot11PCO20MaxDuration OBJECT-TYPE
          SYNTAX INTEGER (1..65535)
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
"The attribute indicates the maximum duration of 20 MHz phase in TU under PCO
operation. The default value of this attribute shall be 60. The value of this
attribute shall be equal to or larger than dot11PCO20MinDuration."
          ::= { dot11OperationEntry 30 }
```

```
dot11PCO40MinDuration OBJECT-TYPE
          SYNTAX INTEGER (1..65535)
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
"The attribute indicates the minimum duration of 40 MHz phase in TU under PCO
operation. The default value of this attribute shall be 40."
          ::= { dot11OperationEntry 31 }


dot11PCO20MinDuration OBJECT-TYPE
          SYNTAX INTEGER (1..65535)
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
"The attribute indicates the minimum duration of 20 MHz phase in TU under PCO
operation. The default value of this attribute shall be 40."
          ::= { dot11OperationEntry 32 }
```

Change Dot11CountersEntry in dot11CountersTable as follows by inserting the following new entries after the existing content represented below by "…":

```
Dot11CountersEntry ::=
          SEQUENCE {
               … ,
               dot11TransmittedAMSDUCountCounter32,
               dot11FailedAMSDUCountCounter32,
               dot11RetryAMSDUCountCounter32,
               dot11MultipleRetryAMSDUCountCounter32,
               dot1TransmittedOctetsInAMSDUCountCounter64,
               dot11AMSDUAckFailureCount Counter32,
               dot11ReceivedAMSDUCountCounter32,
               dot1ReceivedOctetsInAMSDUCountCounter64,
               dot11TransmittedAMPDUCountCounter32,
               dot11TransmittedMPDUsInAMPDUCountCounter32,
               dot11TransmittedOctetsInAMPDUCountCounter64,
               dot11AMPDUReceivedCountCounter32,
               dot11MPDUInReceivedAMPDUCountCounter32,
               dot11ReceivedOctetsInAMPDUCountCounter64,
               dot11AMPDUDelimiterCRCErrorCountCounter32,
               dot11ImplicitBARFailureCountCounter32,
               dot11ExplicitBARFailureCountCounter32,
```

```
                dot11ChannelWidthSwitchCountCounter32,
                dot11TwentyMHzFrameTransmittedCountCounter32,
                dot11FortyMHzFrameTransmittedCountCounter32,
                dot11TwentyMHzFrameReceivedCountCounter32,
                dot11FortyMHzFrameReceivedCountCounter32,
                dot11PSMPSuccessCountCounter32,
                dot11PSMPFailureCountCounter32,
                dot11GrantedRDGUsedCountCounter32,
                dot11GrantedRDGUnusedCountCounter32,
                dot11TransmittedFramesInGrantedRDGCountCounter32,
                dot11TransmittedOctetsInGrantedRDGCountCounter64,
                dot11BeamformingFrameCountCounter32,
                dot11DualCTSSuccessCountCounter32,
                dot11DualCTSFailureCountCounter32,
                dot11STBCCTSSuccessCountCounter32,
                dot11STBCCTSFailureCountCounter32,
                dot11nonSTBCCTSSuccessCountCounter32,
                dot11nonSTBCCTSFailureCountCounter32,
                dot11RTSLSIGSuccessCountCounter32,
                dot11RTSLSIGFailureCountCounter32
}
```

Insert the following definitions after the existing dot11CountersEntry attributes:

```
dot11TransmittedAMSDUCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
                "This counter shall be incremented for an acknowledged A-MSDU
frame with an individual address in the address 1 field or an AMSDU frame
with a multicast address in the address 1 field."
          ::= { dot11CountersEntry 21 }


dot11FailedAMSDUCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
                "This counter shall be incremented when an A-MSDU is not
transmitted successfully due to the number of transmit attempts exceeding
either the dot11ShortRetryLimit or dot11LongRetryLimit."
```

```
          ::= { dot11CountersEntry 22 }

dot11RetryAMSDUCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when an A-MSDU is
successfully transmitted after one or more retransmissions."
          ::= { dot11CountersEntry 23 }

dot11MultipleRetryAMSDUCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when an A-MSDU is
successfully transmitted after more than one retransmission."
          ::= { dot11CountersEntry 24 }

dot1TransmittedOctetsInAMSDU OBJECT-TYPE
          SYNTAX Counter64
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented by the number of octets in
the framebody of an A-MSDU frame when an A-MSDU frame is successfully
transmitted."
          ::= { dot11CountersEntry 25 }

dot11AMSDUAckFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when an acknowledgement to
an AMSDU is not received when expected. This acknowledgement can be in an ACK
or the BlockAck frame."
          ::= { dot11CountersEntry 26 }

dot11ReceivedAMSDUCount OBJECT-TYPE
          SYNTAX Counter32
```

```
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented for a received A-MSDU frame
with the station’s MAC address in the address 1 field or an AMSDU frame with
a multicast address in the address 1 field."
          ::= { dot11CountersEntry 27 }

dot1ReceivedOctesInAMSDUCount OBJECT-TYPE
          SYNTAX Counter64
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented by the number of octets in
the framebody of an A-MSDU frame when an A-MSDU frame is received."
          ::= { dot11CountersEntry 28 }

dot11TransmittedAMPDUCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when an A-MPDU is
transmitted."
          ::= { dot11CountersEntry 29 }

dot11TransmittedMPDUsInAMPDUCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall increment by the number of MPDUs in the A-
MPDU when an A-MPDU is transmitted."
          ::= { dot11CountersEntry 30 }

dot11TransmittedOctetsInAMPDUCount OBJECT-TYPE
          SYNTAX Counter64
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented by the number of octets in
the A-MPDU frame when an A-MPDU frame is transmitted."
```

```
          ::= { dot11CountersEntry 31 }

dot11AMPDUReceivedCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when the MAC receives an A-
MPDU from the PHY."
          ::= { dot11CountersEntry 32 }

dot11MPDUInReceivedAMPDUCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented by the number of MPDUs
received in the A-MPDU when an A-MPDU is received."
          ::= { dot11CountersEntry 33 }

dot11ReceivedOctetsInAMPDUCount OBJECT-TYPE
          SYNTAX Counter64
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented by the number of octets in
the A-MPDU frame when an A-MPDU frame is received."
          ::= { dot11CountersEntry 34 }

dot11AMPDUDelimiterCRCErrorCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when an A-MPDU delimiter
has CRC error when this is the first CRC error in the received A-MPDU or when
the previous delimiter has been decoded correctly.”
          ::= { dot11CountersEntry 35 }

dot11ImplicitBARFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
```

```
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when the expected BlockAck
is not received in response to an Implicit BlockAckReq frame.”
          ::= { dot11CountersEntry 36 }

dot11ExplicitBARFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when the expected BlockAck
is not received in response to an Explicit BlockAckReq.”
          ::= { dot11CountersEntry 37 }

dot11ChannelWidthSwitchCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be increment when the bandwidth used is
switched from 20 to 40 or vice-versa.”
          ::= { dot11CountersEntry 38 }

dot11TwentyMHzTransmittedFrameCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when a Frame is transmitted
only on the primary channel.”
          ::= { dot11CountersEntry 39 }

dot11FortyTransmittedMHzFrameCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when a Frame is transmitted
on both control and secondary channels.”
          ::= { dot11CountersEntry 40 }
```

```
dot11TwentyMHzReceivedFrameCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when a Frame is received
only on the primary channel.”
          ::= { dot11CountersEntry 41 }

dot11FortyMHzReceivedFrameCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when a Frame is received on
both the control and secondary channels.”
          ::= { dot11CountersEntry 42 }

dot11PSMPSuccessCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when an allocated PSMP-UTT
is used."
          ::= { dot11CountersEntry 43 }

dot11PSMPFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when an allocated PSMP-UTT
is not used."
          ::= { dot11CountersEntry 44 }


dot11GrantedRDGUsedCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
```

```
          DESCRIPTION
               "This counter at the RD initiator shall be incremented when an
allocated RDG is used by the station, apart from transmitting a response
frame such as ACK or Block Ack frames."
          ::= { dot11CountersEntry 45 }

dot11GrantedRDGUnusedCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter at the initiatior shall be incremented when an
allocated RDG is not used by the station, apart from transmitting a response
frame such as ACK or Block Ack frames."
          ::= { dot11CountersEntry 46 }

dot11TransmittedFramesInGrantedRDGCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter at the initiatior shall be incremented for every
frame, other than response frames such as ACK or Block Ack frames,
transmitted by the station during a granted RDG."
          ::= { dot11CountersEntry 47 }

dot11TransmittedOctetsInGrantedRDG OBJECT-TYPE
          SYNTAX Counter64
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter at the initiatior shall be incremented by the
number of octets in the framebody of a frame, other than response frames such
as ACK or Block Ack frames, transmitted by the station during a granted RDG."
          ::= { dot11CountersEntry 48 }

dot11BeamformingFrameCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
```

```
                "This counter shall be incremented when th transmitter sends a
frame with new/updated beam forming parameters."
          ::= { dot11CountersEntry 49 }


dot11DualCTSSuccessCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
                "This counter shall be incremented when AP sends a dual CTS in
response to a STA initiating TXOP in extended range."
          ::= { dot11CountersEntry 50 }



dot11DualCTSFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
                "This counter shall be incremented when AP fails to send a
dual CTS in response to a STA initiating TXOP in extended range."
          ::= { dot11CountersEntry 51 }


dot11STBCCTSSuccessCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
                "This counter shall be incremented when AP does not detect a
collision PIFS after sending a CTS to self STBC frame in extended range."
          ::= { dot11CountersEntry 52 }


dot11STBCCTSFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
                "This counter shall be incremented when AP detects a collision
PIFS after sending a CTS to self STBC frame in extended range."
          ::= { dot11CountersEntry 53 }


dot11nonSTBCCTSSuccessCount OBJECT-TYPE
```

```
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when AP does not detect a
collision PIFS after sending a CTS to self that is an non-STBC frame in
extended range."
          ::= { dot11CountersEntry 54 }


dot11nonSTBCCTSFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when AP detects a collision
PIFS after sending a CTS to self that is an non-STBC frame in extended
range."
          ::= { dot11CountersEntry 55 }


dot11RTSLSIGSuccessCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when the duration/ID field
is set according to the rules of EPP in the received CTS following a
transmission of RTS in EPP mode."
          ::= { dot11CountersEntry 56 }


dot11RTSLSIGFailureCount OBJECT-TYPE
          SYNTAX Counter32
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This counter shall be incremented when the duration/ID field
is not set according to the rules of EPP in the received CTS following a
transmission of RTS in EPP mode."
          ::= { dot11CountersEntry 57 }
```

Change dot11PhyType in dot11PhyOperationTable as shown below:

```
dot11PHYType OBJECT-TYPE
```

```
          SYNTAX INTEGER { fhss(1), dsss(2), irbaseband(3), ofdm(4),
hrdsss(5), erp(6), ht (7)  }
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This is an 8-bit integer value that identifies the PHY type
supported by the attached PLCP and PMD. Currently defined values and their
corresponding PHY types are:


               FHSS 2.4 GHz = 01, DSSS 2.4 GHz = 02, IR Baseband = 03, OFDM 5
GHz = 04, HRDSSS = 05, ERP = 06, HT = 07"
::= { dot11PhyOperationEntry 1 }
```

Change Dot11PhyAntennasEntry as shown:

```
Dot11PhyAntennasEntry ::=
SEQUENCE { dot11CurrentTxAntenna Integer32,
          dot11DiversitySupport INTEGER,
          dot11CurrentRxAntenna Integer32,
          dot11AntennaSelectionOptionImpementedTruthValue,
          dot11TransmitExplicitCSIFeedbackASOptionImplemented TruthValue,
          dot11TransmitIndicesFeedbackASOptionImplemented TruthValue,
          dot11ExplicitCSIFeedbackASOptionImplemented TruthValue,
          dot11TransmitIndicesComputationFeedbackASOptionImplemented
TruthValue,
          dot11ReceiveAntennaSelectionOptionImplemented TruthValue,
          dot11TransmitSoundingPPDUOptionImplemented TruthValue
 }
```

Insert the following after the definition of dot11CurrentRxAntenna:

```
dot11AntennaSelectionOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that antenna selection
is supported by the station implementation. The default value of this
attribute is FALSE."
          ::= { dot11PhyAntennasEntry 4 }


dot11TransmitExplicitCSIFeedbackASOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
```

```
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the transmit
Antenna Selection based on explicit CSI feedback is supported by the station
implementation. The default value of this attribute is FALSE."
          ::= { dot11PhyAntennasEntry 5 }


dot11TransmitIndicesFeedbackASOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the transmit
antenna selection based on antenna indices feedback is supported by the
station implementation. The default value of this attribute is FALSE."
          ::= { dot11PhyAntennasEntry 6 }


dot11ExplicitCSIFeedbackASOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the computation of
CSI and feedback to support the peer to do antenna selection is supported by
the station implementation. The default value of this attribute is FALSE."
          ::= { dot11PhyAntennasEntry 7 }


dot11TransmitIndicesComputationFeedbackASOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the transmit
antenna selection based on antenna indices selection computation and
feedback the results to support the peer to do antenna selection is supported
by the station implementation. The default value of this attribute is
FALSE."
          ::= { dot11PhyAntennasEntry 8 }


dot11ReceiveAntennaSelectionOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
```

```
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               “This attribute, when TRUE, indicates that the receive antenna
selection is supported by the station implementation. The default value of
this attribute is FALSE.”
          ::= { dot11PhyAntennasEntry 9 }


dot11TransmitSoundingPPDUOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               “This attribute, when TRUE, indicates that the transmission of
sounding PPDUs is supported by the station implementation. The default value
of this attribute is FALSE.”
          ::= { dot11PhyAntennasEntry 10 }
```

Insert the following dot11PhyHTTable after dot11PhyERPTable:

```
-- **********************************************************************
-- * dot11 Phy HT TABLE
-- **********************************************************************
dot11PhyHTTable OBJECT-TYPE
          SYNTAX SEQUENCE OF Dot11PhyHTEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "Entry of attributes for dot11PhyHTTable. Implemented as a
table indexed on ifIndex to allow for multiple instances on an Agent."
::= { dot11phy 15 }

dot11PhyHTEntry OBJECT-TYPE
          SYNTAX Dot11PhyHTEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "An entry in the dot11PhyHTEntry Table. ifIndex - Each 802.11
interface is represented by an ifEntry. Interface tables in this MIB module
are indexed by ifIndex."
          INDEX {ifIndex}
          ::= { dot11PhyHTTable 1 }
```

```
Dot11PhyHTEntry ::= SEQUENCE {
          dot11FortyMHzOperationImplemented TruthValue,
          dot11FortyMHzOperationEnabled TruthValue,
          dot11CurrentPrimaryChannel INTEGER,
          dot11CurrentSecondaryChannel INTEGER,
          dot11NumberOfSpatialStreamsImplemented INTEGER,
          dot11NumberOfSpatialStreamsEnabled INTEGER,
          dot11GreenfieldOptionImplemented TruthValue,
          dot11GreenfieldOptionEnabled TruthValue,
          dot11ShortGIOptionInTwentyImplemented TruthValue,
          dot11ShortGIOptionInTwentyEnabled TruthValue,
          dot11ShortGIOptionInFortyImplemented TruthValue,
          dot11ShortGIOptionInFortyEnabled TruthValue,
          dot11LDPCCodingOptionImplemented TruthValue,
          dot11LDPCCodingOptionEnabled TruthValue,
          dot11TxSTBCOptionImplemented TruthValue,
          dot11TxSTBCOptionEnabled TruthValue,
          dot11RxSTBCOptionImplemented TruthValue,
          dot11RxSTBCOptionEnabled TruthValue,
          dot11BeamFormingOptionImplemented TruthValue,
          dot11BeamFormingOptionEnabled TruthValue,
          dot11HighestSupportedDataRate Integer,
          dot11TxMCSSetDefined TruthValue,
          dot11TxRxMCSSetNotEqual TruthValue,
          dot11TxMaximumNumberSpatialStreamsSupported Integer,
          dot11TxUnequalModulationSupported TruthValue }


dot11FortyMHzOperationImplemented OBJECT-TYPE
          SYNTAX TRUTHVALUE
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the 40 MHz
Operation is implemented. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 1 }


dot11FortyMHzOperationEnabled OBJECT-TYPE
          SYNTAX TRUTHVALUE
          MAX-ACCESS read-only
          STATUS current
```

```
          DESCRIPTION
               "This attribute, when TRUE, indicates that the 40 MHz
Operation is enabled. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 2 }


dot11CurrentPrimaryChannel OBJECT-TYPE
          SYNTAX INTEGER
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the operating channel. If 20/40 MHz
Mode is currently in use then this attribute indicates the primary channel."
          ::= { dot11PhyHTEntry 3 }


dot11CurrentSecondaryChannel OBJECT-TYPE
          SYNTAX INTEGER
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the channel number of the secondary
channel. If 20/40 MHz mode is not currently in use, this attribute value
shall be 0."
          ::= { dot11PhyHTEntry 4 }



dot11NumberOfSpatialStreamsImplemented OBJECT-TYPE
          SYNTAX INTEGER (1..4)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the maximum number of spatial
streams implemented. The default value of this attribute is 2."
          ::= { dot11PhyHTEntry 5 }


dot11NumberOfSpatialStreamsEnabled OBJECT-TYPE
          SYNTAX INTEGER (1..4)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the maximum number of spatial
streams enabled. The default value of this attribute is 2."
          ::= { dot11PhyHTEntry 6 }
```

```
dot11GreenfieldOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the HT Greenfield
option is implemented. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 7 }

dot11GreenfieldOptionEnabled OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the HT Greenfield
option is enabled. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 8 }



dot11ShortGIOptionInTwentyImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the Short Guard
option is implemented for 20 MHz operation. The default value of this
attribute is FALSE."
          ::= { dot11PhyHTEntry 9 }

dot11ShortGIOptionInTwentyEnabled OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the Short Guard
option is enabled for 20 MHz operation. The default value of this attribute
is FALSE."
          ::= { dot11PhyHTEntry 10 }

dot11ShortGIOptionInFortyImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
```

```
               "This attribute, when TRUE, indicates that the Short Guard
option is implemented for 40 MHz operation. The default value of this
attribute is FALSE."
          ::= { dot11PhyHTEntry 11 }

dot11ShortGIOptionInFortyEnabled OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the Short Guard
option is enabled for 40 MHz operation. The default value of this attribute
is FALSE."
          ::= { dot11PhyHTEntry 12 }

dot11LDPCCodingOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the LDPC coding
option is implemented. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 13 }

dot11LDPCCodingOptionEnabled OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the LDPC coding
option is enabled. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 14 }

dot11TxSTBCOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
STATUS current
DESCRIPTION
               "This attribute, when TRUE, indicates that the entity is
capable of transmitting frames using Space-Time Block Code (STBC) option.
The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 15 }
```

```
dot11TxSTBCOptionEnabled OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the entity’s
capability of transmitting frames using Space-Time Block Code (STBC) option
is enabled. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 16 }

dot11RxSTBCOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the entity is
capable of receiving frames that are sent using the Space-Time Block Code
(STBC). The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 17 }

dot11RxSTBCOptionEnabled OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the entity’s
capability of receiving frames that are sent using the Space-Time Block Code
(STBC) is enabled. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 18 }


dot11BeamFormingOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the Beam Forming
option is implemented. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 19 }

dot11BeamFormingOptionEnabled OBJECT-TYPE
          SYNTAX TruthValue
```

```
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the Beam Forming
option is enabled. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 20 }

dot11HighestSupportedDataRate OBJECT-TYPE
          SYNTAX INTEGER (0..600)
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute shall specify the Highest Data Rate in Mb/s at
which the station may receive data. The default value of this attribute shall
be 0."
          ::= { dot11PhyHTEntry 21 }

dot11TxMCSSetDefined OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the Tx MCS set is
defined. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 22 }

dot11TxRxMCSSetNotEqual OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that the supported Tx
and Rx MCS sets are not equal. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 23 }

dot11TxMaximumNumberSpatialStreamsSupported OBJECT-TYPE
          SYNTAX INTEGER (0..3)
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute indicates the Tx maximum number of spatial
streams supported. The default value of this attribute is 0."
```

```
          ::= { dot11PhyHTEntry 24 }


dot11TxUnequalModulationSupported OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-write
          STATUS current
          DESCRIPTION
               "This attribute, when TRUE, indicates that Tx unequal
modulation is supported. The default value of this attribute is FALSE."
          ::= { dot11PhyHTEntry 25 }

-- **********************************************************************
-- * End of dot11 PHY HT TABLE
-- **********************************************************************


-- **********************************************************************
-- * dot11 Supported MCS Tx TABLE
-- **********************************************************************
dot11SupportedMCSTxTable OBJECT-TYPE
          SYNTAX SEQUENCE OF Dot11SupportedMCSTxEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
          "The Transmit MCS supported by the PLCP and PMD, represented by a
count from 1 to 127, subject to limitations of each individual PHY."
          ::= { dot11phy 16 }


dot11SupportedMCSTxEntry OBJECT-TYPE
          SYNTAX Dot11SupportedDataRatesTxEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
          "An Entry (conceptual row) in the dot11SupportedMCSTx Table.
          ifIndex - Each IEEE 802.11 interface is represented by an
          ifEntry. Interface tables in this MIB module are indexed by
ifIndex."
          INDEX { ifIndex,
dot11SupportedMCSTxIndex }
          ::= { dot11SupportedMCSTxTable 1 }


Dot11SupportedMCSTxEntry ::=
```

```
          SEQUENCE {
               dot11SupportedMCSTxIndex Integer32,
               dot11SupportedMCSTxValue Integer32 }

dot11SupportedMCSTxIndex OBJECT-TYPE
          SYNTAX Integer32 (1..255)
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "Index object that identifies which MCS to access. Range is
1..255."
          ::= { dot11SupportedMCSTxEntry 1 }

dot11SupportedMCSTxValue OBJECT-TYPE
          SYNTAX Integer32 (1..127)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "The Transmit MCS supported by the PLCP and PMD, represented
by a count from 1 to 127, subject to limitations of each individual PHY."
          ::= { dot11SupportedDataRatesTxEntry 2 }
-- ********************************************************************
-- * End of dot11 Supported MCS Tx TABLE
-- ********************************************************************


-- ********************************************************************
-- * dot11 Supported MCS Rx TABLE
-- ********************************************************************
dot11SupportedMCSRxTable OBJECT-TYPE
          SYNTAX SEQUENCE OF Dot11SupportedMCSRxEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "The receive MCS supported by the PLCP and PMD, represented by
a count from 1 to 127, subject to limitations of each individual PHY."
          ::= { dot11phy 16 }

dot11SupportedMCSRxEntry OBJECT-TYPE
          SYNTAX Dot11SupportedDataRatesRxEntry
          MAX-ACCESS not-accessible
          STATUS current
```

```
         DESCRIPTION
              "An Entry (conceptual row) in the dot11SupportedMCSRx Table.
ifIndex - Each IEEE 802.11 interface is represented by an ifEntry. Interface
tables in this MIB module are indexed by ifIndex."
         INDEX {
              ifIndex,
              dot11SupportedMCSRxIndex }
         ::= { dot11SupportedMCSRxTable 1 }

