Cisco Cooperative Project

Channel Selection for LAA with IEEE 802.11 ac

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Outline

- Review Matlab Simulation
- Channel Selection
- Channel Bonding for LAA
- Next steps

Review Matlab Simulation (cont'd)

TABLE I
SIMULATION PARAMETERS FOR WIFI.

Channel bandwidth	20 MHz
Slot time	9 μ s
DIFS	34 μ s
SIFS	16 μ s
Contention window size, q	32
Physical bit rate	72.2 Mbps
Buffer size	1500 packets
Average packet arrival time	Every 400 slots
Average packet size	200 slots

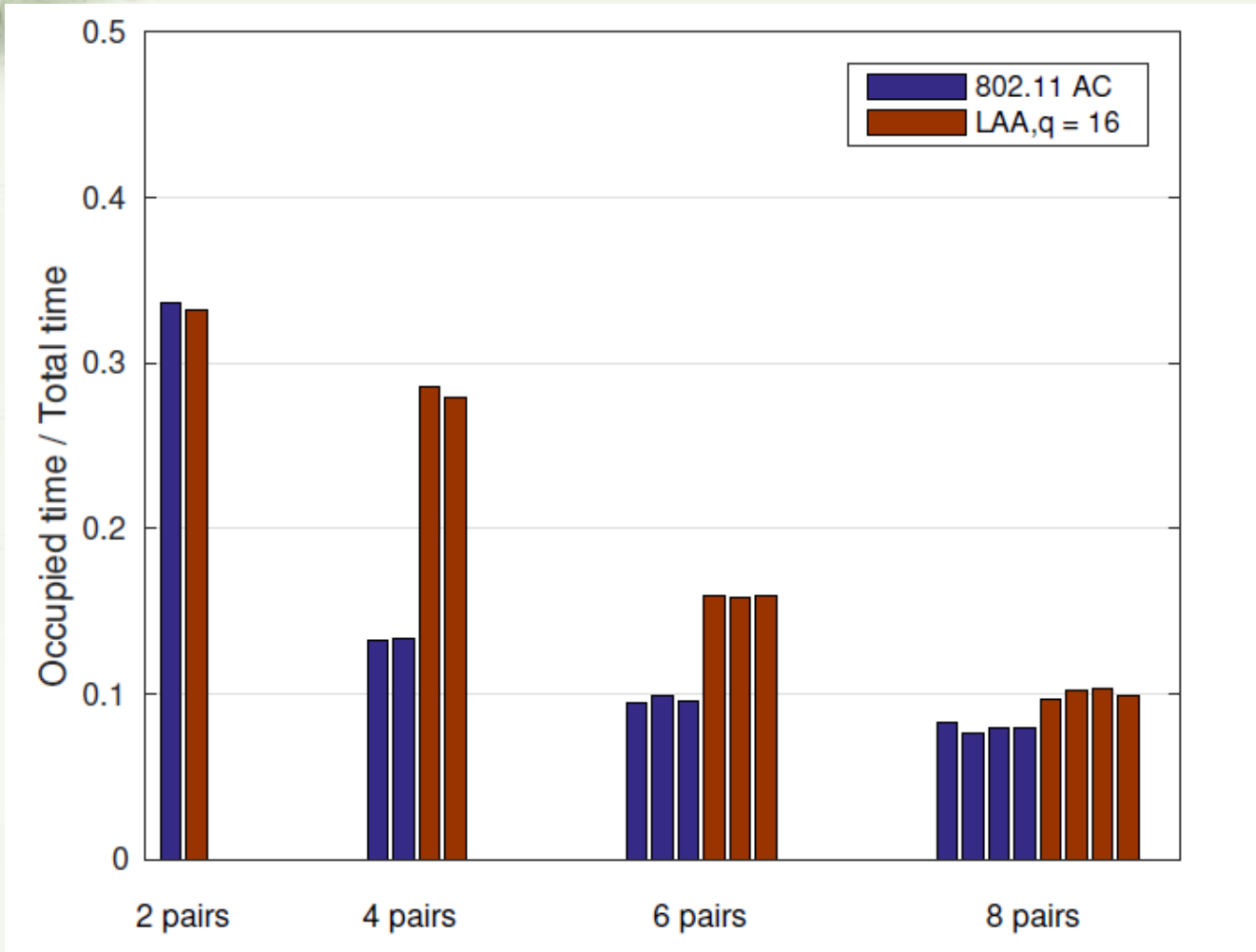
Arrival time and size: Poisson distribution

TABLE II
SIMULATION PARAMETERS FOR LAA.

