IEEE P802.11  
Wireless LANs

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| **Specification Framework for TGbn** | | | | |
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Abstract

This document provides the framework from which the draft TGbn amendment will be developed. The document provides an outline of each the functional blocks that will be a part of the final amendment. The document is intended to reflect the working consensus of the group on the broad outline for the draft specification. As such it is expected to begin with minimal detail reflecting agreement on specific techniques and highlighting areas on which agreement is still required. It may also begin with an incomplete feature list with additional features added as they are justified. The document will evolve over time until it includes sufficient detail on all the functional blocks and their inter-dependencies so that work can begin on the draft amendment itself.

# Revision history

|  |  |  |
| --- | --- | --- |
| Revision | Date | Changes |
| 0 | Jan 25, 2024 | Initial version |
| 1 | Mar 25, 2024 | Add motions passed in 2024 March meeting |
| 2 | May 23, 2024 | Added motions passed in 2024 May meeting |
| 3 | May 29, 2024 | Updated the references |
| 4 | July 22, 2024 | Added motions passed in 2024 July meeting |
| 5 | Sep 22, 2024 | Added motions passed in 2024 Sep meeting |
| 6 | Nov 17, 2024 | Added motions passed in 2024 Nov meeting |
| 7 | Dec 22, 2024 | Added motion s passed on Dec 19, 2024 |
| 8 | Jan 17, 2025 | Added motions passed in 2025 Jan meeting. Added passed motions on PDTs. |
| 9 | Feb 7 2025 | Fixed some typos |

# NOTEs from the editor

1. Further editorial changes by the editor are reflected in tracked mode.

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# Abbreviations and acronyms

AC access category

AID association idenfier

AP access point

BA block acknowledgement

BCC binary convolutional code

BPSK bineary phase shift keying

BSRP buffer status report poll

BSS basic service set

BW bandwidth

CFO carrier frequency offset

Co-BF coordinated beamforming

COEX coexistence

CRC cyclic redundancy code

Co-RTWT coordinated restricted TWT

CSI channel state information

Co-SR coordinated spatial reuse

Co-TDMA coordinated TDMA

CSD cyclic shift diversity

CTS clear to send

DBW distribution bandwdith

DL downlink

DPS dynamic power save

DRU distributed tone RU

DS distribution system

DUP duplicate

EDCA enhanced distributed channel access

EHT extremely high throughput

ELR enhanced long range

EQM equal modulation

ESS extended service set

FCS frame check sequence

HC higher capability

HE high efficiency

HIP high priority

ICF intial control frame

ICR initial control response

ID identifier

LC lower capability

LDPC low-density parity check

LL low latency

L-LTF non-HT long training field

L-preamble legacy preamble

L-SIG non-HT signal field

L-STF non-HT short training field

LTF long training field

MAC medium access control

MCS modulation and coding scheme

MIMO multiple input multiple output

MLD multi-link device

MRU multiple resource unit

MU multiple user

Multi-AP multiple AP

Non-AP none AP

NAV network allocation vector

NDP null data PPDU

NPCA non-primary channel access

NSS number of spatial streams

OBSS overlapping basic service set

OFDMA orthogonal frequency division multiple access

PHY physical layer

PM power save mode

PPDU physical layer (PHY) protocol data unit

P2P peer to peer

QAM quadrature amplitude modulation

QBPSK quadrature binary phase shift keying

QoS qulatify of service

QPSK quadrature phase shift keying

QSRC QoS STA retry count

RL-SIG repeated non-HT signal field

RRU regular RU

RSID ranging session Identifiers

RTS request to send

RU resource unit

SMD seamless mobility domain

SP service period

SS spatial stream

STA station

STF short training field

SU single user

TA transmitter address

TB trigger-based

TBD to be decided

TDMA time division multiple access

TID traffic identifier

TWT target wake time

TXOP transmission opportunity

TXS TXOP sharing

UEQM unequal modulation

UHR ultra high reliability

UL uplink

U-SIG universal signal

VO voice

# UHR PHY



## General

This section describes the functional blocks in the UHR PHY.

* “PHY Version Identifier” is set to 1 in U-SIG field for UHR PPDUs.

[Motion #22, [1] and [38]]

## Distributed-tone RU

### General

* TGbn will define distributed tone RU (“DRU”) transmission

[Motion #3, [1] and [10]]

* TGbn supports a distributed tone RU (DRU) for a TB PPDU transmission
  + The DRU means an RU which consists of subcarriers spreading across a certain bandwidth

[Motion #1, [1] and [2]]

* DRU is allowed in a punctured UHR TB transmission

[Motion #4, [1] and [11]]

* TGbn supports the hybrid mode with DRUs and RRUs (Regular RU as existing RU defined in 11ax/be) in UHR UL TB OFDMA transmissions
  + Minimum PPDU BW for hybrid mode is TBD

[Motion #7, [1] and [14]]

* UL MU-MIMO is not applicable to DRU.

[Motion #37, [1] and [89]]

* DRU only supports up to 2ss

[Motion #38, [1] and [89]]

### Tone plan

* DRUs tone plan design on distribution BW (DBW) 20MHz and 40MHz is 26-tone RU based DRU method (using 26-tone DRUs as basic building blocks).
  + DRUs tone plan design on other distribution BWs is TBD.

[Motion #14, [1] and [33]]

* Minimum size of RRU in hybrid mode in 160MHz and 320MHz is 242 tones.

[Motion #63, [1] and [165]]

* 11bn supports the following DBW dependent DRU size support to maximize BW and power efficiency
  + No MRU in distributed transmission
  + 20MHz: RU26, RU52, RU106
  + 40MHz: RU26, RU52, RU106, RU242
  + 80MHz: RU52, RU106, RU242, RU484
* [Motion #65, [1] and [167]]
* 11bn supports per 80MHz DRU/RRU switch if PPDU BW >80MHz and no hybrid DRU and RRU mode for up to 80MHz

[Motion #66, [1] and [167]]

* In a non-punctured 80 MHz PPDU, the following DBW modes are allowed for DRU
  + 80 MHz
  + 20 MHz + 20 MHz + 40 MHz (or 40 MHz + 20 MHz + 20 MHz)

[Motion #20, [1] and [36]]

* For 160 MHz and 320 MHz PPDUs, in only the non-punctured primary 80 MHz subblock, the following distribution bandwidth mode is allowed for DRU
  + 20 MHz + 20 MHz + 40 MHz (or 40 MHz + 20 MHz + 20 MHz)

[Motion #237, [264] and [277]]

* DRU DBW of 60 MHz is defined in an 80 MHz frequency subblock (with the highest 20 MHz subchannel unallocated) in a UHR TB PPDU
* No allocation is made in the highest 20 MHz subchannel

[Motion #64, [1] and [166]]

* For 80 MHz PPDU where one of the 20 MHz channels is punctured, the following DBW mode is allowed for DRU
  + 20 MHz + 40 MHz (or 40 MHz + 20 MHz) mode

[Motion #87, [1] and [173]]

* For 160 MHz and 320 MHz PPDUs, in an 80 MHz frequency subblock where one of the 20 MHz channels is punctured, the following distribution bandwidth mode is allowed for DRU
  + 20 MHz + 40 MHz (or 40 MHz + 20 MHz) mode

[Motion #88, [1] and [173]]

* For 160 MHz and 320 MHz PPDUs, in an 80 MHz frequency subblock where one of the 40 MHz channels is punctured (i.e., either 1100 or 0011 case), the following DBW mode is allowed for DRU
  + 40 MHz mode

[Motion #89, [1] and [173]]

* For a 40 MHz PPDU, the following DBW mode is allowed for DRU
  + Only 40 MHz mode

[Motion #90, [1] and [173]]

* Data and pilot subcarrier indices for DRUs in a 20 MHz UHR PPDU are defined in following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Data and pilot subcarrier indices for Distributed Tone RUs (DRUs) in a 20 MHz UHR PPDU** | | | | | |
| **DRU type** | **DRU index and subcarrier range** | | | | |
| 26-tone DRU i=1:9 | DRU1 [-120:9:-12, 6:9:114] | DRU2 [-116:9:-8, 10:9:118] | DRU3 [-118:9:-10, 8:9:116] | DRU4 [-114:9:-6, 12:9:120] | DRU5 [-112:9:-4, 5:9:113] |
| DRU6 [-119:9:-11, 7:9:115] | DRU7 [-115:9:-7, 11:9:119] | DRU8 [-117:9:-9, 9:9:117] | DRU9 [-113:9:-5, 4:9:112] |  |
| 52-tone DRU i=1:4 | DRU1 26-tone [DRU1, DRU2] | | DRU2 26-tone [DRU3, DRU4] | |  |
| DRU3 26-tone [DRU6, DRU7] | | DRU4 26-tone [DRU8, DRU9] | |  |
| 106-tone DRU i=1:2 | DRU1 26-tone [DRU1~4], [-3, 3] | | DRU2 26-tone [DRU6~9], [-2, 2] | |  |

[Motion #56, [1] and [33]]

* Data and pilot subcarrier indices for DRUs in a 40 MHz UHR PPDU are defined in following table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Data and pilot subcarrier indices for Distributed Tone RUs (DRUs) in a 40 MHz UHR TB PPDU** | | | | | | |
| **DRU type** | **DRU index and subcarrier range** | | | | | |
| 26-tone DRU i=1:18 | DRU1 [-242:18:-26, 10:18:226] | DRU2 [-233:18:-17, 19:18:235] | DRU3 [-238:18:-22, 14:18:230] | DRU4 [-229:18:-13, 23:18:239] | DRU5 [-225:18:-9, 27:18:243] | DRU6 [-240:18:-24, 12:18:228] |
| DRU7 [-231:18:-15, 21:18:237] | DRU8 [-236:18:-20, 16:18:232] | DRU9 [-227:18:-11, 25:18:241] | DRU10 [-241:18:-25, 11:18:227] | DRU11 [-232:18:-16, 20:18:236] | DRU12 [-237:18:-21, 15:18:231] |
| DRU13 [-228:18:-12, 24:18:240] | DRU14 [-234:18:-18, 18:18:234] | DRU15 [-239:18:-23, 13:18:229] | DRU16 [-230:18:-14, 22:18:238] | DRU17 [-235:18:-19, 17:18:233] | DRU18 [-226:18:-10, 26:18:242] |
| 52-tone DRU i=1:8 | DRU1 [-242:9:-17, 10:9:235] | | DRU2 [-238:9:-13, 14:9:239] | | DRU3 [-240:9:-15, 12:9:237] | |
| DRU4 [-236:9:-11, 16:9:241] | | DRU5 [-241:9:-16, 11:9:236] | | DRU6 [-237:9:-12, 15:9:240] | |
| DRU7 [-239:9:-14, 13:9:238] | | DRU8 [-235:9:-10, 17:9:242] | |  | |
| 106-tone DRU i=1:4 | DRU1 26-tone [DRU1~4], [-8,5] | | DRU2 26-tone [DRU6~9], [-6,7] | | DRU3 26-tone [DRU10~13], [-7,6] | |
| DRU4 26-tone [DRU15~18], [-5,8] | |  | |  | |
| 242-tone DRU i=1:2 | DRU1 106-tone [DRU1~2],26-tone DRU5, [-244,-4,3,9] | | DRU2 106-tone [DRU3~4],26-tone DRU14, [-243,-3,4,244] | |  | |

[Motion #57, [1] and [33]]

* Data and pilot subcarrier indices for DRUs in an 80 MHz UHR PPDU are defined in following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data and pilot subcarrier indices for Distributed Tone RUs (DRUs) in a 80 MHz UHR TB PPDU** | | | | |
| **DRU type** | **DRU index and subcarrier range** | | | |
| 52-tone DRU i=1:16 | DRU1 [-483:36:-51, 17:36:449],[-467:36:-35, 33:36:465] | DRU2 [-475:36:-43, 25:36:457],[-459:36:-27, 41:36:473] | DRU3 [-479:36:-47, 21:36:453],[-463:36:-31, 37:36:469] | DRU4 [-471:36:-39, 29:36:461],[-455:36:-23, 45:36:477] |
| DRU5 [-477:36:-45, 23:36:455],[-461:36:-29, 39:36:471] | DRU6 [-469:36:-37, 31:36:463],[-453:36:-21, 47:36:479] | DRU7 [-481:36:-49, 19:36:451],[-465:36:-33, 35:36:467] | DRU8 [-473:36:-41, 27:36:459],[-457:36:-25, 43:36:475] |
| DRU9 [-482:36:-50, 18:36:450],[-466:36:-34, 34:36:466] | DRU10 [-474:36:-42, 26:36:458],[-458:36:-26, 42:36:474] | DRU11 [-478:36:-46, 22:36:454],[-462:36:-30, 38:36:470] | DRU12 [-470:36:-38, 30:36:462],[-454:36:-22, 46:36:478] |
| DRU13 [-476:36:-44, 24:36:456],[-460:36:-28, 40:36:472] | DRU14 [-468:36:-36, 32:36:464],[-452:36:-20,48:36:480] | DRU15 [-480:36:-48, 20:36:452],[-464:36:-32, 36:36:468] | DRU16 [-472:36:-40, 28:36:460],[-456:36:-24, 44:36:476] |
| 106-tone DRU i=1:8 | DRU1 52-tone [DRU1~2], [-495, 485] | DRU2 52-tone [DRU3~4],[-491, 489] | DRU3 52-tone [DRU5~6],[-489, 491] | DRU4 52-tone [DRU7~8],[-493, 487] |
| DRU5 52-tone [DRU9~10],[-494, 486] | DRU6 52-tone [DRU11~12],[-490,490] | DRU7 52-tone [DRU13~14],[-488,492] | DRU8 52-tone [DRU15~16],[-492,488] |
| 242-tone DRU i=1:4 | DRU1 [-499:4:-19, 17:4:497] | | DRU2 [-497:4:-17, 19:4:499] | |
| DRU3 [-498:4:-18, 18:4:498] | | DRU4 [-496:4:-16, 20:4:500] | |
| 484-tone DRU i=1:2 | DRU1 [-499:2:-17, 17:2:499] | | DRU2 [-498:2:-16, 18:2:500] | |

[Motion #58, [1] and [33]]

* DRUs on frequency subblocks of wide bandwidth PPDU should be defined as DRUs on 20MHz, 40MHz and 80MHz PPDU with the following constant shifts

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Subblock Size** | **BW80** | **BW160** | **BW320** |
| 20MHz | [-380,-133,132,379] | [-892,-645,-380,-133,132,379,644,891] | [ -1916, -1669, -1404, -1157, -892, -645, -380,  -133, 132, 379, 644, 891, 1156, 1403, 1668, 1915] |
| 40MHz | [-256, 256] | [-768,-256,256,768] | [-1792,-1280,-768,-256,256,768,1280,1792] |
| 80MHz | 0 | [-512,512] | [-1536,-512,512,1536] |

[Motion #60, [1] and [163]]

### L-preamble

* If a DRU for a PPDU occupies more than one 20 MHz channel, then the L-STF, L-LTF, L-SIG, and RL-SIG fields are duplicated over all the 20 MHz channels which are occupied by the DRU.

[Motion #21, [1] and [37]]

### UHR-STF

* Global CSD is used for DRU UHR-STF transmission to solve unintentional beamforming issue
* Global CSD is applied in each distribution BW

[Motion #15, [1] and [34]]

* DRU transmission reuses the 8 CSD table/values in 11ax/be for global CSD allocation

[Motion #16, [1] and [34]]

* In DRU transmission, global CSD provides CSD start index i for each DRU. If Nss for this DRU is larger than 1, then it will use CSD[mod(i: i+Nss-1, 8)] for each SS.

[Motion #70, [1] and [167]]

* The UHR-STF for DRU in a TB PPDU uses 11ax/11be trigger based STF sequences.

[Motion #18, [1] and [35]]

* For UHR-STF corresponding to DBW for DRU,
  + STF sequence depends on PPDU BW.
  + Occupied STF tones are the same as that of the largest RRU corresponding to the DBW within PPDU BW.

[Motion #19, [1] and [35]]

* DRU index based global CSD start index assignment will be used for DRU UHR-STF transmission
* Global CSD start index assignment for DRU UHR-STF transmission will be based on the following table

|  |  |
| --- | --- |
| DRU size | Global CSD starting index for DBW 20MHz |
| DRU26, i=1:9 | {1,2,3,4,5,5,6,7,8} |
| DRU52, i=1:4 | {2,4,6,8} |
| DRU106, i=1:2 | {3,7} |

|  |  |
| --- | --- |
| DRU size | Global CSD starting index for DBW 40MHz |
| DRU26, i=1:18 | {1,5,2,6,3,3,7,4,8,1,5,2,6,7,3,7,4,8} |
| DRU52, i=1:8 | {1,2,3,4,5,6,7,8} |
| DRU106, i=1:4 | {2,4,6,8} |
| DRU242, i=1:2 | {3,7} |

|  |  |
| --- | --- |
| DRU size | Global CSD starting index for DBW 80MHz |
| DRU52, i=1:16 | {1,5,2,6,3,7,4,8,1,5,2,6,3,7,4,8} |
| DRU106, i=1:8 | {1,2,3,4,5,6,7,8} |
| DRU242, i=1:4 | {2,4,6,8} |
| DRU484, i=1:2 | {3,7} |

[Motion #59, [1] and [162]]

* For distributed transmission, apply global CSD to UHR-STF only, and UHR-LTF and data still apply local per stream CSD, just like RRU

[Motion #238, [264] and [277]]

### UHR-LTF

* In mixed RRU and DRU transmission the RRU LTF follows the exact same rule as if there is no DRU. The DRU LTF sequence depends on the DBW.

[Motion #67, [1] and [167]]

* DRU only uses 4x LTF.

[Motion #69, [1] and [167]]

* For a DRU transmission, a new 4x UHR-LTF sequence is defined in each DBW
  + A 4x UHR-LTF sequence has coefficients on all tones overlapped with DRU tones defined in each DBW.

[Motion #85, [1] and [172]]

* In a PPDU using DRUs, a UHR-LTF sequence corresponding to the DBW of the DRUs is used regardless of the PPDU bandwidth

[Motion #86, [1] and [172]]

* The following design for 20MHz 4xLTF for DRU:
  + LTF-122:122 = [ ...