Dot11SupportedMCSRxEntry ::=
         SEQUENCE {
              dot11SupportedMCSRxIndex Integer32,
              dot11SupportedMCSRxValue Integer32 }

dot11SupportedMCSRxIndex OBJECT-TYPE
         SYNTAX Integer32 (1..255)
         MAX-ACCESS not-accessible
         STATUS current
         DESCRIPTION
              "Index object that identifies which MCS to access. Range is
1..255."
         ::= { dot11SupportedMCSTxEntry 1 }

dot11SupportedMCSRxValue OBJECT-TYPE
         SYNTAX Integer32 (1..127)
         MAX-ACCESS read-only
         STATUS current
         DESCRIPTION
              "The receive MCS supported by the PLCP and PMD, represented by
a count from 1 to 127, subject to limitations of each individual PHY."
         ::= { dot11SupportedDataRatesTxEntry 2 }

-- **********************************************************************
-- * End of dot11 Supported MCS Rx TABLE
-- **********************************************************************


-- **********************************************************************
-- * dot11 Tx BF Config TABLE
-- **********************************************************************
dot11TxBFConfigTable OBJECT-TYPE
         SYNTAX SEQUENCE OF Dot11TxBFConfigEntry
```

```
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "Entry of attributes for dot11TxBFConfigTable. Implemented as
a table indexed on ifIndex to allow for multiple instances on an Agent."
          ::= { dot11phy 18 }


dot11TxBFConfigEntry OBJECT-TYPE
          SYNTAX Dot11TxBFConfigEntry
          MAX-ACCESS not-accessible
          STATUS current
          DESCRIPTION
               "An entry in the dot11TxBFConfig Table.


               ifIndex - Each 802.11 interface is represented by an ifEntry.
Interface tables in this MIB module are indexed by ifIndex."
          INDEX {ifIndex}
          ::= { dot11TxBFConfigTable 1 }


Dot11PhyHTEntry ::= SEQUENCE {
          dot11ReceiveStaggerSoundingOptionImplemented TruthValue,
          dot11TransmitStaggerSoundingOptionImplemented TruthValue,
          dot11ReceiveNDPOptionImplemented TruthValue,
          dot11TransmitNDPOptionImplemented TruthValue,
          dot11ImplicitTxBFOptionImplemented TruthValue,
          dot11CalibrationOptionImplemented INTEGER,
          dot11ExplicitCSITxBFOptionImplemented TruthValue,
          dot11ExplicitNonCompressedbeamformingMatrixOptionImplemented TruthValue,
          dot11ExplicitBFCSIFeedbackOptionImplemented INTEGER,
          dot11ExplicitNonCompressedbeamformingMatrixFeedbackOptionImplemented
INTEGER,
          dot11ExplicitCompressedbeamformingMatrixFeedbackOptionImplemented INTEGER,
          dot11NumberBeamFormingCSISupportAntenna INTEGER,
          dot11NumberNonCompressedbeamformingMatrixSupportAntenna INTEGER,
          dot11NumberCompressedbeamformingMatrixSupportAntenna INTEGER,
          dot11MaxCSIFeedbackDelay Unsigned32
 }


dot11ReceiveStaggerSoundingOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
```

```
          DESCRIPTION
              "This attribute, when TRUE, indicates that the STA
implementation supports the receiving of staggered sounding frames. The
default value of this attribute is FALSE."
          ::= { dot11TxBFConfigEntry 1 }


dot11TransmitStaggerSoundingOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
              "This attribute, when TRUE, indicates that the STA
implementation supports the transmission of staggered sounding frames. The
default value of this attribute is FALSE."
          ::= { dot11TxBFConfigEntry 2 }


dot11ReceiveNDPOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
              "This attribute, when TRUE, indicates that the STA
implementation is capable of receiving NDP as sounding frames. The default
value of this attribute is FALSE."
          ::= { dot11TxBFConfigEntry 3 }


dot11TransmitNDPOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
              "This attribute, when TRUE, indicates that the STA
implementation is capable of transmitting NDP as sounding frames. The
default value of this attribute is FALSE."
          ::= { dot11TxBFConfigEntry 4 }


dot11ImplicitTxBFOptionImplemented OBJECT-TYPE
          SYNTAX TruthValue
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
```

```
          "This attribute, when TRUE, indicates that STA implementation
is capable of applying implicit transmit beamforming. The default value of
this attribute is FALSE."
     ::= { dot11TxBFConfigEntry 5 }

dot11CalibrationOptionImplemented OBJECT-TYPE
     SYNTAX INTEGER { inCapable (0), unableToInitiate (1),
ableToInitiate (2), fullyCapable (3) }
     MAX-ACCESS read-only
     STATUS current
     DESCRIPTION
          "This attribute indicates the level of calibration supported
by the STA implementation. The default value of this attribute is 0."
     ::= { dot11TxBFConfigEntry 6 }

dot11ExplicitCSITxBFOptionImplemented OBJECT-TYPE
     SYNTAX TruthValue
     MAX-ACCESS read-only
     STATUS current
     DESCRIPTION
          "This attribute, when TRUE, indicates that STA implementation
is capable of applying transmit beamforming using CSI explicit feedback in
its transmission. The default value of this attribute is FALSE."
     ::= { dot11TxBFConfigEntry 7 }

dot11ExplicitNonCompressedbeamformingMatrixOptionImplemented OBJECT-TYPE
     SYNTAX TruthValue
     MAX-ACCESS read-only
     STATUS current
     DESCRIPTION
          "This attribute, when TRUE, indicates that STA implementation
is capable of applying transmit beamforming using non-compressed beamforming
matrix explicit feedback in its transmission. The default value of this
attribute is FALSE."
     ::= { dot11TxBFConfigEntry 8 }



dot11ExplicitBFCSIFeedbackOptionImplemented OBJECT-TYPE
     SYNTAX INTEGER { inCapable (0), delayed (1), immediate (2),
unsolicitedImmediate (3), aggregated (4), delayedAggregated (5),
immediateAggregated(6), unsolicitedImmediateAggregated (7) }
     MAX-ACCESS read-only
```

```
          STATUS current
          DESCRIPTION
               "This attribute indicates the level of CSI explicit feedback
returned by the STA implementation. The default value of this attribute is
0."
          ::= { dot11TxBFConfigEntry 9 }


dot11ExplicitNonCompressedbeamformingMatrixFeedbackOptionImplemented
OBJECT-TYPE
          SYNTAX INTEGER { inCapable (0), delayed (1), immediate (2),
unsolicitedImmediate (3), aggregated (4), delayedAggregated (5),
immediateAggregated(6), unsolicitedImmediateAggregated (7) }
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the level of non-compressed
beamforming matrix explicit feedback returned by the STA implementation. The
default value of this attribute is 0."
          ::= { dot11TxBFConfigEntry 10 }


dot11ExplicitCompressedbeamformingMatrixFeedbackOptionImplemented OBJECT-
TYPE
          SYNTAX INTEGER { inCapable (0), delayed (1), immediate (2),
unsolicitedImmediate (3), aggregated (4), delayedAggregated (5),
immediateAggregated(6), unsolicitedImmediateAggregated (7) }
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the level of non-compressed
beamforming matrix explicit feedback returned by the STA implementation. The
default value of this attribute is 0."
          ::= { dot11TxBFConfigEntry 11 }


dot11NumberBeamFormingCSISupportAntenna OBJECT-TYPE
          SYNTAX INTEGER (1..4)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the maximum number of beamform
antennas the beamformee can support when CSI feedback is required."
          ::= { dot11TxBFConfigEntry 12 }


dot11NumberNonCompressedbeamformingMatrixSupportAntenna OBJECT-TYPE
```

```
          SYNTAX INTEGER (1..4)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the maximum number of beamform
antennas the beamformee can support when non-compressed beamforming matrix
feedback is required."
          ::= { dot11TxBFConfigEntry 13 }


dot11NumberCompressedbeamformingMatrixSupportAntenna OBJECT-TYPE
          SYNTAX INTEGER (1..4)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the maximum number of beamform
antennas the beamformee can support when compressed beamforming matrix
feedback is required."
          ::= { dot11TxBFConfigEntry 14 }


dot11MaxCSIFeedbackDelay OBJECT-TYPE
          SYNTAX Unsigned32 (1..4294967295)
          MAX-ACCESS read-only
          STATUS current
          DESCRIPTION
               "This attribute indicates the maximum allowed delay in
microseconds between the transmission time of a sounding packet and the time
a feedback response arrives (9.17.3 (Explicit feedback beamforming))"
          ::= { dot11TxBFConfigEntry 15 }



-- *********************************************************************
-- * End of dot11 Tx BF Config TABLE
-- *********************************************************************
```

Change dot11Compliance as shown:

```
dot11Compliance MODULE-COMPLIANCE
          STATUS current
          DESCRIPTION
               "The compliance statement for SNMPv2 entities that implement
the IEEE 802.11 MIB."
          MODULE -- this module
          MANDATORY-GROUPS {
               dot11SMTbase~~7~~8,
```

```
               dot11MACbase~~2~~3, dot11CountersGroup~~2~~3,
               dot11SmtAuthenticationAlgorithms,
               dot11ResourceTypeID, dot11PhyOperationComplianceGroup }
```

Insert at the end of the compliance statements after dot11PhyERPComplianceGroup the following component of the compliance statement:

```
GROUP dot11PhyHTComplianceGroup
          DESCRIPTION
               "Implementation of this group is required when object
dot11PHYType has the value of ht. This group is mutually exclusive with the
groups dot11PhyIRComplianceGroup and dot11PhyFHSSComplianceGroup"
```

Change the status of dot11PHYAntennaComplianceGroup to deprecated as shown below:

```
dot11PhyAntennaComplianceGroup OBJECT-GROUP
          OBJECTS
               { dot11CurrentTxAntenna, dot11DiversitySupport,
                 dot11CurrentRxAntenna }
          STATUS ~~current~~deprecated
          DESCRIPTION
               "Attributes for Data Rates for IEEE 802.11."
          ::= { dot11Groups 8 }
```

Change the status of dot11MACbase2 as deprecated as shown below:

```
dot11MACbase2 OBJECT-GROUP
          OBJECTS { dot11MACAddress, dot11Address,
               dot11GroupAddressesStatus,
               dot11RTSThreshold, dot11ShortRetryLimit,
               dot11LongRetryLimit, dot11FragmentationThreshold,
               dot11MaxTransmitMSDULifetime,
               dot11MaxReceiveLifetime, dot11ManufacturerID,
               dot11ProductID, dot11CAPLimit, dot11HCCWmin,
               dot11HCCWmax, dot11HCCAIFSN,
               dot11ADDBAResponseTimeout, dot11ADDTSResponseTimeout,
               dot11ChannelUtilizationBeaconInterval, dot11ScheduleTimeout,
               dot11DLSResponseTimeout, dot11QAPMissingAckRetryLimit,
               dot11EDCAAveragingPeriod }
          STATUS ~~current~~deprecated
          DESCRIPTION
               "The MAC object class provides the necessary support for the
access control, generation, and verification of frame check sequences
(FCSs), and proper delivery of valid data to upper layers."
          ::= { dot11Groups 31 }
```

Change the status of dot11CountersGroup2 to deprecated as shown below:

```
dot11CountersGroup2 OBJECT-GROUP
          OBJECTS { dot11TransmittedFragmentCount,
               dot11MulticastTransmittedFrameCount,
               dot11FailedCount, dot11ReceivedFragmentCount,
               dot11MulticastReceivedFrameCount,
               dot11FCSErrorCount,
               dot11WEPUndecryptableCount,
               dot11TransmittedFrameCount,
               dot11QosDiscardedFragmentCount,
               dot11AssociatedStationCount,
               dot11QosCFPollsReceivedCount,
               dot11QosCFPollsUnusedCount,
               dot11QosCFPollsUnusableCount }
          STATUS ~~current~~deprecated
          DESCRIPTION
               "Attributes from the dot11CountersGroup that are not described
in the dot11MACStatistics group. These objects are mandatory."
::= { dot11Groups 32 }
```

Change the status of dot11SMTbase8 to deprecated as shown below (note the objects and description of this group are represented by "..."):

```
dot11SMTbase8 OBJECT-GROUP
          OBJECTS
               { ... }
STATUS ~~current~~deprecated
DESCRIPTION
               "..."
::= { dot11Groups 40 }
```

Change the Optional Groups of the "Compliance Statements" as follows:

```
-- OPTIONAL-GROUPS { dot11SMTprivacy, dot11MACStatistics,
--        dot11PhyAntennaComplianceGroup, dot11PhyTxPowerComplianceGroup,
--        dot11PhyRegDomainsSupportGroup,
--        dot11PhyAntennasListGroup, dot11PhyRateGroup,
--        dot11SMTbase3, dot11MultiDomainCapabilityGroup,
--        dot11PhyFHSSComplianceGroup, dot11RSNAadditions,
--        dot11RegulatoryClassesGroup, dot11Qosadditions,
--        dot11FTComplianceGroup,
--        dot11PhyAntennaComplianceGroup2,
```

```
--        dot11SMTbase9,
--        dot11HTMACadditions,
--        dot11PhyMCSGroup,
--        dot11TxBFGroup }
```

Change the status of dot11CountersGroup2 to deprecated as shown below:

```
dot11CountersGroup2 OBJECT-GROUP
          OBJECTS { dot11TransmittedFragmentCount,
               dot11MulticastTransmittedFrameCount,
               dot11FailedCount, dot11ReceivedFragmentCount,
               dot11MulticastReceivedFrameCount,
               dot11FCSErrorCount,
               dot11WEPUndecryptableCount,
               dot11TransmittedFrameCount,
               dot11QosDiscardedFragmentCount,
               dot11AssociatedStationCount,
               dot11QosCFPollsReceivedCount,
               dot11QosCFPollsUnusedCount,
               dot11QosCFPollsUnusableCount }
          STATUS ~~current~~deprecated
          DESCRIPTION
               "Attributes from the dot11CountersGroup that are not described
in the dot11MACStatistics group. These objects are mandatory."
::= { dot11Groups 32 }
```

Insert the following units of conformance:

```
dot11PhyAntennaComplianceGroup2 OBJECT-GROUP
          OBJECTS {
               dot11CurrentTxAntenna,
               dot11DiversitySupport,
               dot11CurrentRxAntenna,
               dot11AntennaSelectionOptionImpemented,
               dot11TransmitExplicitCSIFeedbackASOptionImplemented,
               dot11TransmitIndicesFeedbackASOptionImplemented,
               dot11ExplicitCSIFeedbackASOptionImplemented,
               dot11TransmitIndicesComputationFeedbackASOptionImplemented,
               dot11ReceiveAntennaSelectionOptionImplemented }
          STATUS current
          DESCRIPTION
               "Attributes for Data Rates for IEEE 802.11."
          ::= { dot11Groups 41 }
```

```
dot11MACbase3 OBJECT-GROUP
        OBJECTS {
            dot11MACAddress,
            dot11Address,
            dot11GroupAddressesStatus,
            dot11RTSThreshold,
            dot11ShortRetryLimit,
            dot11LongRetryLimit,
            dot11FragmentationThreshold,
            dot11MaxTransmitMSDULifetime,
            dot11MaxReceiveLifetime,
            dot11ManufacturerID,
            dot11ProductID,
            dot11CAPLimit,
            dot11HCCWmin,
            dot11HCCWmax,
            dot11HCCAIFSN,
            dot11ADDBAResponseTimeout,
            dot11ADDTSResponseTimeout,
            dot11ChannelUtilizationBeaconInterval,
            dot11ScheduleTimeout,
            dot11DLSResponseTimeout,
            dot11QAPMissingAckRetryLimit,
            dot11EDCAAveragingPeriod,
            dot11HTOperatingMode,
            dot11RIFSMode,
            dot11PSMPControlledAccess,
            dot11ServiceIntervalGranularity,
            dot11DualCTSProtection,
            dot11LSIGTXOPFullProtectionEnabled,
            dot11NonGFEntitiesPresent, dot11PCOActivated,
            dot11PCO40MaxDuration,
            dot11PCO20MaxDuration,
            dot11PCO40MinDuration,
            dot11PCO20MinDuration }
        STATUS current
        DESCRIPTION
            "The MAC object class provides the necessary support for the
access control, generation, and verification of frame check sequences
(FCSs), and proper delivery of valid data to upper layers."
        ::= { dot11Groups 42 }
```

```
dot11CountersGroup3 OBJECT-GROUP
          OBJECTS {
               dot11TransmittedFragmentCount,
               dot11MulticastTransmittedFrameCount,
               dot11FailedCount,
               dot11ReceivedFragmentCount,
               dot11MulticastReceivedFrameCount,
               dot11FCSErrorCount,
               dot11WEPUndecryptableCount,
               dot11TransmittedFrameCount,
               dot11QosDiscardedFragmentCount,
               dot11AssociatedStationCount,
               dot11QosCFPollsReceivedCount,
               dot11QosCFPollsUnusedCount,
               dot11QosCFPollsUnusableCount,
               dot11QoSCFPollsLostCount,
               dot11TransmittedAMSDUCount,
               dot11FailedAMSDUCount,
               dot11RetryAMSDUCount,
               dot11MultipleRetryAMSDUCount,
               dot1TransmittedOctetsInAMSDUCount,
               dot11AMSDUAckFailureCount,
               dot11ReceivedAMSDUCount,
               dot1ReceivedOctetsInAMSDUCount,
               dot11TransmittedAMPDUCount,
               dot11TransmittedMPDUsInAMPDUCount,
               dot11TransmittedOctetsInAMPDUCount,
               dot11AMPDUReceivedCount,
               dot11MPDUInReceivedAMPDUCount,
               dot11ReceivedOctetsInAMPDUCount,
               dot11AMPDUDelimiterCRCErrorCount,
               dot11ImplicitBARFailureCount,
               dot11ExplicitBARFailureCount,
               dot11ChannelWidthSwitchCount,
               dot11TwentyMHzFrameTransmittedCount,
               dot11FortyMHzFrameTransmittedCount,
               dot11TwentyMHzFrameReceivedCount,
               dot11FortyMHzFrameReceivedCount,
               dot11PSMPSuccessCount,
               dot11PSMPFailureCount,
```

```
                dot11GrantedRDGUsedCount,
                dot11GrantedRDGUnusedCount,
                dot11TransmittedFramesInGrantedRDGCount,
                dot11TransmittedOctetsInGrantedRDGCount,
                dot11BeamformingCount,
                dot11DualCTSSuccessCount,
                dot11DualCTSFailureCount,
                dot11STBCCTSSuccessCount,
                dot11STBCCTSFailureCount,
                dot11nonSTBCCTSSuccessCount,
                dot11nonSTBCCTSFailureCount,
                dot11RTSLSIGSuccessCount,
                dot11RTSLSIGFailureCount }
          STATUS current
          DESCRIPTION
                "Attributes from the dot11CountersGroup that are not described
in the dot11MACStatistics group. These objects are mandatory."
::= { dot11Groups 43 }


dot11SMTbase9 OBJECT-GROUP
          OBJECTS {
                dot11MediumOccupancyLimit,
                dot11CFPollable,
                dot11CFPPeriod,
                dot11CFPMaxDuration,
                dot11AuthenticationResponseTimeOut,
                dot11PrivacyOptionImplemented,
                dot11PowerManagementMode,
                dot11DesiredSSID,
                dot11DesiredBSSType,
                dot11OperationalRateSet,
                dot11BeaconPeriod,
                dot11DTIMPeriod,
                dot11AssociationResponseTimeOut,
                dot11DisassociateReason,
                dot11DisassociateStation,
                dot11DeauthenticateReason,
                dot11DeauthenticateStation,
                dot11AuthenticateFailStatus,
                dot11AuthenticateFailStation,
                dot11MultiDomainCapabilityImplemented,
```

```
                dot11MultiDomainCapabilityEnabled,
                dot11CountryString,
                dot11RSNAOptionImplemented,
                dot11RegulatoryClassesImplemented,
                dot11RegulatoryClassesRequired,
                dot11QosOptionImplemented,
                dot11ImmediateBlockAckOptionImplemented,
                dot11DelayedBlockAckOptionImplemented,
                dot11DirectOptionImplemented,
                dot11APSDOptionImplemented,
                dot11QAckOptionImplemented,
                dot11QBSSLoadOptionImplemented,
                dot11QueueRequestOptionImplemented,
                dot11TXOPRequestOptionImplemented,
                dot11MoreDataAckOptionImplemented,
                dot11AssociateinNQBSS,
                dot11DLSAllowedInQBSS,
                dot11DLSAllowed,
                dot11FastBSSTransitionImplemented,
                dot11HighThroughputOptionImpelemented }
          STATUS current
          DESCRIPTION
                "The SMTbase9  object class provides the necessary support at
the STA to manage the processes in the STA such that the STA may work
cooperatively as a part of an IEEE 802.11 network."
::= { dot11Groups 44  }


dot11PhyMCSGroup OBJECT-GROUP
          OBJECTS {
                dot11SupportedMCSTxValue,
                dot11SupportedMCSRxValue }
          STATUS current
          DESCRIPTION
                "Attributes for Modulation and Coding Schemes (MCS) for IEEE
802.11 HT."
          ::= { dot11Groups 45 }


dot1PhyHTComplianceGroup OBJECT-GROUP
          OBJECTS {
                dot11HighThroughputOptionImplemented,
                dot11FortyMHzOperationImplemented,
```

```
                    dot11FortyMHzOperationEnabled,
                    dot11CurrentPrimaryChannel,
                    dot11CurrentSecondaryChannel,
                    dot11GreenfieldOptionImplemented,
                    dot11GreenfieldOptionEnabled,
                    dot11ShortGIOptionInTwentyImplemented,
                    dot11ShortGIOptionInTwentyEnabled,
                    dot11ShortGIOptionInFortyImplemented,
                    dot11ShortGIOptionInFortyEnabled,
                    dot11LDPCCodingOptionImplemented,
                    dot11LDPCCodingOptionEnabled,
                    dot11TxSTBCOptionImplemented,
                    dot11TxSTBCOptionEnabled,
                    dot11RxSTBCOptionImplemented,
                    dot11RxSTBCOptionEnabled,
                    dot11BeamFormingOptionImplemented,
                    dot11BeamFormingOptionImplemented }
          STATUS current
          DESCRIPTION
                    "Attributes that configure the HT for IEEE 802.11."
          ::= { dot11Groups 46 }

dot11HTMACAdditions OBJECT-GROUP
          OBJECTS {
                    dot11HTOperationalMCSSet,
                    dot11MIMOPowerSave,
                    dot11NDelayedBlockAckOptionImplemented,
                    dot11MaxAMSDULength,
                    dot11PSMPOPtionImplemented,
                    dot11STBCControlFrameOptionImplemented,
                    dot11LsigTxopProtectionOptionImplemented,
                    dot11MaxRxAMPDUFactor,
                    dot11MinimumMPDUStartSpacing,
                    dot11PCOOptionImplemented,
                    dot11TransitionTime,
                    dot11MCSFeedbackOptionImplemented,
dot11HTControlFieldSupported,dot11RDResponderOptionImplemented }
          STATUS current
          DESCRIPTION
                    "Attributes that configure the HT for IEEE 802.11."
          ::= { dot11Groups 47 }
```