Channel bandwidth	20 MHz
Slot time	9 μ s
B_{iCCA}	36 μ s
D_{eCCA}	36 μ s
One eCCA slot	9 μ s
Contention window size, q	16
Physical bit rate	84 Mbps
Buffer size	1500 packets
Average packet arrival time	Every 800 slots
Packet size	400 slots (4 subframes)

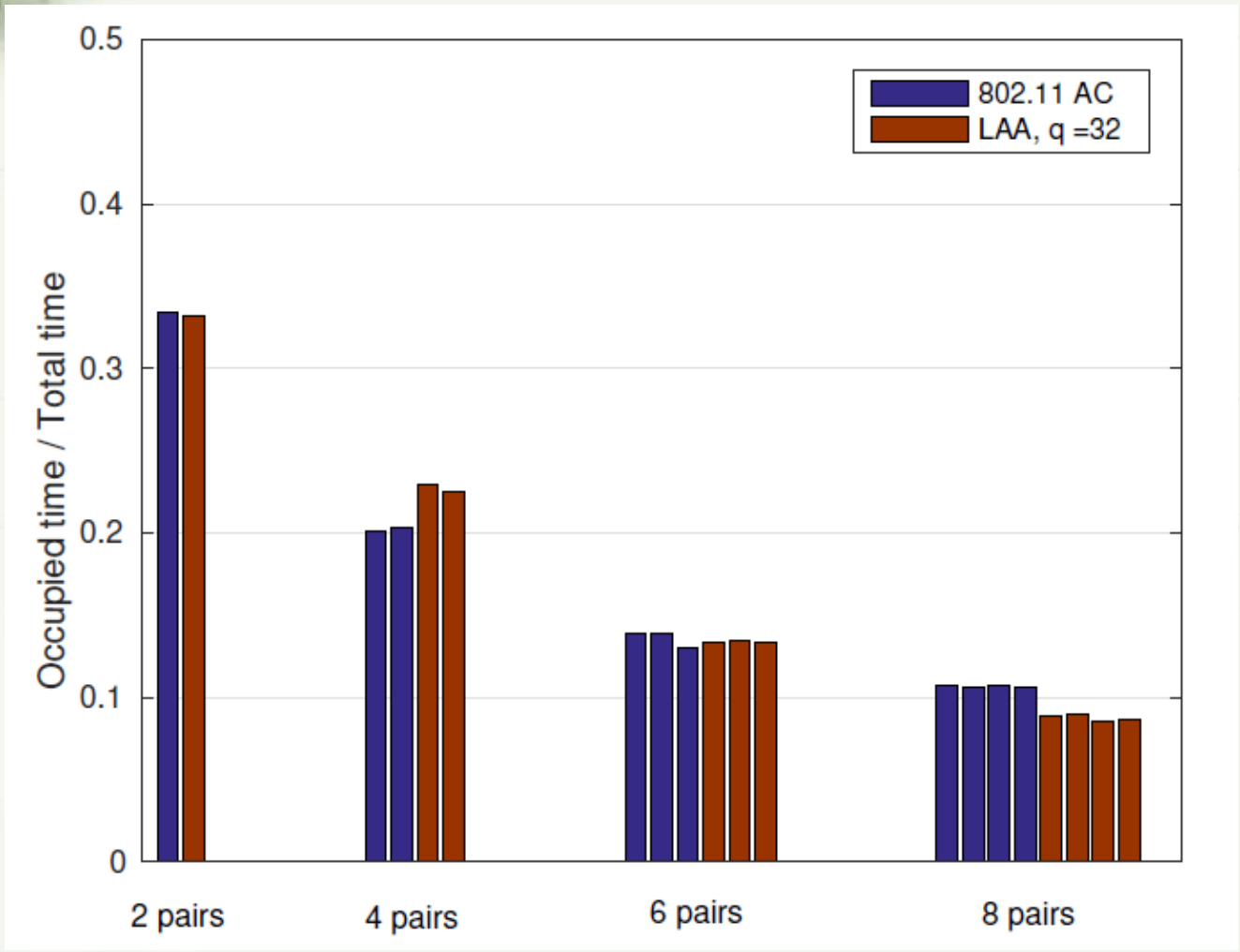
Arrival time: Poisson distribution

Review Matlab Simulation



q = 16

Review Matlab Simulation (cont'd)



q = 32

Review Matlab Simulation (cont'd)

- Different simulation setting may have different results
- [1] Update the contention window *q* between *X* and *Y* via a dynamic backoff or a semi-static backoff
- As the number of pairs increases, LAA becomes less and less aggressive?

[1] *3GPP TR 36.889 V1.0.0 (2015-05)*.

