HE-SIG-B Contents

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HE-SIG-B Structure

- The group agreed the following about HE-SIG-B structure [1]
  - HE-SIG-B is encoded on a per 20 MHz basis using BCC with common and user blocks separated in the bit domain.
  - For bandwidths ≥ 40 MHz, the number of 20 MHz subbands carrying different content is two and with structure as shown in Figure 1. Each square in the figure represents 20 MHz subband and 1/2 represents different signalling information.

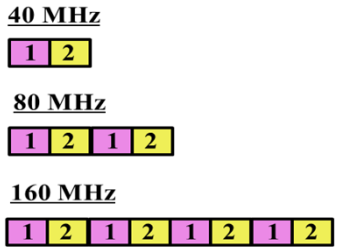


Figure 1 - 20 MHz subchannel content for HE-SIG-B for bandwidths ≥ 40 MHz

  - HE-SIG-B has a common field followed by a user specific field, where
    - The common field includes the information for all of designated STAs to receive the PPDU in corresponding bandwidth
    - The user specific field consists of multiple sub-fields that do not belong to the common field, where one or multiple of those sub-fields are for each designated receiving STA
    - The boundary between the common and the user specific field is at the bit level and not the OFDM symbol level
  - The common field in HE-SIG-B contains Resource Unit (RU) allocation

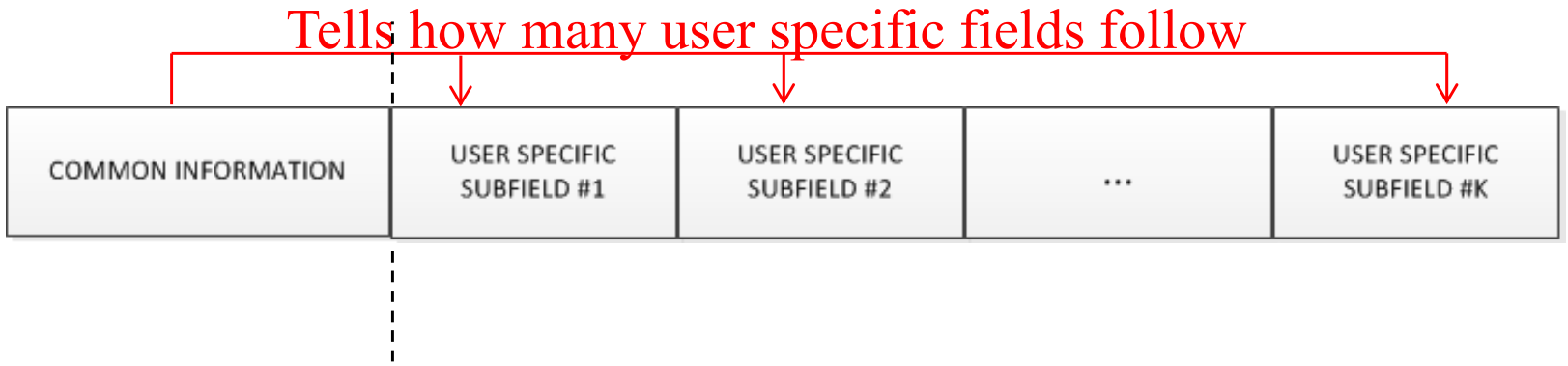
In this presentation

- We build on the progress from the last meeting by adding details on
  - The resource allocation information in the common part of HE-SIG-B
    - The size of the resource allocation information
  - Signaling information for each user in the sub-fields of the user –specific part
  - Improving HE-SIG-B efficiency by load balancing for MU-MIMO allocations
    - Arrangement of the common and the user-specific portions for MU-MIMO RUs > 20MHz.

Resource Allocation Signaling

- The Resource Allocation signaling in the common portion of HE-SIG-B channel indicates
  - Arrangement of RUs in frequency
    - Indicates the distribution of RU allocations for single (SU-MIMO) and multiple (MU-MIMO) users
  - Number of users multiplexed when those RUs are used for MU-MIMO
- OFDMA tone plan is previous defined [2]
  - Allocation sizes are: 1x26, 1x52, 1x106, 1x242 1x484, 1x996, 2x996
- MU-MIMO multiplexing with OFDMA was also previous discussed [3]:
  - We agreed to support MU-MIMO on only RUs of size ≥ 106 tones
  - Assuming a maximum of 8 users can be multiplexed in MU
- Considering all combinations of RUs and number of users in MU-MIMO allocations, for a 20MHz PPDU BW
  - Number of possible combinations of RUs and #users ~ 175
  - 8 bits of resource allocation signaling are needed