```
dot11TxBFGroup OBJECT-GROUP
       OBJECTS {
          dot11ReceiveStaggerSoundingOptionImplemented,
          dot11TransmitStaggerSoundingOptionImplemented,
          dot11ReceiveNDPOptionImplemented,
          dot11TransmitNDPOptionImplemented,
          dot11ImplicitTxBFOptionImplemented,
          dot11CalibrationOptionImplemented,
          dot11ExplicitCSITxBFOptionImplemented,
          dot11ExplicitNonCompressedbeamformingMatrixOptionImplemented,
          dot11ExplicitBFCSIFeedbackOptionImplemented,

dot11ExplicitNonCompressedbeamformingMatrixFeedbackOptionImplemented,
          dot11ExplicitCompressedbeamformingMatrixFeedbackOptionImplemented,
          dot11NumberBeamFormingCSISupportAntenna,
          dot11NumberNonCompressedbeamformingMatrixSupportAntenna,
          dot11NumberCompressedbeamformingMatrixSupportAntenna
           }
       STATUS current
       DESCRIPTION
              "Attributes that configure the Beamforming for IEEE 802.11
HT."
          ::= { dot11Groups 48 }
```

Annex G (informative) **An example of encoding a frame for OFDM PHY**

Change G.2 as follows:

G.2 The message for the BCC example

The message being encoded consists of the first 72 characters (shown in **bold** font) of the well-known "Ode to Joy" by F. Schiller:

Change the first 72 characters of the text quoted from G.2 to a bold font as follows:

Joy, bright spark of divinity,
Daughter of Elysium,
Fire-insired we tread
Thy sanctuary.
Thy magic power re-unites
All that custom has divided,
All men become brothers
Under the sway of thy gentle wings.

The message is converted to ASCII; then it is prepended with an appropriate MAC header and a CRC32 is added. The resulting 100 octets PSDU is shown in Table G.1.

EDITORIAL NOTE—There are four changes: (1) The header for the left column has changed; (2) seven entries in the left column have been corrected; (3) the last 4 entries of the bottom row have the corrected CRC32 value; and (4) the caption indicates the example is specific to BCC.

Replace Table G.1 with the following:

Table G.1—The message for the BCC example

Octet ##	Val	Val	Val	Val	Val
1...5	04	02	00	2E	00
6...10	60	08	CD	37	A6
11...15	00	20	D6	01	3C
16...20	F1	00	60	08	AD
21...25	3B	AF	00	00	4A
26...30	6F	79	2C	20	62
31...35	72	69	67	68	74
36...40	20	73	70	61	72
41...45	6B	20	6F	66	20
46...50	64	69	76	69	6E

Table G.1—The message for the BCC example ***(continued)***

Octet ##	Val	Val	Val	Val	Val
51...55	69	74	79	2C	0A
56...60	44	61	75	67	68
61...65	74	65	72	20	6F
66...70	66	20	45	6C	79
71...75	73	69	75	6D	2C
76...80	0A	46	69	72	65
81...85	2D	69	6E	73	69
86...90	72	65	64	20	77
91...95	65	20	74	72	65
96...100	61	67	33	21	B6

Change the heading of G.5 as follows:

G.5 Generating the DATA bits for the BCC example

G.5.1 Delineating, SERVICE field prepending, and zero padding

Change G.5.1 as follows:

The transmitted message shown in Table G.1 contains 100 octets or, equivalently, 800 bits. The bits are prepended by the 16 SERVICE field bits and are appended by 6 tail bits. The resulting 822 bits are appended by zero bits to yield an integer number of OFDM symbols. For the 36 Mb/s mode, there are 144 data bits per OFDM symbol; the overall number of bits is ceiling (822/144) × 144 = 864. Hence, 864 – 822 = 42 zero bits are appended.

~~The data bits are shown in Table G.13 and Table G.14. For clarity, only the first and last 144 bits are shown.~~ The DATA bits are shown in Table G.13. Note that the bit-ordering of the octets is most significant bit first.

EDITORIAL NOTE—The replacement table G.13 includes all data bits, so it replaces both G.13 and G.14. The replacement table includes the corrected CRC value.

Replace Table G.13 with the following table and delete Table G.14:

Table G.13—The DATA bits before scrambling

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
000-023	00000000	00000000	00000100	0x00	0x00	0x04
024-047	00000010	00000000	00101110	0x02	0x00	0x2E
048-071	00000000	01100000	00001000	0x00	0x60	0x08
072-095	11001101	00110111	10100110	0xCD	0x37	0xA6
096-119	00000000	00100000	11010110	0x00	0x20	0xD6
120-143	00000001	00111100	11110001	0x01	0x3C	0xF1
144-167	00000000	01100000	00001000	0x00	0x60	0x08
168-191	10101101	00111011	10101111	0xAD	0x3B	0xAF
192-215	00000000	00000000	01001010	0x00	0x00	0x4A
216-239	01101111	01111001	00101100	0x6F	0x79	0x2C
240-263	00100000	01100010	01110010	0x20	0x62	0x72
264-287	01101001	01100111	01101000	0x69	0x67	0x68
288-311	01110100	00100000	01110011	0x74	0x20	0x73
312-335	01110000	01100001	01110010	0x70	0x61	0x72
336-359	01101011	00100000	01101111	0x6B	0x20	0x6F
360-383	01100110	00100000	01100100	0x66	0x20	0x64
384-407	01101001	01110110	01101001	0x69	0x76	0x69
408-431	01101110	01101001	01110100	0x6E	0x69	0x74
432-455	01111001	00101100	00001010	0x79	0x2C	0x0A
456-479	01000100	01100001	01110101	0x44	0x61	0x75
480-503	01100111	01101000	01110100	0x67	0x68	0x74
504-527	01100101	01110010	00100000	0x65	0x72	0x20
528-551	01101111	01100110	00100000	0x6F	0x66	0x20
552-575	01000101	01101100	01111001	0x45	0x6C	0x79
576-599	01110011	01101001	01110101	0x73	0x69	0x75
600-623	01101101	00101100	00001010	0x6D	0x2C	0x0A

Table G.13—The DATA bits before scrambling *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
624-647	01000110	01101001	01110010	0x46	0x69	0x72
648-671	01100101	00101101	01101001	0x65	0x2D	0x69
672-695	01101110	01110011	01101001	0x6E	0x73	0x69
696-719	01110010	01100101	01100100	0x72	0x65	0x64
720-743	00100000	01110111	01100101	0x20	0x77	0x65
744-767	00100000	01110100	01110010	0x20	0x74	0x72
768-791	01100101	01100001	01100111	0x65	0x61	0x67
792-815	00110011	00100001	10110110	0x33	0x21	0xB6
816-839	00000000	00000000	00000000	0x00	0x00	0x00
840-863	00000000	00000000	00000000	0x00	0x00	0x00

Change the heading of G.5.2 as follows:

G.5.2 Scrambling the BCC example

Change G.5.2 as follows:

The 864 bits are scrambled by the scrambler of Figure 117 (in 17.3.5.4). The initial state of the scrambler is the state 1011101. The generated scrambling sequence is given in Table G.15.

After scrambling, the 6 bits in location 816 (i.e. bit 817) to 821 (bit 822) are zeroed. ~~The first and last 144 scrambled bits are show in Table G.16 and G.17, respectively.~~ The scrambled DATA bits are shown in Table G.16, with the bit-ordering being most significant bit first.

EDITORIAL NOTE—The replacement table G.16 includes all data bits, so it replaces both G.16 and G.17. The replacement table includes the corrected CRC value.

Replace Table G.16 as follows and delete Table G.17:

Table G.16—The DATA bits after scrambling

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
000-023	01101100	00011001	10001001	0x6C	0x19	0x89
024-047	10001111	01101000	00100001	0x8F	0x68	0x21
048-071	11110100	10100101	01100001	0xF4	0xA5	0x61
072-095	01001111	11010111	10101110	0x4F	0xD7	0xAE
096-119	00100100	00001100	11110011	0x24	0x0C	0xF3
120-143	00111010	11100100	10111100	0x3A	0xE4	0xBC
144-167	01010011	10011000	11000000	0x53	0x98	0xC0
168-191	00011110	00110101	10110011	0x1E	0x35	0xB3
192-215	11100011	11111000	00100101	0xE3	0xF8	0x25
216-239	01100000	11010110	00100101	0x60	0xD6	0x25
240-263	00110101	00110011	11111110	0x35	0x33	0xFE
264-287	11110000	01000001	00101011	0xF0	0x41	0x2B
288-311	10001111	01010011	00011100	0x8F	0x53	0x1C
312-335	10000011	01000001	10111110	0x83	0x41	0xBE
336-359	00111001	00101000	01100110	0x39	0x28	0x66
360-383	01000100	01100110	11001101	0x44	0x66	0xCD
384-407	11110110	10100011	11011000	0xF6	0xA3	0xD8
408-431	00001101	11010100	10000001	0x0D	0xD4	0x81
432-455	00111011	00101111	11011111	0x3B	0x2F	0xDF
456-479	11000011	01011000	11110111	0xC3	0x58	0xF7
480-503	11000110	01010010	11101011	0xC6	0x52	0xEB
504-527	01110000	10001111	10011110	0x70	0x8F	0x9E
528-551	01101010	10010000	10000001	0x6A	0x90	0x81
552-575	11111101	01111100	10101001	0xFD	0x7C	0xA9
576-599	11010001	01010101	00010010	0xD1	0x55	0x12
600-623	00000100	01110100	11011001	0x04	0x74	0xD9

Table G.16—The DATA bits after scrambling *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
624-647	11101001	00111011	11001101	0xE9	0x3B	0xCD
648-671	10010011	10001101	01111011	0x93	0x8D	0x7B
672-695	01111100	01110000	00000010	0x7C	0x70	0x02
696-719	00100000	10011001	10100001	0x20	0x99	0xA1
720-743	01111101	10001010	00100111	0x7D	0x8A	0x27
744-767	00010111	00111001	00010101	0x17	0x39	0x15
768-791	10100000	11101100	10010101	0xA0	0xEC	0x95
792-815	00010110	10010001	00010000	0x16	0x91	0x10
816-839	00000000	11011100	01111111	0x00	0xDC	0x7F
840-863	00001110	11110010	11001001	0x0E	0xF2	0xC9

Change the heading of G.6 as follows:

G.6 Generating the first DATA symbol for the BCC example

Change G.6.1 as follows:

G.6.1 Coding the DATA bits

The scrambled bits are coded with a rate 3/4 convolutional code. ~~The first 144 scrambled bits of Table G.16 are mapped into the 192 bits of G.18.~~ The DATA encoded bits are shown in Table G.18, with the bit-ordering being most significant bit first.

Replace Table G.18 with the following:

Table G.18—The BCC encoded DATA bits

Bit ##	Binary Val	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val	Hex Val
0000-0031	00101011	00001000	10100001	11110000	0x2B	0x08	0xA1	0xF0
0032-0063	10011101	10110101	10011010	00011101	0x9D	0xB5	0x9A	0x1D
0064-0095	01001010	11111011	11101000	11000010	0x4A	0xFB	0xE8	0xC2
0096-0127	10001111	11000000	11001000	01110011	0x8F	0xC0	0xC8	0x73
0128-0159	11000000	01000011	11100000	00011001	0xC0	0x43	0xE0	0x19
0160-0191	11100000	11010011	11101011	10110010	0xE0	0xD3	0xEB	0xB2
0192-0223	10101111	10011000	11111101	01011001	0xAF	0x98	0xFD	0x59
0224-0255	00001111	10001011	01101001	01100110	0x0F	0x8B	0x69	0x66
0256-0287	00001100	10101010	11011001	00010000	0x0C	0xAA	0xD9	0x10
0288-0319	01010110	10001011	10100110	01000000	0x56	0x8B	0xA6	0x40
0320-0351	01100100	10110011	00100001	10011110	0x64	0xB3	0x21	0x9E
0352-0383	10001110	10010001	11000001	00000101	0x8E	0x91	0xC1	0x05
0384-0415	10110111	10110111	11000101	11011000	0xB7	0xB7	0xC5	0xD8
0416-0447	10000000	00101111	10100010	11011101	0x80	0x2F	0xA2	0xDD
0448-0479	01101111	00101011	10010111	01100001	0x6F	0x2B	0x97	0x61
0480-0511	11011001	11011101	00001101	00010010	0xD9	0xDD	0x0D	0x12
0512-0543	01110110	00100111	00000010	01001100	0x76	0x27	0x02	0x4C
0544-0575	10010010	10111100	00010010	01001011	0x92	0xBC	0x12	0x4B
0576-0607	01101010	11110111	01110000	00100011	0x6A	0xF7	0x70	0x23
0608-0639	00100111	10001110	00000001	10110100	0x27	0x8E	0x01	0xB4
0640-0671	11010110	11000011	01101010	01100000	0xD6	0xC3	0x6A	0x60
0672-0703	01001101	01001011	11001011	01010001	0x4D	0x4B	0xCB	0x51
0704-0735	10011100	10110000	10000000	11101011	0x9C	0xB0	0x80	0xEB
0736-0767	10001001	00110100	00010100	01000000	0x89	0x34	0x14	0x40
0768-0799	01101100	10011110	00101100	01010001	0x6C	0x9E	0x2C	0x51
0800-0831	01001011	01111100	01101001	00010001	0x4B	0x7C	0x69	0x11

Table G.18—The BCC encoded DATA bits *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val	Hex Val
0832-0863	00010101	10000110	11111101	10111110	0x15	0x86	0xFD	0xBE
0864-0895	01011110	11111001	10111110	00101000	0x5E	0xF9	0xBE	0x28
0896-0927	11101111	11001010	01010101	00000011	0xEF	0xCA	0x55	0x03
0928-0959	11111101	00100110	10010001	00111011	0xFD	0x26	0x91	0x3B
0960-0991	10010101	11101100	01011011	00100011	0x95	0xEC	0x5B	0x23
0992-1023	10011001	01011111	00101000	00111110	0x99	0x5F	0x28	0x3E
1024-1055	11010100	11101001	11110111	10111000	0xD4	0xE9	0xF7	0xB8
1056-1087	00010011	01110101	10001110	11110010	0x13	0x75	0x8E	0xF2
1088-1119	10100000	00011011	01101100	11101001	0xA0	0x1B	0x6C	0xE9
1120-1151	00000111	01011101	10110000	10111111	0x07	0x5D	0xB0	0xBF

Change G.8 as follows:

G.8 The entire packet for the BCC example

The packet in its entirety is shown in Table G.24 to Table G.32. ~~The short sequences section, the long sequences section, the SIGNAL field, and the DATA symbols are separated by double lines.~~ These tables illustrate the short training sequence section (Table G.24), the long training sequence section (Table G.25), the SIGNAL field (Table G.26), and the six DATA symbols (Table G.27 to G.32).

Replace Table G.24 with the following:

Table G.24—Time domain representation of the short training sequence

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
0	0.023	0.023	1	-0.132	0.002	2	-0.013	-0.079	3	0.143	-0.013
4	0.092	0.000	5	0.143	-0.013	6	-0.013	-0.079	7	-0.132	0.002
8	0.046	0.046	9	0.002	-0.132	10	-0.079	-0.013	11	-0.013	0.143
12	0.000	0.092	13	-0.013	0.143	14	-0.079	-0.013	15	0.002	-0.132
16	0.046	0.046	17	-0.132	0.002	18	-0.013	-0.079	19	0.143	-0.013
20	0.092	0.000	21	0.143	-0.013	22	-0.013	-0.079	23	-0.132	0.002
24	0.046	0.046	25	0.002	-0.132	26	-0.079	-0.013	27	-0.013	0.143
28	0.000	0.092	29	-0.013	0.143	30	-0.079	-0.013	31	0.002	-0.132
32	0.046	0.046	33	-0.132	0.002	34	-0.013	-0.079	35	0.143	-0.013
36	0.092	0.000	37	0.143	-0.013	38	-0.013	-0.079	39	-0.132	0.002
40	0.046	0.046	41	0.002	-0.132	42	-0.079	-0.013	43	-0.013	0.143
44	0.000	0.092	45	-0.013	0.143	46	-0.079	-0.013	47	0.002	-0.132
48	0.046	0.046	49	-0.132	0.002	50	-0.013	-0.079	51	0.143	-0.013
52	0.092	0.000	53	0.143	-0.013	54	-0.013	-0.079	55	-0.132	0.002
56	0.046	0.046	57	0.002	-0.132	58	-0.079	-0.013	59	-0.013	0.143
60	0.000	0.092	61	-0.013	0.143	62	-0.079	-0.013	63	0.002	-0.132
64	0.046	0.046	65	-0.132	0.002	66	-0.013	-0.079	67	0.143	-0.013
68	0.092	0.000	69	0.143	-0.013	70	-0.013	-0.079	71	-0.132	0.002
72	0.046	0.046	73	0.002	-0.132	74	-0.079	-0.013	75	-0.013	0.143
76	0.000	0.092	77	-0.013	0.143	78	-0.079	-0.013	79	0.002	-0.132
80	0.046	0.046	81	-0.132	0.002	82	-0.013	-0.079	83	0.143	-0.013
84	0.092	0.000	85	0.143	-0.013	86	-0.013	-0.079	87	-0.132	0.002
88	0.046	0.046	89	0.002	-0.132	90	-0.079	-0.013	91	-0.013	0.143
92	0.000	0.092	93	-0.013	0.143	94	-0.079	-0.013	95	0.002	-0.132
96	0.046	0.046	97	-0.132	0.002	98	-0.013	-0.079	99	0.143	-0.013
100	0.092	0.000	101	0.143	-0.013	102	-0.013	-0.079	103	-0.132	0.002
104	0.046	0.046	105	0.002	-0.132	106	-0.079	-0.013	107	-0.013	0.143
108	0.000	0.092	109	-0.013	0.143	110	-0.079	-0.013	111	0.002	-0.132
112	0.046	0.046	113	-0.132	0.002	114	-0.013	-0.079	115	0.143	-0.013
116	0.092	0.000	117	0.143	-0.013	118	-0.013	-0.079	119	-0.132	0.002

Table G.24—Time domain representation of the short training sequence *(continued)*

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
120	0.046	0.046	121	0.002	-0.132	122	-0.079	-0.013	123	-0.013	0.143
124	0.000	0.092	125	-0.013	0.143	126	-0.079	-0.013	127	0.002	-0.132
128	0.046	0.046	129	-0.132	0.002	130	-0.013	-0.079	131	0.143	-0.013
132	0.092	0.000	133	0.143	-0.013	134	-0.013	-0.079	135	-0.132	0.002
136	0.046	0.046	137	0.002	-0.132	138	-0.079	-0.013	139	-0.013	0.143
140	0.000	0.092	141	-0.013	0.143	142	-0.079	-0.013	143	0.002	-0.132
144	0.046	0.046	145	-0.132	0.002	146	-0.013	-0.079	147	0.143	-0.013
148	0.092	0.000	149	0.143	-0.013	150	-0.013	-0.079	151	-0.132	0.002
152	0.046	0.046	153	0.002	-0.132	154	-0.079	-0.013	155	-0.013	0.143
156	0.000	0.092	157	-0.013	0.143	158	-0.079	-0.013	159	0.002	-0.132

Insert the following tables, Table G.25 to Table G.32, after Table G.24:

Table G.25—Time domain representation of the long training sequence

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
160	-0.055	0.023	161	0.012	-0.098	162	0.092	-0.106	163	-0.092	-0.115
164	-0.003	-0.054	165	0.075	0.074	166	-0.127	0.021	167	-0.122	0.017
168	-0.035	0.151	169	-0.056	0.022	170	-0.060	-0.081	171	0.070	-0.014
172	0.082	-0.092	173	-0.131	-0.065	174	-0.057	-0.039	175	0.037	-0.098
176	0.062	0.062	177	0.119	0.004	178	-0.022	-0.161	179	0.059	0.015
180	0.024	0.059	181	-0.137	0.047	182	0.001	0.115	183	0.053	-0.004
184	0.098	0.026	185	-0.038	0.106	186	-0.115	0.055	187	0.060	0.088
188	0.021	-0.028	189	0.097	-0.083	190	0.040	0.111	191	-0.005	0.120
192	0.156	0.000	193	-0.005	-0.120	194	0.040	-0.111	195	0.097	0.083
196	0.021	0.028	197	0.060	-0.088	198	-0.115	-0.055	199	-0.038	-0.106
200	0.098	-0.026	201	0.053	0.004	202	0.001	-0.115	203	-0.137	-0.047
204	0.024	-0.059	205	0.059	-0.015	206	-0.022	0.161	207	0.119	-0.004
208	0.062	-0.062	209	0.037	0.098	210	-0.057	0.039	211	-0.131	0.065
212	0.082	0.092	213	0.070	0.014	214	-0.060	0.081	215	-0.056	-0.022
216	-0.035	-0.151	217	-0.122	-0.017	218	-0.127	-0.021	219	0.075	-0.074
220	-0.003	0.054	221	-0.092	0.115	222	0.092	0.106	223	0.012	0.098
224	-0.156	0.000	225	0.012	-0.098	226	0.092	-0.106	227	-0.092	-0.115
228	-0.003	-0.054	229	0.075	0.074	230	-0.127	0.021	231	-0.122	0.017
232	-0.035	0.151	233	-0.056	0.022	234	-0.060	-0.081	235	0.070	-0.014
236	0.082	-0.092	237	-0.131	-0.065	238	-0.057	-0.039	239	0.037	-0.098
240	0.062	0.062	241	0.119	0.004	242	-0.022	-0.161	243	0.059	0.015
244	0.024	0.059	245	-0.137	0.047	246	0.001	0.115	247	0.053	-0.004
248	0.098	0.026	249	-0.038	0.106	250	-0.115	0.055	251	0.060	0.088
252	0.021	-0.028	253	0.097	-0.083	254	0.040	0.111	255	-0.005	0.120
256	0.156	0.000	257	-0.005	-0.120	258	0.040	-0.111	259	0.097	0.083
260	0.021	0.028	261	0.060	-0.088	262	-0.115	-0.055	263	-0.038	-0.106
264	0.098	-0.026	265	0.053	0.004	266	0.001	-0.115	267	-0.137	-0.047
268	0.024	-0.059	269	0.059	-0.015	270	-0.022	0.161	271	0.119	-0.004
272	0.062	-0.062	273	0.037	0.098	274	-0.057	0.039	275	-0.131	0.065
276	0.082	0.092	277	0.070	0.014	278	-0.060	0.081	279	-0.056	-0.022

Table G.25—Time domain representation of the long training sequence *(continued)*

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
280	-0.035	-0.151	281	-0.122	-0.017	282	-0.127	-0.021	283	0.075	-0.074
284	-0.003	0.054	285	-0.092	0.115	286	0.092	0.106	287	0.012	0.098
288	-0.156	0.000	289	0.012	-0.098	290	0.092	-0.106	291	-0.092	-0.115
292	-0.003	-0.054	293	0.075	0.074	294	-0.127	0.021	295	-0.122	0.017
296	-0.035	0.151	297	-0.056	0.022	298	-0.060	-0.081	299	0.070	-0.014
300	0.082	-0.092	301	-0.131	-0.065	302	-0.057	-0.039	303	0.037	-0.098
304	0.062	0.062	305	0.119	0.004	306	-0.022	-0.161	307	0.059	0.015
308	0.024	0.059	309	-0.137	0.047	310	0.001	0.115	311	0.053	-0.004
312	0.098	0.026	313	-0.038	0.106	314	-0.115	0.055	315	0.060	0.088
316	0.021	-0.028	317	0.097	-0.083	318	0.040	0.111	319	-0.005	0.120

Table G.26—Time domain representation of the SIGNAL field (1 symbol)

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
320	0.109	0.000	321	0.033	-0.044	322	-0.002	-0.038	323	-0.081	0.084