Channel Selection: Review

Scenario:

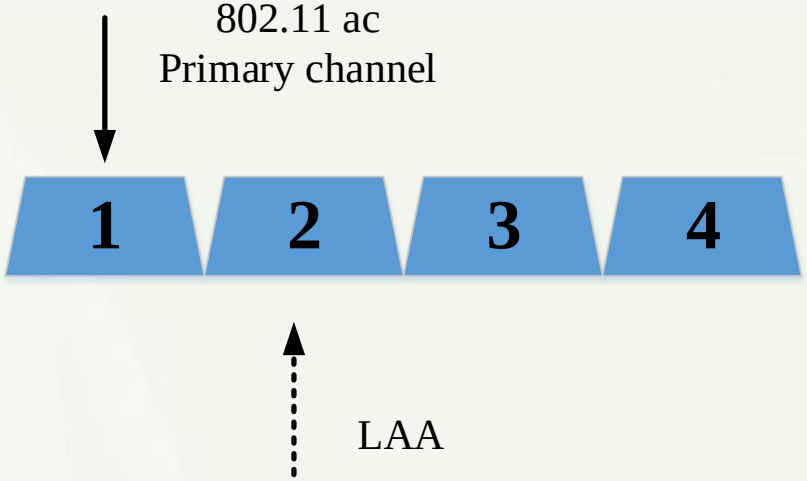
✓One 802.11ac node with fixed primary channel

✓802.11 ac with dynamic 80/40/20 MHz (Primary channel requires to be included in any bandwidth)

✓4 subchannels

✓Poisson source for LAA with LBT CAT 4

✓ Example : one LAA node with different channel selections



	Busy	Idle
LAA: 1	N.A.	80 MHz
LAA: 2	20 MHz	80 MHz
LAA: 3 / 4	40 MHz	80 MHz

Channel Selection: Qualcomm & Ericsson

Channel Selection- Summary

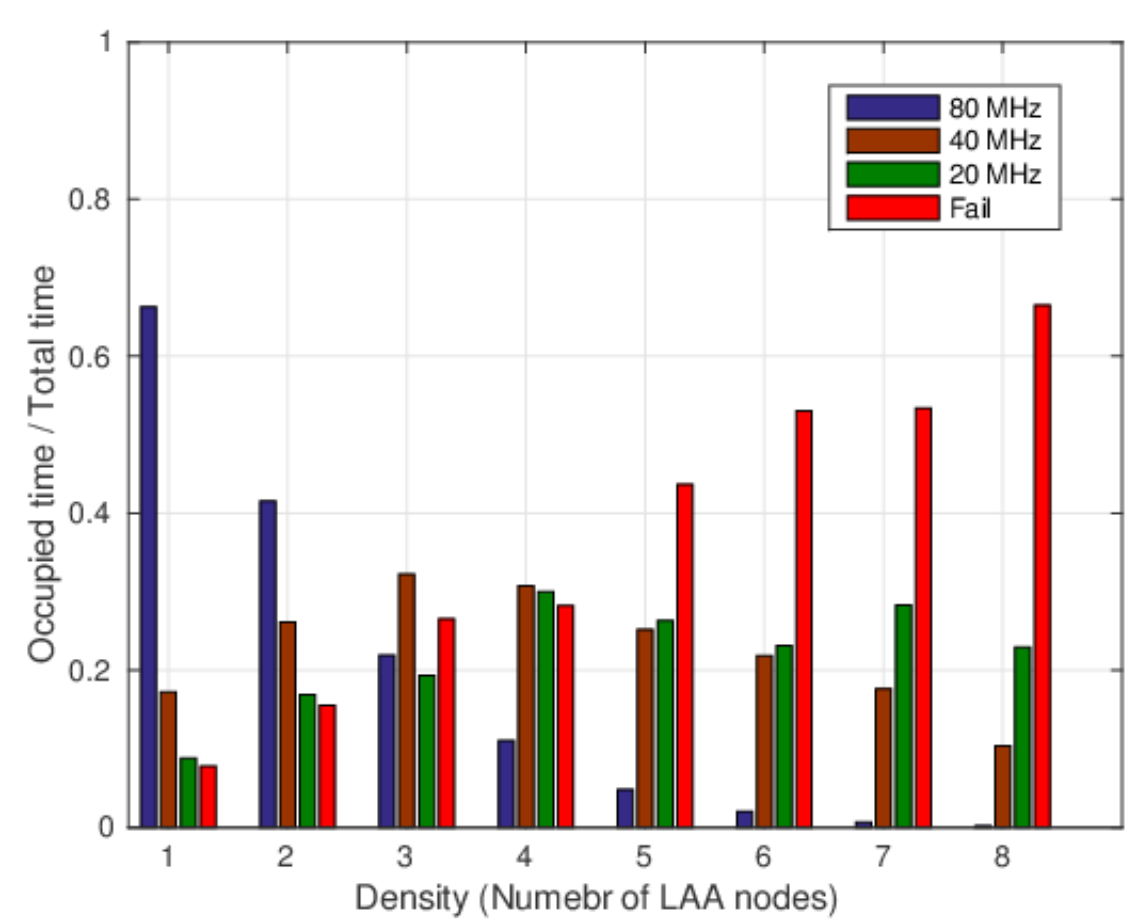
1. Has to be both during initial boot up as well as dynamically during operation
2. Choose the cleanest channel in general
3. If possible avoid primary channels of WiFi
4. If possible avoid channels occupied by other LTE-U operators and choose channel occupied by the same LTE-U operator (Forum coexistence spec 6.1.2)