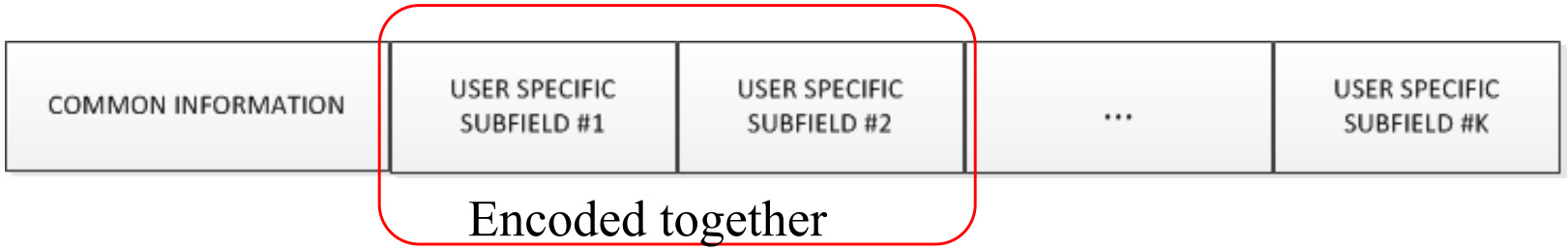
User Specific Fields in HE-SIG-B



- Common information communicates RU arrangement and the number of users for MU-MIMO allocations
- Each user specific field contains information for STA scheduled in the MU- PPDU
  - User specific sub-fields should contain
    - STA-ID for addressing
    - the information necessary to decode the PPDU
      - For single-user allocations in a RU: NSTS (Number of Spatial Streams), TxBF (transmit beamforming), MCS (Modulation and Coding Scheme) and Coding (Use of LDPC)
      - For each user in a multi-user allocation in a RU: Spatial Configuration Fields, MCS and Coding.
    - Other fields are TBD

User Specific Fields in HE-SIG-B

- In an accompanying contribution [5], we propose encoding groups of user specific information field together with one BCC.

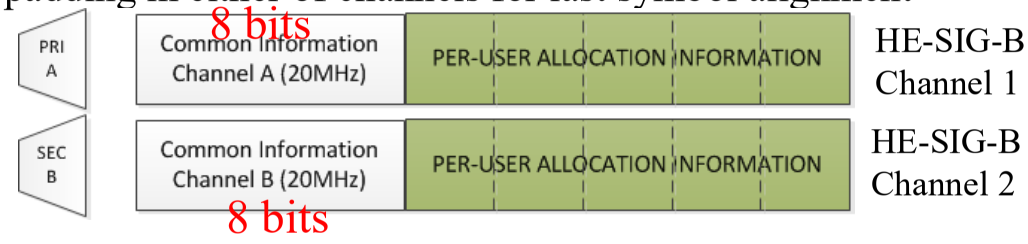


- Each user specific sub-field can carry information for either MU or SU.
  - Each user in a MU–MIMO allocation is separately addressed.
  - Data parsing of the content of user specific sub-fields differs based on SU or MU.
- To enable efficient grouping for joint encoding of user specific sub-fields
  - We prefer that the size of the user specific sub-fields be the same for both SU and MU allocations