324	0.007	-0.100	325	-0.001	-0.113	326	-0.021	-0.005	327	0.136	-0.105
328	0.098	-0.044	329	0.011	-0.002	330	-0.033	0.044	331	-0.060	0.124
332	0.010	0.097	333	0.000	-0.008	334	0.018	-0.083	335	-0.069	0.027
336	-0.219	0.000	337	-0.069	-0.027	338	0.018	0.083	339	0.000	0.008
340	0.010	-0.097	341	-0.060	-0.124	342	-0.033	-0.044	343	0.011	0.002
344	0.098	0.044	345	0.136	0.105	346	-0.021	0.005	347	-0.001	0.113
348	0.007	0.100	349	-0.081	-0.084	350	-0.002	0.038	351	0.033	0.044
352	0.062	0.000	353	0.057	0.052	354	0.016	0.174	355	0.035	0.116
356	-0.051	-0.202	357	0.011	0.036	358	0.089	0.209	359	-0.049	-0.008

Table G.26—Time domain representation of the SIGNAL field (1 symbol) *(continued)*

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
360	-0.035	0.044	361	0.017	-0.059	362	0.053	-0.017	363	0.099	0.100
364	0.034	-0.148	365	-0.003	-0.094	366	-0.120	0.042	367	-0.136	-0.070
368	-0.031	0.000	369	-0.136	0.070	370	-0.120	-0.042	371	-0.003	0.094
372	0.034	0.148	373	0.099	-0.100	374	0.053	0.017	375	0.017	0.059
376	-0.035	-0.044	377	-0.049	0.008	378	0.089	-0.209	379	0.011	-0.036
380	-0.051	0.202	381	0.035	-0.116	382	0.016	-0.174	383	0.057	-0.052
384	0.062	0.000	385	0.033	-0.044	386	-0.002	-0.038	387	-0.081	0.084
388	0.007	-0.100	389	-0.001	-0.113	390	-0.021	-0.005	391	0.136	-0.105
392	0.098	-0.044	393	0.011	-0.002	394	-0.033	0.044	395	-0.060	0.124
396	0.010	0.097	397	0.000	-0.008	398	0.018	-0.083	399	-0.069	0.027

Table G.27—Time domain representation of the DATA field: symbol 1of 6

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
400	-0.139	0.050	401	0.004	0.014	402	0.011	-0.100	403	-0.097	-0.020
404	0.062	0.081	405	0.124	0.139	406	0.104	-0.015	407	0.173	-0.140
408	-0.040	0.006	409	-0.133	0.009	410	-0.002	-0.043	411	-0.047	0.092
412	-0.109	0.082	413	-0.024	0.010	414	0.096	0.019	415	0.019	-0.023
416	-0.087	-0.049	417	0.002	0.058	418	-0.021	0.228	419	-0.103	0.023
420	-0.019	-0.175	421	0.018	0.132	422	-0.071	0.160	423	-0.153	-0.062
424	-0.107	0.028	425	0.055	0.140	426	0.070	0.103	427	-0.056	0.025
428	-0.043	0.002	429	0.016	-0.118	430	0.026	-0.071	431	0.033	0.177
432	0.020	-0.021	433	0.035	-0.088	434	-0.008	0.101	435	-0.035	-0.010
436	0.065	0.030	437	0.092	-0.034	438	0.032	-0.123	439	-0.018	0.092

Table G.27—Time domain representation of the DATA field: symbol 1of 6 *(continued)*

440	0.000	-0.006	441	-0.006	-0.056	442	-0.019	0.040	443	0.053	-0.131
444	0.022	-0.133	445	0.104	-0.032	446	0.163	-0.045	447	-0.105	-0.030
448	-0.110	-0.069	449	-0.008	-0.092	450	-0.049	-0.043	451	0.085	-0.017
452	0.090	0.063	453	0.015	0.153	454	0.049	0.094	455	0.011	0.034
456	-0.012	0.012	457	-0.015	-0.017	458	-0.061	0.031	459	-0.070	-0.040
460	0.011	-0.109	461	0.037	-0.060	462	-0.003	-0.178	463	-0.007	-0.128
464	-0.059	0.100	465	0.004	0.014	466	0.011	-0.100	467	-0.097	-0.020
468	0.062	0.081	469	0.124	0.139	470	0.104	-0.015	471	0.173	-0.140
472	-0.040	0.006	473	-0.133	0.009	474	-0.002	-0.043	475	-0.047	0.092
476	-0.109	0.082	477	-0.024	0.010	478	0.096	0.019	479	0.019	-0.023

Table G.28—Time domain representation of the DATA field: symbol 2 of 6

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
480	-0.058	0.016	481	-0.096	-0.045	482	-0.110	0.003	483	-0.070	0.216
484	-0.040	0.059	485	0.010	-0.056	486	0.034	0.065	487	0.117	0.033
488	0.078	-0.133	489	-0.043	-0.146	490	0.158	-0.071	491	0.254	-0.021
492	0.068	0.117	493	-0.044	0.114	494	-0.035	0.041	495	0.085	0.070
496	0.120	0.010	497	0.057	0.055	498	0.063	0.188	499	0.091	0.149
500	-0.017	-0.039	501	-0.078	-0.075	502	0.049	0.079	503	-0.014	-0.007
504	0.030	-0.027	505	0.080	0.054	506	-0.186	-0.067	507	-0.039	-0.027
508	0.043	-0.072	509	-0.092	-0.089	510	0.029	0.105	511	-0.144	0.003
512	-0.069	-0.041	513	0.132	0.057	514	-0.126	0.070	515	-0.031	0.109
516	0.161	-0.009	517	0.056	-0.046	518	-0.004	0.028	519	-0.049	0.000
520	-0.078	-0.005	521	0.015	-0.087	522	0.149	-0.104	523	-0.021	-0.051
524	-0.154	-0.106	525	0.024	0.030	526	0.046	0.123	527	-0.004	-0.098
528	-0.061	-0.128	529	-0.024	-0.038	530	0.066	-0.048	531	-0.067	0.027
532	0.054	-0.050	533	0.171	-0.049	534	-0.108	0.132	535	-0.161	-0.019
536	-0.070	-0.072	537	-0.177	0.049	538	-0.172	-0.050	539	0.051	-0.075
540	0.122	-0.057	541	0.009	-0.044	542	-0.012	-0.021	543	0.004	0.009
544	-0.030	0.081	545	-0.096	-0.045	546	-0.110	0.003	547	-0.070	0.216
548	-0.040	0.059	549	0.010	-0.056	550	0.034	0.065	551	0.117	0.033
552	0.078	-0.133	553	-0.043	-0.146	554	0.158	-0.071	555	0.254	-0.021
556	0.068	0.117	557	-0.044	0.114	558	-0.035	0.041	559	0.085	0.070

Table G.29—Time domain representation of the DATA field: symbol 3 of 6

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
560	0.001	0.011	561	-0.099	-0.048	562	0.054	-0.196	563	0.124	0.035
564	0.092	0.045	565	-0.037	-0.066	566	-0.021	-0.004	567	0.042	-0.065
568	0.061	0.048	569	0.046	0.004	570	-0.063	-0.045	571	-0.102	0.152
572	-0.039	-0.019	573	-0.005	-0.106	574	0.083	0.031	575	0.226	0.028
576	0.140	-0.010	577	-0.132	-0.033	578	-0.116	0.088	579	0.023	0.052
580	-0.171	-0.080	581	-0.246	-0.025	582	-0.062	-0.038	583	-0.055	-0.062
584	-0.004	-0.060	585	0.034	0.000	586	-0.030	0.021	587	0.075	-0.122
588	0.043	-0.080	589	-0.022	0.041	590	0.026	0.013	591	-0.031	-0.018
592	0.059	0.008	593	0.109	0.078	594	0.002	0.101	595	-0.016	0.054
596	-0.059	0.070	597	0.017	0.114	598	0.104	-0.034	599	-0.024	-0.059
600	-0.081	0.051	601	-0.040	-0.069	602	-0.069	0.058	603	-0.067	0.117
604	0.007	-0.131	605	0.009	0.028	606	0.075	0.117	607	0.118	0.030
608	-0.041	0.148	609	0.005	0.098	610	0.026	0.002	611	-0.116	0.045
612	-0.020	0.084	613	0.101	0.006	614	0.205	-0.064	615	0.073	-0.063
616	-0.174	-0.118	617	-0.024	0.026	618	-0.041	0.129	619	-0.042	-0.053
620	0.148	-0.126	621	-0.030	-0.049	622	-0.015	-0.021	623	0.089	-0.069
624	-0.119	0.011	625	-0.099	-0.048	626	0.054	-0.196	627	0.124	0.035
628	0.092	0.045	629	-0.037	-0.066	630	-0.021	-0.004	631	0.042	-0.065
632	0.061	0.048	633	0.046	0.004	634	-0.063	-0.045	635	-0.102	0.152
636	-0.039	-0.019	637	-0.005	-0.106	638	0.083	0.031	639	0.226	0.028

Table G.30—Time domain representation of the DATA field: symbol 4 of 6

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
640	0.085	-0.065	641	0.034	-0.142	642	0.004	-0.012	643	0.126	-0.043
644	0.055	0.068	645	-0.020	0.077	646	0.008	-0.056	647	-0.034	0.046
648	-0.040	-0.134	649	-0.056	-0.131	650	0.014	0.097	651	0.045	-0.009
652	-0.113	-0.170	653	-0.065	-0.230	654	0.065	-0.011	655	0.011	0.048
656	-0.091	-0.059	657	-0.110	0.024	658	0.074	-0.034	659	0.124	0.022
660	-0.037	0.071	661	0.015	0.002	662	0.028	0.099	663	-0.062	0.068
664	0.064	0.016	665	0.078	0.156	666	0.009	0.219	667	0.147	0.024
668	0.106	0.030	669	-0.080	0.143	670	-0.049	-0.100	671	-0.036	-0.082
672	-0.089	0.021	673	-0.070	-0.029	674	-0.086	0.048	675	-0.066	-0.015

Table G.30—Time domain representation of the DATA field: symbol 4 of 6 *(continued)*

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
676	-0.024	0.002	677	-0.030	-0.023	678	-0.032	0.020	679	-0.002	0.212
680	0.158	-0.024	681	0.141	-0.119	682	-0.146	0.058	683	-0.155	0.083
684	-0.002	-0.030	685	0.018	-0.129	686	0.012	-0.018	687	-0.008	-0.037
688	0.031	0.040	689	0.023	0.097	690	0.014	-0.039	691	0.050	0.019
692	-0.072	-0.141	693	-0.023	-0.051	694	0.024	0.099	695	-0.127	-0.116
696	0.094	0.102	697	0.183	0.098	698	-0.040	-0.020	699	0.065	0.077
700	0.088	-0.147	701	-0.039	-0.059	702	-0.057	0.124	703	-0.077	0.020
704	0.030	-0.120	705	0.034	-0.142	706	0.004	-0.012	707	0.126	-0.043
708	0.055	0.068	709	-0.020	0.077	710	0.008	-0.056	711	-0.034	0.046
712	-0.040	-0.134	713	-0.056	-0.131	714	0.014	0.097	715	0.045	-0.009
716	-0.113	-0.170	717	-0.065	-0.230	718	0.065	-0.011	719	0.011	0.048
720	-0.026	-0.021	721	-0.002	0.041	722	0.001	0.071	723	-0.037	-0.117

Table G.31—Time domain representation of the DATA field: symbol 5 of 6

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
724	-0.106	-0.062	725	0.002	0.057	726	-0.008	-0.011	727	0.019	0.072
728	0.016	0.059	729	-0.065	-0.077	730	0.142	-0.062	731	0.087	0.025
732	-0.003	-0.103	733	0.107	-0.152	734	-0.054	0.036	735	-0.030	-0.003
736	0.058	-0.020	737	-0.028	0.007	738	-0.027	-0.099	739	0.049	-0.075
740	0.174	0.031	741	0.134	0.156	742	0.060	0.077	743	-0.010	-0.022
744	-0.084	0.040	745	-0.074	0.011	746	-0.163	0.054	747	-0.052	-0.008
748	0.076	-0.042	749	0.043	0.101	750	0.058	-0.018	751	0.003	-0.090
752	0.059	-0.018	753	0.023	-0.031	754	0.007	-0.017	755	0.066	-0.017
756	-0.135	-0.098	757	-0.056	-0.081	758	0.089	0.154	759	0.120	0.122
760	0.102	0.001	761	-0.141	0.102	762	0.006	-0.011	763	0.057	-0.039
764	-0.059	0.066	765	0.132	0.111	766	0.012	0.114	767	0.047	-0.106
768	0.160	-0.099	769	-0.076	0.084	770	-0.049	0.073	771	0.005	-0.086
772	-0.052	-0.108	773	-0.073	0.129	774	-0.129	-0.034	775	-0.153	-0.111
776	-0.193	0.098	777	-0.107	-0.068	778	0.004	-0.009	779	-0.039	0.024

Table G.31—Time domain representation of the DATA field: symbol 5 of 6 *(continued)*

780	-0.054	-0.079	781	0.024	0.084	782	0.052	-0.002	783	0.028	-0.044
784	0.040	0.018	785	-0.002	0.041	786	0.001	0.071	787	-0.037	-0.117
788	-0.106	-0.062	789	0.002	0.057	790	-0.008	-0.011	791	0.019	0.072
792	0.016	0.059	793	-0.065	-0.077	794	0.142	-0.062	795	0.087	0.025
796	-0.003	-0.103	797	0.107	-0.152	798	-0.054	0.036	799	-0.030	-0.003

Table G.32—Time domain representation of the DATA field: symbol 6 of 6

##	Real	Imag	##	Real	Imag	##	Real	Imag	##	Real	Imag
800	0.029	-0.026	801	-0.047	0.077	802	-0.007	-0.002	803	0.050	-0.021
804	0.046	-0.040	805	-0.061	-0.099	806	-0.121	0.008	807	0.014	0.050
808	0.145	0.034	809	0.001	-0.046	810	-0.058	-0.121	811	0.040	0.001
812	-0.029	0.041	813	0.002	-0.066	814	0.015	-0.054	815	0.010	-0.029
816	0.008	-0.119	817	-0.134	0.002	818	0.064	0.079	819	0.095	-0.102
820	-0.069	-0.014	821	0.156	0.037	822	0.047	-0.008	823	-0.076	0.025
824	0.117	-0.143	825	0.056	-0.042	826	0.002	0.075	827	-0.039	-0.058
828	-0.092	0.014	829	-0.041	0.047	830	-0.058	0.092	831	0.012	0.154
832	0.079	0.091	833	-0.067	0.017	834	-0.102	-0.032	835	0.039	0.084
836	-0.036	0.014	837	-0.001	-0.046	838	0.195	0.131	839	0.039	0.067
840	-0.007	0.045	841	0.051	0.008	842	-0.074	-0.109	843	-0.033	0.070
844	-0.028	0.176	845	-0.041	0.045	846	0.014	-0.084	847	0.054	-0.040
848	0.110	-0.020	849	0.014	-0.021	850	0.006	0.139	851	0.008	0.011
852	-0.060	-0.040	853	0.008	0.179	854	0.008	0.020	855	0.044	-0.114
856	0.021	-0.015	857	-0.008	-0.052	858	0.091	-0.109	859	-0.025	-0.040
860	-0.049	0.006	861	-0.043	-0.041	862	-0.178	-0.026	863	-0.073	-0.057
864	0.000	-0.031	865	-0.047	0.077	866	-0.007	-0.002	867	0.050	-0.021
868	0.046	-0.040	869	-0.061	-0.099	870	-0.121	0.008	871	0.014	0.050
872	0.145	0.034	873	0.001	-0.046	874	-0.058	-0.121	875	0.040	0.001
876	-0.029	0.041	877	0.002	-0.066	878	0.015	-0.054	879	0.010	-0.029
880	0.004	-0.059									

Insert the following new subclause:

G.9 Generating encoded DATA bits — LDPC example 1

LDPC example 1 is similar to the BCC Example. This example illustrates LDPC shortening, encoding, and puncturing of a single codeword.

Input TXVECTOR parameters for LDPC example 1:

- TxVectorCW = 0(TXVECTOR ChannelWidth = 0 => 20 MHz)
- TxVectorMCS = 4(MCS = 4; QAM 16; Code Rate = 3/4)
- Code Rate R = 3/4
- TXVectorLength = 100 octets(with 16-bit SERVICE field becomes 102 Octets = 816 bits to scramble and encode)
- m_STBC = 1(STBC = OFF)

G.9.1 The message for LDPC example 1

The message being encoded consists of the first 72 characters (shown in **bold** below) of the well-known "Ode to Joy" by F. Schiller:

Joy, bright spark of divinity,
Daughter of Elysium,
Fire-insired we tread
Thy sanctuary.
Thy magic power re-unites
All that custom has divided,
All men become brothers
Under the sway of thy gentle wings.

The message is converted to ASCII; then it is prepended with an appropriate MAC header and a CRC32 is added. The resulting 100 octets PSDU is shown in Table G.33.

NOTE 1—the message for LDPC example 1 is identical to the corrected message for the BCC example, meaning that the FCS field (octets 97-100) has the correct CRC 32 value.

NOTE 2—the DurationID field (i.e., octets 3 and 4) remains 0x02E = 46 µs.

G.9.2 Prepending the SERVICE field for LDPC example 1

The transmitted message shown in Table n33 (The message for LDPC example 1) contains 100 octets, or equivalently, 800 bits. The bits are prepended by the 16 SERVICE field bits (bits 0-15 in Table n34 (The DATA bits for LDPC example 1 before scrambling)), as defined in 20.3.10.1 (The SERVICE field), but tail bits and padding bits are not appended as in the BCC Example. The resulting 816 bits are shown in Table G.34.

NOTE—the CRC32 value is correct in bits 784-815. Bit-ordering of octets is most significant bit first.

G.9.3 Scrambling LDPC example 1

The 816 bits are scrambled by the scrambler of Figure 117. The initial state of the scrambler is the state 1011101 binary (0x5D hexadecimal). The scrambled sequence is given in Table G.35, with the bit-ordering being most significant bit first.

Table G.33—The message for LDPC example 1

Octet ##	Val	Val	Val	Val	Val
1...5	04	02	00	2E	00
6...10	60	08	CD	37	A6
11...15	00	20	D6	01	3C
16...20	F1	00	60	08	AD
21...25	3B	AF	00	00	4A
26...30	6F	79	2C	20	62
31...35	72	69	67	68	74
36...40	20	73	70	61	72
41...45	6B	20	6F	66	20
46...50	64	69	76	69	6E
51...55	69	74	79	2C	0A
56...60	44	61	75	67	68
61...65	74	65	72	20	6F
66...70	66	20	45	6C	79
71...75	73	69	75	6D	2C
76...80	0A	46	69	72	65
81...85	2D	69	6E	73	69
86...90	72	65	64	20	77
91...95	65	20	74	72	65
96...100	61	67	33	21	B6

NOTE—The scrambled entries for the correct CRC32 value are given in bits 784-815.

Table G.34—The DATA bits for LDPC example 1 before scrambling

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
000-023	00000000	00000000	00000100	0x00	0x00	0x04
024-047	00000010	00000000	00101110	0x02	0x00	0x2E
048-071	00000000	01100000	00001000	0x00	0x60	0x08
072-095	11001101	00110111	10100110	0xCD	0x37	0xA6
096-119	00000000	00100000	11010110	0x00	0x20	0xD6
120-143	00000001	00111100	11110001	0x01	0x3C	0xF1
144-167	00000000	01100000	00001000	0x00	0x60	0x08
168-191	10101101	00111011	10101111	0xAD	0x3B	0xAF
192-215	00000000	00000000	01001010	0x00	0x00	0x4A
216-239	01101111	01111001	00101100	0x6F	0x79	0x2C
240-263	00100000	01100010	01110010	0x20	0x62	0x72
264-287	01101001	01100111	01101000	0x69	0x67	0x68
288-311	01110100	00100000	01110011	0x74	0x20	0x73
312-335	01110000	01100001	01110010	0x70	0x61	0x72
336-359	01101011	00100000	01101111	0x6B	0x20	0x6F
360-383	01100110	00100000	01100100	0x66	0x20	0x64
384-407	01101001	01110110	01101001	0x69	0x76	0x69
408-431	01101110	01101001	01110100	0x6E	0x69	0x74
432-455	01111001	00101100	00001010	0x79	0x2C	0x0A
456-479	01000100	01100001	01110101	0x44	0x61	0x75
480-503	01100111	01101000	01110100	0x67	0x68	0x74
504-527	01100101	01110010	00100000	0x65	0x72	0x20
528-551	01101111	01100110	00100000	0x6F	0x66	0x20
552-575	01000101	01101100	01111001	0x45	0x6C	0x79

Table G.34—The DATA bits for LDPC example 1 before scrambling *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
576-599	01110011	01101001	01110101	0x73	0x69	0x75
600-623	01101101	00101100	00001010	0x6D	0x2C	0x0A
624-647	01000110	01101001	01110010	0x46	0x69	0x72
648-671	01100101	00101101	01101001	0x65	0x2D	0x69
672-695	01101110	01110011	01101001	0x6E	0x73	0x69
696-719	01110010	01100101	01100100	0x72	0x65	0x64
720-743	00100000	01110111	01100101	0x20	0x77	0x65
744-767	00100000	01110100	01110010	0x20	0x74	0x72
768-791	01100101	01100001	01100111	0x65	0x61	0x67
792-815	00110011	00100001	10110110	0x33	0x21	0xB6

Table G.35—The DATA bits for LDPC example 1 after scrambling

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
000-023	01101100	00011001	10001001	0x6C	0x19	0x89
024-047	10001111	01101000	00100001	0x8F	0x68	0x21
048-071	11110100	10100101	01100001	0xF4	0xA5	0x61
072-095	01001111	11010111	10101110	0x4F	0xD7	0xAE
096-119	00100100	00001100	11110011	0x24	0x0C	0xF3
120-143	00111010	11100100	10111100	0x3A	0xE4	0xBC
144-167	01010011	10011000	11000000	0x53	0x98	0xC0
168-191	00011110	00110101	10110011	0x1E	0x35	0xB3
192-215	11100011	11111000	00100101	0xE3	0xF8	0x25
216-239	01100000	11010110	00100101	0x60	0xD6	0x25
240-263	00110101	00110011	11111110	0x35	0x33	0xFE
264-287	11110000	01000001	00101011	0xF0	0x41	0x2B
288-311	10001111	01010011	00011100	0x8F	0x53	0x1C
312-335	10000011	01000001	10111110	0x83	0x41	0xBE
336-359	00111001	00101000	01100110	0x39	0x28	0x66
360-383	01000100	01100110	11001101	0x44	0x66	0xCD
384-407	11110110	10100011	11011000	0xF6	0xA3	0xD8

Table G.35—The DATA bits for LDPC example 1 after scrambling *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
408-431	00001101	11010100	10000001	0x0D	0xD4	0x81
432-455	00111011	00101111	11011111	0x3B	0x2F	0xDF
456-479	11000011	01011000	11110111	0xC3	0x58	0xF7
480-503	11000110	01010010	11101011	0xC6	0x52	0xEB
504-527	01110000	10001111	10011110	0x70	0x8F	0x9E
528-551	01101010	10010000	10000001	0x6A	0x90	0x81
552-575	11111101	01111100	10101001	0xFD	0x7C	0xA9
576-599	11010001	01010101	00010010	0xD1	0x55	0x12
600-623	00000100	01110100	11011001	0x04	0x74	0xD9
624-647	11101001	00111011	11001101	0xE9	0x3B	0xCD
648-671	10010011	10001101	01111011	0x93	0x8D	0x7B
672-695	01111100	01110000	00000010	0x7C	0x70	0x02
696-719	00100000	10011001	10100001	0x20	0x99	0xA1
720-743	01111101	10001010	00100111	0x7D	0x8A	0x27
744-767	00010111	00111001	00010101	0x17	0x39	0x15
768-791	10100000	11101100	10010101	0xA0	0xEC	0x95
792-815	00010110	10010001	00010000	0x16	0x91	0x10

G.9.4 Inserting the shortening bits for LDPC example 1

The equations of 20.3.10.6.5 (LDPC PPDU encoding process) are solved to calculate the following derived parameters for LDPC example 1 from the input TXVECTOR parameters:

— $N_{CW} = 1$ (number of codewords)
— $L_{LDPC} = 1944$ (size of codeword)
— $N_{CBPS} = 208$ (number of coded bits per symbol)
— $N_{avbits} = 1248$ (number of available bits)
— $N_{shrt} = 642$ (number of bits to be shortened)
— $N_{punc} = 54$ (number of bits to be punctured)
— $N_{SYM} = 6$ (number of OFDM symbols)
— $N_{rep} = 0$ (number of bits to be repeated)

The results of applying shortening bits, as prescribed in paragraph (c) of 20.3.10.6.5 (LDPC PPDU encoding process) is given in Table G.36, with the bit-ordering being most significant bit first.