[1] Qualcomm, "*LTE-U Technology and Coexistence", May 28, 2015*
[2] Ericsson, *"LTE-U Coexistence", May 28, 2015.*

Channel Selection: Simulation (1)

Percentage of time occupation for 802.11ac

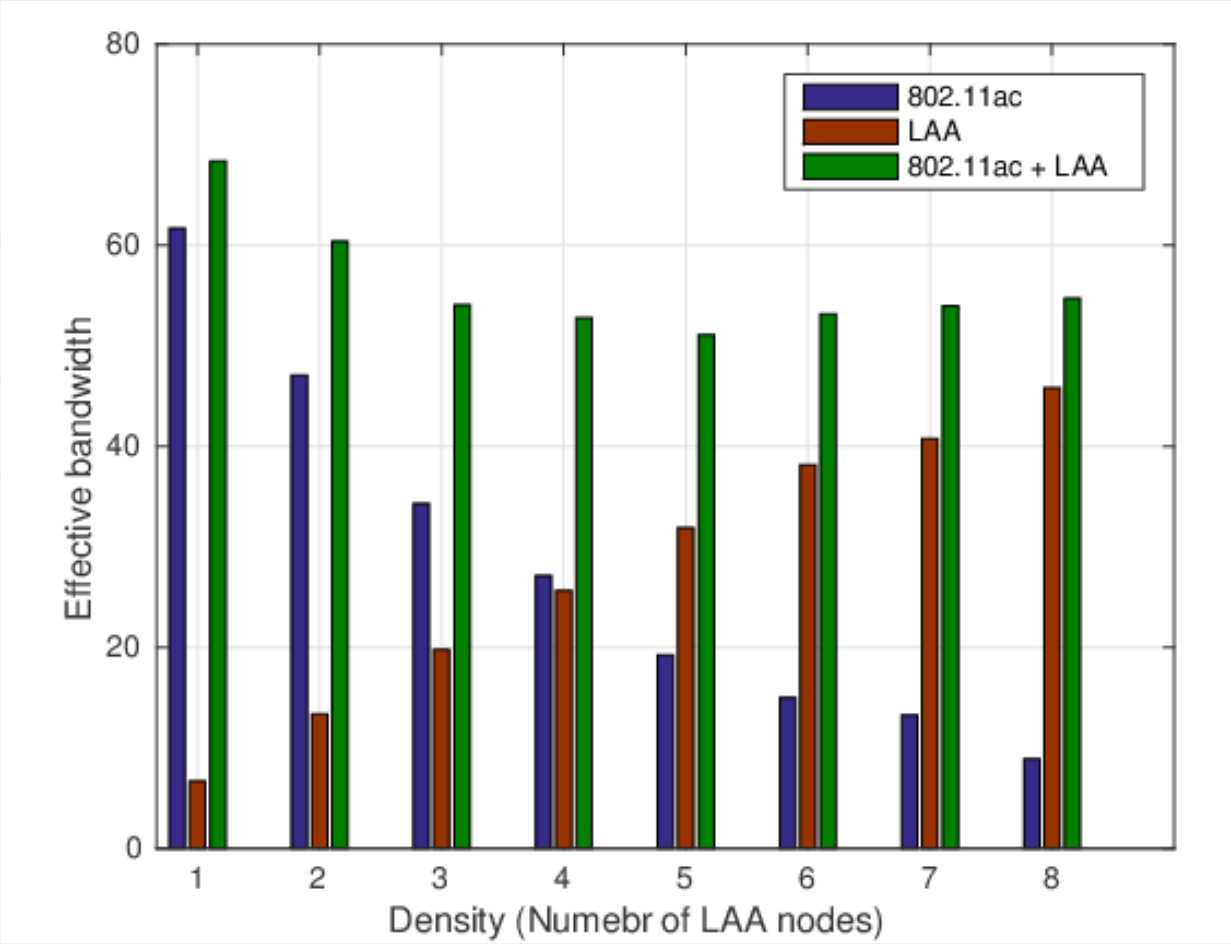
✓ Different number of LAA nodes with random channel selection among No. 1 - No. 4