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 +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 +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 -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 +1 +1 +1 -1 +1 0 0 ];

* Motion #107, [1] and [181]]
* The 40MHz DBW 4xLTF sequence design for DRU is the following.
  + LTF-244:244=[-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 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 -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 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 1 -1 1 1 1 1 -1 -1 1 -1 1 -1 1 -1 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 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 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 -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 -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]

Motion #109, [1] and [182]]

* The following design for 80MHz 4xLTF for DRU

LTF-500:500 = [ ...

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 +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 -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 ...

-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 +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 +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 -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 +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 -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 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 ...

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 +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 -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 ...

+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 -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 -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 +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 -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 -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 ];

Motion #108, [1] and [181]]

### Pilot

* TGbn supports hierarchical pilot structure for DRU
  + Pilot locations of a larger DRU is a subset of pilot locations of smaller component DRUs within the same PPDU BW

[Motion #5, [1] and [12]]

* The number of pilot tones for the same size DRU and RRU is the same
  + The RRU means the existing RU defined in 11ax and 11be

[Motion #6, [1] and [13]]

* DRU transmission uses single stream pilots in both LTF and data portion

[Motion #68, [1] and [167]]

* The following pilot index table from hierarchical uniform pilot structure of distance of 11 will be used for distributed transmission over 20MHz.

|  |  |
| --- | --- |
| **Pilot indices for DRU transmission over 20MHz** | |
| dRU size | *KdRxx\_i* |
| dRU26, i = 1:9 | {-111 15}, {-89 37}, {-100 26}, {-78 48}, {-67 59}, {-56 70}, {-34 92}, {-45 81}, {-23 103} |
| dRU52, i = 1:4 | {-111 -89 15 37}, {-100 -78 26 48}, {-56 -34 70 92}, {-45 -23 81 103} |
| dRU106, i = 1:2 | {-111 -78 15 48}, {-56 -23 70 103} |

[Motion #71, [1] and [167]]

* The following pilot index table from hierarchical uniform pilot structure of distance of 11 will be used for distributed transmission over 40MHz.

|  |  |
| --- | --- |
| **Pilot indices for DRU transmission over 40MHz** | |
| dRU size | *KdRxx\_i* |
| dRU26, i = 1:18 | {-224 28}, {-125 127}, {-202 50}, {-103 149}, {-81 171}, {-114 138}, {-213 39}, {-92 160}, {-191 61}, {-169 83}, {-70 182}, {-147 105}, {-48 204}, {-180 72}, {-59 193}, {-158 94}, {-37 215}, {-136 116} |
| dRU52, i = 1:8 | {-224 -125 28 127}, {-202 -103 50 149}, {-213 -114 39 138}, {-191 -92 61 160},  {-169 -70 83 182}, {-147 -48 105 204}, {-158 -59 94 193}, {-136 -37 116 215} |
| dRU106, i = 1:4 | {-224 -103 28 149}, {-213 -92 39 160}, {-169 -48 83 204}, {-158 -37 94 215} |
| dRU242, i = 1:2 | {-224 -213 -103 -92 28 39 149 160}, {-169 -158 -48 -37 83 94 204 215} |

[Motion #72, [1] and [167]]

* The following pilot index table from hierarchical uniform pilot structure of distance of 11 will be used for distributed transmission over 80MHz.

|  |  |
| --- | --- |
| Pilot indices for DRU transmission over 80MHz | |
| dRU size | *KdRxx\_i* |
| dRU52, i = 1:16 | {-447  -359    53   141}, {-403  -315    97   185},    {-227  -139   273   361}, {-183   -95   317   405},   {-425  -117    75   383}, {-381   -73   119   427},     {-337  -249   163   251}, {-293  -205   207   295},  {-194  -106   306   394}, {-150   -62   350   438},     {-370  -282   130   218}, {-326  -238   174   262},   {-260  -172   240   328}, {-216  -128   284   372},     {-392   -84   108   416}, {-436  -348    64   152} |
| dRU106, i = 1:8 | {-403  -315    97   185}, {-227  -139   273   361},       {-381  -117   119   383}, {-293  -205   207   295},     {-150   -62   350   438}, {-326  -238   174   262},       {-260  -172   240   328}, {-348   -84   152   416} |
| dRU242, i = 1:4 | {-403  -315  -227  -139    97   185   273   361},         {-381  -293  -205  -117   119   207   295   383},         {-326  -238  -150   -62   174   262   350   438},          {-348  -260  -172   -84   152   240   328   416} |
| dRU484, i = 1:2 | {-403  -381  -315  -293  -227  -205  -139  -117    97   119   185   207   273   295   361   383},                        {-348  -326  -260  -238  -172  -150   -84   -62   152   174   240   262   328   350   416   438} |

[Motion #73, [1] and [167]]

## Unequal modulation and new MCS

### General

* TGbn defines unequal modulation (UEQM) over different spatial streams.

[Motion #23, [1] and [39]]

* UHR defines unequal modulation only for LDPC.

[Motion #53, [1] and [159]]

* Introduce new MCSs which are applicable to single spatial stream transmissions, as well as to equal modulation and unequal modulation cases in multiple spatial stream transmissions.

[Motion #34, [1] and [86]]

* For 4 SS, the UEQM patterns only include:

|  |  |  |  |
| --- | --- | --- | --- |
| 1st ss | 2nd SS | 3rd SS | 4th SS |
| M | M | M | M-1 |
| M | M | M | M-2 |
| M | M | M-1 | M-2 |
| M | M-1 | M-1 | M-2 |

Note: M is the constellation index; M-1 refers to the constellation that is one order lower than M; M-2 refers to the constellation that is two orders lower than M.

[Motion #39, [1] and [90]]

* UEQM patterns for Nss=3 are limited to three:

|  |  |  |
| --- | --- | --- |
| 1st ss | 2nd SS | 3rd SS |
| M | M | M-1 |
| M | M | M-2 |
| M | M-1 | M-2 |

Note: M is the constellation index; M-1 refers to the constellation that is one order lower than M; M-2 refers to the constellation that is two orders lower than M.

[Motion #43, [1] and [92]]

* UEQM patterns for Nss=2 are limited to two as:

|  |  |
| --- | --- |
| 1st ss | 2nd SS |
| M | M-1 |
| M | M-2 |

Note: M is the constellation index; M-1 refers to the constellation that is one order lower than M; M-2 refers to the constellation that is two orders lower than M.

[Motion #52, [1] and [159]]

* Add the following modulation and code rate combinations as the new MCSs for 11bn:
  + Modulations of {QPSK, 16QAM, 256QAM} with code rate R=2/3
  + Modulation of 16QAM with code rate R=5/6

[Motion #42, [1] and [86]]

* UHR defines unequal modulation which uses joint LDPC encoding across multiple spatial streams while at least one spatial stream uses a different modulation order compared to the first spatial stream, and is applicable only to non-MU-MIMO beamformed transmissions using 2 to 4 spatial streams in a UHR MU PPDU.

[Motion #117, [1] and [159, 186, 187]]

* Exclude BPSK from UHR UEQM.

[Motion #199, [264] and [267, 268]]

* Include 4096-QAM in UHR UEQM.

[Motion #200, [264] and [267]]

* Mandatory support MCSs of QPSK with code rate 2/3; 16QAM with code rate 2/3; 16QAM with code rate 5/6; 256QAM with code rate 2/3.
  + Support for 256QAM with code rate 2/3 for 20MHz only devices is TBD.

[Motion #216, [264] and [274, 275]]

### Signaling

* For a (non-ELR) UHR MU PPDU, there exists a 1-bit EQM/UEQM indication in a User field for non-MU-MIMO in the UHR-SIG field.

[Motion #40, [1] and [91]]

* For a (non-ELR) UHR MU PPDU, when EQM/UEQM indicates UEQM in a User field for non-MU-MIMO, there exists a MCS field, a NSS field and a 2 bit field indicating UEQM patterns.

[Motion #84, [1] and [171]]

### Segment Parser

* Reuse HT stream parser for UHR UEQM with the following restrictions and extension

  + , for
  + The encoder type is LDPC

[Motion #201, [264] and [267, 269]]

## Enhanced long range extension

### General

* TGbn defines Enhanced Long Range (ELR) PPDU and potentially other Range Extension mechanisms.

[Motion #24, [1] and [40]]

* Define an ELR PPDU in IEEE 802.11bn with the following targets
  + Downlink and Uplink in 2.4 GHz (within BSS range with 11b beacon)
  + Uplink only in 5 GHz and 6 GHz bands
  + Minimum data rate is greater than or equal to 1.5 Mbps
* [Motion #74, [1] and [168]]
* The BW of ELR PPDU is 20MHz and one Spatial stream is used for ELR transmission.

[Motion #92, [1] and [175]]

* In the ELR transmission, a repeating of 52-tone RRU is used in 20MHz.
  + The same data is repeated in four 52-tone RRUs in 20 MHz.
  + The subcarrier allocation of 52-tone RRU equals the 52-tone RU defined in 11be.

[Motion #93, [1] and [175]]

### PPDU format

* 11bn defines the following PPDU frame format for ELR
  + PE TBD

L-SIG

RL-SIG

ELR-Data

L-LTF

L-STF

ELR-mark2

ELR-mark1

ELR-STF

ELR-LTF

ELR-SIG

U-SIG1

U-SIG2

[Motion #81, [1] and [170]]

### L-preamble

* ELR PPDU starts with L-STF, L-LTF, L-SIG, RL-SIG, and U-SIG in the PPDU for the ELR transmission.
* [Motion #32, [1] and [84]]

NOTE from the editor: There is no L-preabmle terminology in Draft P802.11 REVme D7.0.

* In ELR PPDU, STA boosts L-STF and L-LTF by 3 dB
  + For UL, non-AP STA corrects CFO before transmission
  + NOTE: Non-AP STA pre-correction CFO requirement for residual CFO is TBD

[Motion #75, [1] and [168]]

* ELR packet detection is done at L-STF, which has same length as legacy with 3dB power boosting
  + L-LTF also has same length as legacy with same power boosting as L-STF

[Motion #78, [1] and [170]]

### U-SIG field

* In the U-SIG field of a UHR ELR PPDU, the PHY Version Identifier is set to 1. And the PPDU Type And Compression Mode is used to indicate ELR PPDU.

[Motion #33, [1] and [85]]

* U-SIG carries STA-ID in ELR PPDU.

[Motion #79, [1] and [170]]

* The U-SIG field in ELR PPDU consists of 2 OFDM symbols and includes the same version independent fields defined in the U-SIG field of EHT PPDU
* The details for the version dependent fields are TBD.

[Motion #91, [1] and [174]]

* The contents of the U-SIG field in ELR PPDU is defined as follows.

|  |  |  |  |
| --- | --- | --- | --- |
| **Two parts of U-SIG** | **Field** | **Bit Pos** | **Bits** |
| **U-SIG-1** | PHY Version Identifier | B0-B2 | 3 |
| Bandwidth | B3-B5 | 3 |
| UL/DL | B6 | 1 |
| BSS Color | B7-B12 | 6 |
| TXOP | B13-B19 | 7 |
| Disregard | B20-B24 | 5 |
| Validate | B25 | 1 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Two parts of U-SIG** | **Field** | **Bit Pos** | **Bits** |
| **U-SIG-2** | PPDU Type And Compression Mode | B0-B1 | 2 |
| STA-ID | B2-B12 | 11 |
| ELR Validate bits | B13-B15 | 3 |
| CRC | B16-B19 | 4 |
| Tail | B20-B25 | 6 |

* + ELR PPDU indication: PPDU Type And Compression Mode set to ‘11’.
  + STA-ID (11 bit): B2-B12 bit in U-SIG-2.
  + ELR Validate bits (B13-B15 of USIG-2): Set to all ‘1’ for ELR PPDU.
  + Note: B11-B15 – in EHT MU PPDU indicates “Number of EHT-SIG symbols”, and in UHR MU PPDU indicates “Number of UHR-SIG symbols”

### ELR-Mark field

* Define two ELR-Mark symbols for ELR mode classification
  + ELR-Mark symbols carry a known sequence to receiver
  + ELR-Mark symbols carry BSS color info in ELR-Mark sequence
  + No power boosting on ELR-Mark symbols
  + Two ELR-Mark symbols are both QBPSK modulated on data subcarriers
  + ELR-Mark symbols use the following tone plan
    - 4 regular pilots as EHT-SIG + 48 data tones

[Motion #80, [1] and [170]]

* ELR Mark symbols will be composed of two 1x OFDM symbols. Each symbol will have a duration of 4μS (3.2μS + GI=0.8μS).

[Motion #104, [1] and [180]]

* ELR Mark symbols will have the following tone mapping:
  + The 48 data tones are Q-BPSK mapped
  + The pilots follow BPSK mapping (polarity -1 applied to [1,1,1,-1]).

[Motion #105, [1] and [180]]

* Adopt the ELR Mark sequence design as described by the matrix H in 24/1571r2. The detailed design is as follows.
  + 𝐻́  = [𝐻 𝐻𝕁; 𝐻 -𝐻𝕁], where 𝕁 is the exchange matrix of size 48x48

H=[

-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,-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,-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,-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,-1,1,1,1,1,1,-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,-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,-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,-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,-1,1,1,1,1,-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,-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,-1,1,1,-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,-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,-1,1,1,1,-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,-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,-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,-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

-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,-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,-1,1,1,1,1,1,-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,-1,1,1,-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,-1,1,1,-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,-1,1,1,1,-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,-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,-1,1,-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,-1,1,-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,-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,-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]

A number and numbers with a white background

Description automatically generated with medium confidence

The 64x96 Q-BPSK-ELR-mark Matrix, H́

A cross stitch pattern of a grid

Description automatically generated with medium confidence

[Motion #106, [1] and [180]]

### ELR-STF

* ELR PPDU has 3dB boosting applied on ELR-STF
  + ELR PPDU has ELR-STF duration and sequence same as that of UHR DL SU/MU PPDU
    - 4us using EHT-STF sequence for 20MHz

Note that ELR-STF is the short names of UHR-STF for ELR PPDU

[Motion #82, [1] and [170]]

### ELR-LTF

* ELR PPDU has 3dB boosting applied on ELR-LTF
* ELR PPDU defines a fixed/single mode of LTF+GI
  + 11bn supports 2x LTF+1.6us GI only for ELR PPDU
  + 11bn uses two UHR-LTF symbols for ELR PPDU

Note that ELR-LTF is the short names of UHR-LTF for ELR PPDU

[Motion #82, [1] and [170]]

### ELR-SIG field

* ELR-SIG is located right after ELR-LTF in ELR PPDU.
  + Note that ELR-LTF is the short name of UHR-LTF for ELR PPDU

[Motion #36, [1] and [88]]

* ELR PPDU defines two symbols for ELR-SIG, specifically
  + ELR PPDU defines separately encoded two symbols for ELR-SIG
    - Each symbol has separate CRC and tail bits (6 bits)
  + ELR-SIG has same tone plan and duplication scheme as ELR-data and BCC encoded with MCS0

[Motion #83, [1] and [170]]

* ELR-SIG will use the following two OFDM symbols design.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ELR-SIG-1 | B0 | B1 | B2 | B3 | B4-B12 | B13 | B14-B17 | B18-B23 |
| ELR-version  (0 for UHR ELR PPDU) | UL/DL | MCS | Coding | Length  (number of OFDM data symbols -1) | LDPC extra OFDM symbol | CRC | Tail |
| ELR-SIG-2 | B0-B10 | | | | B11-B13 | | B14-B17 | B18-B23 |
| STA-ID | | | | Reserved (Disregard) | | CRC | Tail |

[Motion #95, [1] and [176]]

* Pilot values and mapping rules of ELR-SIG in ELR PPDU are the same as that of four RRU52 in DL OFDMA

[Motion #110, [1] and [183]]

### Data field

* ELR PPDU only supports the following two modulation and coding schemes:
  + BPSK with coding rate R=1/2
  + QPSK with coding rate R=1/2

[Motion #76, [1] and [169]]

* ELR transmission shall apply the phase rotations as below for both BPSK and QPSK modulations
  + The rotation of -1 will be applied on data subcarriers of lower half of RU3 and upper half of RU4 for 52-tone regular RU (RRU52) on 20MHz



[Motion #77, [1] and [169]]

* ELR LDPC rate matching will reuse the existing 802.11ac LDPC rate matching with 1-bit LDPC extra OFDM symbol indication.

[Motion #94, [1] and [176]]

* Pilot values and mapping rules of Data symbols in ELR PPDU are the same as that of four RRU52 in DL OFDMA

[Motion #110, [1] and [183]]

## Interference mitigation

* Define a mode with additional pilots, located within the data portion of the PPDU, which are used for interference estimation and mitigation.
  + Note: zero-energy pilots alternative to be considered as well
* [Motion #35, [1] and [87]]
* The Interference Mitigation feature is only defined with LDPC.

[Motion #245, [264] and [279]]

* For each bandwidth, there is a fixed number of IM pilots (value TBD).

[Motion #246, [264] and [279]]

* Within any transmission that uses IM pilots, they are used in every data OFDM symbol and in the same corresponding subcarriers positions, for a given BW.