HE-SIG-B Multiplexing

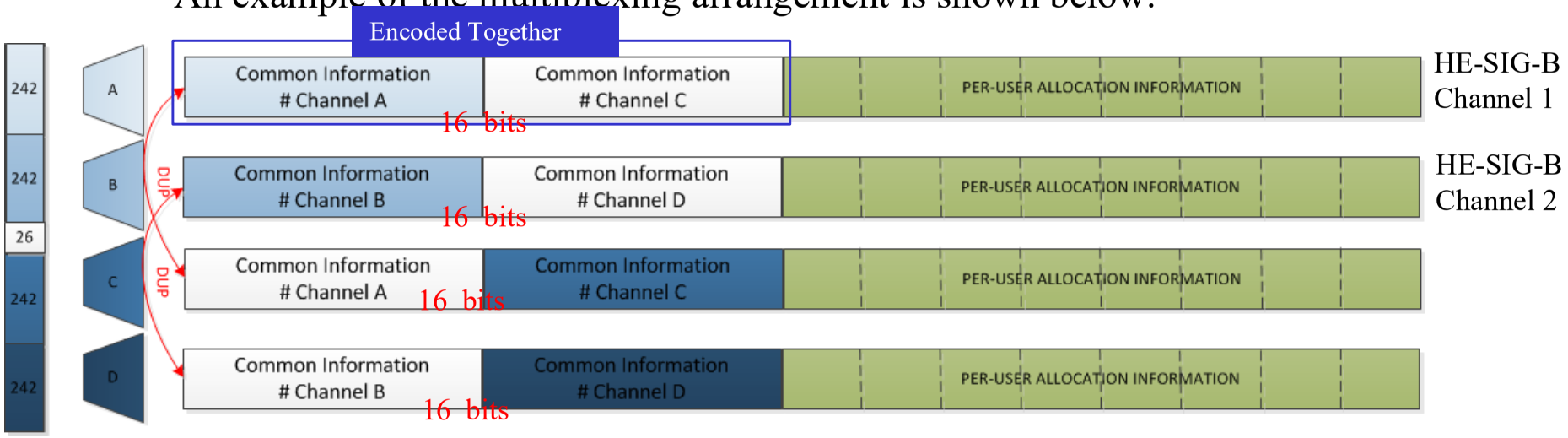
- For 20MHz, the HE-SIG-B construction is straight forward
  - Signal the RU Arrangement + MU information using 8 bits in the common information followed by per-user allocation information
    - STA uses the common information and the position of its allocation to unambiguously identify the RU containing its data

- For 40MHz, the HE-SIG-B has two channels each with different information
  - Each channel carries RU allocation information for users scheduled in the 20MHz segment
    - May require padding in either of channels for last symbol alignment



HE-SIG-B Multiplexing (80MHz)

- Four 20MHz segments have to be mapped to 2 HE-SIG-B channels duplicated per 40MHz [3]
  - 80MHz tone plan not aligned with 20MHz segments.
    - Channel A, B, C, D below refer to 242 tones RUs – and can signal RU arrangements for smaller RUs with-in the 242 tone RUs
      - 8 bits per 242 tone RU – 16 bits total per HE-SIG-B Channel
    - Central 26 tone RU may be signaled separately
  - An example of the multiplexing arrangement is shown below.