Channel Selection: Simulation (1)

Effective bandwidth for 802.11ac and LAA

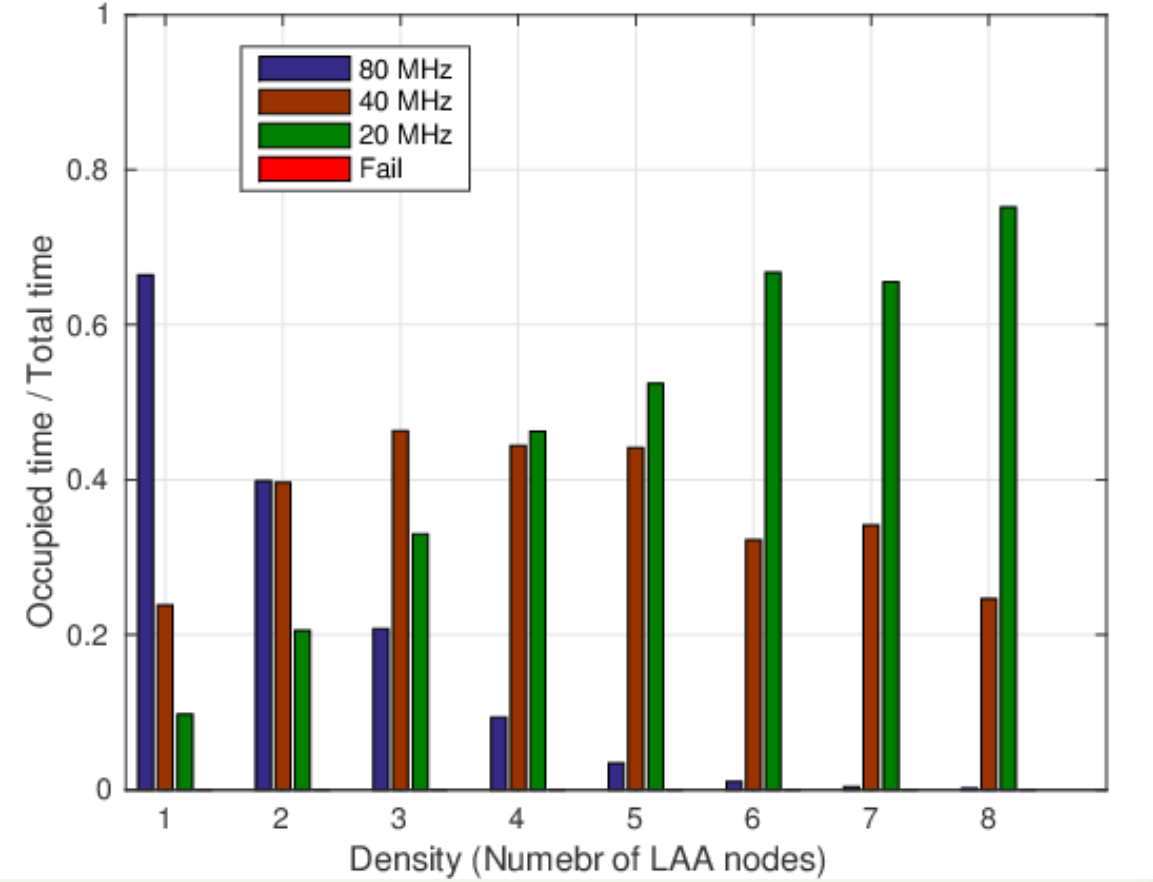
✓ Different number of LAA nodes with random channel selection among No. 1 - No. 4



Channel Selection: Simulation (2)