[Motion #247, [264] and [279]]

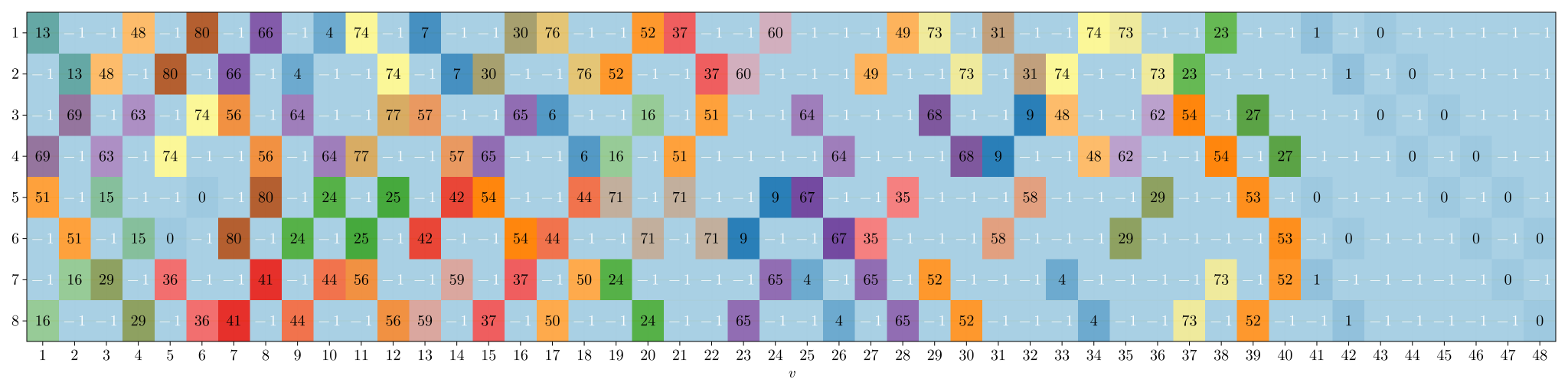
## LDPC enhancement

* Define LDPC codeword length larger than 1944, including 2x1944

[Motion #25, [1] and [41]]

* 802.11bn specification supports LDPC codes with block-length of 3888 bits
  + The supported code rates will be 1/2, 2/3, 3/4 and 5/6
  + The parity matrix representation of these LDPC codes are as follows:

3888-LDPC E(H): R=5/6:



[13,-1,-1,48,-1,80,-1,66,-1,4,74,-1,7,-1,-1,30,76,-1,-1,52,37,-1,-1,60,-1,-1,-1,49,73,-1,31,-1,-1,74,73,-1,-1,23,-1,-1,1,-1,0,-1,-1,-1,-1,-1

-1,13,48,-1,80,-1,66,-1,4,-1,-1,74,-1,7,30,-1,-1,76,52,-1,-1,37,60,-1,-1,-1,49,-1,-1,73,-1,31,74,-1,-1,73,23,-1,-1,-1,-1,1,-1,0,-1,-1,-1,-1

-1,69,-1,63,-1,74,56,-1,64,-1,-1,77,57,-1,-1,65,6,-1,-1,16,-1,51,-1,-1,64,-1,-1,-1,68,-1,-1,9,48,-1,-1,62,54,-1,27,-1,-1,-1,0,-1,0,-1,-1,-1

69,-1,63,-1,74,-1,-1,56,-1,64,77,-1,-1,57,65,-1,-1,6,16,-1,51,-1,-1,-1,-1,64,-1,-1,-1,68,9,-1,-1,48,62,-1,-1,54,-1,27,-1,-1,-1,0,-1,0,-1,-1

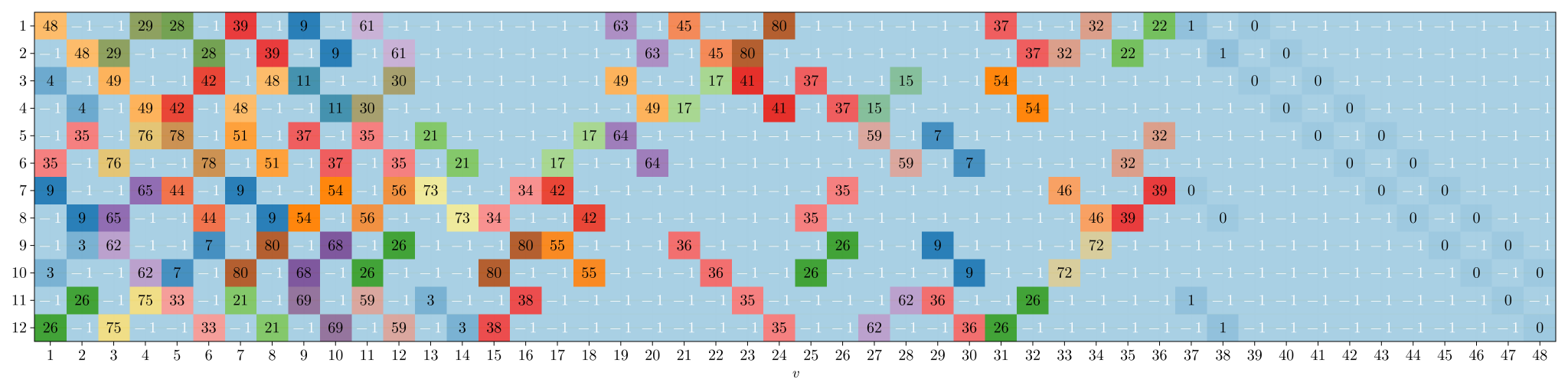
51,-1,15,-1,-1,0,-1,80,-1,24,-1,25,-1,42,54,-1,-1,44,71,-1,71,-1,-1,9,67,-1,-1,35,-1,-1,-1,58,-1,-1,-1,29,-1,-1,53,-1,0,-1,-1,-1,0,-1,0,-1

-1,51,-1,15,0,-1,80,-1,24,-1,25,-1,42,-1,-1,54,44,-1,-1,71,-1,71,9,-1,-1,67,35,-1,-1,-1,58,-1,-1,-1,29,-1,-1,-1,-1,53,-1,0,-1,-1,-1,0,-1,0

-1,16,29,-1,36,-1,-1,41,-1,44,56,-1,-1,59,-1,37,-1,50,24,-1,-1,-1,-1,65,4,-1,65,-1,52,-1,-1,-1,4,-1,-1,-1,-1,73,-1,52,1,-1,-1,-1,-1,-1,0,-1

16,-1,-1,29,-1,36,41,-1,44,-1,-1,56,59,-1,37,-1,50,-1,-1,24,-1,-1,65,-1,-1,4,-1,65,-1,52,-1,-1,-1,4,-1,-1,73,-1,52,-1,-1,1,-1,-1,-1,-1,-1,0]

3888-LDPC E(H): R=3/4:



[48,-1,-1,29,28,-1,39,-1,9,-1,61,-1,-1,-1,-1,-1,-1,-1,63,-1,45,-1,-1,80,-1,-1,-1,-1,-1,-1,37,-1,-1,32,-1,22,1,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,48,29,-1,-1,28,-1,39,-1,9,-1,61,-1,-1,-1,-1,-1,-1,-1,63,-1,45,80,-1,-1,-1,-1,-1,-1,-1,-1,37,32,-1,22,-1,-1,1,-1,0,-1,-1,-1,-1,-1,-1,-1,-1

4,-1,49,-1,-1,42,-1,48,11,-1,-1,30,-1,-1,-1,-1,-1,-1,49,-1,-1,17,41,-1,37,-1,-1,15,-1,-1,54,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1

-1,4,-1,49,42,-1,48,-1,-1,11,30,-1,-1,-1,-1,-1,-1,-1,-1,49,17,-1,-1,41,-1,37,15,-1,-1,-1,-1,54,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1

-1,35,-1,76,78,-1,51,-1,37,-1,35,-1,21,-1,-1,-1,-1,17,64,-1,-1,-1,-1,-1,-1,-1,59,-1,7,-1,-1,-1,-1,-1,-1,32,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1

35,-1,76,-1,-1,78,-1,51,-1,37,-1,35,-1,21,-1,-1,17,-1,-1,64,-1,-1,-1,-1,-1,-1,-1,59,-1,7,-1,-1,-1,-1,32,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1

9,-1,-1,65,44,-1,9,-1,-1,54,-1,56,73,-1,-1,34,42,-1,-1,-1,-1,-1,-1,-1,-1,35,-1,-1,-1,-1,-1,-1,46,-1,-1,39,0,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1

-1,9,65,-1,-1,44,-1,9,54,-1,56,-1,-1,73,34,-1,-1,42,-1,-1,-1,-1,-1,-1,35,-1,-1,-1,-1,-1,-1,-1,-1,46,39,-1,-1,0,-1,-1,-1,-1,-1,0,-1,0,-1,-1

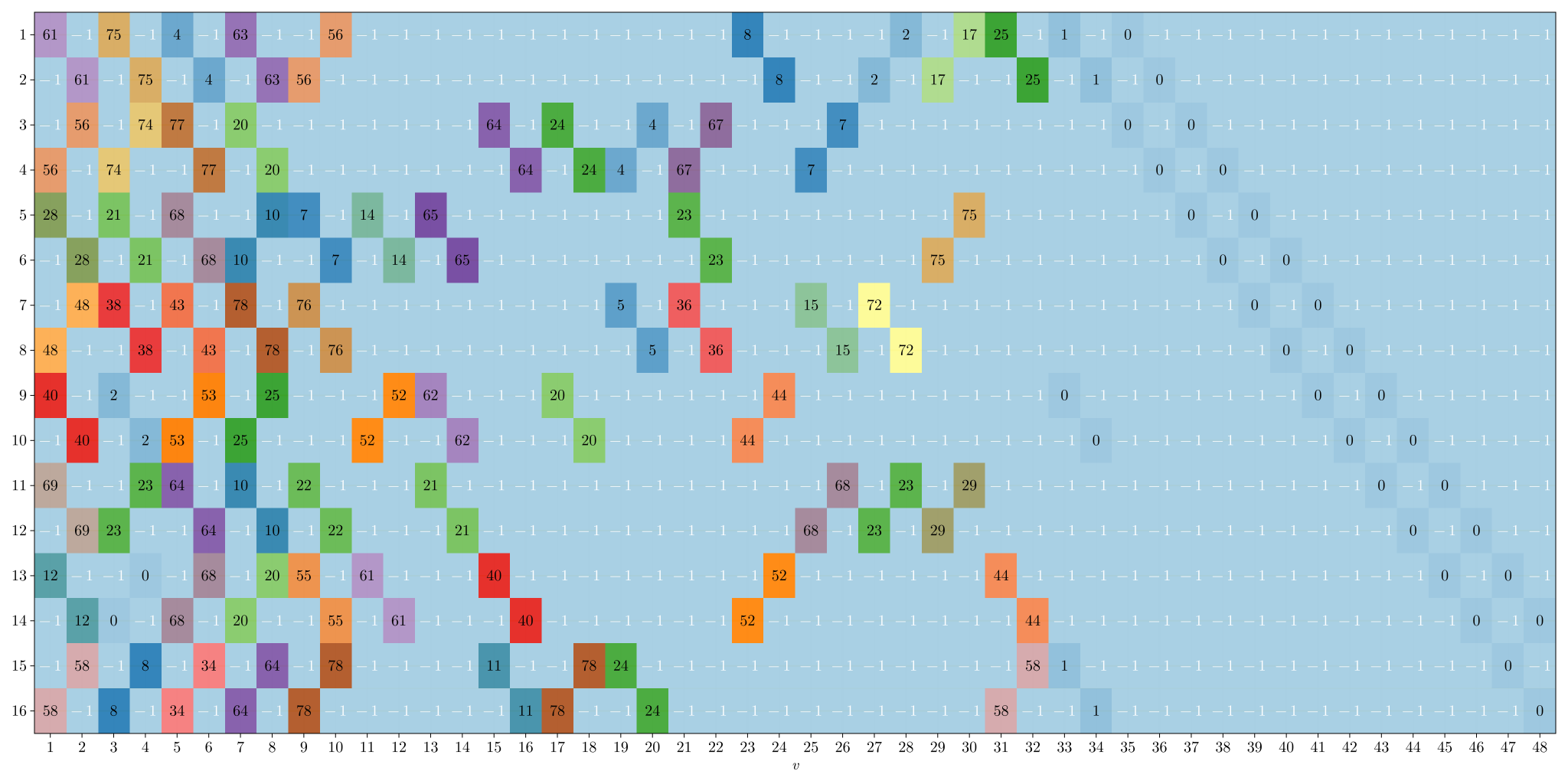
-1,3,62,-1,-1,7,-1,80,-1,68,-1,26,-1,-1,-1,80,55,-1,-1,-1,36,-1,-1,-1,-1,26,-1,-1,9,-1,-1,-1,-1,72,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1

3,-1,-1,62,7,-1,80,-1,68,-1,26,-1,-1,-1,80,-1,-1,55,-1,-1,-1,36,-1,-1,26,-1,-1,-1,-1,9,-1,-1,72,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0

-1,26,-1,75,33,-1,21,-1,69,-1,59,-1,3,-1,-1,38,-1,-1,-1,-1,-1,-1,35,-1,-1,-1,-1,62,36,-1,-1,26,-1,-1,-1,-1,1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1

26,-1,75,-1,-1,33,-1,21,-1,69,-1,59,-1,3,38,-1,-1,-1,-1,-1,-1,-1,-1,35,-1,-1,62,-1,-1,36,26,-1,-1,-1,-1,-1,-1,1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0]

3888-LDPC E(H): R=2/3:



[61,-1,75,-1,4,-1,63,-1,-1,56,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,8,-1,-1,-1,-1,2,-1,17,25,-1,1,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,61,-1,75,-1,4,-1,63,56,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,8,-1,-1,2,-1,17,-1,-1,25,-1,1,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,56,-1,74,77,-1,20,-1,-1,-1,-1,-1,-1,-1,64,-1,24,-1,-1,4,-1,67,-1,-1,-1,7,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

56,-1,74,-1,-1,77,-1,20,-1,-1,-1,-1,-1,-1,-1,64,-1,24,4,-1,67,-1,-1,-1,7,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

28,-1,21,-1,68,-1,-1,10,7,-1,14,-1,65,-1,-1,-1,-1,-1,-1,-1,23,-1,-1,-1,-1,-1,-1,-1,-1,75,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,28,-1,21,-1,68,10,-1,-1,7,-1,14,-1,65,-1,-1,-1,-1,-1,-1,-1,23,-1,-1,-1,-1,-1,-1,75,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1

-1,48,38,-1,43,-1,78,-1,76,-1,-1,-1,-1,-1,-1,-1,-1,-1,5,-1,36,-1,-1,-1,15,-1,72,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1

48,-1,-1,38,-1,43,-1,78,-1,76,-1,-1,-1,-1,-1,-1,-1,-1,-1,5,-1,36,-1,-1,-1,15,-1,72,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1

40,-1,2,-1,-1,53,-1,25,-1,-1,-1,52,62,-1,-1,-1,20,-1,-1,-1,-1,-1,-1,44,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1

-1,40,-1,2,53,-1,25,-1,-1,-1,52,-1,-1,62,-1,-1,-1,20,-1,-1,-1,-1,44,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1

69,-1,-1,23,64,-1,10,-1,22,-1,-1,-1,21,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,68,-1,23,-1,29,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1

-1,69,23,-1,-1,64,-1,10,-1,22,-1,-1,-1,21,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,68,-1,23,-1,29,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1

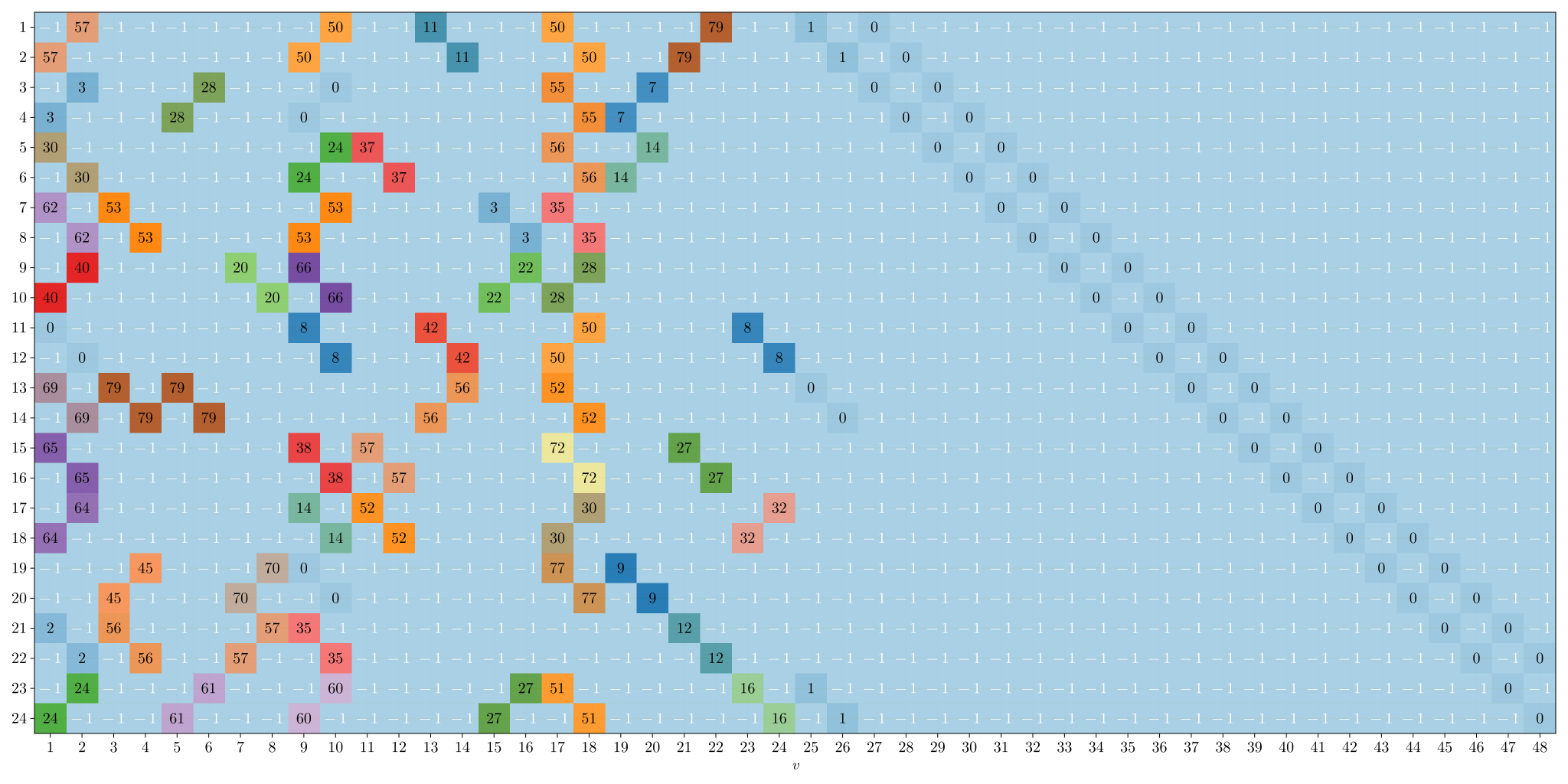
12,-1,-1,0,-1,68,-1,20,55,-1,61,-1,-1,-1,40,-1,-1,-1,-1,-1,-1,-1,-1,52,-1,-1,-1,-1,-1,-1,44,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1

