

OFDMA Non-contiguous Channel Utilization

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Authors:

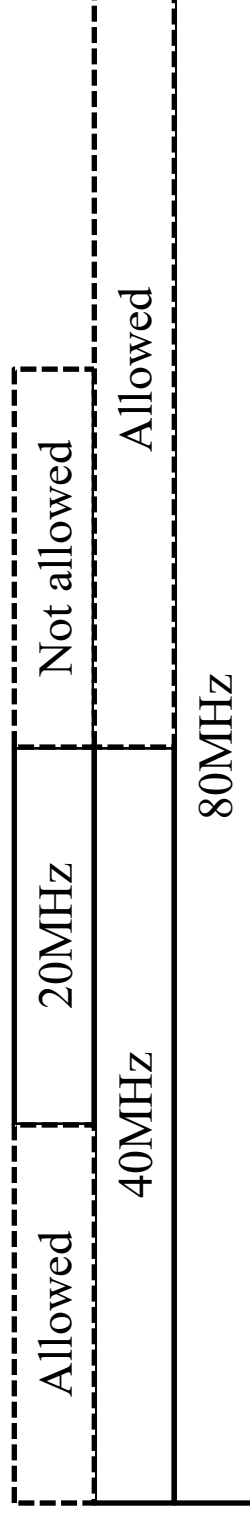
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Background

- **OFDMA is adopted as an 802.11ax transmission scheme[1]**
- **OFDMA and channel utilization**
 - Various new patterns of channel utilization for OFDMA have been discussed [2][3]
 - Contiguous flexible & non-contiguous
 - Approaches in the past OFDMA related contributions
 - Legacy channel utilization for STAs → Low complexity on STAs
 - Extended channel utilization for AP
- **OFDMA channel utilization has not been fully discussed**

OFDMA Channelization

- 11ac channelization allows predetermined contiguous channel utilization on 5GHz band (except 80+80MHz)



- 11ax could enhance its performance via allowing new patterns of channel utilization
- New options of wider bandwidth operation
 - Contiguous flexible channel (e.g., 60MHz, 120MHz, etc)
 - Non-contiguous channel (e.g., 20MHz+20MHz, 20MHz+40MHz, etc)

OFDMA Channelization (Contiguous)

- **Contiguous flexible channel [4]**
 - Better performance for target BSS than 11ac channel utilization



11ac 40MHz

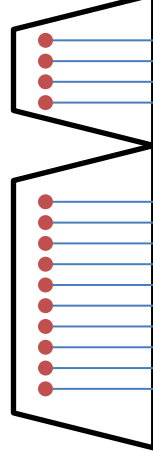


11ac Contiguous 60 MHz

- Need to configure new sub-carrier allocation for new bandwidth
- Or multiple contiguous segments (e.g., contiguous 40+20MHz)



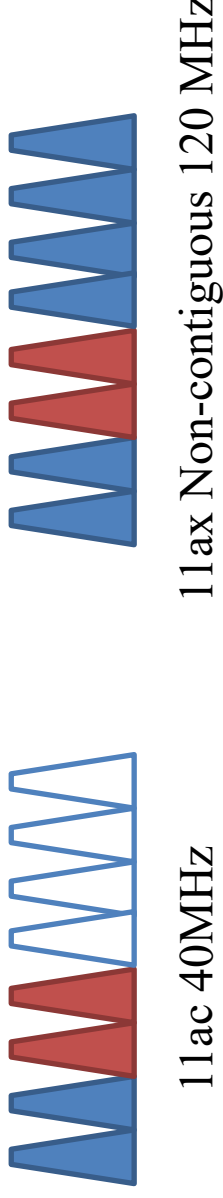
New 11ax 60MHz sub-carrier allocation



11ac 40MHz+11ac 20MHz sub-carrier allocation

OFDMA Channelization (Non-contiguous)

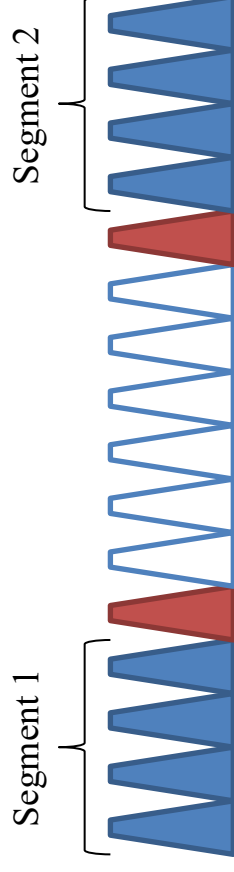
- **Non-contiguous channel utilization [4][5][6][7][8]**
 - Much better performance for target BSS than 11ac channel utilization



- **Non-contiguous channel utilization might be preferable due to better spectral usage**
 - There are technical MAC & PHY issues
 - e.g., Limitation on number of segments, Channel access schemes, etc.