NOTE—N_{shrt} = 642 shortening bits have been inserted as zeroes in bits 816-1457.

G.9.5 Encoding the data for LDPC example 1

The DATA with shortening bits are LDPC encoded as a single (N_{CW} = 1) codeword (L_{LDPC} = 1944; R = 3/

Table G.36—The DATA bits for LDPC example 1 after insertion of shortening bits

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	01101100	00011001	10001001	0x6C	0x19	0x89
0024-0047	10001111	01101000	00100001	0x8F	0x68	0x21
0048-0071	11110100	10100101	01100001	0xF4	0xA5	0x61
0072-0095	01001111	11010111	10101110	0x4F	0xD7	0xAE
0096-0119	00100100	00001100	11110011	0x24	0x0C	0xF3
0120-0143	00111010	11100100	10111100	0x3A	0xE4	0xBC
0144-0167	01010011	10011000	11000000	0x53	0x98	0xC0
0168-0191	00011110	00110101	10110011	0x1E	0x35	0xB3
0192-0215	11100011	11111000	00100101	0xE3	0xF8	0x25
0216-0239	01100000	11010110	00100101	0x60	0xD6	0x25
0240-0263	00110101	00110011	11111110	0x35	0x33	0xFE
0264-0287	11110000	01000001	00101011	0xF0	0x41	0x2B
0288-0311	10001111	01010011	00011100	0x8F	0x53	0x1C
0312-0335	10000011	01000001	10111110	0x83	0x41	0xBE
0336-0359	00111001	00101000	01100110	0x39	0x28	0x66
0360-0383	01000100	01100110	11001101	0x44	0x66	0xCD
0384-0407	11110110	10100011	11011000	0xF6	0xA3	0xD8
0408-0431	00001101	11010100	10000001	0x0D	0xD4	0x81
0432-0455	00111011	00101111	11011111	0x3B	0x2F	0xDF
0456-0479	11000011	01011000	11110111	0xC3	0x58	0xF7
0480-0503	11000110	01010010	11101011	0xC6	0x52	0xEB
0504-0527	01110000	10001111	10011110	0x70	0x8F	0x9E
0528-0551	01101010	10010000	10000001	0x6A	0x90	0x81
0552-0575	11111101	01111100	10101001	0xFD	0x7C	0xA9
0576-0599	11010001	01010101	00010010	0xD1	0x55	0x12
0600-0623	00000100	01110100	11011001	0x04	0x74	0xD9
0624-0647	11101001	00111011	11001101	0xE9	0x3B	0xCD
0648-0671	10010011	10001101	01111011	0x93	0x8D	0x7B
0672-0695	01111100	01110000	00000010	0x7C	0x70	0x02
0696-0719	00100000	10011001	10100001	0x20	0x99	0xA1
0720-0743	01111101	10001010	00100111	0x7D	0x8A	0x27
0744-0767	00010111	00111001	00010101	0x17	0x39	0x15
0768-0791	10100000	11101100	10010101	0xA0	0xEC	0x95

Table G.36—The DATA bits for LDPC example 1 after insertion of shortening bits *(contin-*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0792-0815	00010110	10010001	00010000	0x16	0x91	0x10
0816-0839	00000000	00000000	00000000	0x00	0x00	0x00
0840-0863	00000000	00000000	00000000	0x00	0x00	0x00
0864-0887	00000000	00000000	00000000	0x00	0x00	0x00
0888-0911	00000000	00000000	00000000	0x00	0x00	0x00
0912-0935	00000000	00000000	00000000	0x00	0x00	0x00
0936-0959	00000000	00000000	00000000	0x00	0x00	0x00
0960-0983	00000000	00000000	00000000	0x00	0x00	0x00
0984-1007	00000000	00000000	00000000	0x00	0x00	0x00
1008-1031	00000000	00000000	00000000	0x00	0x00	0x00
1032-1055	00000000	00000000	00000000	0x00	0x00	0x00
1056-1079	00000000	00000000	00000000	0x00	0x00	0x00
1080-1103	00000000	00000000	00000000	0x00	0x00	0x00
1104-1127	00000000	00000000	00000000	0x00	0x00	0x00
1128-1151	00000000	00000000	00000000	0x00	0x00	0x00
1152-1175	00000000	00000000	00000000	0x00	0x00	0x00
1176-1199	00000000	00000000	00000000	0x00	0x00	0x00
1200-1223	00000000	00000000	00000000	0x00	0x00	0x00
1224-1247	00000000	00000000	00000000	0x00	0x00	0x00
1248-1271	00000000	00000000	00000000	0x00	0x00	0x00
1272-1295	00000000	00000000	00000000	0x00	0x00	0x00
1296-1319	00000000	00000000	00000000	0x00	0x00	0x00
1320-1343	00000000	00000000	00000000	0x00	0x00	0x00
1344-1367	00000000	00000000	00000000	0x00	0x00	0x00
1368-1391	00000000	00000000	00000000	0x00	0x00	0x00
1392-1415	00000000	00000000	00000000	0x00	0x00	0x00
1416-1439	00000000	00000000	00000000	0x00	0x00	0x00
1440-1457	00000000	00000000	00 - - - - - -	0x00	0x00	0x0-

4) as prescribed by paragraph (c) of 20.3.10.6.5 (LDPC PPDU encoding process). The results are given in Table G.37, with the bit-ordering being most significant bit first.

NOTE—the LDPC encoder appends 486 bits, bits 1458-1943, after the shortening bits.

G.9.6 Removing the shortening bits and puncturing for LDPC example 1

Table G.37—The DATA bits for LDPC example 1 after LDPC encoding.

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	01101100	00011001	10001001	0x6C	0x19	0x89
0024-0047	10001111	01101000	00100001	0x8F	0x68	0x21
0048-0071	11110100	10100101	01100001	0xF4	0xA5	0x61
0072-0095	01001111	11010111	10101110	0x4F	0xD7	0xAE
0096-0119	00100100	00001100	11110011	0x24	0x0C	0xF3
0120-0143	00111010	11100100	10111100	0x3A	0xE4	0xBC
0144-0167	01010011	10011000	11000000	0x53	0x98	0xC0
0168-0191	00011110	00110101	10110011	0x1E	0x35	0xB3
0192-0215	11100011	11111000	00100101	0xE3	0xF8	0x25
0216-0239	01100000	11010110	00100101	0x60	0xD6	0x25
0240-0263	00110101	00110011	11111110	0x35	0x33	0xFE
0264-0287	11110000	01000001	00101011	0xF0	0x41	0x2B
0288-0311	10001111	01010011	00011100	0x8F	0x53	0x1C
0312-0335	10000011	01000001	10111110	0x83	0x41	0xBE
0336-0359	00111001	00101000	01100110	0x39	0x28	0x66
0360-0383	01000100	01100110	11001101	0x44	0x66	0xCD
0384-0407	11110110	10100011	11011000	0xF6	0xA3	0xD8
0408-0431	00001101	11010100	10000001	0x0D	0xD4	0x81
0432-0455	00111011	00101111	11011111	0x3B	0x2F	0xDF
0456-0479	11000011	01011000	11110111	0xC3	0x58	0xF7
0480-0503	11000110	01010010	11101011	0xC6	0x52	0xEB
0504-0527	01110000	10001111	10011110	0x70	0x8F	0x9E
0528-0551	01101010	10010000	10000001	0x6A	0x90	0x81
0552-0575	11111101	01111100	10101001	0xFD	0x7C	0xA9
0576-0599	11010001	01010101	00010010	0xD1	0x55	0x12
0600-0623	00000100	01110100	11011001	0x04	0x74	0xD9
0624-0647	11101001	00111011	11001101	0xE9	0x3B	0xCD
0648-0671	10010011	10001101	01111011	0x93	0x8D	0x7B
0672-0695	01111100	01110000	00000010	0x7C	0x70	0x02
0696-0719	00100000	10011001	10100001	0x20	0x99	0xA1
0720-0743	01111101	10001010	00100111	0x7D	0x8A	0x27
0744-0767	00010111	00111001	00010101	0x17	0x39	0x15
0768-0791	10100000	11101100	10010101	0xA0	0xEC	0x95

Table G.37—The DATA bits for LDPC example 1 after LDPC encoding. *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0792-0815	00010110	10010001	00010000	0x16	0x91	0x10
0816-0839	00000000	00000000	00000000	0x00	0x00	0x00
0840-0863	00000000	00000000	00000000	0x00	0x00	0x00
0864-0887	00000000	00000000	00000000	0x00	0x00	0x00
0888-0911	00000000	00000000	00000000	0x00	0x00	0x00
0912-0935	00000000	00000000	00000000	0x00	0x00	0x00
0936-0959	00000000	00000000	00000000	0x00	0x00	0x00
0960-0983	00000000	00000000	00000000	0x00	0x00	0x00
0984-1007	00000000	00000000	00000000	0x00	0x00	0x00
1008-1031	00000000	00000000	00000000	0x00	0x00	0x00
1032-1055	00000000	00000000	00000000	0x00	0x00	0x00
1056-1079	00000000	00000000	00000000	0x00	0x00	0x00
1080-1103	00000000	00000000	00000000	0x00	0x00	0x00
1104-1127	00000000	00000000	00000000	0x00	0x00	0x00
1128-1151	00000000	00000000	00000000	0x00	0x00	0x00
1152-1175	00000000	00000000	00000000	0x00	0x00	0x00
1176-1199	00000000	00000000	00000000	0x00	0x00	0x00
1200-1223	00000000	00000000	00000000	0x00	0x00	0x00
1224-1247	00000000	00000000	00000000	0x00	0x00	0x00
1248-1271	00000000	00000000	00000000	0x00	0x00	0x00
1272-1295	00000000	00000000	00000000	0x00	0x00	0x00
1296-1319	00000000	00000000	00000000	0x00	0x00	0x00
1320-1343	00000000	00000000	00000000	0x00	0x00	0x00
1344-1367	00000000	00000000	00000000	0x00	0x00	0x00
1368-1391	00000000	00000000	00000000	0x00	0x00	0x00
1392-1415	00000000	00000000	00000000	0x00	0x00	0x00
1416-1439	00000000	00000000	00000000	0x00	0x00	0x00
1440-1463	00000000	00000000	00100110	0x00	0x00	0x26
1464-1487	00111101	10101001	10011100	0x3D	0xA9	0x9C
1488-1511	01000000	11010111	10110010	0x40	0xD7	0xB2
1512-1535	10000110	11100011	10111111	0x86	0xE3	0xBF
1536-1559	01000011	10100101	11011001	0x43	0xA5	0xD9
1560-1583	00001101	00000110	11010110	0x0D	0x06	0xD6

Table G.37—The DATA bits for LDPC example 1 after LDPC encoding. ***(continued)***

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
1584-1607	01100000	11110100	00011111	0x60	0xF4	0x1F
1608-1631	00110001	00001100	00010011	0x31	0x0C	0x13
1632-1655	01110110	00001111	10011111	0x76	0x0F	0x9F
1656-1679	11011010	10011111	10101001	0xDA	0x9F	0xA9
1680-1703	01110100	01011001	11011100	0x74	0x59	0xDC
1704-1727	10001001	11110010	11100010	0x89	0xF2	0xE2
1728-1751	11011000	01101000	10100001	0xD8	0x68	0xA1
1752-1775	01100011	00011101	10100101	0x63	0x1D	0xA5
1776-1799	10100110	10000000	11010001	0xA6	0x80	0xD1
1800-1823	10001001	01010111	11011100	0x89	0x57	0xDC
1824-1847	10110011	01011101	00110011	0xB3	0x5D	0x33
1848-1871	01110000	11011100	10110010	0x70	0xDC	0xB2
1872-1895	11110110	00111001	00111101	0xF6	0x39	0x3D
1896-1919	00100011	10011011	00110110	0x23	0x9B	0x36
1920-1943	00111110	00010101	00010001	0x3E	0x15	0x11

The shortening bits, applied before LDPC encoding, are now removed as prescribed in paragraph (c) of 20.3.10.6.5 (LDPC PPDU encoding process). Finally, either puncturing is applied as described in paragraph (d) of the same subclause or the copying of repeated bits are applied as described in paragraph (e) of the same subclause. In LDPC example 1, because $N_{punc} = 54$ is non-zero and $N_{rep} = 0$, puncturing is prescribed, completing the LDPC encoding process.

The results are given in Table G.38, with the bit-ordering being most significant bit first.

NOTE—the $N_{shrt} = 642$ shortening bits have been removed and that the $N_{punc} = 54$ bits have been punctured from Table G.37 to produce bits 816-1247 of Table G.38.

G.10 Generating encoded DATA bits — LDPC example 2

LDPC example 2 exercises the alternative branches of the LDPC encoding procedure not exercised in LDPC example 1, employs multiple codewords, and diversifies the TXVECTOR parameters, without making the length of this example cumbersome.

This example exhibits LDPC shortening, encoding, and padding by repetition. The length of the text of the message was increased by 40 octets from 72 characters to 144 characters, in order to illustrate padding (rather than puncturing) and encoding of multiple codewords.

Input TXVECTOR parameters for LDPC example 2:

- TxVectorCW = 1 (TXVECTOR ChannelWidth = 1 => 40 MHz)
- TxVectorMCS = 1 (MCS = 1; QPSK; Code Rate = 1/2)
- Code Rate R = 1/2

Table G.38—The DATA bits for LDPC example 1 after removal of shortening bits and application of puncturing

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	01101100	00011001	10001001	0x6C	0x19	0x89
0024-0047	10001111	01101000	00100001	0x8F	0x68	0x21
0048-0071	11110100	10100101	01100001	0xF4	0xA5	0x61
0072-0095	01001111	11010111	10101110	0x4F	0xD7	0xAE
0096-0119	00100100	00001100	11110011	0x24	0x0C	0xF3
0120-0143	00111010	11100100	10111100	0x3A	0xE4	0xBC
0144-0167	01010011	10011000	11000000	0x53	0x98	0xC0
0168-0191	00011110	00110101	10110011	0x1E	0x35	0xB3
0192-0215	11100011	11111000	00100101	0xE3	0xF8	0x25
0216-0239	01100000	11010110	00100101	0x60	0xD6	0x25
0240-0263	00110101	00110011	11111110	0x35	0x33	0xFE
0264-0287	11110000	01000001	00101011	0xF0	0x41	0x2B
0288-0311	10001111	01010011	00011100	0x8F	0x53	0x1C
0312-0335	10000011	01000001	10111110	0x83	0x41	0xBE
0336-0359	00111001	00101000	01100110	0x39	0x28	0x66
0360-0383	01000100	01100110	11001101	0x44	0x66	0xCD
0384-0407	11110110	10100011	11011000	0xF6	0xA3	0xD8
0408-0431	00001101	11010100	10000001	0x0D	0xD4	0x81
0432-0455	00111011	00101111	11011111	0x3B	0x2F	0xDF
0456-0479	11000011	01011000	11110111	0xC3	0x58	0xF7
0480-0503	11000110	01010010	11101011	0xC6	0x52	0xEB
0504-0527	01110000	10001111	10011110	0x70	0x8F	0x9E
0528-0551	01101010	10010000	10000001	0x6A	0x90	0x81
0552-0575	11111101	01111100	10101001	0xFD	0x7C	0xA9
0576-0599	11010001	01010101	00010010	0xD1	0x55	0x12
0600-0623	00000100	01110100	11011001	0x04	0x74	0xD9
0624-0647	11101001	00111011	11001101	0xE9	0x3B	0xCD
0648-0671	10010011	10001101	01111011	0x93	0x8D	0x7B
0672-0695	01111100	01110000	00000010	0x7C	0x70	0x02
0696-0719	00100000	10011001	10100001	0x20	0x99	0xA1
0720-0743	01111101	10001010	00100111	0x7D	0x8A	0x27
0744-0767	00010111	00111001	00010101	0x17	0x39	0x15

Table G.38—The DATA bits for LDPC example 1 after removal of shortening bits and application of puncturing *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0768-0791	10100000	11101100	10010101	0xA0	0xEC	0x95
0792-0815	00010110	10010001	00010000	0x16	0x91	0x10
0816-0839	10011000	11110110	10100110	0x98	0xF6	0xA6
0840-0863	01110001	00000011	01011110	0x71	0x03	0x5E
0864-0887	11001010	00011011	10001110	0xCA	0x1B	0x8E
0888-0911	11111101	00001110	10010111	0xFD	0x0E	0x97
0912-0935	01100100	00110100	00011011	0x64	0x34	0x1B
0936-0959	01011001	10000011	11010000	0x59	0x83	0xD0
0960-0983	01111100	11000100	00110000	0x7C	0xC4	0x30
0984-1007	01001101	11011000	00111110	0x4D	0xD8	0x3E
1008-1031	01111111	01101010	01111110	0x7F	0x6A	0x7E
1032-1055	10100101	11010001	01100111	0xA5	0xD1	0x67
1056-1079	01110010	00100111	11001011	0x72	0x27	0xCB
1080-1103	10001011	01100001	10100010	0x8B	0x61	0xA2
1104-1127	10000101	10001100	01110110	0x85	0x8C	0x76
1128-1151	10010110	10011010	00000011	0x96	0x9A	0x03
1152-1175	01000110	00100101	01011111	0x46	0x25	0x5F
1176-1199	01110010	11001101	01110100	0x72	0xCD	0x74
1200-1223	11001101	11000011	01110010	0xCD	0xC3	0x72
1224-1247	11001011	11011000	11100100	0xCB	0xD8	0xE4

- TXVectorLength = 140 Octets (with 16-bit SERVICE field becomes 142 Octets = 1136 bits to scramble and encode)
- m_STBC = 2 (STBC = ON)

G.10.1 The message for LDPC example 2

The message being encoded consists of the first 112 characters (shown in **bold** below) of the well-known "Ode to Joy" by F. Schiller:

Joy, bright spark of divinity,
Daughter of Elysium,
Fire-insired we tread
Thy sanctuary.
Thy magic power re-unites
All that custom has divided,
All men become brothers

Under the sway of thy gentle wings.

The message is converted to ASCII; then it is prepended with an appropriate MAC header and a CRC32 is added. The resulting 100 octets PSDU is shown in Table G.39.

Because of the additional 40 characters, note that the message for LDPC example 2 has a different FCS field (octets 137-140) than the previous examples, and that the DurationID field (i.e., octets 3 and 4) changes to 0x036 = 54 µs.

Table G.39—The message for LDPC example 2

Octet ##	Val	Val	Val	Val	Val
1...5	04	02	00	36	00
6...10	60	08	CD	37	A6
11...15	00	20	D6	01	3C
16...20	F1	00	60	08	AD
21...25	3B	AF	00	00	4A
26...30	6F	79	2C	20	62
31...35	72	69	67	68	74
36...40	20	73	70	61	72
41...45	6B	20	6F	66	20
46...50	64	69	76	69	6E
51...55	69	74	79	2C	0A
56...60	44	61	75	67	68
61...65	74	65	72	20	6F
66...70	66	20	45	6C	79
71...75	73	69	75	6D	2C
76...80	0A	46	69	72	65
81...85	2D	69	6E	73	69
86...90	72	65	64	20	77

Table G.39—The message for LDPC example 2 *(continued)*

Octet ##	Val	Val	Val	Val	Val
91...95	65	20	74	72	65
96...100	61	64	0A	54	68
101...105	79	20	73	61	6E
106...110	63	74	75	61	72
111...115	79	2E	0A	54	68
116...120	79	20	6D	61	67
121...125	69	63	20	70	6F
126...130	77	65	72	20	72
131...135	65	2D	75	6E	69
136...140	74	3B	DB	B5	22

G.10.2 Prepending the SERVICE field for LDPC example 2

The transmitted message shown in Table G.39 contains 140 octets, or equivalently, 1120 bits. The bits are prepended by the 16 SERVICE field bits (bits 0-15 in Table G.40), as defined by 20.3.10.1 (The SERVICE field), but tail bits and padding bits are not appended as in the BCC Example. The resulting 1136 bits are shown in Table G.40. Bit-ordering is most significant bit first.

Table G.40—The DATA bits for LDPC example 2 before scrambling

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	00000000	00000000	00000100	0x00	0x00	0x04
0024-0047	00000010	00000000	00110110	0x02	0x00	0x36
0048-0071	00000000	01100000	00001000	0x00	0x60	0x08
0072-0095	11001101	00110111	10100110	0xCD	0x37	0xA6
0096-0119	00000000	00100000	11010110	0x00	0x20	0xD6
0120-0143	00000001	00111100	11110001	0x01	0x3C	0xF1
0144-0167	00000000	01100000	00001000	0x00	0x60	0x08
0168-0191	10101101	00111011	10101111	0xAD	0x3B	0xAF
0192-0215	00000000	00000000	01001010	0x00	0x00	0x4A
0216-0239	01101111	01111001	00101100	0x6F	0x79	0x2C
0240-0263	00100000	01100010	01110010	0x20	0x62	0x72
0264-0287	01101001	01100111	01101000	0x69	0x67	0x68
0288-0311	01110100	00100000	01110011	0x74	0x20	0x73
0312-0335	01110000	01100001	01110010	0x70	0x61	0x72

Table G.40—The DATA bits for LDPC example 2 before scrambling *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0336-0359	01101011	00100000	01101111	0x6B	0x20	0x6F
0360-0383	01100110	00100000	01100100	0x66	0x20	0x64
0384-0407	01101001	01110110	01101001	0x69	0x76	0x69
0408-0431	01101110	01101001	01110100	0x6E	0x69	0x74
0432-0455	01111001	00101100	00001010	0x79	0x2C	0x0A
0456-0479	01000100	01100001	01110101	0x44	0x61	0x75
0480-0503	01100111	01101000	01110100	0x67	0x68	0x74
0504-0527	01100101	01110010	00100000	0x65	0x72	0x20
0528-0551	01101111	01100110	00100000	0x6F	0x66	0x20
0552-0575	01000101	01101100	01111001	0x45	0x6C	0x79
0576-0599	01110011	01101001	01110101	0x73	0x69	0x75
0600-0623	01101101	00101100	00001010	0x6D	0x2C	0x0A
0624-0647	01000110	01101001	01110010	0x46	0x69	0x72
0648-0671	01100101	00101101	01101001	0x65	0x2D	0x69
0672-0695	01101110	01110011	01101001	0x6E	0x73	0x69
0696-0719	01110010	01100101	01100100	0x72	0x65	0x64
0720-0743	00100000	01110111	01100101	0x20	0x77	0x65
0744-0767	00100000	01110100	01110010	0x20	0x74	0x72
0768-0791	01100101	01100001	01100100	0x65	0x61	0x64
0792-0815	00001010	01010100	01101000	0x0A	0x54	0x68
0816-0839	01111001	00100000	01110011	0x79	0x20	0x73
0840-0863	01100001	01101110	01100011	0x61	0x6E	0x63
0864-0887	01110100	01110101	01100001	0x74	0x75	0x61
0888-0911	01110010	01111001	00101110	0x72	0x79	0x2E
0912-0935	00001010	01010100	01101000	0x0A	0x54	0x68
0936-0959	01111001	00100000	01101101	0x79	0x20	0x6D
0960-0983	01100001	01100111	01101001	0x61	0x67	0x69
0984-1007	01100011	00100000	01110000	0x63	0x20	0x70
1008-1031	01101111	01110111	01100101	0x6F	0x77	0x65

Table G.40—The DATA bits for LDPC example 2 before scrambling ***(continued)***

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
1032-1055	01110010	00100000	01110010	0x72	0x20	0x72
1056-1079	01100101	00101101	01110101	0x65	0x2D	0x75
1080-1103	01101110	01101001	01110100	0x6E	0x69	0x74
1104-1127	00111011	11011011	10110101	0x3B	0xDB	0xB5
1128-1135	00100010	--------	--------	0x22	----	----

G.10.3 Scrambling LDPC example 2