-1,12,0,-1,68,-1,20,-1,-1,55,-1,61,-1,-1,-1,40,-1,-1,-1,-1,-1,-1,52,-1,-1,-1,-1,-1,-1,-1,-1,44,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0

-1,58,-1,8,-1,34,-1,64,-1,78,-1,-1,-1,-1,11,-1,-1,78,24,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,58,1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1

58,-1,8,-1,34,-1,64,-1,78,-1,-1,-1,-1,-1,-1,11,78,-1,-1,24,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,58,-1,-1,1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0]

3888-LDPC E(H): R=1/2:



[-1,57,-1,-1,-1,-1,-1,-1,-1,50,-1,-1,11,-1,-1,-1,50,-1,-1,-1,-1,79,-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

57,-1,-1,-1,-1,-1,-1,-1,50,-1,-1,-1,-1,11,-1,-1,-1,50,-1,-1,79,-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

-1,3,-1,-1,-1,28,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,55,-1,-1,7,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

3,-1,-1,-1,28,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,55,7,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

30,-1,-1,-1,-1,-1,-1,-1,-1,24,37,-1,-1,-1,-1,-1,56,-1,-1,14,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,30,-1,-1,-1,-1,-1,-1,24,-1,-1,37,-1,-1,-1,-1,-1,56,14,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

62,-1,53,-1,-1,-1,-1,-1,-1,53,-1,-1,-1,-1,3,-1,35,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,62,-1,53,-1,-1,-1,-1,53,-1,-1,-1,-1,-1,-1,3,-1,35,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,40,-1,-1,-1,-1,20,-1,66,-1,-1,-1,-1,-1,-1,22,-1,28,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

40,-1,-1,-1,-1,-1,-1,20,-1,66,-1,-1,-1,-1,22,-1,28,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

0,-1,-1,-1,-1,-1,-1,-1,8,-1,-1,-1,42,-1,-1,-1,-1,50,-1,-1,-1,-1,8,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,0,-1,-1,-1,-1,-1,-1,-1,8,-1,-1,-1,42,-1,-1,50,-1,-1,-1,-1,-1,-1,8,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1

69,-1,79,-1,79,-1,-1,-1,-1,-1,-1,-1,-1,56,-1,-1,52,-1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1

-1,69,-1,79,-1,79,-1,-1,-1,-1,-1,-1,56,-1,-1,-1,-1,52,-1,-1,-1,-1,-1,-1,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1

65,-1,-1,-1,-1,-1,-1,-1,38,-1,57,-1,-1,-1,-1,-1,72,-1,-1,-1,27,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1,-1

-1,65,-1,-1,-1,-1,-1,-1,-1,38,-1,57,-1,-1,-1,-1,-1,72,-1,-1,-1,27,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1,-1

-1,64,-1,-1,-1,-1,-1,-1,14,-1,52,-1,-1,-1,-1,-1,-1,30,-1,-1,-1,-1,-1,32,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1,-1

64,-1,-1,-1,-1,-1,-1,-1,-1,14,-1,52,-1,-1,-1,-1,30,-1,-1,-1,-1,-1,32,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1,-1

-1,-1,-1,45,-1,-1,-1,70,0,-1,-1,-1,-1,-1,-1,-1,77,-1,9,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1,-1

-1,-1,45,-1,-1,-1,70,-1,-1,0,-1,-1,-1,-1,-1,-1,-1,77,-1,9,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1,-1

2,-1,56,-1,-1,-1,-1,57,35,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,12,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0,-1

-1,2,-1,56,-1,-1,57,-1,-1,35,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,12,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0

-1,24,-1,-1,-1,61,-1,-1,-1,60,-1,-1,-1,-1,-1,27,51,-1,-1,-1,-1,-1,16,-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

24,-1,-1,-1,61,-1,-1,-1,60,-1,-1,-1,-1,-1,27,-1,-1,51,-1,-1,-1,-1,-1,16,-1,1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,0]

* [Motion #54, [1] and [160]]
* Update the LDPC PPDU encoding parameter table for UHR as below:
  + If FEC coding scheme is LDPC and Navbits ≤ 3888, the 2xLDPC subfield shall be set to 0 and the LDPC codeword length selection shall follow the pre-UHR LDPC procedure, specifically using codeword lengths (648, 1296, or 1944) bits based on the table below

|  |  |  |
| --- | --- | --- |
| **Range of Navbits (bits)** | **Number of LDPC codewords (NCW)** | **LDPC codeword length LLDPC (bits)** |
| Navbits ≤ 648 | 1 | 1296, if Navbits ≥ Npld+ 912 × (1-R) 648, otherwise |
| 648 < Navbits ≤ 1296 | 1 | 1944, if Navbits ≥ Npld+ 1464 × (1-R) 1296, otherwise |
| 1296 < Navbits ≤ 1944 | 1 | 1944 |
| 1944 < Navbits ≤ 2592 | 2 | 1944, if Navbits ≥ Npld+ 2916 × (1-R) 1296, otherwise |
| 2592 < Navbits <=3888 | 2 | 1944 |
| 3888 < Navbits |  | 3888, if 2xLDPC subfield in User (Info) field is set to 1  1944, Otherwise |

[Motion #55, [1] and [161]]

## Coordinated beamforming (Co-BF) PHY

### General

* Two separate capabilities shall be defined for the maximum number of spatial streams supported for reception of a sounding NDP in UHR and the maximum total number of streams (across all users) supported for reception in UHR DL MU-MIMO and Co-BF PPDUs
  + The only possible values for each capability are 4 and 8.

[Motion #98, [1] and 178]

* In a Co-BF transmission, the maximum number of spatial streams given to one user will be 2.

[Motion #114, [1] and 184]

* For the maximum number of spatial streams supported for reception of sounding NDP in UHR and the maximum total number of streams (across all users) supported for reception in UHR DL MU-MIMO and Co-BF PPDUs:
  + - 4 is mandatory except for a non-AP STA with 20 MHz-Only Limited Capabilities Support subfield equal to 1.
    - 8 is optional for DL MU-MIMO and sounding NDP (Note: More than 4 is not allowed for Co-BF PPDUs

[Motion #115, [1] and 185]

### PPDU for Co-BF

* The pre-UHR portion (the portion up-to and including UHR-SIG) of the Co-BF PPDU shall be transmitted in a non-beamformed (omni) manner.

[Motion #111, [1] and [184]]

* The pre-UHR portion of a Co-BF PPDU shall have identical content across two APs.

[Motion #112, [1] and [184]]

* The cyclic shift for pre-UHR modulated fields in UHR MU PPDU used for Co-BF transmission is based on local transmit chain index at each AP.

[Motion #215, [264]]

* Co-BF data transmission shall be indicated in the U-SIG field for IEEE802.11bn

[Motion #113, [1] and [184]]

* LDPC is the only coding mode for Co-BF.

[Motion #173, [1] and [246]]

* 11bn defines an indication to identify the BSS color for Co-BF transmissions.

[Motion #183, [1] and [246, 249]]

* 1-bit indication in the per-user SIG field to resolve the BSS color for Co-BF transmissions.
  + The coding bit is re-purposed for this indication

[Motion #214, [264] and [273, 249]]

* 2 BSS colors are indicated in the preamble of a Co-BF PPDU.
  + One BSS color for the sharing AP and another BSS color for the shared AP.

[Motion #220, [264] and [249]]

## Coordinated spatial reuse (Co-SR) PHY

* The maximum number of spatial streams transmitted by each AP in CSR is 4.

[Motion #217, [264]]

* 11bn defines the following modes for co-SR transmission:
  + Mode 1: trigger + same L-SIG contents, could be different U-SIG contents.
    - For UHR+EHT, or EHT+UHR or EHT+EHT co-SR transmission.
    - Provided no changes to non-UHR EHT non-AP STAs are needed.
  + Mode 2: Tigger + same L-SIG contents + same U-SIG contents
    - For UHR+UHR co-SR transmission.
  + For all modes, the two PPDUs will start and end at the same time.
  + UHR PPDU for co-SR transmission will be used for either mode 1 or mode 2 when UHR transmission exists.
    - There exists an indication in U-SIG field to indicate the UHR PPDU is a UHR PPDU for co-SR transmission.

[Motion #252, [264] and [282]]

## UHR preambles

### U-SIG field

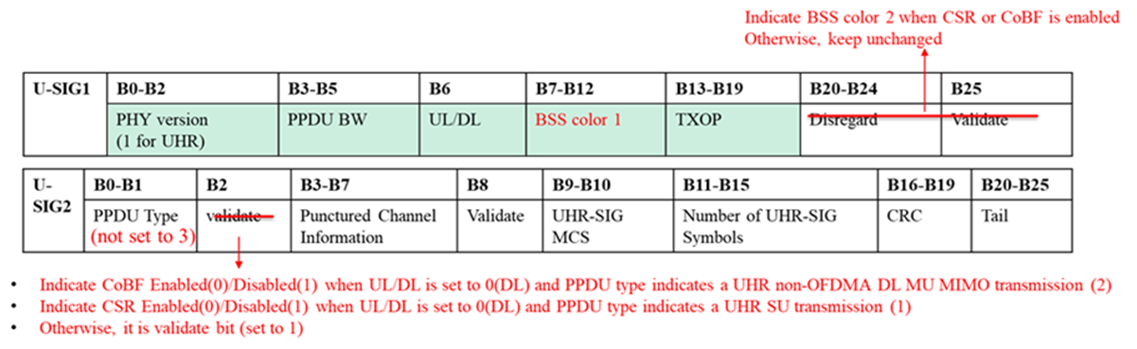
* The UHR TB PPDU, and UHR MU PPDU with DL OFDMA transmission, SU transmission, and DL non-OFDMA MU-MIMO use same combinations of the UL/DL subfield and PPDU Type And Compression Mode subfield values for indication as in EHT

[Motion #175, [1] and [248]]

* Reuse the U-SIG field structure in EHT TB PPDUs for the U-SIG in UHR TB PPDUs
  + PHY Version Identifier is set to 0 or 1 to differentiate EHT or UHR
  + How to set Disregard and Validate bits is TBD

[Motion #176, [1] and [248]]

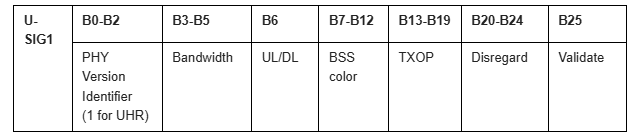
* CoBF is only applied in DL non-OFDMA MU MIMO transmission
* Co-SR is only applied in DL SU transmission in each BSS
* The entire U-SIG format in a UHR MU PPDU is as in the following figure
* BSS color 1 and 2 are the BSS color of the two Coordinated BSSs with the order TBD

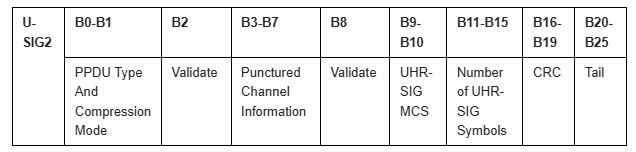


[Motion #206, [264] and [248, 270, 271]]

* Keep all the fields in U-SIG for UHR MU PPDU to be the same as that in U-SIG for EHT MU PPDU as following, and PHY Version Identifier is set to 1 for UHR, UHR-SIG MCS and Number of UHR-SIG Symbols subfields replace the EHT-SIG MCS and Number of EHT-SIG Symbols subfields

Note- The Disregard and Validate bits may be updated for new features.





[Motion #182, [1] and [247, 248]]

### UHR-SIG field

* Keep other fields except the Disregard bits in Common field for non-OFDMA transmission in UHR-SIG to be the same as that in Common field for non-OFDMA transmission in EHT-SIG as following

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **B0-B3** | **B4-B5** | **B6-B8** | **B9** | **B10-B11** | **B12** | **B13-B15** | **B16-B18** |
| Spatial Reuse | GI+LTF Size | Number of UHR-LTF Symbols | LDPC Extra Symbol Segment | Pre-FEC padding Factor | PE Disambiguity | Disregard | Number of non-OFDMA Users |

[Motion #165, [1] and [243, 244]]

* Keep the Common field format of UHR-SIG for OFDMA transmission adheres to the Table 36-33 of 11be D7.0

Note: The entries defined for OFDMA + MU-MIMO in RU Allocation table may be updated

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Common field for OFDMA transmission** | | | | | | | | | | | | | |
| B0-B3 | B4-B5 | B6-B8 | B9 | B10-B11 | B12 | B13-B16 | B17-B16+9N | B17+9N-B20+9N | B21+9N-B26+9N | B27+9N-B26+9N+9M | B27+9N+9M-B30+9N+9M | B31+9N+9M-B36+9N+9M |
| Spatial Reuse | GI+LTF Size | Number of UHR-LTF Symbols | LDPC Extra Symbol Segment | Pre-FEC padding Factor | PE Disambiguity | Disregard | RU Allocation-A | CRC | Tail | RU Allocation-B | CRC | Tail |

[Motion #166, [1] and [243]]

* Signaling design for MU-MIMO User field in UHR-SIG field as shown in the below figure.
  + Also, when Coding field indicates LDPC, then 2xLDPC indication:
    - Bit22 set to 1: TX encode LDPC using code size as 2x1944
    - Bit22 set to 0: TX encode LDPC using code size of 648, 1296, or 1944.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| STA-ID | | | | | | | | | | | MCS | | | | | Spatial Configuration | | | | Reserved | Coding | 2xLDPC |

[Motion #167, [1] and [245, 244]]

* Signaling design for non-MU MIMO User field in UHR-SIG field as shown in the below figure.
  + UEQM indication
    - Bit19 set to 1: UEQM is applied, B20-21 are redefined to indicate UEQM patterns.
    - Bit19 set to 0: EQM is applied. (B20 and B21 are Bfed and Coding bits)
  + Also, when Coding field indicates LDPC, then 2xLDPC indication:
    - Bit22 set to 1: TX encode LDPC using code size as 2x1944
    - Bit22 set to 0: TX encode LDPC using code size of 648, 1296, or 1944

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** |
| **STA-ID** | | | | | | | | | | | **MCS** | | | | | **NSS** | | | **UEQM** | **Beamformed** | **Coding** | **2xLDPC** | |
| **UEQM Patterns** | |

[Motion #168, [1] and [245, 244]]

* The MCS field in the User field of UHR-SIG field consists of 5 bits.
  + The B11 ~ B15 of the UHR-SIG field is assigned for the MCS field
  + The configuration of MCS field is TBD.

[Motion #190, [264] and [265]]

* The first 16 entries of the 5-bit MCS table (MCS0 to MCS15) are identical to 11be

[Motion #181, [1] and [252]]

* In the 5bit MCS table
  + MCS17 signals QPSK rate 2/3;
  + MCS19 signals 16QAM rate 2/3;
  + MCS20 signals 16QAM rate 5/6;
  + MCS23 signals 256QAM rate 2/3

[Motion #195, [264] and [252]]

* Define the assigned bits for the NSS field and Spatial Configuration field by considering the maximum NSS is 8 in 11bn
  + For non-MU-MIMO allocation of the UHR SIG field
    - NSS field consists of 3 bits in the User field
* For MU-MIMO allocation of the UHR SIG field
  + Spatial Configuration field consists of 4 bits in the User field.

[Motion #191, [264] and [265]]

* Add a 1-bit 2xLDPC subfield in the UHR variant User Info field in MU-MIMO and non-MU-MIMO User field formats in UHR-SIG
* The 2xLDPC subfield is set to 1 to indicate 2xLDPC (nominal codeword size of 3888) is used, or set to 0 to indicate it’s not used, if the coding scheme is LDPC
* In the MU-MIMO or non-MU-MIMO User field formats, the 2xLDPC subfield is set to 1 and treat as Validate if Coding is BCC (0)

[Motion #174, [1] and [247, 248]]

* The UEQM patterns indication for NSS=2, 3 and 4 are as follows:

NSS=2:

|  |  |  |
| --- | --- | --- |
| Index | 1st SS | 2nd SS |
| 0 | M | M-1 |
| 1 | M | M-2 |
| 2-3 | Reserved | |

NSS=3:

|  |  |  |  |
| --- | --- | --- | --- |
| Index | 1st SS | 2nd SS | 3rd SS |
| 0 | M | M | M-1 |
| 1 | M | M | M-2 |
| 2 | M | M-1 | M-2 |
| 3 | Reserved | | |

NSS=4:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | 1st SS | 2nd SS | 3rd SS | 4th SS |
| 0 | M | M | M | M-1 |
| 1 | M | M | M | M-2 |
| 2 | M | M | M-1 | M-2 |
| 3 | M | M-1 | M-1 | M-2 |

* Note: Reserved entries will be further categorized as Validate or Disregard, following principles in IEEE 802.11be

[Motion #169, [1] and [171]]

* The Spatial Configuration field in User field of UHR-SIG field in PPDUs for Co-BF transmission re-uses the same design as in UHR DL MU-MIMO.
  + Encoding table will be same as 11ax

[Motion #171], [1] and [184]]

* In a PPDU of Co-BF transmission, all the User fields of UHR-SIG field belonging to an AP and the corresponding spatial streams are contiguous.
  + The User fields of one AP are together followed by the ones of the other AP and the same holds for spatial streams

[Motion #172], [1] and [184]]

* Use B13 in the Common field of UHR-SIG in non-OFDMA to indicate Interference Mitigation (IM) ON/OFF
  + Value 0 indicates IM enabled
  + Value 1 indicates IM disabled (because B13 was originally “set to 1 and Disregard at RX’)

[Motion #177], [1] and [248]]

## Data field

### Stream Parser

* For bandwidths greater than 80 MHz, the coded bit parsing of UHR is stream parsing first followed by segment parsing.

[Motion #203, [264] and [267]]

### Segment Parser

* For equal modulation, UHR stream parser remains the same as EHT.