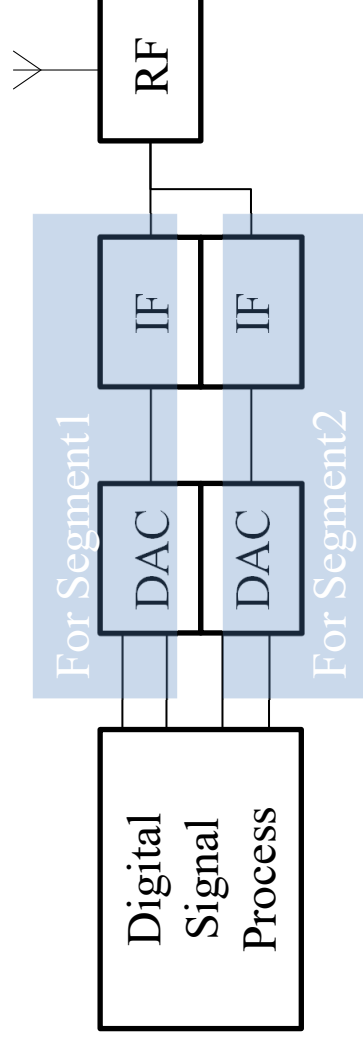
Non-contiguous channel utilization

- **Supporting non-contiguous channels**
 - Legacy 802.11(before ac) utilizes only one frequency segment of certain center frequency
 - Frequency segment: a block of contiguous frequency bandwidth which has one center frequency
 - 802.11ac could utilize 2 frequency segments to utilize 80+80MHz bandwidth of different two center frequency
 - VHT operation information element includes each center frequency of two segments



Issues on Non-contiguous channel

- **PHY needs to handle non-contiguous bandwidth**
 - Multiple RF(or multiple IF part) may be required to support non-contiguous channels [5][6][7]
 - Each frequency segment may require one IF [7]
 - Synchronous non-contiguous channel utilization is feasible [5][6][7]
 - Non-contiguous channel utilization could enhance 11ax throughput by increasing opportunity of wideband operation [4][7][8][9]



Issues on Non-contiguous channel

- **Non-contiguous channel support with PHY restriction might be required**
 - Utilizing all available channel is burden to PHY and could degrade spectral reuse on dense OBSS scenario
 - Therefore, restriction on numbers of segment need to be considered
 - 11ac considered 2 segments at most
 - Complexity and AP/STA capability needs to be considered
- **Many legacy channel access schemes might be re-defined or enhanced for Non-contiguous channel**
 - STAs' capability for non-contiguous channel support might vary
 - CCA, contention and back-off and other channel access schemes might be required to be re-defined for non-contiguous channel

Issues on Non-contiguous channel

- **Minimizing impacts on non-contiguous channel utilization**
 - Secondary non-contiguous segment(s) might require a new control channel(s)
 - A new control channel utilizes same lax channel access schemes (CCA, wideband operation, etc.) as primary channel
 - By utilizing new control channel(s) STA does not need to listen to all possible channels
- **Further performance enhancement with new control channel on non-contiguous segment**
 - Secondary non-contiguous segment can be utilized even when a primary channel is busy