The 1136 bits are scrambled by the scrambler of Figure 117. The initial state of the scrambler is the state 1011101 binary (0x5D hexadecimal). The scrambled sequence is given in Table G.41, with the bit-ordering being most significant bit first.

Table G.41—The DATA bits for LDPC example 2 after scrambling

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	01101100	00011001	10001001	0x6C	0x19	0x89
0024-0047	10001111	01101000	00111001	0x8F	0x68	0x39
0048-0071	11110100	10100101	01100001	0xF4	0xA5	0x61
0072-0095	01001111	11010111	10101110	0x4F	0xD7	0xAE
0096-0119	00100100	00001100	11110011	0x24	0x0C	0xF3
0120-0143	00111010	11100100	10111100	0x3A	0xE4	0xBC
0144-0167	01010011	10011000	11000000	0x53	0x98	0xC0
0168-0191	00011110	00110101	10110011	0x1E	0x35	0xB3
0192-0215	11100011	11111000	00100101	0xE3	0xF8	0x25
0216-0239	01100000	11010110	00100101	0x60	0xD6	0x25
0240-0263	00110101	00110011	11111110	0x35	0x33	0xFE
0264-0287	11110000	01000001	00101011	0xF0	0x41	0x2B
0288-0311	10001111	01010011	00011100	0x8F	0x53	0x1C
0312-0335	10000011	01000001	10111110	0x83	0x41	0xBE
0336-0359	00111001	00101000	01100110	0x39	0x28	0x66
0360-0383	01000100	01100110	11001101	0x44	0x66	0xCD
0384-0407	11110110	10100011	11011000	0xF6	0xA3	0xD8
0408-0431	00001101	11010100	10000001	0x0D	0xD4	0x81
0432-0455	00111011	00101111	11011111	0x3B	0x2F	0xDF
0456-0479	11000011	01011000	11110111	0xC3	0x58	0xF7

Table G.41—The DATA bits for LDPC example 2 after scrambling *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0480-0503	11000110	01010010	11101011	0xC6	0x52	0xEB
0504-0527	01110000	10001111	10011110	0x70	0x8F	0x9E
0528-0551	01101010	10010000	10000001	0x6A	0x90	0x81
0552-0575	11111101	01111100	10101001	0xFD	0x7C	0xA9
0576-0599	11010001	01010101	00010010	0xD1	0x55	0x12
0600-0623	00000100	01110100	11011001	0x04	0x74	0xD9
0624-0647	11101001	00111011	11001101	0xE9	0x3B	0xCD
0648-0671	10010011	10001101	01111011	0x93	0x8D	0x7B
0672-0695	01111100	01110000	00000010	0x7C	0x70	0x02
0696-0719	00100000	10011001	10100001	0x20	0x99	0xA1
0720-0743	01111101	10001010	00100111	0x7D	0x8A	0x27
0744-0767	00010111	00111001	00010101	0x17	0x39	0x15
0768-0791	10100000	11101100	01010101	0xA0	0xEC	0x55
0792-0815	10001010	00111111	01101011	0x8A	0x3F	0x6B
0816-0839	10110110	11011000	10110001	0xB6	0xD8	0xB1
0840-0863	10001000	10000100	00001111	0x88	0x84	0x0F
0864-0887	00101100	10001000	10101000	0x2C	0x88	0xA8
0888-0911	11111000	10010010	10100000	0xF8	0x92	0xA0
0912-0935	10110111	10011110	00111100	0xB7	0x9E	0x3C
0936-0959	01100100	01010101	00001110	0x64	0x55	0x0E
0960-0983	01111000	11111011	01110011	0x78	0xFB	0x73
0984-1007	01010100	00000000	01000010	0x54	0x00	0x42
1008-1031	10101011	10000010	10111111	0xAB	0x82	0xBF
1032-1055	11100111	11001011	00100110	0xE7	0xCB	0x26
1056-1079	11110011	01000000	00001101	0xF3	0x40	0x0D
1080-1103	00000111	01101010	00010101	0x07	0x6A	0x15
1104-1127	00010111	11111111	10100101	0x17	0xFF	0xA5
1128-1135	11011100	--------	--------	0xDC	----	----

G.10.4 Inserting the shortening bits for LDPC example 2

The equations of 20.3.10.6.5 (LDPC PPDU encoding process) are solved to calculate the following derived parameters for LDPC example 2 from the input TXVECTOR parameters:

- $N_{CW} = 2$ (number of codewords)

- $L_{LDPC} = 1296$ (size of codeword)
- $N_{CBPS} = 216$ (number of coded bits per symbol)
- $N_{avbits} = 2592$ (number of available bits)
- $N_{shrt} = 160$ (number of bits to be shortened)
- $N_{punc} = 0$ (number of bits to be punctured)
- $N_{SYM} = 12$ (number of OFDM symbols)
- $N_{rep} = 160$ (number of bits to be repeated)

The results of applying shortening bits, as prescribed in paragraph (c) of 20.3.10.6.5 (LDPC PPDU encoding process) is given in Table G.42, with the bit-ordering being most significant bit first.

NOTE— $N_{shrt} = 160$ shortening bits have been inserted as zeroes, 80 zeroes at bits 568-647 and 80 zeroes at bits 1216-1295, which equally distributes the shortening bits across the $N_{CW} = 2$ codewords.

Table G.42—The DATA bits for LDPC Example #2 after insertion of shortening bits

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	01101100	00011001	10001001	0x6C	0x19	0x89
0024-0047	10001111	01101000	00111001	0x8F	0x68	0x39
0048-0071	11110100	10100101	01100001	0xF4	0xA5	0x61
0072-0095	01001111	11010111	10101110	0x4F	0xD7	0xAE
0096-0119	00100100	00001100	11110011	0x24	0x0C	0xF3
0120-0143	00111010	11100100	10111100	0x3A	0xE4	0xBC
0144-0167	01010011	10011000	11000000	0x53	0x98	0xC0
0168-0191	00011110	00110101	10110011	0x1E	0x35	0xB3
0192-0215	11100011	11111000	00100101	0xE3	0xF8	0x25
0216-0239	01100000	11010110	00100101	0x60	0xD6	0x25
0240-0263	00110101	00110011	11111110	0x35	0x33	0xFE
0264-0287	11110000	01000001	00101011	0xF0	0x41	0x2B
0288-0311	10001111	01010011	00011100	0x8F	0x53	0x1C
0312-0335	10000011	01000001	10111110	0x83	0x41	0xBE
0336-0359	00111001	00101000	01100110	0x39	0x28	0x66
0360-0383	01000100	01100110	11001101	0x44	0x66	0xCD
0384-0407	11110110	10100011	11011000	0xF6	0xA3	0xD8
0408-0431	00001101	11010100	10000001	0x0D	0xD4	0x81
0432-0455	00111011	00101111	11011111	0x3B	0x2F	0xDF
0456-0479	11000011	01011000	11110111	0xC3	0x58	0xF7
0480-0503	11000110	01010010	11101011	0xC6	0x52	0xEB
0504-0527	01110000	10001111	10011110	0x70	0x8F	0x9E
0528-0551	01101010	10010000	10000001	0x6A	0x90	0x81

Table G.42—The DATA bits for LDPC Example #2 after insertion of shortening bits *(contin-*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0552-0575	11111101	01111100	00000000	0xFD	0x7C	0x00
0576-0599	00000000	00000000	00000000	0x00	0x00	0x00
0600-0623	00000000	00000000	00000000	0x00	0x00	0x00
0624-0647	00000000	00000000	00000000	0x00	0x00	0x00
0648-0671	10101001	11010001	01010101	0xA9	0xD1	0x55
0672-0695	00010010	00000100	01110100	0x12	0x04	0x74
0696-0719	11011001	11101001	00111011	0xD9	0xE9	0x3B
0720-0743	11001101	10010011	10001101	0xCD	0x93	0x8D
0744-0767	01111011	01111100	01110000	0x7B	0x7C	0x70
0768-0791	00000010	00100000	10011001	0x02	0x20	0x99
0792-0815	10100001	01111101	10001010	0xA1	0x7D	0x8A
0816-0839	00100111	00010111	00111001	0x27	0x17	0x39
0840-0863	00010101	10100000	11101100	0x15	0xA0	0xEC
0864-0887	01010101	10001010	00111111	0x55	0x8A	0x3F
0888-0911	01101011	10110110	11011000	0x6B	0xB6	0xD8
0912-0935	10110001	10001000	10000100	0xB1	0x88	0x84
0936-0959	00001111	00101100	10001000	0x0F	0x2C	0x88
0960-0983	10101000	11111000	10010010	0xA8	0xF8	0x92
0984-1007	10100000	10110111	10011110	0xA0	0xB7	0x9E
1008-1031	00111100	01100100	01010101	0x3C	0x64	0x55
1032-1055	00001110	01111000	11111011	0x0E	0x78	0xFB
1056-1079	01110011	01010100	00000000	0x73	0x54	0x00
1080-1103	01000010	10101011	10000010	0x42	0xAB	0x82
1104-1127	10111111	11100111	11001011	0xBF	0xE7	0xCB
1128-1151	00100110	11110011	01000000	0x26	0xF3	0x40
1152-1175	00001101	00000111	01101010	0x0D	0x07	0x6A
1176-1199	00010101	00010111	11111111	0x15	0x17	0xFF
1200-1223	10100101	11011100	00000000	0xA5	0xDC	0x00
1224-1247	00000000	00000000	00000000	0x00	0x00	0x00
1248-1271	00000000	00000000	00000000	0x00	0x00	0x00
1272-1295	00000000	00000000	00000000	0x00	0x00	0x00

G.10.5 Encoding the data for LDPC example 2

The DATA with shortening bits are LDPC encoded as two ($N_{CW} = 2$) codewords ($L_{LDPC} = 1296$; $R = 1/2$) as prescribed by paragraph (c) of 20.3.10.6.5 (LDPC PPDU encoding process) . The results are given in Table G.43, with the bit-ordering being most significant bit first.

NOTE—the LDPC encoder appends 648 bits as follows: bits 648-1295 after the first shortened codeword; and another 648 bits, bits 1944-2591, after the second shortened codeword.

Table G.43—The DATA bits for LDPC example 2 after LDPC encoding

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	01101100	00011001	10001001	0x6C	0x19	0x89
0024-0047	10001111	01101000	00111001	0x8F	0x68	0x39
0048-0071	11110100	10100101	01100001	0xF4	0xA5	0x61
0072-0095	01001111	11010111	10101110	0x4F	0xD7	0xAE
0096-0119	00100100	00001100	11110011	0x24	0x0C	0xF3
0120-0143	00111010	11100100	10111100	0x3A	0xE4	0xBC
0144-0167	01010011	10011000	11000000	0x53	0x98	0xC0
0168-0191	00011110	00110101	10110011	0x1E	0x35	0xB3
0192-0215	11100011	11111000	00100101	0xE3	0xF8	0x25
0216-0239	01100000	11010110	00100101	0x60	0xD6	0x25
0240-0263	00110101	00110011	11111110	0x35	0x33	0xFE
0264-0287	11110000	01000001	00101011	0xF0	0x41	0x2B
0288-0311	10001111	01010011	00011100	0x8F	0x53	0x1C
0312-0335	10000011	01000001	10111110	0x83	0x41	0xBE
0336-0359	00111001	00101000	01100110	0x39	0x28	0x66
0360-0383	01000100	01100110	11001101	0x44	0x66	0xCD
0384-0407	11110110	10100011	11011000	0xF6	0xA3	0xD8
0408-0431	00001101	11010100	10000001	0x0D	0xD4	0x81
0432-0455	00111011	00101111	11011111	0x3B	0x2F	0xDF
0456-0479	11000011	01011000	11110111	0xC3	0x58	0xF7
0480-0503	11000110	01010010	11101011	0xC6	0x52	0xEB
0504-0527	01110000	10001111	10011110	0x70	0x8F	0x9E
0528-0551	01101010	10010000	10000001	0x6A	0x90	0x81
0552-0575	11111101	01111100	00000000	0xFD	0x7C	0x00
0576-0599	00000000	00000000	00000000	0x00	0x00	0x00
0600-0623	00000000	00000000	00000000	0x00	0x00	0x00
0624-0647	00000000	00000000	00000000	0x00	0x00	0x00
0648-0671	00001001	11000001	11111011	0x09	0xC1	0xFB

Table G.43—The DATA bits for LDPC example 2 after LDPC encoding *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0672-0695	01101000	11001101	00000101	0x68	0xCD	0x05
0696-0719	10110110	11000111	01100101	0xB6	0xC7	0x65
0720-0743	10100101	10011001	11100000	0xA5	0x99	0xE0
0744-0767	01110011	01110000	01101101	0x73	0x70	0x6D
0768-0791	01011110	01111001	11100011	0x5E	0x79	0xE3
0792-0815	01100111	00100111	01011110	0x67	0x27	0x5E
0816-0839	10010101	10101000	11110110	0x95	0xA8	0xF6
0840-0863	00110101	01001000	10100111	0x35	0x48	0xA7
0864-0887	00100110	00101001	00110001	0x26	0x29	0x31
0888-0911	00101110	00011001	11110100	0x2E	0x19	0xF4
0912-0935	00110100	01101111	01010000	0x34	0x6F	0x50
0936-0959	01010000	11101001	11000100	0x50	0xE9	0xC4
0960-0983	00000110	11011001	11101110	0x06	0xD9	0xEE
0984-1007	11111000	00011011	11011001	0xF8	0x1B	0xD9
1008-1031	01101100	10000110	11010011	0x6C	0x86	0xD3
1032-1055	11101001	01100100	11001000	0xE9	0x64	0xC8
1056-1079	11110001	10100001	00001011	0xF1	0xA1	0x0B
1080-1103	11000010	01000100	01010100	0xC2	0x44	0x54
1104-1127	10100000	10001100	10111011	0xA0	0x8C	0xBB
1128-1151	10100011	11100100	10101001	0xA3	0xE4	0xA9
1152-1175	10101011	01010000	11100010	0xAB	0x50	0xE2
1176-1199	01110000	00101000	00110110	0x70	0x28	0x36
1200-1223	11111100	00110000	00110100	0xFC	0x30	0x34
1224-1247	01101010	01001001	00100010	0x6A	0x49	0x22
1248-1271	11010101	00000111	11001111	0xD5	0x07	0xCF
1272-1295	00110101	00111010	10001110	0x35	0x3A	0x8E
1296-1319	10101001	11010001	01010101	0xA9	0xD1	0x55
1320-1343	00010010	00000100	01110100	0x12	0x04	0x74
1344-1367	11011001	11101001	00111011	0xD9	0xE9	0x3B
1368-1391	11001101	10010011	10001101	0xCD	0x93	0x8D
1392-1415	01111011	01111100	01110000	0x7B	0x7C	0x70
1416-1439	00000010	00100000	10011001	0x02	0x20	0x99
1440-1463	10100001	01111101	10001010	0xA1	0x7D	0x8A

Table G.43—The DATA bits for LDPC example 2 after LDPC encoding *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
1464-1487	00100111	00010111	00111001	0x27	0x17	0x39
1488-1511	00010101	10100000	11101100	0x15	0xA0	0xEC
1512-1535	01010101	10001010	00111111	0x55	0x8A	0x3F
1536-1559	01101011	10110110	11011000	0x6B	0xB6	0xD8
1560-1583	10110001	10001000	10000100	0xB1	0x88	0x84
1584-1607	00001111	00101100	10001000	0x0F	0x2C	0x88
1608-1631	10101000	11111000	10010010	0xA8	0xF8	0x92
1632-1655	10100000	10110111	10011110	0xA0	0xB7	0x9E
1656-1679	00111100	01100100	01010101	0x3C	0x64	0x55
1680-1703	00001110	01111000	11111011	0x0E	0x78	0xFB
1704-1727	01110011	01010100	00000000	0x73	0x54	0x00
1728-1751	01000010	10101011	10000010	0x42	0xAB	0x82
1752-1775	10111111	11100111	11001011	0xBF	0xE7	0xCB
1776-1799	00100110	11110011	01000000	0x26	0xF3	0x40
1800-1823	00001101	00000111	01101010	0x0D	0x07	0x6A
1824-1847	00010101	00010111	11111111	0x15	0x17	0xFF
1848-1871	10100101	11011100	00000000	0xA5	0xDC	0x00
1872-1895	00000000	00000000	00000000	0x00	0x00	0x00
1896-1919	00000000	00000000	00000000	0x00	0x00	0x00
1920-1943	00000000	00000000	00000000	0x00	0x00	0x00
1944-1967	01100100	10110110	01010100	0x64	0xB6	0x54
1968-1991	00110001	00000001	01100001	0x31	0x01	0x61
1992-2015	00101001	00010011	01110000	0x29	0x13	0x70
2016-2039	01010000	10000000	11001110	0x50	0x80	0xCE
2040-2063	01000101	11000000	10101000	0x45	0xC0	0xA8
2064-2087	11001101	11111000	01111100	0xCD	0xF8	0x7C
2088-2111	01010011	01010001	01001110	0x53	0x51	0x4E
2112-2135	11010011	10101110	00010011	0xD3	0xAE	0x13
2136-2159	11110000	11101101	10111111	0xF0	0xED	0xBF
2160-2183	10001110	10010100	00110100	0x8E	0x94	0x34
2184-2207	11111011	00010000	11011001	0xFB	0x10	0xD9
2208-2231	10111110	00110001	10011111	0xBE	0x31	0x9F
2232-2255	01100000	00011100	10100110	0x60	0x1C	0xA6

Table G.43—The DATA bits for LDPC example 2 after LDPC encoding *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
2256-2279	01010101	11111001	10100110	0x55	0xF9	0xA6
2280-2303	10101010	00111000	01110001	0xAA	0x38	0x71
2304-2327	01111010	10101100	10110010	0x7A	0xAC	0xB2
2328-2351	11110101	11010001	10000001	0xF5	0xD1	0x81
2352-2375	01010000	11110001	00001011	0x50	0xF1	0x0B
2376-2399	10111101	10010011	10001011	0xBD	0x93	0x8B
2400-2423	10100010	10010110	00100101	0xA2	0x96	0x25
2424-2447	11100011	01101100	11000111	0xE3	0x6C	0xC7
2448-2471	00000101	00011000	00101000	0x05	0x18	0x28
2472-2495	11110011	00111001	11011000	0xF3	0x39	0xD8
2496-2519	00010001	01110101	00010111	0x11	0x75	0x17
2520-2543	11011101	11111011	11010010	0xDD	0xFB	0xD2
2544-2567	10101010	11101011	10100110	0xAA	0xEB	0xA6
2568-2591	10000101	10110011	01011000	0x85	0xB3	0x58

G.10.6 Removing the shortening bits and repetition for LDPC example 2

The shortening bits, applied before LDPC encoding, are now removed as prescribed in paragraph (c) of 20.3.10.6.5 (LDPC PPDU encoding process). Finally, either puncturing is applied as described in paragraph (d) of the same subclause or the copying of repeated bits are applied as described in paragraph (e) of the same subclause. In LDPC example 1, because N_{punc} = 0 and N_{rep} = 160 is non-zero, repetition is prescribed, completing the LDPC encoding process.

The results are given in Table G.44, with the bit-ordering being most significant bit first.

NOTE 1—N_{shrt} = 642 shortening bits have been removed and N_{punc} = 54 bits have been punctured from Table G.37 to produce bits 816-1247 of Table G.38.

NOTE 2—The first 80 shortening bits (bits 568-647 from Table G.43) have been removed from the first codeword between bit 567 and 568 of Table G.44, and that the second 80 shortening bits (bits 1864-1943 of Table G.43) have been removed between bits 1215 and 1216 of Table G.44. Also, 80 bits have been repeated from the beginning of the first codeword (bits 0-79) to the end of the first codeword (bits 1216-1295), and 80 bits have been repeated from the beginning of the second codeword (bits 1296-1375) to end of the second codeword (bits 2512-2591) in Table G.44.

Table G.44—The DATA bits for LDPC example 2 after removal of shortening bits and copying of repetition bits

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0000-0023	01101100	00011001	10001001	0x6C	0x19	0x89
0024-0047	10001111	01101000	00111001	0x8F	0x68	0x39
0048-0071	11110100	10100101	01100001	0xF4	0xA5	0x61
0072-0095	01001111	11010111	10101110	0x4F	0xD7	0xAE
0096-0119	00100100	00001100	11110011	0x24	0x0C	0xF3
0120-0143	00111010	11100100	10111100	0x3A	0xE4	0xBC
0144-0167	01010011	10011000	11000000	0x53	0x98	0xC0
0168-0191	00011110	00110101	10110011	0x1E	0x35	0xB3
0192-0215	11100011	11111000	00100101	0xE3	0xF8	0x25
0216-0239	01100000	11010110	00100101	0x60	0xD6	0x25
0240-0263	00110101	00110011	11111110	0x35	0x33	0xFE
0264-0287	11110000	01000001	00101011	0xF0	0x41	0x2B
0288-0311	10001111	01010011	00011100	0x8F	0x53	0x1C
0312-0335	10000011	01000001	10111110	0x83	0x41	0xBE
0336-0359	00111001	00101000	01100110	0x39	0x28	0x66
0360-0383	01000100	01100110	11001101	0x44	0x66	0xCD
0384-0407	11110110	10100011	11011000	0xF6	0xA3	0xD8
0408-0431	00001101	11010100	10000001	0x0D	0xD4	0x81
0432-0455	00111011	00101111	11011111	0x3B	0x2F	0xDF
0456-0479	11000011	01011000	11110111	0xC3	0x58	0xF7
0480-0503	11000110	01010010	11101011	0xC6	0x52	0xEB
0504-0527	01110000	10001111	10011110	0x70	0x8F	0x9E
0528-0551	01101010	10010000	10000001	0x6A	0x90	0x81
0552-0575	11111101	01111100	00001001	0xFD	0x7C	0x09
0576-0599	11000001	11111011	01101000	0xC1	0xFB	0x68
0600-0623	11001101	00000101	10110110	0xCD	0x05	0xB6
0624-0647	11000111	01100101	10100101	0xC7	0x65	0xA5
0648-0671	10011001	11100000	01110011	0x99	0xE0	0x73
0672-0695	01110000	01101101	01011110	0x70	0x6D	0x5E
0696-0719	01111001	11100011	01100111	0x79	0xE3	0x67
0720-0743	00100111	01011110	10010101	0x27	0x5E	0x95
0744-0767	10101000	11110110	00110101	0xA8	0xF6	0x35

Table G.44—The DATA bits for LDPC example 2 after removal of shortening bits and copying of repetition bits *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
0768-0791	01001000	10100111	00100110	0x48	0xA7	0x26
0792-0815	00101001	00110001	00101110	0x29	0x31	0x2E
0816-0839	00011001	11110100	00110100	0x19	0xF4	0x34
0840-0863	01101111	01010000	01010000	0x6F	0x50	0x50
0864-0887	11101001	11000100	00000110	0xE9	0xC4	0x06
0888-0911	11011001	11101110	11111000	0xD9	0xEE	0xF8
0912-0935	00011011	11011001	01101100	0x1B	0xD9	0x6C
0936-0959	10000110	11010011	11101001	0x86	0xD3	0xE9
0960-0983	01100100	11001000	11110001	0x64	0xC8	0xF1
0984-1007	10100001	00001011	11000010	0xA1	0x0B	0xC2
1008-1031	01000100	01010100	10100000	0x44	0x54	0xA0
1032-1055	10001100	10111011	10100011	0x8C	0xBB	0xA3
1056-1079	11100100	10101001	10101011	0xE4	0xA9	0xAB
1080-1103	01010000	11100010	01110000	0x50	0xE2	0x70
1104-1127	00101000	00110110	11111100	0x28	0x36	0xFC
1128-1151	00110000	00110100	01101010	0x30	0x34	0x6A
1152-1175	01001001	00100010	11010101	0x49	0x22	0xD5
1176-1199	00000111	11001111	00110101	0x07	0xCF	0x35
1200-1223	00111010	10001110	01101100	0x3A	0x8E	0x6C
1224-1247	00011001	10001001	10001111	0x19	0x89	0x8F
1248-1271	01101000	00111001	11110100	0x68	0x39	0xF4
1272-1295	10100101	01100001	01001111	0xA5	0x61	0x4F
1296-1319	10101001	11010001	01010101	0xA9	0xD1	0x55