[Motion #202, [264] and [267]]

## Packet Extension

* In the UHR MU PPDU in 11bn, the PE requirements of UEQM with the constellation order x of the first spatial stream is equal to the PE requirements of EQM with the constellation order x.

[Motion #251, [264] and [281]]

## MU-MIMO

* MU-MIMO+OFDMA in both DL and UL is limited to UHR PPDU of 160 and 320MHz only
  + 160MHz PPDU – 996 and, when the PPDU is punctured, 484+242
  + 320 MHz PPDU: 2x996, 3x996 and, when the PPDU is punctured, 996+484, 2x996+484
* MU-MIMO+OFDMA is further limited to a maximum of 2 RUs supporting MU-MIMO and each 80MHz segment is either MU-MIMO or OFDMA
* RU Allocation table in UHR-SIG is the same as that in EHT-SIG except that the rows for RU 242, 484 and 3x996+484 with two or more users are changed to Validate

[Motion #196, [264] and [266]]

## PHY feature #

Description for PHY feature #

# UHR MAC



## General

This section describes the functional blocks in the UHR MAC.

## Roaming

* TGbn defines a mechanism that enables a non-AP MLD to roam from one AP MLD to another AP MLD and the non-AP MLD remains in state 4 (see 11.3) during and after roaming to the other AP MLD

[Motion #2, [1] and [3-9]]

* TGbn defines that when a non-AP MLD is in the process of roaming from the current AP MLD to a target AP MLD, the context related to the non-AP MLD is transferred to the target AP MLD such that it preserves the data exchange context for the non-AP MLD or the context can be renegotiated with the target AP MLD.
  + Details on what context can be transferred and what context can be renegotiated are TBD.
  + How to transfer the context is TBD.

[Motion #26, [1] and [7,8,42-47]]

* As part of the seamless roaming procedure, during roaming,
  + after the request/response exchange that initiates notification of the DS mapping change from the current AP MLD to the target AP MLD,
    - The current AP MLD may deliver buffered DL data frames for a TBD period of time.
    - The non-AP MLD may retrieve buffered DL data frames from the current AP MLD
    - The non-AP MLD may send UL data to target AP MLD.
    - It is assumed that the target AP MLD is able to deliver data frames to non-AP MLD after the DS mapping change
  + The current AP MLD may forward DL data to the target AP MLD.
    - When and how to initiate the forwarding of DL data is TBD

[Motion #27, [1] and [3, 7, 8, 42-48]]

* Define a request frame sent by a non-AP MLD in state 4 to initiate the roaming procedure
* The roaming procedure performs context transfer to the target AP MLD and perform the necessary changes of the DS mapping from the current AP MLD to the target AP MLD
* Define a response frame sent to the non-AP MLD to indicate readiness for the non-AP MLD to send class 3 frames to the target AP MLD
* TBD on data transmission from non-AP MLD to current AP MLD during the request/response frame exchange
* NOTE – What context is transferred is TBD.
* NOTE – TBD on which request/response frame to use

[Motion #44, [1] and [3, 7, 8, 42-47, 93]]

* As part of the seamless roaming procedure, before the request/response exchange requesting the roaming transition from a current AP MLD to a target AP MLD, a roaming preparation procedure can be performed that includes:
  + Transfer or renegotiation of the context to a target AP MLD, and
  + Setting up the link(s) with a target AP MLD.
* Details on what context can be transferred or renegotiated is TBD

[Motion #162] and [42, 3, 6, 8, 93, 43-47, 9, 47, 231-238]]

* As part of seamless roaming procedure, a non-AP MLD can initiate a roaming preparation procedure with a target AP MLD by sending a TBD request frame to its current AP MLD.
  + The request frame indicates the set of links to be set up with the target AP MLD.
  + The request frame indicates the context to be transferred or renegotiated with the target AP MLD.
  + The current AP MLD sends a TBD response frame to the non-AP MLD to indicate the status (accept/reject) of the link setup.
    - If the link setup is accepted, the transferable context is transferred to the target AP MLD.
  + TBD on whether/how the renegotiation of context is performed in these request/response frames
  + TBD – multiple candidate target AP MLDs selection
* [Motion #283, [264] and [42, 3, 6, 8, 93, 43-45, 307, 239, 46, 231, 9, 47, 232-238, 308,233, 236, 237, 309, 316, 317]]
* 11bn defines a Seamless Mobility Domain (SMD, exact name TBD) that covers multiple AP MLDs, where a non-AP MLD can use the UHR seamless roaming procedure to roam between the AP MLDs of the SMD
  + A logical SMD Management Entity (SMD-ME, exact name TBD) provides association, IEEE 802.1X Authenticator (except for the management of 802.1X control ports which is TBD) and RSNA Key management for non-AP MLDs across all AP MLDs of the SMD.
  + A non-AP MLD transitions between AP MLDs within the SMD while maintaining its association and security association with the SMD-ME.
  + The non-AP MLD can transition from one SMD to another SMD that are part of the same MD (Mobility Domain) using FT with improvements

[Motion #279, [264] and [305, 306. 42, 3, 6, 8, 93, 43-45, 307, 239, 46, 231, 9, 47, 232-238, 308,233, 236, 237, 309]]

* 11bn defines that within a Seamless Mobility Domain (SMD, exact name TBD) the data path includes either one MAC-SAP for the SMD or a separate MAC-SAP per AP MLD of the SMD.
  + In the case of a separate MAC-SAP per AP MLD, the DS mapping is updated when the non-AP MLD roams to another AP MLD within the SMD.
  + In the case of a separate MAC-SAP per AP MLD, the component of the 802.1X Authenticator in the SMD-ME interacts with an 802.1X Authenticator component in the AP MLD that manages the 802.1X controlled port for the non-AP MLD.
  + In the case of a single MAC-SAP for the SMD, the 802.1X Authenticator in the SMD-ME manages the 802.1X controlled port for the non-AP MLD.

[Motion #280, [264] and [305, 306. 42, 3, 6, 8, 93, 43-45, 307, 239, 46, 231, 9, 47, 232-238, 308, 233, 236, 237, 309]]

* When a non-AP MLD is in the process of roaming from a current AP MLD to a target AP MLD, the non-AP MLD can request to the current AP MLD what context needs to be transferred from the current AP MLD to the target AP MLD.
  + What context can be requested is TBD
  + It applies when the current AP MLD and the Target AP MLD support the context transfer

[Motion #282, [264] and [313, 45, 93, 235, 314, 309, 315, 308, 4, 42]]

* As part of seamless roaming procedure, a non-AP MLD in state 4 with the SMD-ME can perform roaming transition through a target AP MLD that is a part of the SMD.
* TBD on the conditions and details for performing roaming through target AP MLD

[Motion #284, [264] and [239, 307, 235, 3, 42]]

* For security in seamless roaming, when a non-AP MLD is in the process of roaming from the current AP MLD to a target AP MLD within the SMD, the same PMKSA, established with the SMD-ME, shall be used to protect communications with the current AP MLD and the target AP MLD.

[Motion #285, [264] and [308, 305, 306, 42, 3, 6, 8, 43-45, 307, 239, 46, 231, 9, 47, 234, 235]]

* For security in seamless roaming, when a non-AP MLD is in the process of roaming from the current AP MLD to a target AP MLD within the SMD, the same PTKSA, established with the SMD-ME, shall be used to protect communications with the current AP MLD and the target AP MLD.

[Motion #286, [264] and [308, 305, 306, 42, 3, 6, 8, 43-45, 307, 239, 46, 231, 9, 47, 234, 235]]

## Power save

* TGbn defines a power save mode for a STA that is a UHR Mobile AP or a UHR non-AP STA wherein the STA may transition from a lower capability mode to a higher capability mode upon reception of an initial control frame
  + Lower capability mode (e.g., 20 MHz BW, one SS, limited data rates, PPDU format)
  + Higher capability mode (e.g., operating BW, NSS and MCSs, with at least one higher capability than that in the lower power capability mode)
  + Initial Control frame is TBD
  + Whether that applies for a non-mobile AP is TBD

[Motion #9, [1] and [15-19]]

* TGbn defines cross link power save signaling mechanism
  + Allowing a non-AP MLD to indicate to its associated AP MLD that supports the mechanism, in a frame sent on one enabled link, the power management mode for one or more of its affiliated non-AP STAs
  + Whether support for the mechanism is mandatory or optional is TBD
* [Motion #10, [1] and [19-20]]
* A UHR STA that uses the power save mode to transition from lower capability (LC) mode to higher capability (HC) mode, advertises the amount of padding it needs in a received initial control frame.
  + Padding values range between 0 and a maximum value that is TBD with a TBD resolution.

[Motion #45, [1] and [31, 16, 94-101]]

* Define a new mechanism and/or enhance existing mechanism for AP power save

[Motion #49, [1] and [15, 69, 149, 150, 94, 97, 98, 95]]

* If a UHR STA (UHR non-AP STA or UHR Mobile AP) operates with the power save mode where the STA transitions from a lower capability mode to a higher capability mode upon reception of an initial control frame (that we call power save mode dynamic power save (DPS)), then its associated peer UHR STA shall include an intermediate FCS, if needed by the STA, in the initial control frame that it transmits to the STA.
  + Note: intermediate FCS may not be needed, for instance, if the STA requires no padding.

[Motion #122, [1] and [31, 16, 18, 19, 97, 99, 100, 129, 130]]

* Scheduled periodic power save on AP side is performed in UHR using Broadcast TWT with TWT ID=0 with Responder PM=1 as described in 26.8.3.2 (Rules for TWT scheduling AP)

[Motion #161, [1] and [67-70, 149, 73, 150, 212, 228-230]]

## Non-primary channel access

* TGbn defines a mode of operation that enables a STA to access the secondary channel while the primary channel is known to be busy due to OBSS traffic or other TBD conditions.
  + The mode of operation shall not assume that the STA is capable to detect or decode a frame and obtain NAV information of the secondary channel concurrently with the primary channel.
  + A BSS shall only have a single Non-Primary Channel Access (NPCA) primary channel (name TBD) on which the STA contends while the primary channel of the BSS is known to be busy due to OBSS traffic or other TBD conditions.

[Motion #11, [1] and [21-30]]

* TGbn defines a mode of operation in NPCA where the NPCA non-AP does not use untriggered UL transmissions on the NPCA primary channel
  + This mode can be enabled/disabled by the AP
  + Whether the mode is for all associated non-APs or per non-AP is TBD
  + TBD whether MU EDCA parameters mechanism is used for this or not

[Motion #129, [1] and [195, 196, 200, 202]]

* An NPCA STA shall indicate the following to its peer NPCA STA
  + NPCA switching delay
    - time it needs to switch from the BSS Primary channel to the NPCA Primary channel
  + NPCA switch back delay
    - time it needs to switch from the NPCA Primary channel to the BSS Primary channel
  + Delay values range between 0 and 256 us with a 4 us resolution

[Motion #124, [1] and [195-198, 22]]

* An AP that is capable of NPCA announces at most one NPCA Primary channel
  + NPCA Primary channel is in AP's BSS operating channel width
  + NPCA Primary channel is not a punctured 20 MHz subchannel (as indicated in EHT Operation element)
  + Details on signaling is TBD

[Motion #130, [1] and [22, 24, 25, 26, 203, 29, 198, 204, 196, 195]]

* All the APs in a multiple BSSID set that enable NPCA announce the same NPCA primary channel

[Motion #131, [1] and [205]]

* An NPCA STA shall initiate frame exchange on the NPCA Primary channel with an NPCA Initial Control Frame (ICF) in the non-HT PPDU or non-HT duplicate PPDU format using a rate of 6 Mb/s, 12 Mb/s, or 24 Mb/s
  + Details on NPCA ICF are TBD

[Motion #125, [1] and [195-200]]

* The event that triggers switching to the NPCA primary channel shall be
  + OBSS Control frame exchange (e.g., (MU-)RTS/CTS) or
  + OBSS HE/EHT/UHR PPDU
  + Note: Other conditions TBD

[Motion #144, [1] and [203, 195]]

* The NPCA operation shall use the same EDCA parameters ((MU) EDCA Parameter Set, EPCS EDCA Parameters), on both the BSS primary channel and the NPCA primary channel.

[Motion #145, [1] and [203, 195]]

* An NPCA STA shall initiate a TXOP on the NPCA Primary channel following the rules defined in 10.23.2.2 (EDCA backoff procedure) and 10.23.2.4 (Obtaining an EDCA TXOP) with the following exception:
  + Every time the STA switches to the NPCA Primary channel, it shall initialize CW\_NPCA[AC] to TBD value and pick a new backoff counter (BO\_NPCA) randomly between 0 and CW\_NPCA[AC]. QSRC\_NPCA[AC] shall be set to 0.
  + NOTE – Baseline EDCA procedure is followed on the BSS Primary channel. The values of CW\_NPCA and BO\_NPCA are discarded by the NPCA STA when it switches back to the BSS Primary channel.

[Motion #126, [1] and [195-198, 201]]

* After an NPCA STA has gained the right to initiate a TXOP on the NPCA Primary channel, it can transmit on a set of channels that:
  + Includes the NPCA Primary channel, and
  + are within the AP’s BSS bandwidth, and
  + do not include the channels in the bandwidth occupied by the OBSS traffic that caused the NPCA STA to switch from the BSS primary channel to the NPCA primary channel, and
  + do not include the channels that are indicated as punctured in the Disabled Subchannel Bitmap subfield in the EHT Operation element,
  + It is TBD whether a frame that does not solicit TB PPDUs can puncture 20 MHz subchannels not indicated as punctured in the Disabled Subchannel Bitmap subfield of the EHT Operation element

[Motion #127, [1] and [195-197]]

* When transmitting a Trigger frame on the NPCA Primary channel, the NPCA AP shall signal the RU index considering the NPCA Primary channel as the reference primary channel
  + The Trigger frame shall explicitly indicate that it is transmitted via the NPCA Primary channel (details TBD)

[Motion #128, [1] and [195-198, 200, 202]]

* When an NPCA STA switches to the NPCA Primary channel, it shall not initiate a transmission to its peer NPCA STA until the peer STA’s switching delay has elapsed since TBD switch start time

[Motion #132, [1] and [206, 195, 22]]

* An AP that enables NPCA announces the minimum duration threshold of the BSS primary channel busyness because of OBSS activity for switching to NPCA primary channel
  + If the duration of the OBSS activity that makes the primary channel busy is smaller than the duration threshold, the NPCA STAs (AP and non-AP) do not switch to the NPCA primary channel.

[Motion #133, [1] and [206, 195, 198, 204]]

* An AP shall not allow the use of NPCA within its BSS if the BSS operating bandwidth is less than or equal to TBD MHz, where TBD = 40 MHz or 80 MHz

[Motion #134, [1] and [199]]

* If an NPCA STA receives an OBSS RTS frame in a non-HT duplicate PPDU that does not include the bandwidth signaling TA, the NPCA STA shall not switch to the NPCA Primary channel,
* If an NPCA STA receives an OBSS RTS frame in a non-HT duplicate PPDU that includes the bandwidth signaling TA and the signaled PPDU bandwidth is 320 MHz, the NPCA STA shall not switch to the NPCA Primary channel,
* If an NPCA STA receives a CTS frame in a non-HT duplicate PPDU without receiving the soliciting OBSS RTS or MU-RTS frame, the NPCA STA shall not switch to the NPCA Primary channel

[Motion #164, [1] and [200, 204, 240, 241]]

## Buffer status report

* TGbn enables per-TID buffer size reporting of a larger queue in UHR.
  + Note: It is an optional feature.
  + Note: In the baseline, the maximum approximate per-TID queue size to report is 2,147,328 octets
* [Motion #13, [1] and [32]]
* Define an Enhanced BSR Control subfield in A-Control subfield to report a larger per TID queue size
  + The Enhanced BSR Control subfield consists of at least a TID subfield and an unsigned value subfield to report the larger queue size (QS) of the TID
  + The reported QS is equal to 2147328 Octets + the value reported in the Queue Size field of the defined Enhanced BSR Control subfield
  + When the QoS Control with the same TID as the Enhanced BSR Control subfield is present in the same MPDU, the QS subfield of the QoS Control is set to value 254
  + TBD if the Enhanced BSR Control subfield shares the control ID with other Control subfield proposals in UHR
  + Note: The baseline rules which regulate HT control field to be the same in all MPDUs of the same frame type in an A-MPDU do not change
  + Note: Encoding of the baseline QS subfield in QoS Control does not change.
  + Note: Length of the Enhanced BSR Control subfield allows to aggregate the UPH in the same A-Control subfield

[Motion #257, [264] and [285, 32]]

## Multi-AP Coordination Framework

* 11bn defines a common framework of a Multi-AP Coordination for various coordination schemes.
  + Note - Coordination schemes such as (but not limited to): Co-SR (TXOP-based with power control), Co-BF, Co-TDMA, Co-RTWT, etc.

[Motion #50, [1] and [131, 151, 134, 137, 141, 152-156, 117, 157, 158]]

* 11bn defines a common framework of a Multi-AP Coordination that can enable the following procedures:
  + Multi-AP Coordination Discovery procedure
  + Multi-AP Coordination agreement negotiation procedure
  + Note: Details of the procedures and whether the above procedures are mandatory/optional - TBD

[Motion #51, [1] and [131, 151, 134, 137, 141, 152-156, 117, 157, 158]]

* A UHR AP shall indicate to another AP its capability to respond in a TB PPDU or not

[Motion #120, [1] and [108, 115, 122, 123, 124]]

* The sharing AP, that transmits a Trigger frame as part of a transmission sequence in a Multi-AP coordinated transmission scheme, identifies the shared AP via an AP ID carried in the AID12 field of the User Info field of the frame
  + Note: the name of "sharing AP" and "shared AP" are TBD
  + Note: Multi-AP coordinated transmission schemes are Co-SR, Co-BF and Co-TDMA

[Motion #135, [1] and [207, 208, 157, 117, 118, 122, 123, 108, 115, 124, 158]]

* APs that intend to participate in Multi-AP coordination can use management frames to advertise/discover the capabilities and/or parameters of individual schemes.

[Motion #147, [1] and [134, 110, 117, 157, 158, 218]]

* APs that discovered each other and want to establish agreement(s) for Multi-AP coordination scheme(s), can use individually addressed management frames to establish the agreement(s) and negotiate parameters
  + Note: The management frame can be a Public Action and/or new Action frames, and so on.