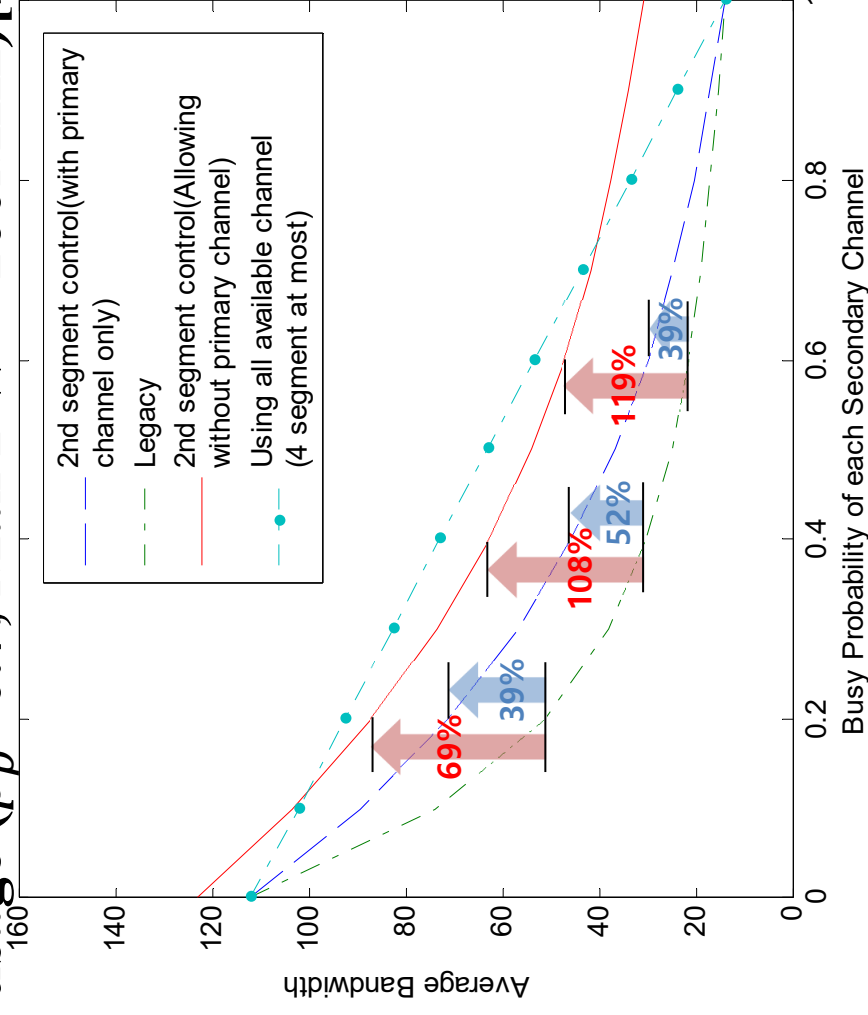
Issues on Non-contiguous channel

- **Resource utilization comparison [9]**
 - CH1 is Primary Channel
 - CH3 is 2nd segment control channel

	Channel (Colored means busy)				Legacy				All available CH				With 2 nd segment control channel			
	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4	CH1	CH2	CH3	CH4
Case1				Busy												
Case2			Busy													
Case3		Busy														
Case4		Busy		Busy												
Case5			Busy	Busy												
Case6	Busy															

Non-contiguous channel

- Non-contiguous channel utilization enhances throughput
- Channel usage ($p_p=0.7$, Max BW = 160MHz)[9]



Conclusions

- **Non-contiguous channel utilization may improve 11ax throughput**
 - All possible non-contiguous methods improve effective channel utilization
- **Frequency segment might be restricted by PHY capability**
 - If there are no restriction(using all available channel case), 4 non-contiguous segment need to be supported on 160MHz band
 - Numerous frequency segments might not be feasible due to PHY limitations
- **Channel access schemes need to consider non-contiguous channel utilization**
 - Allocating control channel to additional frequency segments could be one of possible solutions

References

- [1] IEEE 802.11-15/0132r2 "Specification Framework for TGax"
- [2] IEEE 802.11-13/1382r0 "Discussion on OFDMA in HEW"
- [3] IEEE 802.11-15/0035r0 "Scalable Channel Utilization"
- [4] IEEE 802.11-13/1058r0 "Efficient wider bandwidth operation"
- [5] IEEE 802.11-09/1037r0 "Considerations on Multi-Channel in TGac"
- [6] IEEE 802.11-09/1022r0 "Multi-channel Transmissions"
- [7] IEEE 802.11-10/0103r1 "Gains provided by multichannel transmissions"
- [8] IEEE 802.11-10/0385r1 "80MHz and 160MHz channel access modes"
- [9] IEEE 802.11-15/0132r2 "DL-OFDMA Procedure in IEEE 802.11ax"

Straw Poll 1

- **Do you agree to add the to the TG Specification Frame work document?**
 - 3.y.z The amendment shall support non-contiguous channel transmission.
- **Y**
- **N**
- **ABS**