1320-1343	00010010	00000100	01110100	0x12	0x04	0x74
1344-1367	11011001	11101001	00111011	0xD9	0xE9	0x3B
1368-1391	11001101	10010011	10001101	0xCD	0x93	0x8D
1392-1415	01111011	01111100	01110000	0x7B	0x7C	0x70
1416-1439	00000010	00100000	10011001	0x02	0x20	0x99
1440-1463	10100001	01111101	10001010	0xA1	0x7D	0x8A
1464-1487	00100111	00010111	00111001	0x27	0x17	0x39
1488-1511	00010101	10100000	11101100	0x15	0xA0	0xEC
1512-1535	01010101	10001010	00111111	0x55	0x8A	0x3F

Table G.44—The DATA bits for LDPC example 2 after removal of shortening bits and copying of repetition bits *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
1536-1559	01101011	10110110	11011000	0x6B	0xB6	0xD8
1560-1583	10110001	10001000	10000100	0xB1	0x88	0x84
1584-1607	00001111	00101100	10001000	0x0F	0x2C	0x88
1608-1631	10101000	11111000	10010010	0xA8	0xF8	0x92
1632-1655	10100000	10110111	10011110	0xA0	0xB7	0x9E
1656-1679	00111100	01100100	01010101	0x3C	0x64	0x55
1680-1703	00001110	01111000	11111011	0x0E	0x78	0xFB
1704-1727	01110011	01010100	00000000	0x73	0x54	0x00
1728-1751	01000010	10101011	10000010	0x42	0xAB	0x82
1752-1775	10111111	11100111	11001011	0xBF	0xE7	0xCB
1776-1799	00100110	11110011	01000000	0x26	0xF3	0x40
1800-1823	00001101	00000111	01101010	0x0D	0x07	0x6A
1824-1847	00010101	00010111	11111111	0x15	0x17	0xFF
1848-1871	10100101	11011100	01100100	0xA5	0xDC	0x64
1872-1895	10110110	01010100	00110001	0xB6	0x54	0x31
1896-1919	00000001	01100001	00101001	0x01	0x61	0x29
1920-1943	00010011	01110000	01010000	0x13	0x70	0x50
1944-1967	10000000	11001110	01000101	0x80	0xCE	0x45
1968-1991	11000000	10101000	11001101	0xC0	0xA8	0xCD
1992-2015	11111000	01111100	01010011	0xF8	0x7C	0x53
2016-2039	01010001	01001110	11010011	0x51	0x4E	0xD3
2040-2063	10101110	00010011	11110000	0xAE	0x13	0xF0
2064-2087	11101101	10111111	10001110	0xED	0xBF	0x8E
2088-2111	10010100	00110100	11111011	0x94	0x34	0xFB
2112-2135	00010000	11011001	10111110	0x10	0xD9	0xBE
2136-2159	00110001	10011111	01100000	0x31	0x9F	0x60
2160-2183	00011100	10100110	01010101	0x1C	0xA6	0x55
2184-2207	11111001	10100110	10101010	0xF9	0xA6	0xAA
2208-2231	00111000	01110001	01111010	0x38	0x71	0x7A
2232-2255	10101100	10110010	11110101	0xAC	0xB2	0xF5
2256-2279	11010001	10000001	01010000	0xD1	0x81	0x50
2280-2303	11110001	00001011	10111101	0xF1	0x0B	0xBD

Table G.44—The DATA bits for LDPC example 2 after removal of shortening bits and copying of repetition bits *(continued)*

Bit ##	Binary Val	Binary Val	Binary Val	Hex Val	Hex Val	Hex Val
2304-2327	10010011	10001011	10100010	0x93	0x8B	0xA2
2328-2351	10010110	00100101	11100011	0x96	0x25	0xE3
2352-2375	01101100	11000111	00000101	0x6C	0xC7	0x05
2376-2399	00011000	00101000	11110011	0x18	0x28	0xF3
2400-2423	00111001	11011000	00010001	0x39	0xD8	0x11
2424-2447	01110101	00010111	11011101	0x75	0x17	0xDD
2448-2471	11111011	11010010	10101010	0xFB	0xD2	0xAA
2472-2495	11101011	10100110	10000101	0xEB	0xA6	0x85
2496-2519	10110011	01011000	10101001	0xB3	0x58	0xA9
2520-2543	11010001	01010101	00010010	0xD1	0x55	0x12
2544-2567	00000100	01110100	11011001	0x04	0x74	0xD9
2568-2591	11101001	00111011	11001101	0xE9	0x3B	0xCD

Annex I (informative) **Regulatory Classes**

Insert a new row after the tenth Behavior limits set row, and change the last row of Table I.3 as shown:

Table I.3—Behavior limits sets

Behavior limits set	USA	Europe	Japan
13 40 MHz Primary channel with Secondary = 1 and also 20 MHz operation on primary channel	Reserved	Reserved	Reserved
14 40 MHz Primary channel with Secondary = -1 and also 20 MHz operation on primary channel	Reserved	Reserved	Reserved
15~~11~~ – 255	Reserved	Reserved	Reserved
NOTE—For 20 MHz operation where the regulatory class signifies 40 MHz channel spacing, the 20 MHz channel corresponds to the channel number indicated.			

Annex J(normative) **Country information element and regulatory classes**

Insert new penultimate rows, change the last row and insert the note after the last row of Table J.1 as shown:

Table J.1—Regulatory classes in the USA

Regulatory Class	**Channel Starting Frequency (GHz)**	**Channel Spacing (MHz)**	**Channel set**	**Transmit Power limit (mW)**	**Emissions Limits set**	**Behavior Limits set**
22	5	40	36, 44	40	1	1,2,13
23	5	40	52, 60	200	1	1,13
24	5	40	100, 108, 116, 124, 132	200	1	1,13
25	5	40	149, 157	800	1	1,13
26	5	40	149, 157	1000	4	10,13
27	5	40	40, 48	40	1	1,2,14
28	5	40	56, 64	200	1	1,14
29	5	40	104, 112, 120, 128, 136	200	1	1,14
30	5	40	153, 161	800	1	1,14
31	5	40	153, 161	1000	4	10,14
32	2.407	40	1-7	1000	4	10,13
33	2.407	40	5-11	1000	4	10,14
~~12~~31-255	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

NOTE—The Channel Spacing for Regulatory Class 22-33 is for the supported bandwidth rather than the operating bandwidth. In these regulatory classes, the AP operates in 20/40 MHz mode, and the operating bandwidth for a non-AP STA is either 20 MHz or 40 MHz.

Insert new penultimate rows and change the last row of Table J.2 as shown:

Table J.2—Regulatory classes in Europe

Regulatory Class	Channel Starting Frequency (GHz)	Channel Spacing (MHz)	Channel set	Transmit Power limit (mW)	Emissions Limits set	Behavior Limits set
5	5	40	36, 44	200	1	2,3,13
6	5	40	52, 60	200	1	1,3,4,13
7	5	40	100, 108, 116, 124, 132	1000	1	1,3,4,13
8	5	40	40, 48	200	1	2,3,14
9	5	40	56, 64	200	1	1,3,4,14
10	5	40	104, 112, 120, 128, 136	1000	1	1,3,4,14
11	2.407	40	1-9	100	4	10,13
12	2.407	40	5-13	100	4	10,14
413-255	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

NOTE—The Channel Spacing for Regulatory Class 5-12 is for the supported bandwidth rather than the operating bandwidth. In these regulatory classes, the AP operates in 20/40 MHz mode, and the operating bandwidth for a non-AP STA is either 20 MHz or 40 MHz.

Annex R (normative) **HT LDPC matrix definitions**

Table R.1 defines the Matrix prototypes of the parity-check matrices for a codeword block length n=648 bits, with a subblock size z=27 bits.

Table R.1—Matrix prototypes of parity-check matrices for codeword block length *n*=648 bits, subblock size is *Z* = 27 bits.

(a) Code rate *R*= 1/2.

0	-	-	-	0	0	-	-	0	-	-	0	1	0	-	-	-	-	-	-	-	-	-	-
22	0	-	-	17	-	0	0	12	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-
6	-	0	-	10	-	-	-	24	-	0	-	-	-	0	0	-	-	-	-	-	-	-	-
2	-	-	0	20	-	-	-	25	0	-	-	-	-	-	0	0	-	-	-	-	-	-	-
23	-	-	-	3	-	-	-	0	-	9	11	-	-	-	-	0	0	-	-	-	-	-	-
24	-	23	1	17	-	3	-	10	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-
25	-	-	-	8	-	-	-	7	18	-	-	0	-	-	-	-	-	0	0	-	-	-	-
13	24	-	-	0	-	8	-	6	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-
7	20	-	16	22	10	-	-	23	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-
11	-	-	-	19	-	-	-	13	-	3	17	-	-	-	-	-	-	-	-	-	0	0	-
25	-	8	-	23	18	-	14	9	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
3	-	-	-	16	-	-	2	25	5	-	-	1	-	-	-	-	-	-	-	-	-	-	0

(b) Code rate *R*= 2/3.

25	26	14	-	20	-	2	-	4	-	-	8	-	16	-	18	1	0	-	-	-	-	-	-
10	9	15	11	-	0	-	1	-	-	18	-	8	-	10	-	-	0	0	-	-	-	-	-
16	2	20	26	21	-	6	-	1	26	-	7	-	-	-	-	-	-	0	0	-	-	-	-
10	13	5	0	-	3	-	7	-	-	26	-	-	13	-	16	-	-	-	0	0	-	-	-
23	14	24	-	12	-	19	-	17	-	-	-	20	-	21	-	0	-	-	-	0	0	-	-
6	22	9	20	-	25	-	17	-	8	-	14	-	18	-	-	-	-	-	-	-	0	0	-
14	23	21	11	20	-	24	-	18	-	19	-	-	-	-	22	-	-	-	-	-	-	0	0
17	11	11	20	-	21	-	26	-	3	-	-	18	-	26	-	1	-	-	-	-	-	-	0

(c) Code rate *R*= 3/4.

16	17	22	24	9	3	14	-	4	2	7	-	26	-	2	-	21	-	1	0	-	-	-	-
25	12	12	3	3	26	6	21	-	15	22	-	15	-	4	-	-	16	-	0	0	-	-	-
25	18	26	16	22	23	9	-	0	-	4	-	4	-	8	23	11	-	-	-	0	0	-	-
9	7	0	1	17	-	-	7	3	-	3	23	-	16	-	-	21	-	0	-	-	0	0	-
24	5	26	7	1	-	-	15	24	15	-	8	-	13	-	13	-	11	-	-	-	-	0	0
2	2	19	14	24	1	15	19	-	21	-	2	-	24	-	3	-	2	1	-	-	-	-	0

(d) Code rate *R*= 5/6.

17	13	8	21	9	3	18	12	10	0	4	15	19	2	5	10	26	19	13	13	1	0	-	-
3	12	11	14	11	25	5	18	0	9	2	26	26	10	24	7	14	20	4	2	-	0	0	-
22	16	4	3	10	21	12	5	21	14	19	5	-	8	5	18	11	5	5	15	0	-	0	0
7	7	14	14	4	16	16	24	24	10	1	7	15	6	10	26	8	18	21	14	1	-	-	0

Table R.2 defines the Matrix prototypes of the parity-check matrices for a codeword block length n=1296 bits, with a subblock size z=54 bits.

Table R.2—Matrix prototypes of parity-check matrices for codeword block length *n*= 1296 bits, subblock size is *Z*= 54 bits.

(a) Code rate *R*= 1/2.

40	-	-	-	22	-	49	23	43	-	-	-	1	0	-	-	-	-	-	-	-	-	-	-
50	1	-	-	48	35	-	-	13	-	30	-	-	0	0	-	-	-	-	-	-	-	-	-
39	50	-	-	4	-	2	-	-	-	-	49	-	-	0	0	-	-	-	-	-	-	-	-
33	-	-	38	37	-	-	4	1	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-
45	-	-	-	0	22	-	-	20	42	-	-	-	-	-	-	0	0	-	-	-	-	-	-
51	-	-	48	35	-	-	-	44	-	18	-	-	-	-	-	-	0	0	-	-	-	-	-
47	11	-	-	-	17	-	-	51	-	-	-	0	-	-	-	-	-	0	0	-	-	-	-
5	-	25	-	6	-	45	-	13	40	-	-	-	-	-	-	-	-	-	0	0	-	-	-
33	-	-	34	24	-	-	-	23	-	-	46	-	-	-	-	-	-	-	-	0	0	-	-
1	-	27	-	1	-	-	-	38	-	44	-	-	-	-	-	-	-	-	-	-	0	0	-
-	18	-	-	23	-	-	8	0	35	-	-	-	-	-	-	-	-	-	-	-	-	0	0
49	-	17	-	30	-	-	-	34	-	-	19	1	-	-	-	-	-	-	-	-	-	-	0

(b) Code rate *R*= 2/3.

39	31	22	43	-	40	4	-	11	-	-	50	-	-	-	6	1	0	-	-	-	-	-	-
25	52	41	2	6	-	14	-	34	-	-	-	24	-	37	-	-	0	0	-	-	-	-	-
43	31	29	0	21	-	28	-	-	2	-	-	7	-	17	-	-	-	0	0	-	-	-	-
20	33	48	-	4	13	-	26	-	-	22	-	-	46	42	-	-	-	-	0	0	-	-	-
45	7	18	51	12	25	-	-	-	50	-	-	5	-	-	-	0	-	-	-	0	0	-	-
35	40	32	16	5	-	-	18	-	-	43	51	-	32	-	-	-	-	-	-	-	0	0	-
9	24	13	22	28	-	-	37	-	-	25	-	-	52	-	13	-	-	-	-	-	-	0	0
32	22	4	21	16	-	-	-	27	28	-	38	-	-	-	8	1	-	-	-	-	-	-	0

(c) Code rate *R*= 3/4.

39	40	51	41	3	29	8	36	-	14	-	6	-	33	-	11	-	4	1	0	-	-	-	-
48	21	47	9	48	35	51	-	38	-	28	-	34	-	50	-	50	-	-	0	0	-	-	-
30	39	28	42	50	39	5	17	-	6	-	18	-	20	-	15	-	40	-	-	0	0	-	-
29	0	1	43	36	30	47	-	49	-	47	-	3	-	35	-	34	-	0	-	-	0	0	-
1	32	11	23	10	44	12	7	-	48	-	4	-	9	-	17	-	16	-	-	-	-	0	0
13	7	15	47	23	16	47	-	43	-	29	-	52	-	2	-	53	-	1	-	-	-	-	0

(d) Code rate *R*= 5/6.

48	29	37	52	2	16	6	14	53	31	34	5	18	42	53	31	45	-	46	52	1	0	-	-
17	4	30	7	43	11	24	6	14	21	6	39	17	40	47	7	15	41	19	-	-	0	0	-
7	2	51	31	46	23	16	11	53	40	10	7	46	53	33	35	-	25	35	38	0	-	0	0
19	48	41	1	10	7	36	47	5	29	52	52	31	10	26	6	3	2	-	51	1	-	-	0

Table R.3defines the Matrix prototypes of the parity-check matrices for a codeword block length n=1944 bits, with a subblock size z=81 bits.

Table R.3—Matrix prototypes of parity-check matrices for codeword block length *n*=1944 bits, subblock size is *Z* = 81 bits.

(a) Code rate *R*= 1/2.

57	-	-	-	50	-	11	-	50	-	79	-	1	0	-	-	-	-	-	-	-	-	-	-
3	-	28	-	0	-	-	-	55	7	-	-	-	0	0	-	-	-	-	-	-	-	-	-
30	-	-	-	24	37	-	-	56	14	-	-	-	-	0	0	-	-	-	-	-	-	-	-
62	53	-	-	53	-	-	3	35	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-
40	-	-	20	66	-	-	22	28	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-
0	-	-	-	8	-	42	-	50	-	-	8	-	-	-	-	-	0	0	-	-	-	-	-
69	79	79	-	-	-	56	-	52	-	-	-	0	-	-	-	-	-	0	0	-	-	-	-
65	-	-	-	38	57	-	-	72	-	27	-	-	-	-	-	-	-	-	0	0	-	-	-
64	-	-	-	14	52	-	-	30	-	-	32	-	-	-	-	-	-	-	-	0	0	-	-
-	45	-	70	0	-	-	-	77	9	-	-	-	-	-	-	-	-	-	-	-	0	0	-
2	56	-	57	35	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	0	0
24	-	61	-	60	-	-	27	51	-	-	16	1	-	-	-	-	-	-	-	-	-	-	0

(b) Code rate *R*= 2/3.

61	75	4	63	56	-	-	-	-	-	-	8	-	2	17	25	1	0	-	-	-	-	-	-
56	74	77	20	-	-	-	64	24	4	67	-	7	-	-	-	-	0	0	-	-	-	-	-
28	21	68	10	7	14	65	-	-	-	23	-	-	-	75	-	-	-	0	0	-	-	-	-
48	38	43	78	76	-	-	-	-	5	36	-	15	72	-	-	-	-	-	0	0	-	-	-
40	2	53	25	-	52	62	-	20	-	-	44	-	-	-	-	0	-	-	-	0	0	-	-
69	23	64	10	22	-	21	-	-	-	-	-	68	23	29	-	-	-	-	-	-	0	0	-
12	0	68	20	55	61	-	40	-	-	-	52	-	-	-	44	-	-	-	-	-	-	0	0
58	8	34	64	78	-	-	11	78	24	-	-	-	-	-	58	1	-	-	-	-	-	-	0

(c) Code rate *R*= 3/4.

48	29	28	39	9	61	-	-	-	63	45	80	-	-	-	37	32	22	1	0	-	-	-	-
4	49	42	48	11	30	-	-	-	49	17	41	37	15	-	54	-	-	-	0	0	-	-	-
35	76	78	51	37	35	21	-	17	64	-	-	-	59	7	-	-	32	-	-	0	0	-	-
9	65	44	9	54	56	73	34	42	-	-	-	35	-	-	-	46	39	0	-	-	0	0	-
3	62	7	80	68	26	-	80	55	-	36	-	26	-	9	-	72	-	-	-	-	-	0	0
26	75	33	21	69	59	3	38	-	-	-	35	-	62	36	26	-	-	1	-	-	-	-	0

(d) Code rate *R*= 5/6.

13	48	80	66	4	74	7	30	76	52	37	60	-	49	73	31	74	73	23	-	1	0	-	-
69	63	74	56	64	77	57	65	6	16	51	-	64	-	68	9	48	62	54	27	-	0	0	-
51	15	0	80	24	25	42	54	44	71	71	9	67	35	-	58	-	29	-	53	0	-	0	0
16	29	36	41	44	56	59	37	50	24	-	65	4	65	52	-	4	-	73	52	1	-	-	0

Insert the following new Annex heading:

Annex S (Informative) Frame exchange sequences

EDITORIAL NOTE—Editing instructions in 9.12 move that subclause into this informative annex. Editing instructions in this Annex assume that this repositioning has taken place.

Change the first paragraph as follows:

The allowable frame exchange sequences are defined using an extension of the EBNF format as defined in ISO/IEC 14977: 1996(E). The elements of this syntax that are used here are:

- [a] = a is optional
- {a} = a is repeated zero or more times
- n{a} = a is repeated *n* or more times. For example*,* 3{a} requires 3 or more "a".
- a|b = a xor b
- () = grouping, so "a (b|c)" is equivalent to "a b | a c"
- (* a *) = "a" is a comment. Comments are placed before the text they relate to.
- ~~<> = order of frames not relevant*e.g.*. For example, <a b> is either "a b" or "b a"~~
- A rule is terminated by a semicolon ";"
- Whitespace is not significant, but ~~it~~is used to highlight the nesting of grouped terms.

Change the second paragraph as follows:

Two types of terminals are defined:

- *Frames*: A frame is shown in Bold, and identified by its type/subtype. For example*,* **Beacon** and **Data.** Frames are shown in an initial capital letter.
- *Attributes*: Attributes are shown in italic. An attribute is introduced by the "+" character. The attribute specifies a condition that applies to the frame that precedes it. Where there are multiple attributes applied, they are generally ordered in the same order of the fields in the frame they refer to. The syntax a+(b|c) where b and c are attributes is equivalent to (a+b) | (a+c).

Change Table 76 appropriately renumbered following its move to this annex as follows:.

Table 76—Attributes applicable to frame exchange sequence definition

Attribute	Description
ampdu	Frame is part of an A-MPDU aggregate
ampdu-end	Frame is the last frame in an A-MPDU aggregate
block-ack	QoS Data frame has Ack Policy set to Block Ack
broadcast	Frame RA is the broadcast address
CF	Beacon contains a CFP element
CF-Ack	Data type CF-Ack subtype bit set to 1 or CF-End+CF-Ack frame
CF-Poll	Data type CF-Poll subtype bit set to 1
csi	A Management Action frame carrying channel state feedback (either channel state information, uncompressed or compressed beamforming matrices).
csi-request	A +HTC frame with the Feedback Request field set to a value > 0
delayed	BlockAck or BlockAckReq under a delayed policy
delayed-no-ack	BlockAck or BlockAckReq frame has No Ack Ack Policy
DTIM	Beacon is a DTIM
frag	Frame has its More Fragments field set to 1
group	Frame RA has Individual/Group bit set to 1
HTC	+HTC frame, i.e., a QoS Data or Control frame with the Order field of the Frame Control field set to 1
implicit-bar	QoS Data frame in an A-MPDU with Normal Ack Ack Policy
individual	Frame RA has i/g bit set to 0
last	Frame has its More Fragments field set to 0
L-sig	L-sig duration not equal to PPDU duration
action-no-ack	Management frame of subtype Action No Ack
mfb	A +HTC frame with the MFB field is not set to all ones
more-psmp	A PSMP frame with the More PSMP field set to 1
mrq	A +HTC frame with the MRQ field set to 1
mtba	Ack Policy of QoS data frame is set to MTBA
ndp-announce	A +HTC frame with the NDP Announcement field set to 1
no-ack	QoS Data frame has Ack Policy set to No Ack
no-more-psmp	A PSMP frame with the More PSMP field set to 0
normal-ack	QoS Data frame has Ack Policy set to Normal Ack
non-QAP	Frame is transmitted by a non-AP QSTA

Table 76—Attributes applicable to frame exchange sequence definition *(continued)*

Attribute	Description
non-stbc	PPDU TXVECTOR STBC parameter is set to 0
null	Data type Null Data subtype bit set
pifs	Frame is transmitted~~ using~~following a PIFS
QAP	Frame is transmitted by a QAP
QoS	Data type QoS subtype bit set
RD	Frame includes an HT control field in which the RD subfield is set to 1
self	Frame RA = TA
sounding	PPDU TXVECTOR NOT_SOUNDING parameter present and set to 0
stbc	PPDU TXVECTOR STBC parameter is set to a value >0
trq	Frame is a +HTC frame with the TRQ field set to 1

Change the txop-sequence term as follows:

(* A TXOP (either polled or EDCA) may be filled with txop-sequences, which are initiated by the TXOP holder. *)
txop-sequence = (((**RTS CTS**) | **CTS**+*self*) **Data**+*individual*+*QoS*+(*block-ack*|*no-ack*)) |
[**RTS CTS**] (TXOP-part-requiring-ack TXOP-part-providing-ack) |
[**RTS CTS**] (**Management**|(**Data**+QAP))+*individual* **Ack** |
[**RTS CTS**] (**BlockAckReq BlockAck**) |
ht-txop-sequence;

Delete the term poll-sequence as shown:

~~(* A poll-sequence is the start of a polled TXOP, in which the HC delivers a polled TXOP to a QSTA. The poll may or may not piggyback a CF-Ack according to whether the previous frame received by the HC was a Data frame. *)~~
~~poll-sequence =~~ ~~non-cf-ack-piggybacked-qos-poll-sequence |~~

~~cf-ack-piggybacked-qos-poll-sequence;~~

Modify the term txop-part-requiring-ack as follows:

(* These frames require acknowledgement *)
txop-part-requiring-ack = **Data**+*individual*[+*null*] |
Data+*individual*[+*null*]+*QoS*+*normal-ack* |
BlockAckReq+*delayed* |
BlockAck+*delayed*;

Modify the term txop-part-providing-ack as follows:

(* These frames provide acknowledgement to the TXOP-part-requiring-ack *)
txop-part-providing-ack= **Ack** |

(* An HC responds with a new polled TXOP on expiry of current TXOP *)
cf-ack-piggybacked-qos-poll-sequence |

(* An HC responds with CF-Ack and its own data on expiry of TXOP *)
cf-ack-piggybacked-qos-data-sequence |
Data+*CF-Ack*;

Insert the following paragraphs after the term starting "cf-ack-piggybacked-qos-data-sequence":

(* The ht-TXOP-sequence describes the additional sequences that may be initiated by an HT STA that is the holder of a TXOP *)
ht-TXOP-sequence = L-sig-protected-sequence |
long-nav-protected-sequence |
nav-protected-sequence |
dual-cts-protected-sequence |
1{initiator-sequence};

(* an L-sig-protected-sequence is a sequence protected using the L-sig TXOP protection feature *)
L-sig-protected-sequence = L-sig-protection-set 1{initiator-sequence} eifs-reset;