[Motion #148, [1] and [134, 110, 117, 157, 158, 218]]

* Define a mechanism in 11bn that defines:
  + AP-to-AP frame formats to enable interoperable MAPC across APs and including MLME primitive(s) so that a pair of AP’s SMEs can orchestrate the over-the-air transmission and reception of these frames
  + MLME primitive(s) so that a pair of AP’s SMEs may send the content of the non-real-time instances of such AP-to-AP frames over-the-DS between peer AP-MLMEs (rather than over-the-air via peer AP MACs)

[Motion #185, [1] and [260, 261]]

* As a part of M-AP coordination agreement procedure, an AP may assign an AP ID to another AP with the following constraints:
  + The AP ID is used for the AP to identify another AP as a coordinated AP, when necessary.
  + The AP ID field has the same size and the field value has a range as defined in AID field (see 9.4.1.8)
  + The AP shall ensure that the AP ID value is not assigned by the AP or by its affiliated MLD to any other STA (e.g., STA is an associated non-AP STA, an unassociated non-AP STA that has been allocated a (Ranging session Identifier) RSID , or any other coordinated AP), or a non-AP MLD that is associated with the AP MLD
  + It's TBD whether the AP ID value is greater than 2^n where n is the maximum of the value carried in the MBSSID Indicator (n) field of the Multiple BSSID element for any AP affiliated with the AP MLD that belongs to a multiple BSSID set

[Motion #265, [264] and [207, 208, 157, 117, 118, 122, 123, 108, 115, 124, 158, ]]

## Coordinated spatial reuse (Co-SR) MAC

* TGbn defines a multi-AP Coordinated Spatial Reuse (Co-SR) at TXOP-level with power control.
* Other multi-AP coordination modes are TBD.

[Motion #29, [1] and [49-65]]

* In Coordinated Spatial Reuse:
  + A sharing AP that intends to initiate a Coordinated Spatial Reuse transmission shall transmit a Trigger frame to initiate concurrent Co-SR transmissions with one (whether to allow more is TBD) other AP within its obtained TXOP BW;
  + When all addressed non-AP STAs are UHR STAs, the concurrent Co-SR transmission starts SIFS after the Trigger frame
  + Which trigger frame is TBD

[Motion #253, [264] and [283, 284]]

* In Coordinated Spatial Reuse, the following information shall be carried in the Trigger frame that initiates concurrent CSR transmissions of the 2 APs
  + The duration of the data PPDU transmitted by the sharing AP and of the data PPDU transmitted by the shared AP, which are the same, after the Trigger frame
  + Other parameters TBD

[Motion #254, [264] and [283, 284]]

## Coordinated beamforming (Co-BF) MAC

### General

* TGbn defines multi-AP Coordinated Beamforming (Co-BF).
* Other multi-AP coordination modes are TBD.

[Motion #29, [1] and [49-65]]

* The Coordinated beamforming (Co-BF) transmission phase in 802.11bn shall be limited to 2 APs.

[Motion #99, [1] and 179]

* The Co-BF sequential sounding support to be conditional mandatory if the device supports Co-BF.

[Motion #116, [1] and 185]

### Sounding Procedure

* Both sequential NDP based and joint NDP based sounding options will be supported for Co-BF in 802.11bn.

[Motion #97, [1] and 178]

* The sequential NDP based sounding protocol will be as shown below for Co-BF
  + Sounding happens one BSS at a time
  + NDPA only addresses the in-BSS STAs
  + MAC related additional frames are TBD.



[Motion #100, [1] and 179]

* The joint NDP based sounding protocol will be as shown below for Co-BF
  + Sounding happens for one BSS’s STAs at a time
  + NDPA only addresses the in-BSS STAs
  + MAC related additional frames are TBD
  + Joint NDP based feedback will be based on large V-based feedback where the eigen-vectors span the antennas across both Aps .



[Motion #101, [1] and 179]

* For joint NDP based sounding, one AP will frequency synchronize to the other for both of its NDP transmissions
  + For both the NDPs, the AP doing the correction brings its frequency within a certain TBD range of the reference AP.
* [Motion #102, [1] and 179]
* For sequential NDP based sounding, one AP will frequency synchronize to the other for both of its NDP transmissions
* For both its NDPs, the AP doing the correction brings its frequency within a certain TBD range of the reference AP.

[Motion #118, [1] and 179]

* In the UHR sounding process for Co-BF, for the joint sounding case as well as for the sequential sounding case, the NDP shall always carry the BSS color of the AP which transmitted the NDPA.

[Motion #103, [1] and 179]

## Coordinated TDMA (Co-TDMA)

* TGbn shall define a Coordinated TDMA (Co-TDMA) procedure for an AP to share its time resources of an obtained TXOP with a set of APs.
  + Set of APs is TBD.
  + The set can consist of one AP.

[Motion #46, [1] and [102-125]]

* As part of the Co-TDMA procedure, a sharing AP may solicit a poll response in a TB PPDU from another AP only if the other AP has indicated support for responding via a TB PPDU

[Motion #121, [1] and [108, 115, 122, 123, 124]]

* A TXOP owner AP shall announce~~s~~ its intention of sharing a portion of the time resource of its TXOP for Co-TDMA operation, in an Initial Control frame (exact ICF and name TBD) sent at the beginning of the TXOP. The frame polls AP(s) with whom it may share the TXOP to determine their interest
  + A TXOP owner AP that intends to share its TXOP is referred to as a sharing AP.
  + A candidate AP identified (polled) in the ICF is referred to as a polled AP.
  + The Duration field of the frame is set to the length of time required to transmit the solicited response frame plus one SIFS.
  + ~~Whether or not the sharing AP is mandated to send the ICF that announces that intention is TBD.~~

[Motion #156, [1] and [108, 110, 112, 114, 115, 117, 118, 122-124]]

[Motion #268, [264] and [108, 110, 115, 122-124]]

* As part of the Co-TDMA procedure, a candidate AP that is polled by the sharing AP shall provide, via a response,
  + Its intention not to participate in TXOP sharing during the current TXOP.
    - Note: If the sharing AP doesn’t receive a response from a polled AP, it assumes that the polled AP is not interested in TXOP sharing during the current TXOP.
  + Its intention to participate in TXOP sharing during the current TXOP.
  + Signaling details (including traffic indication) are TBD.

[Motion #157, [1] and [108, 110, 112, 114, 115, 117, 118, 122-124]]

* As part of the Co-TDMA procedure, to share a time portion of its TXOP, a sharing AP shall send a MU-RTS TXOP sharing (TXS) Trigger frame to another non-collocated AP.
  + The Allocation Duration field of the frame indicates the duration of that time portion.
  + The Duration field of the frame is set to the time required to transmit the solicited response frame plus one SIFS.

[Motion #159, [1] and [104, 108-110, 112-115, 156, 117, 118, 122-125, 225-227, 242]]

* As part of the Co-TDMA procedure, TGbn defines a mechanism for an AP, that received a time portion of a TXOP from a sharing AP, to return the remainder of the allocated time (if any) back to the sharing AP.
  + Signaling details and the condition(s) for TXOP return are TBD.

[Motion #160, [1] and [108-110, 112-115, 156, 117, 118, 121-125, 225-227, 242]]

* Define a mechanism as part of the procedure of time sharing during a TXOP (e.g. Co-TDMA, TXS, …) to support fairness to neighboring STAs (APs and non-APs)?
  + Exact mechanism is TBD

[Motion #274, [264] and [111, 301]]

* As part of Co-TDMA operation, TGbn defines a mechanism for a Co-TDMA sharing AP to transmit to a Co-TDMA coordinated AP an indication of whether the Co-TDMA coordinated AP is to return the remainder of the allocated time (if any) back to the Co-TDMA sharing AP.
  + How to signal the indication is TBD
  + Note: This mechanism is to be enabled only if the Co-TDMA sharing AP is capable of receiving the TXOP return.

[Motion #277, [264] and [125, 227, 118, 123]]

## Coordinated restricted TWT (Co-RTWT)

* Define mechanisms that enable APs to coordinate their rTWT schedule(s) and/or to ensure that one AP provides the protection of the rTWT schedule(s) of the other AP.
* NOTE – TBD mechanisms including negotiation between 2 APs and advertisement.

[Motion #48, [1] and [131-148]]

* If an AP extends the protection of the rTWT schedule of another AP, following negotiation or through other means, then:
  + The AP shall ensure its TXOP ends before the start time of the corresponding OBSS rTWT SP(s)
  + The AP, if it has at least one associated STA that is capable of rTWT, shall advertise in the beacon frames it transmits the OBSS rTWT schedule so that its associated STAs supporting rTWT follow the baseline rTWT rules for the OBSS rTWT schedule.

[Motion #149, [1] and [131-137, 139, 141, 146-147, 219-221, 136, 143, 144, 158, 222]]

* For negotiation over the wireless medium, an AP that requests protection for its R-TWT schedule(s) via negotiations with another AP includes information carried in TBD fields of the Broadcast TWT Parameter Set field corresponding to each R-TWT schedule being negotiated in a TBD individually addressed Management frame that it transmits to the other AP.

[Motion #281, [264] and [143, 136, 310, 158, 146, 135, 222, 131, 133, 137]]

## In-device coexistence

* 11bn defines a mechanism for a non-AP STA to report unavailability at TXOP level and define or reuse/update existing mechanism for a non-AP STA to report long term (periodic) unavailability.

[Motion #30, [1] and [66-82]]

* TGbn defines a mechanism that allows a STA to provide an update to its peer STA of specific operational Tx/Rx parameters using management frame exchanges (which parameters is TBD, focusing generally on local constraints (for example, coexistence constraints))

[Motion #136, [1] and [67-70]]

* The parameter update mechanism, done using management frame exchanges, allows a non-AP STA to transition in/out of a limited operation/capability mode
  + A STA in limited operation/capability mode changes one or more of the following TX/RX parameters: Maximum PPDU duration, Maximum MCS, use of LDPC, use of HT-immediate BlockAck, Disabled Subchannel bitmap, etc.
  + Optional/mandatory TBD

[Motion #137, [1] and [67-70]]

* The AP maintains up to one dynamic unavailability report per STA
* And the most recent dynamic unavailability report is the valid one

[Motion #143, [1] and [217]]

* A non-AP STA that is a TXOP responder can indicate in a response frame 1) for how long it will be available, if known and/or 2) whether it will be unavailable after a specific point in time and, if known, for how long
  + The response frame is a multi-STA BlockAck frame sent by the non-AP STA in response to the initial control frame or to MPDUs that solicit an immediate response

[Motion #146, [1] and [69, 66, 78, 214, 68, 74, 212, 71]]

* 11bn defines or reuses/updates existing mechanism for a UHR AP to report long term (periodic) unavailability
  + Applies when non-AP STA(s) support the mechanism

[Motion #150, [1] and [223, 68-70, 149]]

* A non-AP STA can request its associated AP to initiate TXOPs/frame exchanges with the STA with an initial control frame that enables the non-AP STA to include unavailability feedback in the initial response frame.

[Motion #153, [1] and [69, 71, 68, 74, 212, 78, 214, 213]]

* Periodic unavailability announcements from a non-AP STA are performed in UHR by enhancing the P2P TWT mechanism.

[Motion #155, [1] and [68-70, 149, 212, 77]]

* Define a mechanism so that a non-AP STA as a TXOP holder can indicate in a BSRP as the ICF frame 1) for how long it will be available, if known and/or 2) whether it will be unavailable after a specific point in time and, if known, for how long
  + There are conditions under which such a BSRP can be sent, and those conditions are TBD.

[Motion #158, [1] and [224, 212, 78, 214]]

* Include the COEX unavailability information in a new “Special User Info” field with AID12 set to 2008 of the BSRP Trigger frame when used as an ICF to report COEX unavailability information
  + A feedback type field (name TBD) (4 bits field – B12 to B15 of the “Special User Info” field) which is set to 0 to indicate that the “Special User Info” field is carrying CoEx unavailability information
  + COEX unavailability information includes two parameters: Unavailability Target Start Time and Unavailability Duration (these fields are already defined)

[Motion #261, [264] and [212, 272, 210]]

## Target wake time service period management

* TGbn defines a mechanism that enables a non-AP STA to indicate that it does not have pending traffic to deliver during the current ongoing TWT SP.
  + NOTE 1 – The exact signaling mechanism is TBD
  + NOTE 2 – This does not propose changing the SP termination mechanism/signaling itself. As per current spec, a TWT SP may be terminated by an AP as specified in 26.8.5
  + NOTE 3 – It is optional for the non-AP STA to provide such an indication

[Motion #31, [1] and [83]]

## Enhanced EDCA

* TGbn improves EDCA to reduce tail access delay of Low Latency (LL) traffic in multi-BSS dense scenarios in presence of best effort traffic
  + The solution to improve EDCA is distributed
  + The impact on legacy device has to be balanced
  + Low Latency traffic is treated as AC\_VO traffic. Other cases are TBD
* [Motion #123, [1] and [188- 194]]
* Define High Priority (HIP) EDCA in UHR where a STA with LL traffic may be allowed, based on TBD conditions, to send a Defer Signal (it is TBD whether CTS or RTS is used) to start a protected short contention for pending LL data
  + Conditions to be allowed to send a Defer Signal is TBD
  + STA in HIP EDCA always use RTS/CTS as initial frame exchange and retry.
  + Duration of protected short contention is TBD.
  + Access parameters (AIFSN, CW and the expansion rules) used to transmit the Defer Signal are TBD. The retry count where the Defer Signal is allowed to be sent is TBD
  + Contention parameters for the protected short contention are TBD. The STAs that transmitted a Defer Signal but did not win the protected short contention will initiate a new retry.
  + LL traffic is treated as AC\_VO traffic. Other cases are TBD.
  + The solution would provide control on the degree of collisions that may occur while using it and, allows for autonomous randomness or/and controlled by the AP
  + No new mandatory synchronization requirement on STA side
  + HIP EDCA is used by the STAs in a BSS only when this feature is enabled by the AP

[Motion #272, [264] and [188, 193, 287]]

## Indication and Notification of LL Traffic

* TGbn defines or improves an existing mechanism so that a non-AP STA that is a TXOP responder can indicate its buffered LL traffic needs (for traffic from the TXOP responder to the TXOP Holder) in a control response frame. The TXOP holder should consider the indication in determining subsequent actions. Subsequent actions related to this indication are out of the scope of the standard.
  + Note: whether an AP can indicate its low latency needs is TBD

[Motion #273, [264] and [288-300]]

## Sounding

* There is no UHR sounding sequence for SU TxBF or DL MU-MIMO. UHR SU TxBF and UHR DL MU-MIMO uses EHT sounding sequence.

[Motion #179, [1] and [249]]

* UHR sounding sequence uses EHT NDP. I.e., there is no UHR NDP.
  + UHR Co-BF sounding sequence is the only UHR sounding sequence

[Motion #180, [1] and [249-251]]

## Peer-to-Peer (P2P) communications

* 11bn enhances existing mechanism(s) to improve latency for a non-AP STA communication with another non-AP STA on the base channel and off-channel, respectively, by
  + enhancing mechanism(s) to allow an AP to share a TXOP with multiple peer-to-peer (P2P) non-AP STAs(s)
  + enhancing the baseline Channel Usage procedure to provide better recommendation on channel selection for P2P by enabling coordination between APs that do not belong to the same ESS so that the channels recommended for P2P operation sent by those APs are the same.

Note 1: the coordinated channel recommendation is an optional feature. Also, the responding AP has an option to reject the request for such coordination.

Note 2:

* Base channel is the channel where the AP associated with the non-AP STA is operating.
* A channel outside its associated AP’s operating BW is an off-channel for the non-AP STA.

[Motion #184, [1] and [253-259]]

## UHR SCS/MSCS procedure

* An AP MLD may optionally include a QoS Map element within the SCS Response frame transmitted by the AP MLD to update the DSCP-to-UP mapping for UL if the following conditions are true
  + the TID and the User Priority subfields of the Control Info field in the associated QoS Characteristics element are set to different values within 0~7
  + the AP MLD and the non-AP MLD supports the QoS map operation

[Motion #235, [264] and [276]]

* UHR should allow more than two TIDs to be mapped to high priority ACs (i.e., VO or VI)?
* Up to one TID for each AC currently assigned to BE and BK are remapped.
* Those TIDs may be used dynamically (e.g., following an SCS flow setup).

[Motion #276, [264] and [302-304, 276]]

## MAC feature #

Description for MAC feature #

# Frame format



## General

## Initial Control frame

* TGbn defines a way in 11bn to include in an initial control frame (ICF) an intermediate FCS for UHR STA(s) that precedes padding and the FCS field.

[Motion #12, [1] and [31, 19]]

* If an ICF includes an intermediate FCS for UHR STA(s) that precedes padding and the FCS field, the intermediate FCS has the size of 32 bits.

[Motion #47, [1] and [99, 31, 126-128, 100, 129-130]]

* TGbn uses BSRP Trigger frame as a UHR ICF sent:
  + From an AP for soliciting response in TB PPDU format from one or more scheduled STAs to allow a Multi-STA BA frame to be included in the TB PPDU sent by the UHR scheduled STAs in response, when carrying unavailability information
    - BSRP Trigger frame follows baseline rules for the solicited TB PPDU

[Motion #139, [1] and [210-212, 215]]

* The ICF (polling frame) sent as part of Co-TDMA operation shall be a BSRP Trigger frame

[Motion #269, [264] and [124, 118]]

* An individually addressed BSRP Trigger, used as an ICF, can indicate whether the responding PPDU is a non-HT (duplicate) PPDU and contains a multi-STA BA?
  + The indication (TBD whether reserved value or a reserved bit) is carried in the Common Info field of the BSRP Trigger frame

[Motion #152, [1] and [224, 212]]

* If a UHR non-AP MLD operates in the eMLSR mode, then its associated UHR AP MLD, that supports transmitting intermediate FCS, shall include an intermediate FCS, if needed by the non-AP MLD, in every Initial Control Frames for eMLSR transmitted to the non-AP MLD through its affiliated APs on the eMLSR links
  + Mandatory/optional support for transmitting intermediate FCS is TBD
  + The field that carries the Intermediate FCS shall be designed to be ignored by legacy STAs if they are scheduled in the same initial control frame
  + Note: intermediate FCS may not be needed, for instance, if the STA requires no padding.