Percentage of time occupation for 802.11ac

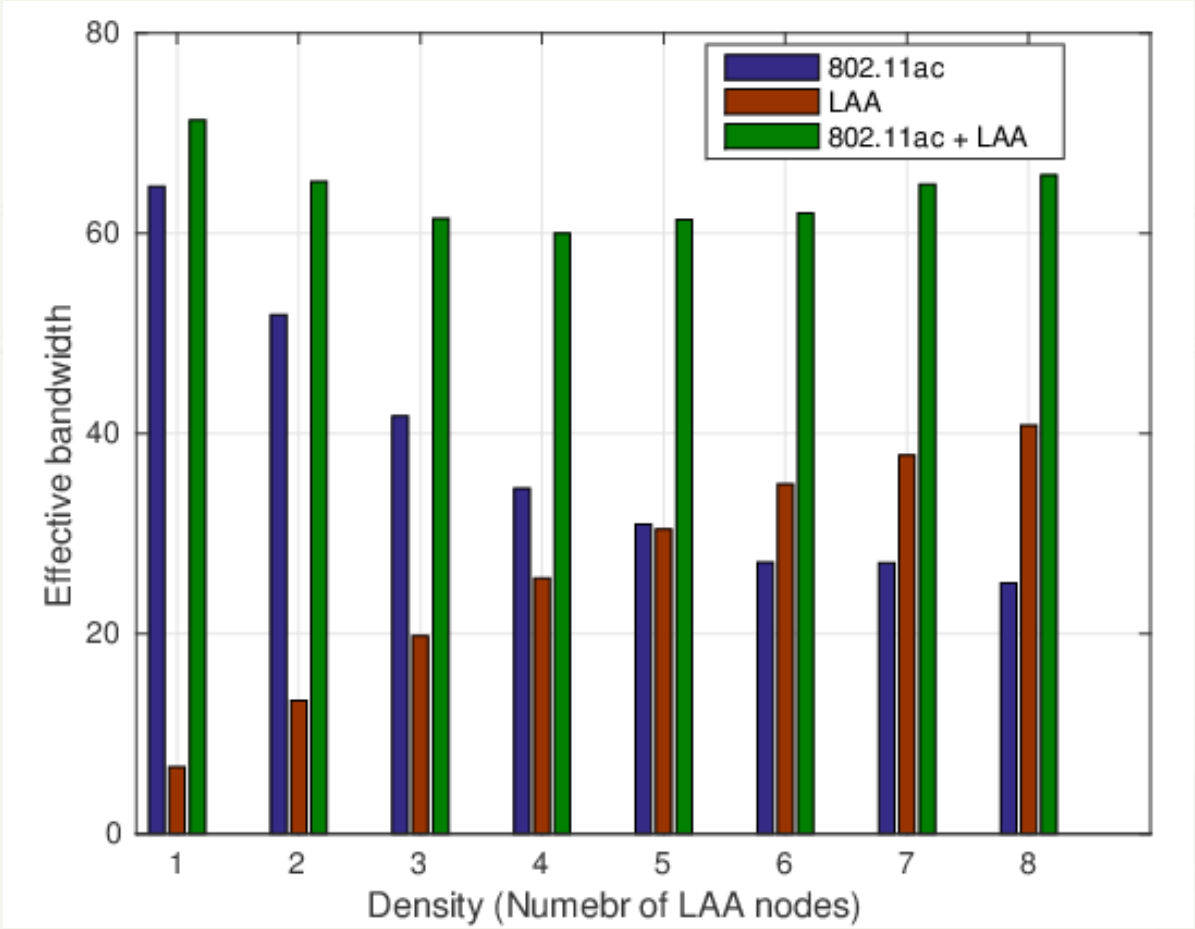
✓ Different number of LAA nodes with random channel selection among No. 2 - No. 4 (No. 1 is the primary channel for AC)