(* An eifs-cancellation sequence is transmitted at the end of an L-sig-protected-sequence in order to reset the EIFS state of non-HT STA. The L-sig duration expires before the eifs-cancellation sequence starts. *)
eifs-reset = **CF-End | (CF-End+***non-QAP* **CF-End+***QAP***)**;

(* a long-nav-protected sequence consists of setting the NAV, performing one or more initiator-sequences and then resetting the NAV if time permits, or resetting EIFS if non-HT devices are present. *)
long-nav-protected-sequence = nav-set 1{initiator-sequence} [nav-reset | eifs-reset];

(* nav-protected-sequence starts with a sequence that sets the NAV, followed by sequences initiated by the TXOP holder, followed by an eifs-reset sequence if non-HT devices are present. *)
nav-protected-sequence = nav-set 1{initiator-sequence} [eifs-reset];

(* a dual-cts-protected-sequence is a sequence protected using the dual CTS protection feature *)
dual-cts-protected-sequence = dual-cts-nav-set 1{initiator-sequence};
(* a dual-cts-nav-set is an initial exchange that establishes NAV protection using dual CTS protection.
dual-cts-nav-set = (* A dual CTS initiated by a non-AP STA that is not STBC capable *)
(**RTS**+*non-stbc*+*non-QAP* **CTS**+*non-stbc*+*QAP* **CTS**+*stbc*+*pifs*+*QAP*) |

(* A dual CTS initiated by a non-AP STA that is STBC capable *)
(**RTS**+*stbc*+*non-QAP* **CTS**+*stbc*+*QAP* **CTS**+*non-stbc*+*QAP*) |

(* An STBC initiator-sequence (i.e., containing STBC PPDUs) transmitted by the QAP is protected by non-STBC CTS to self *)
(**CTS**+*self*+*non-stbc*+*QAP*) |

(* A non-STBC initiator-sequence transmitted by the QAP is protected by STBC CTS to self *)
(**CTS**+*self*+*stbc*+*QAP*);

(* an ma-no-ack-htc represents a Management Action No Ack + HTC frame *)
ma-no-ack-htc = **Management**+*action-no-ack*+*HTC;*

(* This is the sequence of frames that establish protection using the L-sig TXOP protection method *)
L-sig-protection-set = **(RTS**+*L-sig*[+*HTC*] **CTS**+*L-sig*[+*HTC*]) |
(RTS+*L-sig*[+*HTC*] **CTS**+*L-sig*[+*HTC*]+*ampdu*
ma-no-ack-htc+*ampdu*+*ampdu-end*) |

(**Data**+*individual*+*L-sig* [+*HTC*][+*null*][+*QoS*+*normal-ack*] **Ack**+*L-sig*) |
(**Data**+*individual*+*L-sig* [+*HTC*][+*null*][+Q*oS*+(*normal-ack*|*block-ack*)]) |
(**Data**+*group*+*L-sig* [+*null*][+*QoS*]) |
(**BlockAckReq**+*L-sig*[+*HTC*] (**BlockAck**[+*HTC*]|**Ack**)+*L-sig*) |
(**BlockAck**+*L-sig*[+*HTC*] **Ack**);

(* These are the series of frames that establish NAV protection for an HT sequence *)
nav-set = (**RTS**[+*HTC*] **CTS**[+*HTC*]) |
(**RTS**[+*HTC*] **CTS**[+*HTC*]+*ampdu* ma-no-ack-htc+*ampdu*+*ampdu-end*) |
CTS+*self* |
(**Data**[+*HTC*]+*individual*[+*null*][+*QoS*+*normal-ack*] **Ack)** |
Data[+*HTC*]+*individual*[+*null*][+*QoS*+(*normal-ack*|*block-ack*)] |
Data+*group*[+*null*][+*QoS*] |
(**BlockAckReq**[+*HTC*] (**BlockAck**[+*HTC*]|**Ack**)) |
(**BlockAck**[+*HTC*] **Ack**);

nav-reset = **CF-End | (CF-End+***non-QAP* **CF-End+***QAP***)**;

(* This is an initiator sequence. The different forms arise from whether the initiator transmits a frame that requires a BlockAck (BA), and whether it delivers a reverse direction grant. When a reverse direction grant is delivered, the response is distinguished according to whether it demands a BlockAck response from the initiator or not. *)
initiator-sequence = (* No BA expected, no RD granted *)
burst

(* BlockAckReq (BAR) delivered, BA expected. No RD *)
burst-BAR **BlockAck** |

(* No BAR delivered, RD granted *)
(burst-RD (
burst |
burst-BAR initiator-sequence-BA
)
) |

(burst-RD-BAR **Ack)** |
(burst-RD-BAR (
burst-BA |
burst-BA-BAR initiator-sequence-BA
)
) |
ht-ack-sequence |
psmp-sequence | link-adaptation-exchange ;

(* This is the same as the initiator-sequence, except the initiator is constrained to generate a BlockAck (BA) response because a previous reverse direction response contained a BAR *)
initiator-sequence-BA = burst-BA |
(burst-BA-BAR **BlockAck**) |
(burst-BA-RD (
burst |
burst-BAR initiator-sequence-BA
)

) |
(burst-BA-RD-BAR **Ack)** |
(burst-BA-RD-BAR (
burst-BA |
burst-BA-BAR initiator-sequence-BA
)
);

(* These are sequences that occur within an ht-TXOP-sequence that have an ack response *)
ht-ack-sequence = (**BlockAck**+*delayed*[+*HTC*] **Ack**) |
(**BlockAckReq**+*delayed*[+*HTC*] **Ack**) |
(Data[+*HTC*]+*individual*[+*null*][+*QoS*+*normal-ack*] **Ack)**;

(* A burst is a sequence of 1 or more packets, none of them requiring a response *)
burst = 1{PPDU-not-requiring-response};

(* A burst containing a BAR *)
burst-BAR = {PPDU-not-requiring-response} PPDU-BAR;

(* A burst containing a BA *)
burst-BA = PPDU-BA {PPDU-not-requiring-response};

(* A burst containing a BA and BAR, either in the same packet, or in separate packets. *)
burst-BA-BAR = (PPDU-BA {PPDU-not-requiring-response} PPDU-BAR) |
PPDU-BA-BAR;

(* A burst delivering an RD grant *)
burst-RD = {PPDU-not-requiring-response} PPDU-RD;

(* A burst containing a BAR and delivering an RD grant *)
burst-RD-BAR = burst PPDU-RD-BAR;

(* A burst containing a BA and delivering an RD grant *)
burst-BA-RD = (PPDU-BA {PPDU-not-requiring-response} PPDU-RD) |
PPDU-BA-RD;

(* A burst containing a BAR and BA and delivering an RD grant *)
burst-BA-RD-BAR = (PPDU-BA {PPDU-not-requiring-response} PPDU-RD-BAR) |
PPDU-BA-RD-BAR;

(* A PPDU not requiring a response is either a single frame not requiring response, or an A-MPDU of such frames.*)
PPDU-not-requiring-response =
frame-not-requiring-response |
1{frame-not-requiring-response+*ampdu*}+*ampdu-end*;

(* A frame not requiring response is one of the delayed BA policy frames sent under "no ack" Ack Policy, or Data that doesn't require an immediate ack, or a Management Action No Ack frame. A frame-not-requiring-response may be included with any of the following sequences in any position, except the initial position when this contains a BlockAck or Multi-TID BlockAck: PPDU-BAR, PPDU-BA-BAR, PPDU-BA, PPDU-RD, PPDU-RD-BAR, PPDU-BA-RD-BAR, psmp-ppdu *)
frame-not-requiring-response =

BlockAck[+*HTC*]+*delayed-no-ack* |
BlockAckReq[+*HTC*]+*delayed-no-ack* |
Data[+*null*][+*HTC*]+*QoS*+(*no-ack*|*block-ack*) |
ma-no-ack-htc;

(* A PPDU containing a BAR is either a non-A-MPDU BAR, or an A-MPDU containing Data carrying implicit BAR *).
PPDU-BAR= **BlockAckReq**[+*HTC*] |
(1{**Data**[+*HTC*]+*QoS*+*implicit-bar*+*ampdu*} + *ampdu-end*);

(* A PPDU containing both BA and BAR is an A-MPDU that contains a BA, plus either a BlockAckReq frame, or 1 or more Data frames carrying implicit BAR. *)
PPDU-BA-BAR= **BlockAck**[+*HTC*]+*ampdu*
(
BlockAckReq[+*HTC*]+*ampdu* |
1{**Data**[+*HTC*]+*QoS*+*implicit-bar*+*ampdu*}) **+** *ampdu-end;*

(*A PPDU containing BA is either a non-A-MPDU BlockAck, or an A-MPDU containing a BlockAck, and also containing data that does not carry implicit BAR. *)
PPDU-BA= **BlockAck**[+*HTC*] |
(
BlockAck[+*HTC*]+*ampdu*
1{**Data**[+*HTC*]+*QoS*+(*no-ack*|*block-ack*)+*ampdu*}
) + *ampdu-end;*

(* A PPDU delivering an RD grant, but not delivering a BAR is either a Data frame, not requiring immediate acknowledgement, or a BlockAck or BlockAckReq, not requiring immediate acknowledgement *).
PPDU-RD= **Data**+*HTC*[+*null*]+*QoS*+(*no-ack*|*block-ack*)+*RD* |
(BlockAck|BlockAckReq)+*HTC*+*delayed-no-ack*+*RD* |
(
1{**Data**+*HTC*+*QoS*+*RD*+*ampdu*}
) + *ampdu-end*;

(* A PPDU containing a BAR and delivering an RD grant is either an non-A-MPDU BlockAckReq frame, or an A-MPDU containing at least one Data frame with RD and implicit-bar. *)
PPDU-RD-BAR= **BlockAckReq**+*HTC*+*RD* |
(
1{**Data**+*HTC*+*QoS*+*implicit-bar*+*RD*+*ampdu*}
) + ampdu-end;

(* A PPDU containing a BA and granting RD is either an unaggregated BlockAck or an A-MPDU that contains a BlockAck and at least one data frame containing RD, but not implcit BAR. *)
PPDU-BA-RD= **BlockAck**+*HTC*+*RD* |
(
BlockAck+*ampdu* (
1{**Data**+*HTC*+*QoS*+(*no-ack*|*block-ack*)+*RD*+*ampdu*}
)

) + *ampdu-end;*

(* A PPDU containing a BA, BAR and granting RD is an A-MPDU that contains a BlockAck and either an explicit BAR (and no data frames) or data frames carrying the implicit BAR. The RD attribute is present in all frames carrying an HT Control field, and at least one of these frames is present. This constraint is not expressed in the syntax below. *)
PPDU-BA-RD-BAR= (
BlockAck[+*HTC*+*RD*]+*ampdu*
BlockAckReq[+*HTC*+*RD*]+*ampdu*
) + *ampdu-end* |
(
BlockAck[+*HTC*+*RD*]+*ampdu*
1{**Data**[+*HTC*+*RD*]+*QoS*+*implicit-bar*+*ampdu*}
) + *ampdu-end*;

(* A PSMP burst is a sequence of PSMP sequence ending with a last-psmp-sequence *)
psmp-burst = {non-last-psmp-sequence} last-psmp-sequence;
non-last-psmp-sequence = **PSMP**+*more-psmp*+*QAP* downlink-phase uplink-phase;
last-psmp-sequence = **PSMP**+*no-more-psmp*+*QAP* downlink-phase uplink-phase;

(* The downlink phase is a sequence of allocations to STA as defined in the PSMP frame during which they may expect to receive. *)
downlink-phase = {psmp-allocated-time};

(* The uplink phase is a sequence of allocations to STA as defined in the PSMP frame during which they are allowed to transmit *)
uplink-phase = {psmp-allocated-time};

(* During a time allocation, one or more packets may be transmitted of contents defined by psmp-ppdu *)
psmp-allocated-time = 1{psmp-ppdu};

(* The packets that may be transmitted during PSMP are: isolated MTBA or MTBAR frames, or an A-MPDU containing an optional MTBA and one or more data frames sent under the MTBA Ack Policy. *)
psmp-ppdu = **MTBA** |
MTBAR |
(
[**MTBA**+*ampdu*]
1{**Data**[+*HTC*]+*individual*+*QoS*+*mtba*+*ampdu*};
) + *ampdu-end*;

(* A link adaptation exchange is a frame exchange sequence in which on the air signaling is used to control or return the results of link measurements so that the initiator device can choose effective values for its TXVECTOR parameters. *)
link-adaptation-exchange =
mcs-adaptation |
implict-txbf |
explicit-txbf;

(* An mcs-adaptation exchange includes an MCS measurement request and subsequent MCS feedback. The MCS request and MCS feedback may be present in any +HTC frame. The exchange can occur either as a fast exchange, in which the feedback is supplied in a response frame, an exchange in which the response is supplied along with some other data frame within the same TXOP, or is supplied in a subsequent TXOP won by the MCS responder. Only the fast response is shown in the syntax that follows.*)

mcs-adaptation = (**RTS**+*HTC*+*mrq* **CTS**+*HTC*+*mfb*) |
(**Data**+*HTC*+*QoS*+*mrq*+*normal-ack* **Ack**+*HTC*+*mfb*) |
(**BlockAckReq**+*HTC*+*mrq* (**BlockAck**+*mfb* | **Ack**+*HTC*+*mfb*)) |
(**BlockAck**+*HTC*+*mrq*+*delayed* **Ack**+*HTC*+*mfb*);

(* An implicit txbf starts with the transmission of a request to sound the channel. The initiator measures the channel based on the sounding packet and updates its beamforming matrices based on its observations of the sounding packet. No channel measurements are sent over the air.*)

implict-txbf =
(**RTS**+*HTC*+*trq* **(CTS**+*sounding* | **CTS**+*HTC*+*ndp-announce* **NDP**)) **|**
(**Data**+*HTC*+*trq*+*QoS*+*normal-ack*
(Ack+*sounding* | **Ack**+*HTC*+*ndp-announce* **NDP**)
) **|**
(**BlockAckReq**+*HTC*+*trq*
(BlockAck+*sounding* |
BlockAck+*HTC*+*ndp-announce* **NDP**
)
) **|**
(**BlockAck**+*HTC*+*trq*+*delayed*
(Ack+*sounding* |
Ack+*HTC*+*ndp-announce* **NDP**
)
)
(* The trq/sounding protocol also operates within aggregates. In this case the TRQ is carried in all +HTC frames (of which there has to be at least one) within the TRQ initiator's transmission. The response PPDU is either a sounding PPDU, or carries at least one +HTC frame with an ndp-announce, in which case the following PPDU is an NDP sounding PPDU. The following syntax is an simplified representation of this sequnce. *)
(**[BlockAck**+*HTC*+*trq*+*ampdu*] {**Data**+*HTC*+*trq*+*QoS*+*ampdu*}+*ampdu-end*)
(
(**[BlockAck**+*HTC*+*ampdu*]
{**Data**+*HTC*+*QoS*+*ampdu*}+*ampdu-end*+*sounding*)
) |
(
(**[BlockAck**+*HTC*+*ndp-announce*+*ampdu*]
{**Data**+*HTC*+*ndp-announce*+*QoS*+*ampdu*}+*ampdu-end*)
) **NDP**
);

(* During operation of explicit txbf, there are three encodings of feedback information. These are not distinguished here and are all identified by the *csi* attribute. The feedback position may be: immediate, aggregate or unsolicited. Immediate feedback follows a SIFS after a CSI request, identified by the *csi-request* attribute. Aggregate feedback occurs during an aggregate within the same TXOP, and may accompany Data frames in the same PPDU. Unsolicited feedback occurs during a subsequent TXOP during which the CSI responder is TXOP intiator. Only immediate feedback is described in the syntax below. The frame indicating any *csi-request* is carried in a sounding PPDU or followed by an NDP. The CSI response is carried in a management action no ack frame, which may be aggregated with the CTS, BlockAck, or Ack response frame. *)

explicit-txbf = (
(RTS+*HTC*+*csi-request*+*sounding* |
(RTS+*HTC*+*csi-request*+*ndp-announce* **NDP**))
(CTS+*ampdu*
Management+*action-no-ack*+*HTC*+*csi*+*ampdu-end*)
) |
(**Data**+*HTC*+*csi-request*+*QoS*+*normal-ack*+*sounding* |
(**Data**+*HTC*+*csi-request*+*QoS*+*normal-ack*+*ndp-announce*
NDP))
(Ack+*ampdu*
Management+*action-no-ack*+*HTC*+*csi*+*ampdu-end*)
) |
(BlockAckReq+*HTC*+*csi-request*+*sounding* |
BlockAckReq+*HTC*+*csi-request*+*ndp-announce* **NDP**)
(BlockAck+*ampdu*
Management+*action-no-ack*+*HTC*+*csi*+*ampdu-end*)
) |
(BlockAckReq+*HTC*+*csi-request*+*delayed*+*sounding* |
(BlockAckReq+*HTC*+*csi-request*+*ndp-announce*+*delayed*
NDP))
(Ack+*ampdu*
Management+*action-no-ack*+*HTC*+*csi*+*ampdu-end*)

) ;

Insert the following Annex:

Annex T (Informative) Additional High Throughput information

T.1 Waveform Generator Tool

Add the following text:

As an informative extension to the specification, the Waveform Generator Tool has been written to model the PHY transmission process described in Clauses 17, 19, and 20.

The waveform generator can be downloaded from the public IEEE web site.

The purpose of the Tool is to promote common understanding of complex PHY algorithms, facilitate device interoperability by providing reference test vectors, and assist researchers in industry and academia to develop next generation wireless solutions.

The code is written in the MATLAB computing language, and can be configured to generate test vectors for most PHY configurations, defined by the specification. Instructions on how to configure and run the Tool are specified in the documentation files that are supplied with the code. A command line interface and GUI interface exist to configure the tool. For consistency with specification, the configuration interface is made very similar to the TXVECTOR parameters defined in 20.2.2 (TXVECTOR and RXVECTOR parameters).

The Waveform Generator Tool produces test vectors for all transmitter blocks, defined in Figure n63 (Transmitter block diagram for the non-HT portion and the HT signal field of the HT mixed format packet) and Figure n64 (Transmitter block diagram for the greenfield format packet and HT portion of the mixed format packet except HT signal field), generating reference samples in both frequency and time domains. Outputs of the Tool are time domain samples for all transmitting chains.

T.2 Summary of the use of HT Protection Signalling

This subclause contains a summary of typical use of the OBSS Non-HT STAs Present field, NonERP_Present bit and Use_Protection bit.

Separate fields and bits are used for status reporting (OBSS Non-HT STAs Present and NonERP_Present) and for protection (Operating Mode and Use_Protection) so that protection extends to the BSS directly detecting the non-HT STAs and to the nearby BSSs, but not beyond. Table T.1 describes typical uses of these fields and bits. A first AP has non-HT STAs associated to its BSS or directly observes a non-HT BSS, and reports this status to its neighbors (Layer 1c). A second AP's BSS overlaps the first AP's BSS, and may respond to the status report by requiring protection (Layer 2b or 2c). The second AP does not relay the status report further. A third AP's BSS overlaps the second AP's BSS but not the first, and so the third AP sees no report of non-HT STAs and so requires no protection (Layer 3).

Table T.1—Summary of typical use of the OBSS Non-HT STAs Present field, NonERP_Present bit and Use_Protection bit

	Indication from overlapping BSS		Indication to Associated STAs		Indication to overlapping BSSs		
Layer	**OBSS Non-HT STAs Present from overlapping BSS**	**ERP IE is present and NonERP_Present equals 1 from overlapping BSS**	**Operating Mode**	**ERP IE is present and Use_Protection equals 1**	**OBSS Non-HT STAs Present**	**ERP IE is present and NonERP_present equals 1**	**Typical Use**
1a	0	0	1	0	0	0	Non-HT STAs may be present in both the primary and the secondary channel, but protection by overlapping BSSs is determined to not be necessary.
1b	0	0	3	0, 1	0	0	Non-HT STAs are associated to and protected by the BSS, but protection by overlapping BSSs is determined to not be necessary.
1c	0	0	3	0, 1	1	0, 1	Non-HT STAs are associated to and protected by the BSS, and protection by overlapping BSSs is determined to be necessary.
1d	1	0	3	0	1	0	Both the BSS and an overlapping BSS have determined that protection by the BSS is necessary, and protection by overlapping BSSs is determined to be necessary.
		0		1		1	
		1		0		1	
		1		1		1	
2a	1	0, 1	1	0	0	0	An overlapping BSS has determined that protection by the BSS is necessary, but the BSS is advising that there may be non-HT STAs, rather than requiring protection.
2b	1	0, 1	3	0, 1	0	0	An overlapping BSS has determined that protection by the BSS is necessary, the BSS has no associated non-ERP STAs, and the BSS is requiring the determined protection.
2c	1	0, 1	3	1	0	0	An overlapping BSS has determined that protection by the BSS is necessary, the BSS has associated non-ERP STAs, and the BSS is requiring protection.
3	0	0	0, 2	0	0	0	No non-HT STAs are present. (Layer 3)
Various	Other combinations of values						None or unusual.