[Motion #154, [1] and [31, 100]]

* An AP transmitting a BSRP Trigger frame as an ICF which is addressed to at least a UHR non-AP STA that has enabled a dynamic unavailability operation mode, shall ensure that the UL Length field is set to a sufficient length so that the PPDU that contains a Multi-STA BA as an ICR, includes unavailability information in the Multi-STA BA in addition to other baseline requirements

[Motion #212, [264] and [272]]

* Allowed UHR ICF to be transmitted by a non-AP STA (addressing the associated AP STA)
* Legend: Green: allowed; Orange: disallowed

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Allowed UHR ICF to be transmitted by a non-AP STA (addressing the associated AP STA)** | | | | | | | |
| **ICF** | **eMLSR** | **AP DPS** | **Solicited Coex** | **Unsolicited Coex** | **NPCA** | **C-TDMA (ICF)** | **Co-BF/Co-SR** |
| **RTS** | **N/A** | **Yes** | **N/A\*** | **No** | **No** | **N/A** | |
| **MU RTS** | **No** | **No** | **No** |
| **BSRP Trigger** | **No** | **No** | **No** |
| **BSRP GI3** | **Yes** | **Yes** | **Yes** |
| **Notes:**   * RTS solicits CTS frame; BSRP GI3 Trigger frame solicits an M-BA that is contained in a non-HT (dup) PPDU. * C-TDMA, C-BF, CSR ICF transmission is to other APs. No expectations for non-AP STAs, unless due to other functionalities already enabled/supported by non-AP STA. * Solicited and Unsolicited Coex are part of DUO. * N/A means that either the non-AP STA is not allowed to send an ICF or the AP STA is not allowed to respond with ICR for this scheme/operation mode. * \*DUO is only approved for non-AP STAs. So, a non-AP STA cannot send an ICF to an AP soliciting unavailability information in ICR (i.e., solicited CoEx).   **Acronyms: DPS: Dynamic Power Save, DUO: Dynamic Unavailability Operation, Unsolicited CoEx: Reporting unavailability in ICF, Co-BF: Coordinated beamforming, Co-SR: Coordinated Spatial Reuse, BSRP GI3: BSRP Trigger soliciting an M-BA in non-HT (dup) PPDU** | | | | | | | |

[Motion #287, [264] and [212, 318, 124, 199]]

## Initial Control Response frame

* TGbn uses Multi-STA BA for Initial Control Response frame (ICR) for DL and UL, at least when carrying the unavailability information

[Motion #138, [1] and [209-214, 74, 78]]

* TGbn defines a special Feedback Per AID TID Info field (name TBD) that carries control feedback in the Multi-STA BA frame
  + The control feedback (i.e., unavailability indication) is carried instead of the BlockAck Bitmap in that Feedback Per AID TID Info field
  + The Ack Type subfield of the Per AID TID Info field is set to 0 and the TID subfield of the Per AID TID Info field is set to a reserved value
  + The AID11 subfield of this Per AID TID Info field is set to a reserved TBD value if the control feedback is addressed to all STAs or to the AID11 that identifies the intended recipient STA
  + The Starting Sequence Number field of this Per AID TID Info field is reserved

[Motion #141, [1] and [74, 209, 211, 82, 212, 216, 78, 214]]

* 11bn allows Multi-STA BA to carry one or more types of feedback (e.g., unavailability) information
  + How to include feedback information is TBD.

[Motion #151, [1] and [78, 214, 74, 212, 82]]

* TGbn defines the following fields for unavailability indication in M-STA BA frames:
  + an Unavailability Target Start Time field defined as the TSF time at which the STA becomes unavailable (range and resolution TBD, expectation is to use a portion of the TSF)
  + an Unavailability Duration field defined as the time during which the STA is unavailable (field may be not present or set to an unknown value)

[Motion #140, [1] and [74, 209, 211, 82, 212, 216]]

* TGbn defines the following:
  + Unavailability Target Start Time is indicated using 9 bits with a granularity of 64us
  + Unavailability Duration is indicated using 9 bits with a granularity of 64us

[Motion #142, [1] and [74, 209, 211, 82, 212, 216]]

* As part of Co-TDMA operation, a poll response from a polled AP solicited by the ICF shall be carried in an M-BA frame

[Motion #270, [264] and [124, 118]]

* In response to BSRP Trigger frame as an ICF transmitted by a non-AP STA as the TXOP holder, an AP transmits a Multi-STA BlockAck frame
  + Whether Block Ack Starting Sequence Control subfield and Block Ack Bitmap subfield are present or not is TBD
  + Values of Ack Type and TID are TBD

[Motion #271, [264] and [272]]

## Trigger frame

### General

* TGbn defines the UHR variant of Trigger Frame.
  + Reuse the EHT variant of Trigger Frame format for the UHR variant of Trigger Frame, with one Special User Info field immediately after the Common Info field
* Differentiate EHT and UHR variant by the value of the PHY Version Identifier in the Special User Info field being 0 or 1
* Reuse the EHT variant Common Info field and Special User Info field for UHR
  + B60-B62 in the UHR variant common info field are “UHR Reserved”
* Reserved bits in the UHR variant Common Info field and Special User Info field may be used for other UHR features
* The UHR variant of Trigger frame includes the UHR variant User Info field.
  + It has the same length as the EHT variant User Info field

[Motion #186, [1] and [247, 262, 263]]

### Common field

* Use 4-bit bitmap in Common Info field (B56-B59) for DRU indication
  + 1 bit/80MHz to indicate each 80MHz is used for DRU or RRU

[Motion #61, [1] and [164]]

* For UHR-variant Trigger frame:
  + iFCS present: 1 bit field in UHR-variant Common Info field
    - TBD for HE/EHT-variant

[Motion #278, [264] and [128, 99]]

### UHR variant User Info field

* Re-purpose 2 bits of SS Allocation subfield in User Info field for DBW indication if DRU

[Motion #62, [1] and [164]]

* Add a 1-bit 2xLDPC subfield in the UHR variant User Info field in Trigger Frame
* The 2xLDPC subfield is set to 1 to indicate 2xLDPC (nominal codeword size of 3888) is used, or set to 0 to indicate it’s not used, if the coding scheme is LDPC
* In the UHR Variant User Info field in Trigger Frame, the 2xLDPC subfield is set to 1 and reserved if UL FEC Coding Type is BCC (0)

[Motion #174, [1] and [247, 248]]

* For a UHR TB PPDU transmission, there exists a 5-bit UL UHR MCS in a User Info field for UHR variant of Trigger frame.

[Motion #187, [1] and [262]]

* Use the following UHR variant User Info field design

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B11 | B12 | B19 | B20 | B21 | B25 | B26 | B27 | B31 | B32 | B38 | B39 |  |
|  | AID12 | | RU Allocation | | UL FEC Coding Type | UL UHR-MCS | | 2xLDPC | SS Allocation | | UL Target Receive Power | | PS160 | Trigger Dependent User Info |
| Bits: | 12 | | 8 | | 1 | 5 | | 1 | 5 | | 7 | | 1 | variable |
| **Figure 4-1: UHR variant User Info field format** | | | | | | | | | | | | | | | |

* **The SS Allocation subfield design depends on RRU or DRU**
  + Repurpose 1 bit in the SS Allocation subfield in the UHR variant User Info field to indicate NSS (1SS or 2SS) in the case of DRU

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 |  | B2 | B3 | B4 |
|  | Starting Stream Index | | | Number Of Spatial Streams | |
| Bits: | 3 | | | 2 | |
|  | **Figure 4-2: SS Allocation subfield format of a UHR variant User Info field in the case of RRU** | | | | |
|  |  |  |  |  |  |
|  | B0 | B1 | B2 | B3 | B4 |
|  | Distribution BW | | Reserved | | Number Of Spatial Streams |
|  |
| Bits: | 2 | | 2 | | 1 |
|  | **Figure 4-3: SS Allocation subfield format of a UHR variant User Info field in the case of DRU** | | | | |

[Motion #188, [1] and [147]]

* 11bn supports indicating a 60 MHz DBW using a value of 3 in the 2-bit DBW indication subfield within the UHR variant User Info field of a Trigger Frame in the case of DRU

[Motion #240, [264] and [278]]

## NDP Announcement frame

* NDP Announcement Variant subfield shall be set to 3 for Co-BF NDPA in UHR.

[Motion #189, [1] and [184, 250, 251]]

* For the Co-BF case, the information in the NDP Announcement frame for the responding AP has a unified design for joint-NDP based sounding as well as cross-BSS section of sequential sounding.

[Motion #219, [264] and [249]]

* 11bn defines 5-bit Recommended CSI MCS subfield in the second Special STA Info field of the NDPA targeted for OBSS AP in the UHR Co-BF sounding
  + It is set from B20 to B24 in the second Special STA Info field
  + The 5-bit MCS level includes “No Recommendation” MCS entry in addition to the UHR MCS entries
    - Index 31 indicates “No Recommendation”
  + The Recommended CSI MCS is for the OBSS AP to set the MCS in the BFRP trigger frame sent in the future Cross-BSS sounding / Joint Sounding sequence
  + When there are multiple OBSS STAs to feedback the CSI report, the Recommended CSI MCS can be set to the lowest MCS among all those OBSS STAs

[Motion #250, [264] and [280]]

* When the initiating AP requests the responding AP to join the Co-BF sounding, the red subfields in the first and second User Info fields of the NDPA shall be set as follows.
  + NDPA Version Identifier is set to 0 for Co-BF sounding in UHR
  + Number of LTF symbols is set to 0 and 1 for 4 and 8 symbols, respectively
  + Starting Spatial Stream is set to 0 and 1 for the 1st and 5th streams, respectively
  + Number of spatial streams is set to 0 and 1 for the 4 and 8 streams, respectively
  + LTF+GI is set to 0 and 1 for 2x LTF+0.8us GI and 2x LTF+1.6us GI, respectively
  + B20-26, which are shown as Reserved in the second User Info field, can be used in the future

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bit | 0 - 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | 19 | 20 - 24 | 25-26 | 27 | 28 | 29 | 30 | 31 | |
| 1st User Info field | AID11: 2047 | NDPA Version Identifier | | | BSS Color | | | | | | | TXOP | | Disambiguation | Bandwidth | | | | Reserved | |
| 2nd User Info field | AID11: AID of responding AP | Punctured Channel Information | | | | | Number of LTF Symbols | Starting Spatial  Stream | | Number of Spatial Streams | LTF+GI | Recommended CSI MCS | Reserved | Disambiguation | Reserved | | | | | |

[Motion #262, [264] and [249, 250]]

[Motion #250, [264] and [280]]

## Field #

Description for Field #

# Passed motions on PDTs

The passed motions on PDTs are reflected in 1[1-24/1698r15](https://mentor.ieee.org/802.11/dcn/24/11-24-1698-15-00bn-tgbn-d0-1-spec-text-volunteers-and-status.docx).