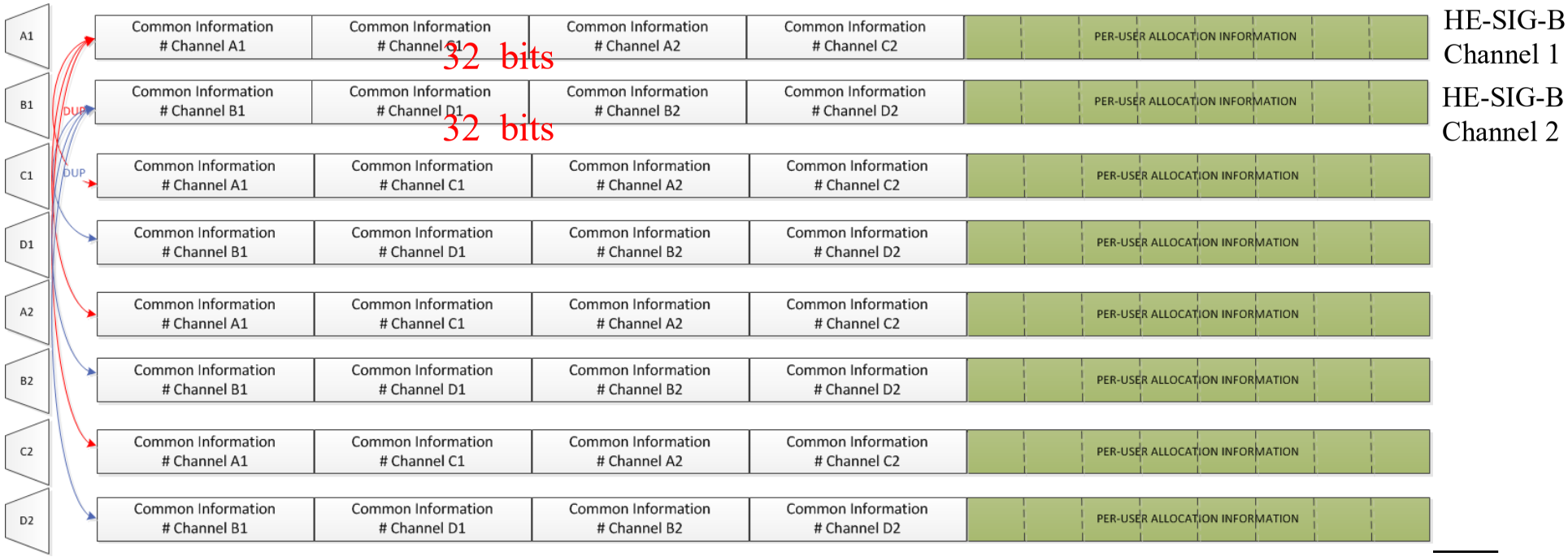


- Duplication of HE-SIG-B channels keeps control information in the 20MHz sub-carriers closest to the data sub-carriers.

Extending Multiplexing Support to 160MHz

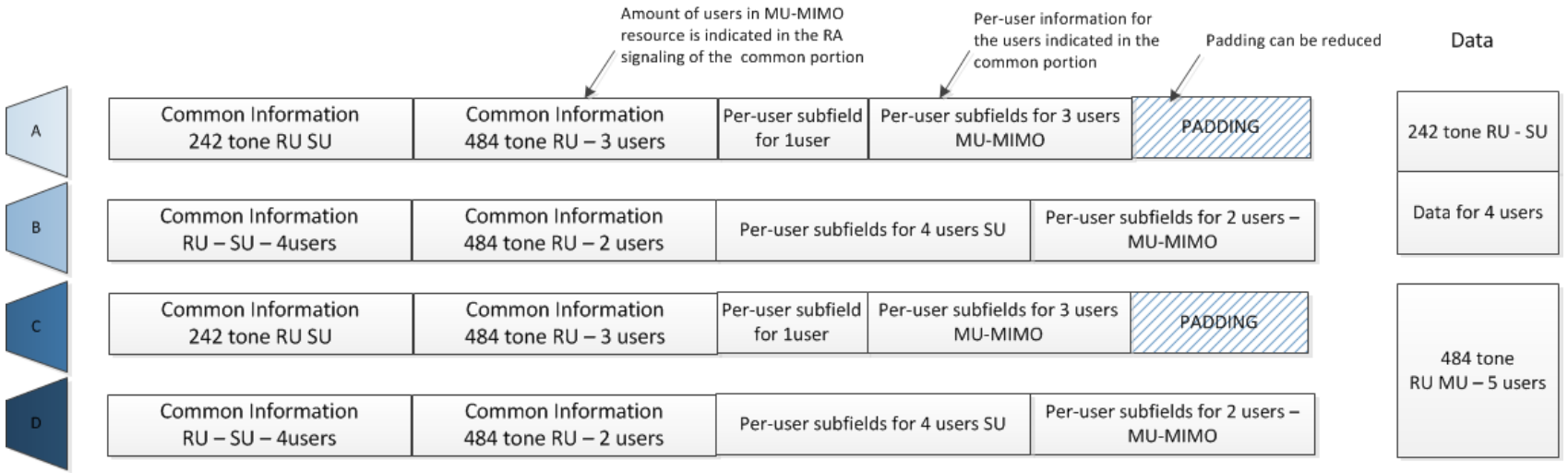
- Eight 20MHz segments have to be mapped to 2 HE-SIG-B channels duplicated per 40MHz
  - 160MHz tone plan built as two concatenated 80MHz tone plans
    - Channel A, B, C, D below refer to 242 tones RUs – and can signal RU arrangements for smaller RUs with-in the 242 tone RUs
      - 32 bits totally for the four channels
    - Two central 26 tone RUs in each 80MHz may be signaled separately.