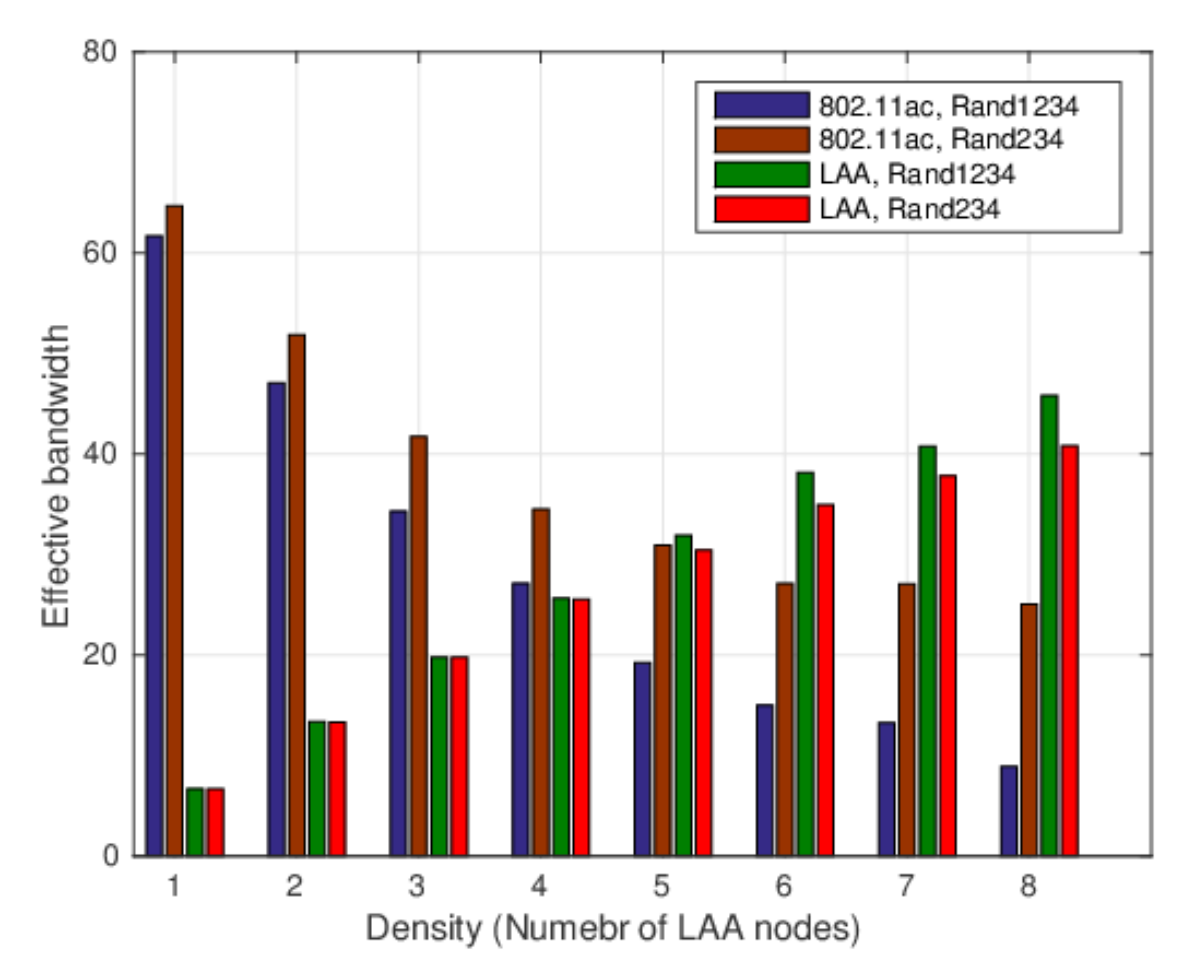
Channel Selection: Simulation (2)

Effective bandwidth for 802.11ac and LAA

✓ Different number of LAA nodes with random channel selection among No. 2 - No. 4 (No. 1 is the primary channel for AC)



Channel Selection: Comparison



- Random selection excluding primary channel has less impact on AC without too much loss in LAA

Channel Bonding for LAA

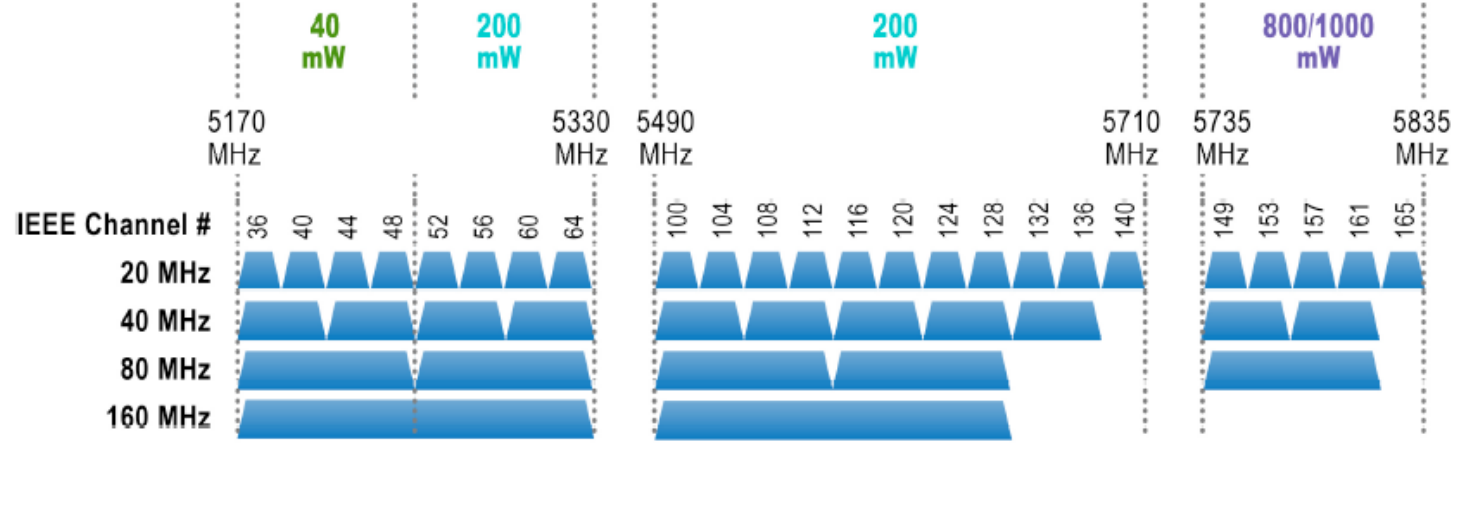
Scenario:

✓One 802.11ac node with dynamic 80/40/20 MHz (Primary channel requires to be included in any bandwidth)

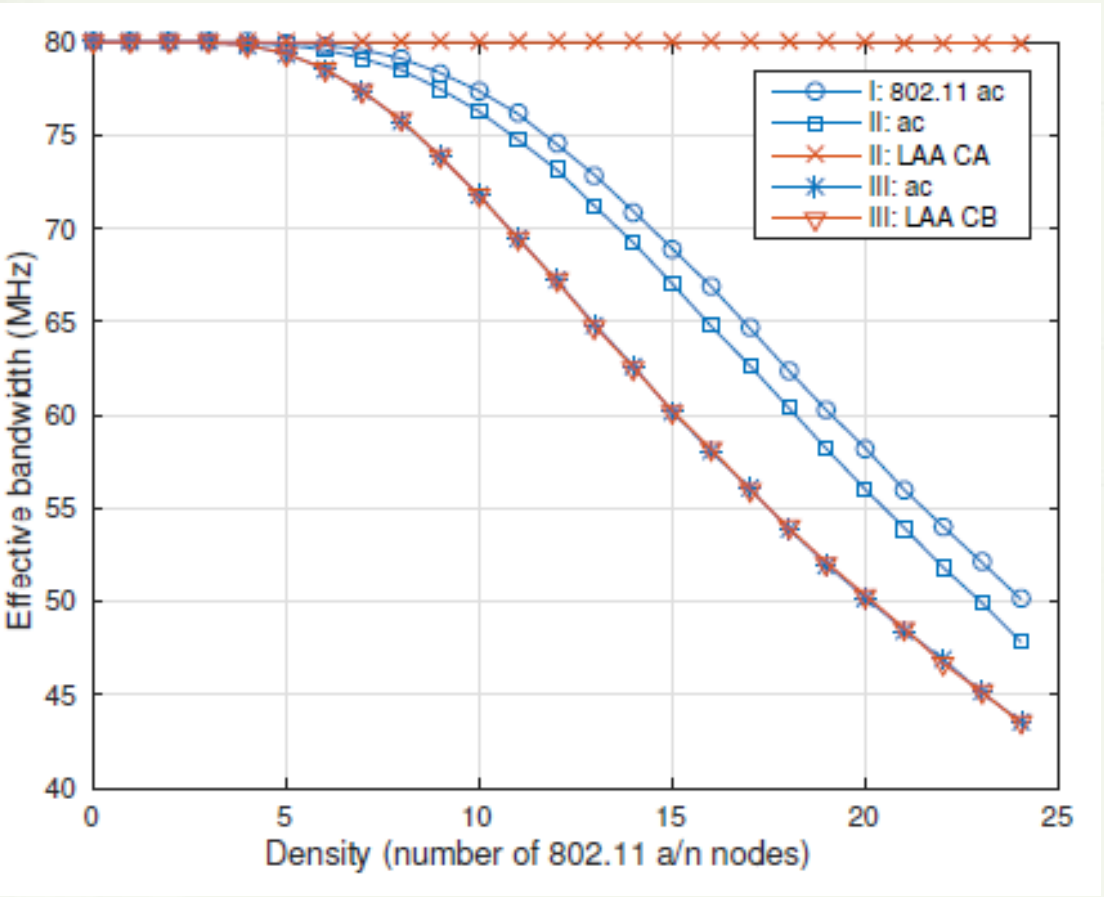
✓24 subchannels

✓One LAA node can work in 80/40/20 MHz using carrier aggregation (can be noncontiguous) or channel bonding (same as WiFi)

✓Different number of 802.11a nodes with fixed load rate of 0.5



Channel Bonding for LAA



- ✓ I: only one 802.11ac node
- ✓ II: one 802.11ac nodeand one LAA node using CA
- ✓ III: one 802.11ac node and one LAA node using CB

- EB of 802.11ac decreases with one more LAA node
- CA is better then CB both for 802.11ac and LAA in this case (due to four more subchannels?).

Next steps

- Consider different locations for 802.11ac and LAA
- Propose some more efficient channel selection algorithms
- Continue to study LAA with CB or CA
- Consider the effect of multi-user beamforming, which leads to less interference