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82. [11-24/1247r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1247-00-00bn-icf-icr-design-for-coex.pptx): 11-24-1247-00-00bn-icf-icr-design-for-coex, Abdel Karim Ajami (Apple Inc.)
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84. [11-24/1184r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1184-01-00bn-considerations-on-elr-transmission.pptx): 11-24-1184-01-00bn-considerations-on-elr-transmission, Dongguk Lim (LG Electronics)
85. [11-24/1410r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1410-00-00bn-legacy-preamble-for-elr-ppdu.pptx): 11-24-1410-00-00bn-legacy-preamble-for-elr-ppdu, Ross Jian Yu (Huawei)
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98. [11-24/0671r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0671-00-00bn-enhancements-on-ap-power-save.pptx): 11-24-0671-00-00bn-enhancements-on-ap-power-save, Sanghyun Kim (WILUS)
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106. [11-23/1085r0](https://mentor.ieee.org/802.11/dcn/23/11-23-1085-00-0uhr-thoughts-on-coordinated-tdma.pptx): 11-23-1085-00-0uhr-thoughts-on-coordinated-tdma, Geonhwan Kim (LG Electronics)
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128. [11-24/0544r1](https://mentor.ieee.org/802.11/dcn/24/11-24-0544-01-00bn-power-save-protocols-for-uhr-follow-up.pptx): 11-24-0544-01-00bn-power-save-protocols-for-uhr-follow-up, Sherief Helwa (Qualcomm Technologies Inc)
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130. [11-24/1256r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1256-00-00bn-the-padding-after-intermediate-fcs.pptx): 11-24-1256-00-00bn-the-padding-after-intermediate-fcs, Yunbo Li (Huawei)
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133. [11-23/0860r0](https://mentor.ieee.org/802.11/dcn/23/11-23-0860-00-0uhr-further-thoughts-on-coordinated-twt.pptx): 11-23-0860-00-0uhr-further-thoughts-on-coordinated-twt, Rubayet Shafin (Samsung Research America)
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137. [11-23/1932r3](https://mentor.ieee.org/802.11/dcn/23/11-23-1932-03-00bn-further-considerations-on-coordinated-twt.pptx): 11-23-1932-03-00bn-further-considerations-on-coordinated-twt, Rubayet Shafin (Samsung Research America)
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142. [11-23/2084r1](https://mentor.ieee.org/802.11/dcn/23/11-23-2084-01-00bn-enhanced-r-twt-for-uhr.pptx): 11-23-2084-01-00bn-enhanced-r-twt-for-uhr, Jeongki Kim (Ofinno)
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162. [11-24/1188r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1188-02-00bn-global-csd-index-assignment-for-dru-stf-transmission-in-11bn.pptx): 11-24-1188-02-00bn-global-csd-index-assignment-for-dru-stf-transmission-in-11bn, Shengquan Hu (Mediatek)
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167. [11-24/1510r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1510-02-00bn-open-issues-on-dru.pptx): 11-24-1510-02-00bn-open-issues-on-dru, Lin Yang (Qualcomm Inc.)
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170. [11-24/1478r4](https://mentor.ieee.org/802.11/dcn/24/11-24-1478-04-00bn-elr-ppdu-design.pptx): 11-24-1478-04-00bn-elr-ppdu-design, Lin Yang (Qualcomm Inc.)
171. [11-24/1772r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1772-00-00bn-signaling-for-uhr-ppdu-follow-up.pptx): 11-24-1772-00-00bn-signaling-for-uhr-ppdu-follow-up, Ross Jian Yu (Huawei)
172. [11-24/1097r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1097-01-00bn-thoughts-on-uhr-ltf-for-dru.pptx): 11-24-1097-01-00bn-thoughts-on-uhr-ltf-for-dru, Eunsung Park (LG Electronics)
173. [11-24/1471r3](https://mentor.ieee.org/802.11/dcn/24/11-24-1471-03-00bn-signaling-for-dru-in-trigger-frame.pptx): 11-24-1471-03-00bn-signaling-for-dru-in-trigger-frame, Eunsung Park (LG Electronics)
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175. [11-24/1486r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1486-01-00bn-performance-evaluation-of-elr-transmission.pptx): 11-24-1486-01-00bn-performance-evaluation-of-elr-transmission, Dongguk Lim (LG Electronics)
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179. [11-24/1542r5](https://mentor.ieee.org/802.11/dcn/24/11-24-1542-05-00bn-sounding-schemes-for-coordinated-beamforming.pptx): 11-24-1542-05-00bn-sounding-schemes-for-coordinated-beamforming, Sameer Vermani (Qualcomm)
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182. [11-24/1901r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1901-00-00bn-dru-ltf-sequence-design-for-40mhz-dbw.pptx): 11-24-1901-00-00bn-dru-ltf-sequence-design-for-40mhz-dbw, Chenchen LIU (Huawei)
183. [11-24/1488r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1488-01-00bn-elr-ppdu-transmission-design.pptx): 11-24-1488-01-00bn-elr-ppdu-transmission-design, Shengquan Hu (Mediatek)
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185. [11-24/1582r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1582-02-00bn-coordinated-sounding-for-cobf.pptx): 11-24-1582-02-00bn-coordinated-sounding-for-cobf, You-Wei Chen (MediaTek)
186. [11-24/0498r4](https://mentor.ieee.org/802.11/dcn/24/11-24-0498-04-00bn-unequal-modulation-in-mimo-txbf-and-new-mcs-for-11bn.pptx): 11-24-0498-04-00bn-unequal-modulation-in-mimo-txbf-and-new-mcs-for-11bn, Alice Chen (Qualcomm)
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188. [11-24/1144r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1144-01-00bn-hip-edca-proposal-follow.pptx): 11-24-1144-01-00bn-hip-edca-proposal-follow, Dmitry Akhmetov (Intel)
189. [11-23/2126r0](https://mentor.ieee.org/802.11/dcn/23/11-23-2126-03-00bn-low-latency-channel-access-follow-up.pptx): 11-23-2126-03-00bn-low-latency-channel-access-follow-up, Dmitry Akhmetov (Intel)
190. [11-23/1065r0](https://mentor.ieee.org/802.11/dcn/23/11-23-1065-00-0uhr-low-latency-channel-access.pptx): 11-23-1065-00-0uhr-low-latency-channel-access, Laurent Cariou (Intel)
191. [11-24/0467r1](https://mentor.ieee.org/802.11/dcn/24/11-24-0467-01-00bn-hip-edca-follow-up-legacy-impact.pptx): 11-24-0467-01-00bn-hip-edca-follow-up-legacy-impact, Dmitry Akhmetov (Intel)
192. [11-24/0840r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0840-00-00bn-hip-edca-proposal.pptx): 11-24-0840-00-00bn-hip-edca-proposal, Dmitry Akhmetov (Intel)
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196. [11-24/1155r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1155-00-00bn-further-discussions-on-npca.pptx): 11-24-1155-00-00bn-further-discussions-on-npca, Sanghyun Kim (WILUS)
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208. [11-24/1389r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1389-00-00bn-coordinated-spatial-reuse-design-details.pptx): 11-24-1389-00-00bn-coordinated-spatial-reuse-design-details, Jason Yuchen Guo (Huawei)
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210. [11-24/0494r2](https://mentor.ieee.org/802.11/dcn/24/11-24-0494-02-00bn-in-device-coexistence-follow-up.pptx): 11-24-0494-02-00bn-in-device-coexistence-follow-up, Liwen Chu (NXP)
211. [11-24/1226r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1226-00-00bn-icf-icr-design.pptx): 11-24-1226-00-00bn-icf-icr-design, Laurent Cariou (Intel)
212. [11-24/1558r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1558-02-00bn-in-device-coexistence-follow-up.pptx): 11-24-1558-02-00bn-in-device-coexistence-follow-up, Sherief Helwa (Qualcomm)
213. [11-24/1504r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1504-00-00bn-considerations-on-aperiodic-in-device-coexistence.pptx): 11-24-1504-00-00bn-considerations-on-aperiodic-in-device-coexistence, Hyeonjun Sung (WILUS Inc.)
214. [11-24/1490r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1490-01-00bn-more-consideration-of-icr-crf-for-in-device-coexistence.pptx): 11-24-1490-01-00bn-more-consideration-of-icr-crf-for-in-device-coexistence, Hongwon Lee (LG Electronincs)
215. [11-24/1562r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1562-00-00bn-in-device-coexistence-follow-up.pptx): 11-24-1562-02-00bn-in-device-coexistence-follow-up, Liwen Chu (NXP)
216. [11-24/1848r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1848-00-00bn-frame-exchange-sequences-for-in-device-coexistence.pptx): 11-24-1848-00-00bn-frame-exchange-sequences-for-in-device-coexistence, Sanghyun Kim (WILUS)
217. [11-24/1559r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1559-01-00bn-in-device-coexistence-next-steps.pptx): 11-24-1559-01-00bn-in-device-coexistence-next-steps, Sindhu Verma (Broadcom)
218. [11-24/1849r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1849-00-00bn-management-of-the-established-multi-ap-coordination.pptx): 11-24-1849-00-00bn-management-of-the-established-multi-ap-coordination, Sanghyun Kim (WILUS)
219. [11-22/1556r1](https://mentor.ieee.org/802.11/dcn/22/11-22-1556-01-0uhr-multi-ap-coordination-for-low-latency-traffic-delivery.pptx): 11-22-1556-01-0uhr-multi-ap-coordination-for-low-latency-traffic-delivery, Liuming Lu (OPPO)
220. [11-22/1899r0](https://mentor.ieee.org/802.11/dcn/22/11-22-1899-00-0uhr-multi-ap-operation-for-low-latency-traffic-delivery-follow-up.pptx): 11-22-1899-00-0uhr-multi-ap-operation-for-low-latency-traffic-delivery-follow-up, Liuming Lu (OPPO)
221. [11-23/0046r2](https://mentor.ieee.org/802.11/dcn/23/11-23-0046-02-0uhr-multi-ap-coordination-for-low-latency-traffic-delivery-usage-scenarios-and-potential-features.pptx): 11-23-0046-02-0uhr-multi-ap-coordination-for-low-latency-traffic-delivery-usage-scenarios-and-potential-features, Liuming Lu (OPPO)
222. [11-23/0226r2](https://mentor.ieee.org/802.11/dcn/23/11-23-0226-02-0uhr-coordination-of-r-twt-for-multi-ap-deployment.pptx): 11-23-0226-02-0uhr-coordination-of-r-twt-for-multi-ap-deployment, Abdel Karim Ajami (Qualcomm Inc.)
223. [11-24/1108r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1108-02-00bn-periodic-idc-signaling-for-mobile-ap.pptx): 11-24-1108-02-00bn-periodic-idc-signaling-for-mobile-ap, Hongwon Lee (LG Electronincs)
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225. [11-23/1327r0](https://mentor.ieee.org/802.11/dcn/23/11-23-1327-00-0uhr-considerations-on-return-txop-between-aps.pptx): 11-23-1327-00-0uhr-considerations-on-return-txop-between-aps, Si-Chan Noh (Newracom)
226. [11-23/1846r1](https://mentor.ieee.org/802.11/dcn/23/11-23-1846-01-00bn-protection-of-extended-txop-sharing.pptx): 11-23-1846-01-00bn-protection-of-extended-txop-sharing, Si-Chan Noh (Newracom)
227. [11-24/1701r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1701-00-00bn-nav-protection-for-c-tdma-follow-up.pptx): 11-24-1701-00-00bn-nav-protection-for-c-tdma-follow-up, Si-Chan Noh (Newracom)
228. [11-23/1835r0](https://mentor.ieee.org/802.11/dcn/23/11-23-1835-00-00bn-ap-power-management.pptx): 11-23-1835-00-00bn-ap-power-management, Yongsen Ma (Samsung)
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230. [11-24/0813r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0813-00-00bn-discussions-on-ap-power-save.pptx): 11-24-0813-00-00bn-discussions-on-ap-power-save, Yongsen Ma (Samsung)
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232. [11-24/1425r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1425-00-00bn-considerations-for-context-transfer-in-11bn.pptx): 11-24-1425-00-00bn-considerations-for-context-transfer-in-11bn, Peshal Nayak (Samsung)
233. [11-24/0881r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0881-00-00bn-improving-stability-during-roaming-process.pptx): 11-24-0881-00-00bn-improving-stability-during-roaming-process, Tuncer Baykas (Ofinno)
234. [11-24/1882r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1882-00-00bn-link-setup-for-seamless-roaming.pptx): 11-24-1882-00-00bn-link-setup-for-seamless-roaming, Chitto Ghosh (Apple)
235. [11-24/1883r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1883-00-00bn-seamless-roaming.pptx): 11-24-1883-00-00bn-seamless-roaming, Giovanni Chisci (Qualcomm Technologies Inc.)
236. [11-24/1897r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1897-00-00bn-control-frame-protection-keys.pptx): 11-24-1897-00-00bn-control-frame-protection-keys, Nehru Bhandaru (Broadcom)
237. [11-24/0349r3](https://mentor.ieee.org/802.11/dcn/24/11-24-0349-03-00bn-enhanced-fast-bss-transition.pptx): 11-24-0349-03-00bn-enhanced-fast-bss-transition, Guogang Huang (Huawei)
238. [11-24/0480r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0480-00-00bn-details-on-context-transfer-and-data-forwarding-under-ft-protocol.pptx): 11-24-0480-00-00bn-details-on-context-transfer-and-data-forwarding-under-ft-protocol, Guogang Huang (Huawei)
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240. [11-24/1878r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1878-00-00bn-obss-bandwidth-ambiguity-in-npca.pptx): 11-24-1878-00-00bn-obss-bandwidth-ambiguity-in-npca, Gaurang Naik (Qualcomm)
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242. [11-24/0375r1](https://mentor.ieee.org/802.11/dcn/24/11-24-0375-01-00bn-nav-protection-for-c-tdma.pptx): 11-24-0375-01-00bn-nav-protection-for-c-tdma, Si-Chan Noh (Newracom)
243. [12-24/1831r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1831-02-00bn-uhr-u-sig-and-uhr-sig-common-field-general-design.pptx): 11-24-1831-02-00bn-uhr-u-sig-and-uhr-sig-common-field-general-design, Juan Fang (Intel)
244. [11-24/1840r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1840-01-00bn-uhr-mu-ppdu-user-info-field-signaling.pptx): 11-24-1840-01-00bn-uhr-mu-ppdu-user-info-field-signaling, Rui Cao (NXP)
245. [11-24/1695r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1695-01-00bn-11bn-signaling-design-for-extra-mcs-ueqm-2xldpc.pptx): 11-24-1695-01-00bn-11bn-signaling-design-for-extra-mcs-ueqm-2xldpc, You-Wei Chen (MediaTek)
246. [11-24/1829r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1829-01-00bn-uhr-sig-signaling-for-cobf.pptx): 11-24-1829-01-00bn-uhr-sig-signaling-for-cobf, Shengquan Hu (Mediatek)
247. [11-24/1833r4](https://mentor.ieee.org/802.11/dcn/24/11-24-1833-04-00bn-trigger-frame-design-for-uhr.pptx): 11-24-1833-04-00bn-trigger-frame-design-for-uhr, Alice Chen (Qualcomm)
248. [11-24/1834r4](https://mentor.ieee.org/802.11/dcn/24/11-24-1834-04-00bn-11bn-non-elr-signaling-design-for-new-features.pptx): 11-24-1834-04-00bn-11bn-non-elr-signaling-design-for-new-features, Alice Chen (Qualcomm)
249. [11-24/1822r4](https://mentor.ieee.org/802.11/dcn/24/11-24-1822-04-00bn-cobf-design-for-uhr.pptx): 11-24-1822-04-00bn-cobf-design-for-uhr, Sameer Vermani (Qualcomm)
250. [11-24/1835r3](https://mentor.ieee.org/802.11/dcn/24/11-24-1835-03-00bn-backward-compatible-sounding-for-cobf.pptx): 11-24-1835-03-00bn-backward-compatible-sounding-for-cobf, Qinghua Li (Intel)
251. [11-24/1865r3](https://mentor.ieee.org/802.11/dcn/24/11-24-1865-03-00bn-universal-sounding-and-ndpa-signaling.pptx): 11-24-1865-03-00bn-universal-sounding-and-ndpa-signaling, You-Wei Chen (MediaTek)
252. [11-24/1826r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1826-01-00bn-5bit-mcs-table-design.pptx): 11-24-1826-00-00bn-5bit-mcs-table-design, Ron Porat (Broadcom)
253. [11-22/1528r1](https://mentor.ieee.org/802.11/dcn/22/11-22-1528-01-0uhr-enhanced-device-connectivity-with-robust-qos-support.pptx): 11-22-1528-01-0uhr-enhanced-device-connectivity-with-robust-qos-support, Rubayet Shafin (Samsung Research America)
254. [11-23/0294r1](https://mentor.ieee.org/802.11/dcn/23/11-23-0294-01-0uhr-channel-usage-enhancements-for-p2p-in-uhr.pptx): 11-23-0294-01-0uhr-channel-usage-enhancements-for-p2p-in-uhr, Rubayet Shafin (Samsung Research America)
255. 11-[23/1424r0](https://mentor.ieee.org/802.11/dcn/23/11-23-1424-00-0uhr-follow-up-on-peer-to-peer-p2p-communication-for-uhr.pptx): 11-23-1424-00-0uhr-follow-up-on-peer-to-peer-p2p-communication-for-uhr, Rubayet Shafin (Samsung Research America)
256. [11-23/1929r0](https://mentor.ieee.org/802.11/dcn/23/11-23-1929-00-00bn-peer-to-peer-p2p-resource-management.pptx): 11-23-1929-00-00bn-peer-to-peer-p2p-resource-management, Rubayet Shafin (Samsung Research America)
257. [11-24/0392r1](https://mentor.ieee.org/802.11/dcn/24/11-24-0392-01-00bn-enhancements-on-base-channel-peer-to-peer-p2p-communications.pptx): 11-24-0392-01-00bn-enhancements-on-base-channel-peer-to-peer-p2p-communications, Rubayet Shafin (Samsung Research America)
258. [11-24/0393r3](https://mentor.ieee.org/802.11/dcn/24/11-24-0393-03-00bn-enhancements-on-off-channel-peer-to-peer-p2p-communications.pptx): 11-24-0393-03-00bn-enhancements-on-off-channel-peer-to-peer-p2p-communications, Rubayet Shafin (Samsung Electronics)
259. [11-24/0403r2](https://mentor.ieee.org/802.11/dcn/24/11-24-0403-02-00bn-managed-on-channel-p2p-communication.pptx): 11-24-0403-02-00bn-managed-on-channel-p2p-communication, Inaki Val (MaxLinear)
260. [11-24/1595r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1595-01-00bn-scope-of-mapc-and-roaming-standardization.pptx): 11-24-1595-01-00bn-scope-of-mapc-and-roaming-standardization, Brian Hart (Cisco Systems)
261. [11-24/0838r1](https://mentor.ieee.org/802.11/dcn/24/11-24-0838-01-00bn-backhaul-design-and-channel-setting-for-multi-ap.pptx): 11-24-0838-01-00bn-backhaul-design-and-channel-setting-for-multi-ap, Kosuke Aio (Sony Corporation)
262. [11-24/1765r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1765-00-00bn-consideration-on-11bn-trigger-frame-for-phy-signailng.pptx): 11-24-1765-00-00bn-consideration-on-11bn-trigger-frame-for-phy-signailng, Dongguk Lim (LG Electronics)
263. [11-24/1507r3](https://mentor.ieee.org/802.11/dcn/24/11-24-1507-03-00bn-uhr-trigger-frame-design.pptx): 11-24-1507-03-00bn-uhr-trigger-frame-design, Mahmoud Hasabelnaby (Huawei)
264. [11-25/0014r7](https://mentor.ieee.org/802.11/dcn/25/11-25-0014-07-00bn-tgbn-motions-list-part-2.pptx): 11-25-0014-07-00bn-tgbn-motions-list-part-2, Alfred Asterjadhi (Qualcomm Technologies Inc.)
265. [11-24/1427r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1427-02-00bn-signaling-for-mcs-and-ueqm-in-11bn.pptx): 11-24-1427-02-00bn-signaling-for-mcs-and-ueqm-in-11bn, Dongguk Lim (LG Electronics)
266. [11-24/1827r1:](https://mentor.ieee.org/802.11/dcn/24/11-24-1827-01-00bn-on-ofdma-mu-mimo.pptx) 11-24-1827-01-00bn-on-ofdma-mu-mimo, Ron Porat (Broadcom)
267. [11-24/1832r6](https://mentor.ieee.org/802.11/dcn/24/11-24-1832-06-00bn-stream-parser-for-unequal-modulation.pptx): 11-24-1832-06-00bn-stream-parser-for-unequal-modulation, Qinghua Li (Intel)
268. [11-24/1807r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1807-00-00bn-follow-up-on-ueqm-stream-parser.pptx): 11-24-1807-00-00bn-follow-up-on-ueqm-stream-parser, Ying Wang (InterDigital)
269. [11-24/1451r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1451-02-00bn-ueqm-transmission-over-spatial-streams.pptx): 11-24-1451-02-00bn-ueqm-transmission-over-spatial-streams, Ying Wang (InterDigital)
270. [12-24/1831r3](https://mentor.ieee.org/802.11/dcn/24/11-24-1831-03-00bn-uhr-u-sig-and-uhr-sig-common-field-general-design.pptx): 11-24-1831-03-00bn-uhr-u-sig-and-uhr-sig-common-field-general-design, Juan Fang (Intel)
271. [11-24/1864r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1864-01-00bn-map-ppdu-consideration-and-harmonized-u-sig-signaling.pptx): 11-24-1864-01-00bn-map-ppdu-consideration-and-harmonized-u-sig-signaling, You-Wei Chen (MediaTek)
272. [11-24/1464r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1464-02-00bn-discussion-on-icf.pptx): 11-24-1464-02-00bn-discussion-on-icf, Insun Jang (LG Electronics)
273. [11-24/1829r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1829-02-00bn-uhr-sig-signaling-for-cobf.pptx): 11-24-1829-02-00bn-uhr-sig-signaling-for-cobf, Shengquan Hu (Mediatek)
274. [11-24/0469r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0469-00-00bn-new-mcss-for-11bn.pptx): 11-24-0469-00-00bn-new-mcss-for-11bn, Shengquan Hu (Mediatek)
275. [11-24/0753r1](https://mentor.ieee.org/802.11/dcn/24/11-24-0753-01-00bn-new-mcs-simulation-results.pptx): 11-24-0753-01-00bn-new-mcs-simulation-results, Ron Porat (Broadcom)
276. [11-24/2123r1](https://mentor.ieee.org/802.11/dcn/24/11-24-2123-01-00bn-discussion-on-hol-blocking-issue.pptx): 11-24-2123-01-00bn-discussion-on-hol-blocking-issue, Guogang Huang (Huawei)
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278. [11-25/0129r0](https://mentor.ieee.org/802.11/dcn/25/11-25-0129-00-00bn-dru-distribution-bw-indication-in-uhr-trigger-frame.pptx): 11-25-0129-00-00bn-dru-distribution-bw-indication-in-uhr-trigger-frame, Mahmoud Hasabelnaby (Huawei)
279. [11-24/1785r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1785-02-00bn-interference-mitigation-pilots-definitions.pptx): 11-24-1785-02-00bn-interference-mitigation-pilots-definitions, Shimi Shilo (Huawei)
280. [11-25/0078r0](https://mentor.ieee.org/802.11/dcn/25/11-25-0078-00-00bn-special-sta-info-field-in-uhr-ndpa.pptx): 11-25-0078-00-00bn-special-sta-info-field-in-uhr-ndpa, Junghoon Suh (Huawei)
281. [11-25/0128r0](https://mentor.ieee.org/802.11/dcn/25/11-25-0128-00-00bn-discussion-on-pe-requirement-for-ueqm.pptx): 11-25-0128-00-00bn-discussion-on-pe-requirement-for-ueqm, Mengshi Hu (Huawei)
282. [11-25/0104r0](https://mentor.ieee.org/802.11/dcn/25/11-25-0104-00-00bn-co-sr-preamble-signaling.pptx): 11-25-0104-00-00bn-co-sr-preamble-signaling, Ross Jian Yu (Huawei)
283. [11-23/1868r2](https://mentor.ieee.org/802.11/dcn/23/11-23-1868-02-00bn-coordinated-spatial-reuse-design.pptx): 11-23-1868-02-00bn-coordinated-spatial-reuse-design, Jason Yuchen Guo (Huawei)
284. [11-24/1092r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1092-00-00bn-multi-ap-coordinated-concurrent-transmission-protocol.pptx): 11-24-1092-00-00bn-multi-ap-coordinated-concurrent-transmission-protocol, Kosuke Aio (Sony Corporation)
285. [11-24/0963r3](https://mentor.ieee.org/802.11/dcn/24/11-24-0963-03-00bn-enhancement-of-bsr-follow-up.pptx): 11-24-0963-03-00bn-enhancement-of-bsr-follow-up, Frank Hsu (Mediatek Inc.)
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287. [11-24/1193r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1193-01-00bn-edca-for-high-priority-access.pptx): 11-24-1193-01-00bn-edca-for-high-priority-access, Mingyu LEE (Samsung Electronics)
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