↵ Example Arrangement:



Load Balancing for large MU-MIMO allocations

- When RU sizes > 20MHz are used, AP divides the per-user content blocks between allocated channels dynamically based on load in each allocated channel
  - Since information spans 2 channels, control is carried over a 20MHz segment of the data - reliability in HE-SIG-B is ensured.
- Common Control Portion:
  - Repeat MU-MIMO allocation *size* in each allocated channel
  - Indicate number of per-user content blocks carried in the corresponding channel
- User specific fields:
  - Transmit per-user content blocks for the subset of users indicated in the common portion



Summary

- Resource Allocation Signaling in the common portion of HE-SIG-B needs 8 bits per 20MHz PPDU and indicates
  - RU Arrangement in the frequency domain
  - If MU-MIMO Capable RUs carry MU-MIMO
    - Number of users multiplexed when those RUs are used for MU-MIMO
- Resource Allocation Signaling indicates the number of user allocation sub-fields that follow the common portion of HE-SIG-B
  - Each user allocation sub-field addresses and STA and gives necessary information to decode data in the PPDU
  - Data parsing of the content of user allocation sub-fields differs based on SU or MU. The size of the sub-field should be the same for both SU and MU.

Summary

- For BW > 20MHz, the mapping of control information to two HE-SIG-B channels is done such that
  - the control information is carried in the same 20MHz segment as the data – ensures reliability.
  - For 80MHz, duplication of HE-SIG-B requires that
    - Control information for 2 segments be carried in each HE-SIG-B channel.
      - 8 bits per 20MHz segment – 16 bits of common control
  - For 160 MHz, control information for 4 segments be carried in each HE-SIG-B channel
    - 32 bits of common control information.
- For MU-MIMO allocations spanning larger than 20MHz BW, the AP can dynamically allocate users to each HE-SIG-B channel to improve load balancing among the two 2 HE-SIG-B channels.

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References

[1] 11-15-0132-07-00ax-spec-framework

[2] 11-15-0330-04-00ax-OFDMA-numerology-and-structure

[3]11-15-0832-00-00ax-performance-evaluation-of-su-mu-mimo-in-ofdma

[4] 11-15-0873-00-00ax-HE-SIG-B-encoding-structure

[5] 11-15-0821-02-00ax-HE-SIG-B-structure

[6] 11-15-1059-00-00ax-sig-b-encoding-structure-part-II

Straw Poll #1

Do you agree to add the following text to the 11ax SFD:

The RU allocation signaling in the common field of HE-SIG-B signals an 8 bit per 20MHz PPDU BW for signaling

- The RU arrangement in frequency domain
- Number of MU-MIMO allocations: The RUs allocated for MU-MIMO and the number of users in the MU-MIMO allocations.

The exact mapping of the 8 bit to the RU arrangement and the number of MU-MIMO allocations is TBD.

Signaling for the center 26 unit in 80MHz is TBD

Straw Poll #2

Do you agree to add the following text to the 11ax SFD:

The user specific subfields of HE-SIG-B containing the per user dedicated information include the following fields

- STA-ID
- For single-user allocations in a RU: NSTS (Number of Spatial Streams), TxBF (transmit beamforming), MCS (Modulation and Coding Scheme) and Coding (Use of LDPC)
- For each user in a multi-user allocation in a RU: Spatial Configuraiton Fields, MCS and Coding.

Other fields are TBD.

Straw Poll #3

Do you agree to add the following text to the 11ax SFD:

The length of the user specific subfield in HE-SIG-B for a single-user allocation is equal to the length of the user specific subfield of each user in a multi-user allocation.

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Straw Poll #4

Do you agree to add the following text to the 11ax SFD:

For MU-MIMO allocation of RU size > 20MHz, the user-specific subfields is dynamically split between two HE-SIG-B content channels(1/2) and the split is decided by the AP (on a per case basis)

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APPENDIX

Number of bits for RA signaling

#1	#2	#3	#4	#5	#6	#7	#8	#9
26	26	26	26	26	26	26	26	26
52		52		26	52		52	
52		26	26	26	26	26	26	26
26	26	52		26	26	26	26	26
26	26	26	26	26	52		26	26
26	26	26	26	26	26	26	52	
52		52		26	26	26	26	26
52		26	26	26	52		26	26
52		26	26	26	26	26	52	
26	26	52		26	52		26	26
26	26	52		26	26	26	52	
26	26	26	26	26	52		52	
52		52		26	52		26	26
52		52		26	26	26	52	
52		26	26	26	52		52	
26	26	52		26	52		52	
106				26	106			
106				26	26	26	26	26
106				26	26	26	52	
106				26	52		26	26
106				26	52		52	
26	26	26	26	26	106			
26	26	52		26	106			
52		26	26	26	106			
52		52		26	106			
242								

484
996
2*996

8 bits are sufficient for resource allocation signaling in 20MHz PPDU BW